# Arthur Collins

## *Radio Wizard*

Ben W. Stearns


**Orders received by Collins Radio Company in World War II for equipment it had developed transformed the firm from a small to a large business. The highest volume product built during the war was the AN/ART-13, an aircraft communication transmitter equipped with the Collins Autotune automatic frequency tuning device. Above is a copy of an ad run by Collins in late stages of the war to promote aviation radio capabilities.**

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by

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# Table of Contents

# About This Book

To persons who worked directly with Arthur Collins or in the environment he created to carry out his company's projects, the man was a legend. At almost all gatherings of former Collins Radio Company employees, the talk turns to stories about Arthur. Literally hundreds of persons have personal stories to tell from associating with him. The comment often has been made that such stories should be preserved. This book project became an effort to write down some of those stories, relate some major happenings in Arthur's life and his company, and to provide recognition for achievements which many have said Arthur deserved but never sought for himself.

The author is indebted to many persons for contributions to this effort. Special appreciation is extended to George Benning, Rod Blocksome and Myron (Mike) Wilson for their ongoing encouragement and support. Very special thanks are extended for help from Arthur's widow, Mary Collins, until her death in 1998, and others of the Collins family, Alan, David, Michael and Susan.

And the book would not have been possible without the interest and contributions by many former colleagues, employees and acquaintances of Arthur who have provided much information and background. That list, by no means everyone who could be named, includes Willard Anderson, Ed Andrade, John Andrea, Joe Beler, Les Bessemer, Warren Bruene, Tom Campobasso, Chuck Carney, Bob Cattoi, Bob Cox, Morgan Craft, Dennis Day, Vince DeLong, Mel Doelz, George Foerstner, Bob Frost, Don Gallagher, John Giacoletto, Don Hanson, Carl Henrici, Harvey Hop, Bill Hubbard, J.B. Jenkins, Fred Johnson, Vern Jones, Art Kemper, Warren Klehfoth, Elmer Koehn, Ernest Kosek, Terry Lamb, Clayton Lander, Peck Lasho, Gene Marner, Dick May, Joe McCaddon, John McElroy, Bill McKnight, Bob Miedke, Glen Morris, Marvin Moody, Gordon Nicholson, John Nyquist, Roy Olson, Don Palmer, Ernie Pappenfus, Mike Phillips, Roger Pierce, William Quarton, Keith Rathjen, Carl Rollert, Bill Roodhouse, Ray Ruggiero, Don Schmidt, Gene Senti, Roshan Sharma, Bob Samuelson, Milo Soukup, Bill Stewart, Ken Thompson, Kenny Vaughn, Howard Walrath, Bill Weinhardt, Ted Welch, Jim Westcot, Ed Williams, Rolf Wollan and Bob Yaw.

Much other material has been referenced from company publications and annual reports, newspaper accounts and files of Arthur Collins and M.H. Collins donated to the University of Iowa by Mary Collins. Thanks also are extended to Joseph V. Brown and G. Richard Johnson for special assistance, and to Aviation Writers Philip J. Klass and James Holahan for their contributions, and to my family for interest and support.

*Ben Stearns*

# INTRODUCTION
# A Man of Genius

The final week of February, 1987 brought the deaths of three prominent Americans. Two of them, Andy Warhol and David Susskind, were indeed famous: Warhol as perhaps the world's foremost pop artist, and Susskind an accomplished television, film and theatrical producer. Their passing and the contributions they had made to American culture received extensive media coverage at the time.

The third man to die was less widely known, except in select technical circles and the communities where he worked. His death at the age of 77 received scant if any notice in most newspapers and national media. It was major news only in Cedar Rapids, Iowa, Dallas, Texas and Newport Beach, California.

Yet his lifetime achievements will be long felt in terms of their advancement of technology and their impact on activities of millions of people every day.

He was Arthur Andrews Collins, inventor par excellence, a genius in the field of radio communications and builder of a major business enterprise.

He has been compared with the great Guglielmo Marconi in that both men made vast and significant contributions to the advancement of radio. There are many striking parallels in the lives, work habits and personalities of the two men.

Neither Collins or Marconi discovered major new scientific phenomena, but both utilized such findings by others to develop practical equipment.

Marconi is credited with inventing a system of wireless telegraphy, the basis of modern radio. When Arthur Collins came along years later, he made radio work far better than scientists before him had done. He had a unique understanding of the physics of radio waves and the ability to design equipment to more effectively transmit and receive radio signals.

Collins adapted his skills to a wide range of applications in the field of radio communications. Some were truly innovative first-time applications, others were major advances in the state of the art. He was either the inventor or the guiding force in equipment and techniques that made possible the many achievements of himself and his company.

Arthur himself, through his own creativity, can be credited with important roles in several historic events of the twentieth century.

Today the work of Arthur Collins is a factor in the flight of every commercial airliner. No single person has been more responsible for the ability of air transports to fly and land safely in adverse weather and on schedule than Arthur Collins. He and his colleagues developed many of the electronic systems for air-to-ground and air-to-air radio communication and navigation, as well as aircraft instrumentation and flight control. The business he founded in 1931 continues today to be the world leader in designing and producing high performance avionics systems. (Avionics comes from the words aviation and electronics).

Equipment he developed gave America and its Allies a significant edge in many areas of communications capability in World War II, the Korean and Vietnam conflicts and the so-called Cold War. And since that time the Collins company continued to play a major role in communications and avionics equipment for the military and manned spacecraft.

Collins equipment, often out of sight but as essential to communication as an engine is to making a car go, has been part of many historic events of this century. A Collins-built transmitter aboard the U.S. Battleship Missouri enabled the world to hear (in those pre-television times) the Japanese surrender ceremony which ended World War II. Collins transmitters have made thousands of other overseas and Voice of America broadcasts possible. Collins amateur, or ham, radio equipment, for years the unquestioned leader in that field, has been used to summon help in numerous floods, earthquakes and international crises.

The atmosphere of engineering creativity which Arthur Collins fostered in his company led to a long list of technical breakthroughs. Experiments by the company after World War II helped prove that intelligible radio signals could be transmitted through the void of outer space. The firm later made the spacecraft radios by which Americans heard the voices from space of all the Mercury, Gemini and Apollo astronauts, and provided much of the ground antenna equipment to communicate with spacecraft. Collins systems transmitted television of astronauts on the moon.

Arthur Collins revolutionized high frequency (short wave) radio, the primary method of long range communication before satellite relay became possible, and which probably always will be widely used.

His work in high frequency single sideband was a major advance which gave U.S. commanders reliable around-the-world communication with SAC bombers when they were our main defense against Soviet hostility in early days of the Cold War.

He spawned major innovations in commercial broadcasting transmitters and in microwave radio relay systems. He was responsible for breakthroughs in achieving dependable data transmission and for much of the technology marrying computers and communications. He even can be credited with innovations in computers themselves.

Had he been able to continue his company's major development project when he was forced to give up control of the firm, he may well have advanced computer technology and integrated systems management applications by many years. He and his engineers developed and were using data transmission and computer control concepts understood by very few in the 1960s, but which became commonplace with the advent of e-mail and the Internet.

Years after his death, much was touted about the digital revolution and information highway. Arthur Collins saw them coming, and tried diligently to make them happen much sooner than the evolution of such developments. As far back as the 1950s, he was preaching on the digital theme.

Barely out of his teens in the Great Depression years of the early 1930s, he started a company that quickly gained recognition in radio circles for equipment of advanced design and higher quality than anything available to that time.

Still a small enterprise when World War II broke out, by the time the war ended the Collins name had become legend to those servicemen who worked with radio gear used on ships, aircraft, vehicles and in ground stations. Stories of the reliability and performance of Collins-built equipment under the most severe of wartime conditions were widely repeated in radio circles.

The post-war era which followed was a springboard for a literal explosion of technical developments coming out of the Collins Radio Company. Arthur Collins either suggested or was the lead engineer on most of them.

Arthur Collins' company was a fascinating place for the person who combined technical ability with an innovative and curious mind. Activities within his firm were a reflection of more interests than radio communications — cyclotrons, hydrodynamics, aerodynamics, celestial navigation and more.

Growing recognition and soaring sales volume in the late 1950s gave Collins Radio Company a fleeting period as the darling of Wall Street, becoming the most actively traded stock soon after going on the New York Stock Exchange. Some of the company's products were in such demand they literally sold themselves.

Few American companies can match the record of technical "firsts" which Collins laboratories yielded over four decades. Arthur Collins personally was responsible for 20 patents and a co-inventor on nine others, numbers far lower than he could have claimed. Through it all he had an unrelenting fetish for quality in design, manufacture and performance.

Many Collins products, including some of World War II vintage, still operate flawlessly and continue to be in high demand years after being outmoded by more advanced technology. Collins transmitters made in the 1940s and '50s not only remain in use — they often are held up as the standard against which more recent designs are measured.

That devotion to the highest possible quality level kept Arthur Collins firmly opposed to developing and producing an affordable mass production, consumer market product, although he was urged to do so in the interest of profit.

Arthur Collins' philosophy about what was required for his products was simple: if a certain part, component or manufacturing technique needed to meet our standards does not exist, we invent it. At one time the Collins Radio Company had nearly 1,000 products in its inventory which it could build — every one of them an original company design.

There is no doubt, as with almost every major achiever of this world, that the times and circumstances of his life played a major role in what Arthur Collins did. Still, he was the one with the talent, drive and foresight to take advantage of opportunities confronting him and his organization.

Indeed, his singular greatest forte may have been his vision. He had the unique talent to foresee the future trends and capabilities of technology, and how they could be adapted for users of technology. Then, in many instances, he formulated concepts, designed and developed hardware and systems through his company to meet the needs of users. He was admired by his supporters and both envied and despised by his competitors for thinking and doing years ahead of his industry contemporaries.

Arthur Collins surrounded himself with teams of talented persons who could learn from him, who could contribute to common objectives, and from whom he could learn. Only a few of them ever felt they knew him well.

To the majority of his employees, numbering nearly 25,000 at one time, he was regarded as somewhat of a mystery man but a technical genius. In reality he was anything but the inept business manager which some detractors called him, because of the sometimes disappointing financial performance of the company.

There was no doubt in his mind that the company he founded (at its peak equal to a multi-billion-dollar firm in today's dollars) existed to give bent to his technical ability and ambitions.

Unlike many American industries today, the Collins Radio Company of 1931 to 1971 was not afraid of risks. Rather than taking a safe, conservative course which would please Wall Street, the firm continuously risked its future on advancing the state of the art in communications technology, challenges it usually won.

As Collins Radio Company was different in that way from most business enterprises, it differed in other ways as well. Many employed there found it not only a demanding but a fun place to work.

The primary emphasis at Collins Radio Company was always on technical disciplines and achievement. Consequently, it was the professional employee with technical skills and training, the engineer and engineering support person, who was held in the highest regard.

Arthur was not motivated by money, although it was important. Neither was he motivated by esteem or prestige. He demanded creativity, dedication, loyalty, trust and integrity of himself and his employees. He paid them well but not lavishly. He was more concerned about their work environment, the tools and resources they needed to do their jobs, the quality and reliability of the work output.

Thus the main reward for those who stayed with him was fulfillment in their achievements — knowing in most instances they were associated with the best in a given product and a company which was a winner.

*You never had to apologize for being with Collins Radio* was a phrase repeated by many who sold the products.

Arthur Collins was a self-educated, complex, studious, soft-spoken man who often was regarded as an introvert. He shunned interviews and was terribly uncomfortable on those rare occasions when he consented to give a speech. He read extensively with a wide range of interests, but in particular had an insatiable appetite for scientific knowledge.

His true nature was that of a relentless driver of seemingly tireless energy in pursuit of technical goals which often looked impossible to co-workers. But once the goal was reached, he was the first to give credit to his associates for the attainment. Then, it would be on to the next project or projects. One colleague described Arthur as the hardest working person he had ever known, and one who truly loved what he was doing.

He was dedicated to his family as well as his work, and lived by an uncompromising high standard of ethics. He had a well developed sense of humor, which because of his reserved nature was known to only a few colleagues.

He was a patriot of the highest order, with an unyielding concern for United States superiority in military and technical arenas. At the same time, he had great respect for foreign quality and ingenuity, as evident from his fondness for Mercedes automobiles and Japanese electronic products.

Unfortunately, Arthur Collins' career was not a success for as long as he would have liked. His priority concern was technical achievement, which he depended upon to produce necessary profits in a seemingly endless series of races he won more often than he lost.

But in time he was forced by the financial realities of the American business world to give up control of his company. His determination to pursue an ambitious computer development program which was ahead of its time cost more than could be paid from earnings or raised by borrowing. Like some other noted American entrepreneurs, he had traits of stubbornness which did as much to bring him down as his genius and ambition did to build the empire he ruled over.

He often was intolerant of those who disagreed with him, even when they offered sound counsel, which if followed, might have been beneficial.

He may not have been universally loved by those with whom he worked, but few men have been surpassed in the respect he is held for his achievements.

There have been and will be few persons in this world to make as deep a mark in the field of their endeavors as Arthur Collins has done in radio communications and aviation electronics.

The story of Arthur Collins and his Collins Radio Company is both an example of the creativity and ambition which have made the United States great, and how a great innovative enterprise is required to adhere to the bottom line or fail in the American capitalist system.

Ralph Waldo Emerson wrote that an institution is the lengthened shadow of one man.

Arthur Collins left a long and lasting shadow.

This is a story about much of his life and career and the company which was his life. It is a story which could not have included details about him if written during his lifetime. He never would have felt comfortable about it, considering his life to be a private affair.

Arthur rarely reminisced about the past. He always said he wanted to move forward, not look back. Consequently, he left few detailed accounts of events from his perspective.

There is no way this narrative can tell everything that happened or was significant in the life of Arthur Collins, who began achieving as a teen-ager and kept up that pattern until his final days. And certainly it cannot relate everything that happened in his company over 40 years, or the countless stories told about him.

Nor is it possible to name and give due credit to all of the hundreds of innovative and dedicated persons who worked with Arthur and made major contributions to the success of him and his company. Each one of the several hundred, perhaps even a thousand or more, of radios and related equipment developed at Collins Radio Company could have a story written about it. The ideas, inventions and intense efforts of hundreds of creative persons made them possible.

Still, the story deserves telling — that of a rare, inventive genius who built an enterprise to give reality to his creative endeavors, left a legacy of achievements and serves as an inspiration for the technically brave and innovative of generations to come.

# Chapter 1
# TEEN-AGE RADIO WIZARD

It has been said that some critically ill persons, realizing death is near, have appeared to be fully resigned to the inevitable and ready to die calmly, at peace with the world and their God.

While no one can ever know the exact inner thoughts of another being, it is unlikely that Arthur Collins accepted death in that manner.

On the day before his departure from the living of this world, lying in a Dallas hospital with one side paralyzed, barely able to speak or hear, he summoned the strength to tell a long-time colleague, "There are still so many things I need to do."

But a failing body at age 77 could no longer support that brilliant mind and intense dedication to his work. Death occurred February 25, 1987, three weeks after he suffered a stroke, further complicated by pneumonia as he struggled to recover. Even during those three weeks he had a computer brought to his hospital room so that he might try to continue working.

Arthur may or may not have been angry that death was overtaking him. While he always was impatient to solve the problem or complete the project before him, he did not allow anger to distract him more than briefly from tasks at hand.

Since his boyhood years he had the intellect, talent, energy and determination, and for much of that time the means, to create, to develop and convert the complex technical schemes existing in his mind into practical and workable equipment.

Only a highly disciplined, organized, super energetic personality, possessing the drive and leadership ability to fulfill what to many were impossible goals, could have achieved what he did in his lifetime.

His choice of radio over other scientific disciplines that he could have pursued may have been due to a natural talent he had for it. He certainly had great interest and enthusiasm for the field.

It led to the founding of a company which over a span of 40 years would produce waves of inventions and technical advances in radio communication, aviation electronics and data transmission.

He was born into this world with genius in his makeup, and he used that genius fully. From a boyhood interest in radio he built a business enterprise which ranked 196th among the Fortune 500, became the world leader in design and production of aircraft electronics equipment, was one of the nation's most important defense contractors, provided voice communication for astronauts in space and very nearly revolutionized the computer industry.

Just how did it all start?

Like his father, Arthur Andrews Collins was a true entrepreneur and a willing risk taker. Although he researched and calculated his risks with as much depth and knowledge as was possible, he put great dependence upon personal insight. He was a voracious reader, rapidly absorbed new information and had an innate ability to foresee and create new products.

His father, Merle Hunter Collins, or M.H. as he preferred to be called, had been born October 5, 1878 in Orion, Illinois, a small town near Moline. M.H. was the son of The Rev. Josephus and Jane Toinette King Collins. Josephus, of Irish heritage, had been born in Canada in 1844, became a Methodist minister, moved to the United States in 1868 and began serving pastorates in Illinois. He and Jane Toinette King, who had been born in Garnavillo, Iowa, were married in 1876.

The Irish forebears of Josephus, M.H. and Arthur Collins included Matthew Lyon, one of the most contentious and picturesque politicians of the American revolution and early years of the republic. Lyon's relation to Arthur Collins was great, great, great, great, great grandfather. Born in Ireland in 1750, Lyon came to America as an indentured servant at age 14, earned his freedom and fought with Ethan Allen's Green Mountain Boys in the revolution. While disgraced following one questionably shady incident, he later was regarded as a war hero. Lyon founded a town in Vermont and in 1796 was elected to Congress, an outspoken member of the minority Republican party of Thomas Jefferson. He once was attacked on the floor of the House by an opposition congressman wielding a wooden cane, and grabbed fireplace tongs to defend himself. It was one of the most famous fights in the history of Congress, widely caricatured by cartoonists of the time. His opponents had him tried and convicted under the Alien and Sedition Acts. That legislation, regarded as a dark episode in American history, enabled President John Adams to deport or arrest and convict political opponents, notably of French or Irish descent. Lyon served four months in jail, was freed by supporters of Jefferson, and returned to Congress a martyr. He later was credited with casting the deciding vote in the House that made Jefferson the third U.S. president.

The Rev. Josephus Collins was directed by the Methodist hierarchy in 1882 to move with his family to Kansas and serve churches there. One of the churches was at Washington, Kansas. They later moved to Wellington, Kansas, located south of Wichita near the Oklahoma border.

Those were years of the Oklahoma land rush, when white homesteaders could acquire land originally set aside for Indians. Merle, then about 17, and Josephus each obtained homestead plots at Kingfisher, 35 miles northwest of Oklahoma City. They built houses on their plots and moved there in 1896. The houses were still in use as residences 100 years later.

Also in 1896, a new institution for higher education, Kingfisher College, began operating at Kingfisher under auspices of the Congregational Church. Leaving the Methodist clergy, Josephus joined the college administrative staff as treasurer, and served as a trustee. Jane Toinette Collins taught art, drawing and painting at the school. Josephus also was president of the Kingfisher public school board for several years.

Kingfisher College lasted only until 1922, continually hampered by inadequate financing and endowments. It did turn out some outstanding graduates who went on to distinguished careers, including three Rhodes scholars.

M.H. attended the college at least one year, but did not graduate. His sister, Florence, was a 1912 graduate.

M.H. got into the buying and selling of land and the mortgage investment business in Kingfisher. In 1904 he married Faith Andrews at Topeka, Kansas. M.H. knew Faith from days in Washington, Kansas, where the Andrews were members of his father's church. They were wed after she attended Rockford College for Women in Rockford, Illinois and the Oberlin Conservatory in Ohio. She was the daughter of a medical doctor, from a family which traced its roots to Scotland. To this union their only child, Arthur Andrews Collins, was born September 9, 1909 at Kingfisher.

M.H. was described in a family geneology as a man of "driving ambition and remarkable business acumen." His business fortunes reportedly ranged from boom to bust to boom during his career as a young man in Kingfisher. He acquired land holdings in both Kansas and Oklahoma during that period.

His business activities brought an association with Eastern investors, who recognized his abilities. They were instrumental in having him leave Oklahoma to set up a new venture in the fertile agricultural state of Iowa.

In September, 1916 M.H. moved his family to Cedar Rapids and established the Collins Mortgage Company, specializing in farm loans. As the years went by his mortgage business grew and M.H. became a wealthy man. Josephus and Jane came to Cedar Rapids in 1923, the year after Kingfisher College closed, and he joined his son in the mortgage company. Josephus also continued his church affiliation, serving as an assistant pastor of the Cedar Rapids Congregational Church.

But M.H. was to become more involved in agriculture than his financier capacity. He noticed many farms standing idle after mortgage foreclosures.

And, as he observed the farming practices then in common use in Iowa's rich soil, he envisioned methods to increase crop yields by trying out new land utilization and production techniques.

He started acquiring some of those idle farms in 1925, and hiring knowledgeable agricultural men, embarked upon a two-year trial program of implementing revolutionary new farming systems. Based on the success of the initial venture, in 1928 he formed the Collins Farms Company with himself as president and A.G. Thurman vice president and general manager. Thurman had been the first extension director of Linn County, where Cedar Rapids is located. The primary objective of the farms was the efficient production of grain. "Why not produce food on a large scale by intensive farming methods in Iowa, where high yields could be obtained and at a low cost?", a 1930 Collins Farms bulletin stated.

This would be done by bringing a number of contiguous farms in one area together, to make farms of 1,500 to 2,000 acres. The average Iowa farm at that time was about 160 acres. By 1931, the Collins Farms comprised what had been 165 farms totaling nearly 30,000 acres in 39 Iowa counties. Almost all of the tracts were located on hard-surfaced roads to facilitate movement of equipment and harvests.

One acreage associated with the Collins enterprise, near Springville a few miles northeast of Cedar Rapids, had a run-down but solid old wood frame farmhouse on the grounds. It had been built in 1846 by a pioneer couple who raised 11 boys there, called to meals by a dinner bell mounted on the roof of an adjoining shed. Faith Collins was smitten by the place and had it restored and remodeled as a picturesque country home, furnished with antiques. Faith called it *the playhouse.* She and M.H. used it as a summer home, with the country breezes providing pleasant relief from Iowa heat and humidity.

Inevitably, with The Collins Farms being such an ambitious undertaking, some people accused M.H. of using his mortgage company to foreclose on farms he wanted for his venture. M.H. maintained, however, that he only "provided a market for lands forced on the bargain counter" and helped support land values of the period. He claimed that 89 percent of the farms in his company previously had been operated by tenants renting from absentee owners who cared little about the land or whether the renters could make a decent living from their labors. He called the absentee owner-tenant arrangement "a relic of the feudal system," seldom providing for the capital improvements needed to maintain farm productivity. He also noted that many of the farms which he acquired had been sitting idle for extensive periods.

The farms experiment drew its share of criticism, and indeed the Collins farms were resented in some areas. The idea of corporate farming was not popular with independent-minded Iowa farmers. Some complained the Collins Farms were displacing families and pupils needed to keep their one-room schools open. Neighboring farmers also disliked Sunday work done on the Collins properties, including the burning of wheat fields.

M.H.'s methods were indeed revolutionary at the time.

Traditionalists considered him somewhat of a crackpot, while other observers watched with interest to see if his theories would prove out.

Descriptions of the Collins Farms operations were widely reported in Iowa and Midwest newspapers. One writer depicted the operation as similar to Russian collective agriculture.

Compared with farms of a few decades later, most Iowa farms of the late 1920s were inefficient labor-intensive units, used to raise both crops and livestock. A typical crop rotation and harvest was 35 bushels of corn one year and 40 bushels of oats per acre the next year. In M.H.'s view, the system resulted in low crop yields and robbed the soil of nutrients needed for fertility.

His method began with soil replenishment by applying large amounts of powdered limestone and planting sweet clover to restore nitrogen. Another initial step was burying miles of tile to drain wet parts of fields, control drainage and utilize subsoil moisture.

He also introduced mechanization on a scale new at the time in Iowa farming. He brought in large plows, discs, cultivators and planters, removing fences to fully utilize the equipment. The power units were high-speed, lightweight tractors. All machinery was equipped with lights for 24-hour operation during peak planting and harvesting times.

A promotional film produced by The Collins Farms claimed that a single powered cultivation unit could do the same amount of work as 10 men and 20 horses.

There were many instances when the right type of equipment either did not exist or could not be found. In such cases the Collins Farms mechanics, including Ted Saxon and John Dayhoff, put their inventive talents to good use.

Also used were two-row mechanical corn pickers, the latest design available, which could harvest 1,200 bushels of corn a day. Many farmers then still picked corn by hand, hoping to husk 50 bushels a day.

Equipment was moved from farm to farm by semi-trailers, and serviced in the field by mechanics with portable machine shops. Arthur Collins, who worked for his father in the mortgage and farm companies after a year away at college, designed some of the large flat-bed semi-trailers on which farm implements were moved.

Arthur once commented that his period with the farms company *showed me that was not what I wanted to do with my life.*

Harvested crops were stored in large metal silos, another relatively new innovation of the period.

Among crops planted on the Collins Farms were corn, oats, wheat, sweet clover, soybeans, alfalfa, flax and barley. M.H. maintained that winter wheat could be a successful crop in Iowa.

Corn varieties included then new hybrids developed by Henry Wallace, who went on to become vice president of the U.S. from 1941-45. M.H. and Arthur knew Henry Wallace on a first name basis. Collins Farms also produced and processed much of its own hybrid seed corn. Its engineers designed and built the firm's corn driers.

Salaried foremen and farm specialists, many of them agricultural college graduates, supervised the work of tractor operators and other employees on the farm units. M.H. took pride in noting the wages he paid allowed many of the younger men employed by the company to drive new Fords from where they lived to field work sites.

The Collins Farms did achieve some of M.H.'s goals, including low production costs and 85-bushel-per-acre corn yields. During the 1929 crop year, the corn yield for the Collins Farms was 25 percent higher than the state average.

The methods used — soil enrichment, soil conservation, mechanization, crop rotation, diligent analysis of costs, education in new developments and other practices — were forerunners of the type of farming which became the standard in later years.

Whether the Collins Farms project could have become a long-term success was never proven.

Along with many enterprises of that period, the venture became a victim of the Great Depression triggered by the stock market crash of October, 1929. It had required millions of dollars to acquire farms, pay operating costs and finance equipment purchases. M.H. once went into Chicago and placed an order for 150 International Harvester Farmall tractors.

In August of 1931, M.H. projected the farm operations for that calendar year should produce income totaling $100,000. But just a few weeks later, the Collins Farms Company and the Collins Mortgage Company were in deep trouble. The problems soon caused repercussions that shook Cedar Rapids' financial community.

The Collins Mortgage Company long had been associated with Equitable Life Assurance Company of New York, arranging for and selling farm mortgages to the firm. Locally, M.H. had worked with the Cedar Rapids National Bank on many loan transactions, and had a $1.2 million line of credit with the bank.

At that time there also was a widespread practice by many banks of making non-amortized real estate mortgages.

Rumors began to surface that a large Cedar Rapids mortgage firm was having financial problems.

On October 5, 1931, federal bank examiners discovered that the Cedar Rapids National Bank, the city's second largest bank, held some $900,000 thought to be first mortgages but which were actually second mortgages, many of them tied in with the Collins Mortgage Company. The loans represented almost a tenth of the bank's total assets.

Much of the problem apparently resulted from the bank's custom of allowing M.H. to issue mortgages under his line of credit and pay them back at his discretion either when he collected on them or sold them to Equitable. M.H. long had a mutually beneficial and trusting relationship with the Cedar Rapids National Bank. When asked for a reference, bank officers glowingly described M.H. as a highly ethical, competent, knowledgeable businessman.

But with prices for their grain and livestock at rock bottom during the depression, many farmers were unable to make their mortgage payments. M.H. hated to see them lose their farms and often issued second mortgages, which big eastern insurance firms refused to handle, and the local bank was stuck with them.

The chief federal examiner pressed Equitable to advance $810,000 to apply on the mortages, but the bank still faced a large write-off. In addition, there was a run of withdrawals at the bank and its solvency was threatened. The bank's directors faced a traumatic situation — in those days they were held personally responsible for bank losses.

The bank examiners reportedly gave Cedar Rapids National an ultimatum: close or merge, and have it done quickly. After intense negotiations with Cedar Rapids' largest bank, Merchants National, the boards of the two banks agreed on a merger, with Merchants taking over Cedar Rapids National October 29, 1931.

The merger and ensuing court proceedings involving disposition of the farms company left the Collins family at odds with the Merchants bank. Merchants reportedly also refused Arthur Collins' request for a business loan for his fledgling radio company. As a result of those circumstances, the Collins Radio Company, from 1931 to 1971 under Arthur Collins' control and which became Cedar Rapids' largest business firm, never did business with Merchants National, Cedar Rapids' largest bank.

The final fate of the Collins Farms Company eventually was decided in federal courts, after several years of legal actions. Those began in mid-July, 1932 when Equitable filed a $10,000 farm foreclosure suit against the Collins Farms and Mortgage Companies in the Winnebago County, Iowa district court.

The Collins interests responded with a counterclaim asking a judgment of $1,562,637 from Equitable. That was soon followed by a second suit against Equitable for $1,325,568.

In February, 1933 Equitable sued the Collins Farms Company for $3,567,570, and sought foreclosure actions on 29,344 acres of Iowa farm land in 39 counties. Those suits were filed in federal courts in Fort Dodge and Des Moines.

Finally, in February, 1934 the federal court for the northern district of Iowa appointed Don Preussner of Sioux City, a former U.S. marshal, as receiver to take charge of the farms properties and recommend what should be done with them. In time many were sold to individual farm operators to satisfy claims of Equitable, Merchants National Bank and others on the properties. One of the former Collins Farms areas just northeast of Marion was purchased by Cedar Rapids Radio Station WMT as the site for its transmitter building and antenna towers.

Later in 1934 the Equitable Life Assurance Society and M.H. Collins agreed to release each other from all claims which they had filed, thus ending the legal actions between the two parties. A similar agreement followed between M.H. and Merchants National Bank. M.H. also agreed to sign over the Collins Farms and Mortgage Company properties in which he still held interest to Equitable and Merchants National Bank.

Financially, M.H. was not wiped out entirely, but his assets were considerably depleted. He also was the object of hard feelings by many people who lost money from the Collins Farms and Cedar Rapids National Bank failures.

M.H. also had another business that was not part of the Collins Farms and Mortgage Company actions, called the Mississippi Valley Farms Company, a real estate and farms holding firm. That remained in existence until about 1942.

What he did have left, too, was his exceptional organizational ability, which he soon would apply for his remaining years to the radio company started by son Arthur in 1931.

Arthur Collins was born just eight years after Marconi first transmitted a wireless signal across the Atlantic, and three years after the first transmission of a human voice by radio. He was 7 years old when he came to Iowa with his parents. As a youngster he had asthma, which caused him to be less active physically and stay inside rather than be out playing with the other children in the neighborhood. By the time he was 9 he began to show an intense interest and curiosity in the ways communications can be transmitted. From then on he learned as much as he could about electricity and communications technology, be it radio, telegraph or telephone, and built upon that knowledge throughout his life.

Arthur's passion for radio was not initially shared by his parents, but M.H. and Faith soon realized the boy showed exceptional talent for it and gave their full support from then on.

One of his first experiences, Arthur told a company sales meeting in 1962, "consisted of two tin cans connected by binder twine, stretched between my house and a friend's house down the street.

"I can now describe it as an analog system since it, more or less, faithfully transmitted and reproduced voice waveforms," he said.

Arthur also offered some insight into other early learning activities in a letter written in his latter years to a young student.

"Both of my parents always gave me every possible encouragement in my home projects and helped me to meet other boys and men with kindred interests. When we moved to Cedar Rapids there was a grain dealer's office next to my father's office (in the Cedar Rapids National Bank Building, northeast corner of Second Avenue and Third Street SE). When father took me to his office I could hear the click-clack of the telegraph sounders carrying the Chicago Board of Trade quotations in the Wilder Grain Co. office next door. This fascinated me, especially when Mr. Wilder would visit patiently with me for several minutes and then stop briefly to write out in beautifully formed handwriting every quotation that had come over the wire while we had been talking. In response to my curiosity and, I fear, impertinent questions, Mr. Wilder gave me several telegraph keys, sounders and 'gravity' battery electrodes and explained how it all worked.

"Soon there was a telegraph line connecting three boys and a girl on our block on Grande Avenue. We never mastered Morse code but instead used the slower but easier to learn Continental Morse used by the Army Signal Corps.

"To reach out further we all built crystal detector wireless receivers and the telegraph line was chopped up into aerials so we could copy Hank Nemec and Clark Chandler who had spark transmitters across town. Tom Brian across the street got a de Forest 'audion' vacuum tube; on good nights he could receive time signals from NAA (Navy radio station) in Arlington, VA at 9 p.m. so we could all solemnly set our watches to the exact second. More than a dream this was a very real and ever widening new world for all of us."

Bob Yaw, who knew Arthur when both were in their boyhood years, remembered Arthur and the other young scientists could obtain the ingredients for crystal sets from the downtown Cedar Rapids Kresge and Woolworth dime stores in those days, when home radio receivers were just beginning to become popular. Yaw, who became a prominent Cedar Rapids businessman, recalled that radio was not the only boyhood pursuit which occupied Arthur when the Collins family lived at 1725 Grande Avenue SE.

"There were vacant lots around Beaver Avenue and Blake Boulevard where we flew kites. Art had an uncle in Wisconsin who had a venetian blind factory. He would send down basswood strips, and Art used those to make some pretty exotic kites," Yaw recalled.

Arthur's interest in radio grew to building transmitters and receivers that were more advanced than crystal sets. He began to get deeply interested in radio in 1918, but under rules at the time had to wait until 1923, when he was 14, to obtain his amateur radio operator's license. He was assigned the call letters 9CXX.

Of his first transmitter, Arthur said in later years, "I used a Quaker Oats box to wind the tuning coil and used a Model T spark coil." Also part of his early equipment were pieces of coal or coke for rectifiers, glass from towel racks for insulators and copper tubes "which made the set look like a still."

"Other parts of the station were recruited from a rural telephone service. The way we calibrated was to pick up signals from WWV (government radio station in the Wshhington, DC area)," Arthur once told an interviewer.

As Arthur advanced from Johnson Elementary School through McKinley Junior High and into the old Washington High School, radio had become his dominant interest.

The hours he spent at it were such a subject of mystery to his young friends in the neighborhood that Mrs. Collins once invited a group of them in to explain what he was doing. In time his amateur station became a popular gathering place for local hams.

The knowledge which Arthur was acquiring came from whatever sources he could find. Schools taught very little about the still young field of radio in those days. Arthur avidly read periodicals such as QST and Wireless Age and professional engineering journals.

Arthur never was content to just build a transmitter or crystal receiver. He sought to understand the laws of physics and the scientific principles and interactions of every part, material and circuit design that went into a radio, as well as everything he could find out about electricity, radio signals and radio waves. He experimented and tested tirelessly to see what would and would not work. He gained insight into the complexities of wireless communication which allowed him even as a teen-ager to innovate beyond the conventional level of most amateur radio practitioners of that time.

Ernest Kosek, a high school classmate of Arthur's who later became a prominent Cedar Rapids businessman and state legislator, recalled: *When it came to electricity, Art seemed to know everything there was to know about it.*

His parents also helped by arranging for him to attend several "Two-Day Short Courses in Wireless" at what was then Iowa State College in Ames.

When he failed to find an answer from his reading or experimenting, young Arthur sometimes made trips to nearby Iowa City to consult with physics professors at the University of Iowa.

Arthur gained little of his knowledge of radio from high school, where he said the word radio was almost unknown. But he picked up a lot in those formulative years of the mid-1920s from what he called the "campus" of Washington High, located across from Greene Square on Fourth Avenue SE in Cedar Rapids. Writing in later years, he described the old Washington High, built in 1855 and used until 1935, as *a big, stone, castle-like building and a real firetrap* with its wooden floors and stairways.

Arthur recalled study hall periods presided over by an elderly teacher "who was nearly deaf and blind."

That circumstance, he wrote, "allowed students to explore the campus which included the pool hall across the street, George Wilson's Electric Specialty

Manufacturing Company (at the rear of 610 Fourth Avenue) located across the alley from the telephone central office, and the Carnegie Library which strangely held all volumes of the Proceedings of the Institute of Radio Engineers. I was a born loser at pool so I spent study periods at ESCO or reading IRE Proceedings. Wilson's one-man enterprise repaired farmers' mutual telephone switchboards that had been demolished by lightning strokes and other jobs which required the skill of a genius like Wilson. His product line included beautiful brass connector clamps used for splicing steel telephone lines. Wilson taught me to run his ancient South Bend turret lathe and a small bench milling machine. Under a highly informal arrangement, in return for machining a small batch of connectors, I used his tools to make parts for my ham station and to extract needed parts and pieces from ESCO's gold mine one-of-everything stockroom. These study periods were accompanied by well-spiced lectures on the telephone business, past, present and future. Wilson had worked in Chicago at Automatic Electric where the first automatic telephone switches were built; he was truly an expert in his field."

What kind of a student was Arthur, and what grades did he earn?

In his latter years he found his old high school report cards among his mother's papers and remembered that all of his grades were in the high 90s. He said that should lead to a bit of advice for students: Don't assume when high school grades come easy that you do not need to learn how to study. He found out that if he got to class early he could scan a geometry theorem "and see what scheme Euclid used to get down to the QED. When I got to the blackboard a few minutes later I could whiz through the demonstration quickly on my feet before I forgot how to work it out. Later in college I found out that I had to learn to study like everyone else."

Arthur reminisced that his teachers were helpful, "and encouraged our curiosity about a larger world of people and ideas."

He recalled that one of his teachers at McKinley Junior High was Grant Wood, later to achieve great fame as one of America's most outstanding artists. Wood's most famous work, American Gothic, done in 1930, has been the most parodied painting in American art history.

"He realized that most of the students in our class were totally lacking in artistic talent but he made it a fun class nonetheless. One week he brought a scratchy portable phonograph and a large canvas to the classroom. When he showed us his painting we saw a pattern of brightly colored curves which he said were pictures of the sounds he heard in a few well-worn grooves on the record. Grant painted a few more grooves of the symphony for us while we watched and teased him good naturedly. He was showing us how artists can see harmony in the mind's eye," Arthur recalled.

Among Washington High teachers he remembered was Elizabeth Cock, in whose English class Arthur Collins, Paul Engle and Robert Gates were the only students. "She was a demanding teacher," Arthur wrote in later years, "a fascinating and inspiring person who taught Paul Engle how to become a Rhodes scholar and a poet and Gates and Collins how to read great literature."

Engle later became one of America's foremost poets and longtime director of the internationally famous Writers Workshop at the University of Iowa. Gates for many years was a top official of Collins Radio Company, becoming executive vice president of finance and serving on the board of directors.

Another teacher was Eva M. Byerly, who taught Latin, then considered an essential subject for educated persons.

"Miss Byerly was a niece of Dr. Robert Millikan, a Nobel prize-winning physicist who founded the California Institute of Technology. She shared the traits of a high intellect family. In the second and third year Latin classes Arnold Pyle (an artist) and Doug Bennet Sinclair (a brain) and myself were almost the only students remaining. I am afraid we were all poor Latin students but Miss Byerly led us into many discussions of the civilizations of the Middle East, Greece, the Roman Empire, the Middle Ages and the Renaissance," Arthur recalled.

"Grace DeNoon taught geometry and Hilda H. Horn taught botany; both were dedicated teachers. Miss Horn signed our papers with a monogram formed by three vertical and one horizontal pen strokes. In Hilda's classes students cracked a cover glass on a microscope slide only once!", Arthur remembered.

Arthur's grades earned him at least one honor. The Washington High annual of 1927, called the Cedar, listed him as a member of Sophrosyne, the school chapter of the National Honorary Society for scholastic achievement.

While he obviously enjoyed his school courses, it was his hobby of radio that interested him more. From his first transmitter he kept improving on the design of his transmitters and antennas as he learned more about radio, and discovered what would and would not work.

His parents once bought for him a $135 tube (a lot of money in the 1920s) and a high voltage transformer.

Setting up a ham station in the 1920s was not just a matter of ordering ready-made gear, as it did not exist. Amateurs then were primarily experimenters, and to have a working radio they had to buy or make parts to create a set. Most ham rigs resembled Rube Goldberg contraptions rather than neatly constructed radios.

Arthur followed a different path. He diligently researched the principles of radio and functions of parts and materials required for wireless communication. He tested and experimented to obtain optimum and uniform performance. He carefully designed and assembled the parts to provide a neat, efficient unit that produced superior results.

Young Arthur's ham shack was a third-floor room of the colonial style "dream house" which M.H. and Faith had built in 1922 at 514 Fairview Drive in southeast Cedar Rapids. It was a room under a peaked roof, with the ceiling slanting down to walls about five feet high. By the time he was 15, a ceiling area about five by six feet above his transmitter was covered with QSL cards received from other amateurs with whom he had radio contact.

Among his hundreds of cards were many from foreign locations — England, Scotland, Belgium, Puerto Rico, Cuba, Chile, Tahiti, Mexico, Australia and other points.

Based on the vast knowledge of radio he had acquired even in his teen years, Arthur found the upstairs location to be an advantage with the antenna limitations he faced. Unable to erect an antenna tower due to his parents' and neighbors' objections, he had a wire antenna coming from the house at the third floor height and strung across tree branches.

Just how far Arthur Collins' ability and expertise had come by age 15 was soon to be demonstrated when he engaged in radio experiments which were as advanced as what learned university researchers might undertake.

Arthur wrote an account of the experience many years later, starting with the background which led up to it:

"The early physicists, Helmholz and Hertz, first proposed and demonstrated that electromagnetic waves longer than visible light waves obeyed the laws of optics and could be focused in a line-of-sight beam, reflected, etc. just like visible light. Hertz' experiments were done in the centimeter wavelength region now used for radar and satellite communication. Marconi found that if still longer waves were used the waves would be refracted around the curvature of the earth and over the horizon, and even transoceanic communication was possible. When I first became an amateur, scientists had neatly packaged these theories in what was known as the Austin-Cohen radio propagation formula. This formula showed that waves shorter than about 200 meters (higher in frequency than about 1,500 kilohertz) were nearly useless for long distance communication. All naval and commercial wireless stations used wavelengths longer than 500 meters. Our present AM radio band lies between 200 and 500 meters. Accordingly, amateur experimenters were allowed to explore the 'useless' wavelengths shorter than 200 meters. Two other scientists, Kennelly and Heaviside, theorized that the sun's ultraviolet light must ionize the outer atmosphere forming ionized layers that would absorb medium wavelength radio waves and that this would account for the limited range of daytime communication experienced by ships at sea. Only very long wavelengths requiring tremendously high antennas could be used for long distance communication in daylight hours.

"Amateurs had found that short waves became very weak at distances of 100-200 miles as predicted by theory, but surprisingly became strong again at about 1,000 miles. Could it be that short waves were being reflected back earthward by the Kennelly-Heaviside ionized layer? I had been able to contact a fellow ham, John Reinartz, 1QP, in Massachusetts in this way on 80 meters," Arthur wrote.

Reinartz was an electrician by trade and an amateur radio experimenter with little formal technical training. He became well known in amateur radio circles in the early 1920s for his equipment designs described in amateur journals, particularly receivers, and for his work in short wave communications below 200 meters in wavelength.

"John told me that he was planning a test with Ed Willis, 6TS, in Los Angeles in full daylight. This would require a double bounce back from the ionized layer to span 3,000 miles but there was a chance it might work at the short 20 meter wavelength! This seemed like a crazy scheme, but why not try it? I decided to tune my receiver to 20 meters at the scheduled time to see what would happen.

Their signals came through loud and clear, so I scrambled to get my transmitter working on 20 meters overnight and was able to make it a three-way contact the next day. We reasoned the 1QP's and 6TS's signals were making two hops between Massachusetts and California, being reflected twice by the ionized layer and once by the earth's surface near the midpoint. My station 9CXX in Cedar Rapids was about at the midpoint distance from both the east and west coasts, giving me one-hop transmission to 1QP on the east coast and to 6TS on the west coast. Later research done by many people would show that, indeed, this could be the case but that other, more complex propagation modes also existed on short waves.

"Reinartz' crazy scheme caught the attention of the Arctic explorer, Capt. Donald B. MacMillan, and the National Geographic Society. He was asked to sail as the radio operator on the schooner Bowdoin on a voyage to Etah at the northern tip of Greenland the following year (one of MacMillan's many expeditions to the Arctic.) My parents obligingly arranged our spring vacation so that we would be at Wiscasset, Maine when the Bowdoin sailed for Etah (departure was June 20, 1925). I met Reinartz on the Bowdoin and carefully worked out schedules, wavelengths and radio operating plans based on what we had learned about the behavior of 20-meter waves. As we expected and hoped, once the Bowdoin reached about 60 degrees north latitude the Kennelly-Heaviside layer started working for us and we had strong mid-day (not night time) signals both ways every day. My only problem was using my left hand to keep my receiver tuned to Reinartz' frequency which reacted to the Bowdoin's roll in the seas while I copied his CW (continuous wave radio telegraph) signals with my right hand.

"The small Navy vessel, Peary, accompanying the Bowdoin, was equipped with standard long wavelength Navy transmitters, but the small size of its antenna made long wave communication inefficient beyond a few hundred miles range. John Reinartz' success using 20 meter daylight waves on the Arctic expedition was being closely watched by Dr. A. Hoyt Taylor, director of the newly founded Naval Research Laboratory in Anacostia, D.C. Dr. Taylor quickly launched a truly scientific study of short wave propagation that led to adoption of short wave radio by the U.S. Navy. It was my privilege to meet Dr. Taylor many times and he showed me how scientific work is done.

"After copying MacMillan's sometimes lengthy messages on humid Iowa summer days, I would cool off while coasting down hill on my bike to the Western Union office (at 314 Second Avenue SE) to file the dispatches at 'press rate' (collect) to the National Geographic Society in Washington, D.C." (The Geographic was the main sponsor of the MacMillan expedition along with the Navy).

One of the entries in the personal radio log kept by Reinartz on the expedition made reference to Navy aviation operations on the expedition, under the command of Lieutenant Commander Richard E. Byrd, Jr. Plans, well publicized in advance of the voyage, were to have aircraft fly exploratory missions over Arctic areas from a runway constructed of planks on a beach at Etah. The log notation was:

> "August 11 — The three planes off to Ellesmere Island at 10:47 a.m. The NA-3 back at 2:15 p.m., the NA-2 back at 2:30 p.m. and the NA-1 back at 2:44 p.m. They could not land (on Ellesmere) due to fog. Was in radio communication with Washington, D.C. through Cedar Rapids, Iowa and gave notification the instant the planes returned. Newspapers had news within 15 minutes of their return."

Fred Fisher, a school chum of Arthur's and later a Cedar Rapids attorney, recalled being at the Collins home one day at the time he was receiving a message from the Bowdoin.

"Art would type out the MacMillan messages to take them down to the telegraph office. His father had taught him how to type," Fisher said.

For 22 days Arthur was the only operator to be in regular communication with the expedition, working from 8 a.m. to 5 p.m. daily to handle a variety of messages. Those included both personal and official messages and articles for newspapers. The National Geographic both sent and received traffic through Arthur's station.

Thus it happened that the Reinartz' connection, and the ability of two amateur operators to communicate at long distances when the U.S. Navy could not, brought widespread recognition to young Arthur Collins, both locally and across the U.S. (Reinartz eventually did contact Navy ships in the Pacific on the voyage.)

"LOCAL BOY PICKS UP ARCTIC MESSAGE" was the front page banner headline of the August 3, 1925 Cedar Rapids Gazette, a story also distributed nationally by the wire services. The article recounted how "Arthur Collins, 15-year-old radio wizard," had received the message from the MacMillan Arctic expedition about 3 p.m. the day before and conversed in continental code for more than an hour.

A Gazette follow-up feature story August 11 described in detail many of Arthur's achievements in the world of ham radio, with a large photo of Arthur in his home radio station. It was apparent that the interviewer had to draw out from Arthur the information for her story. She called him "a tall, quiet, modest youth of 15."

The story ended with the prophetic observation, that "he hopes to realize great radio ambitions, by and by."

One of those who eventually would help him realize great ambitions was the Navy lieutenant commander on the MacMillan expedition, Richard E. Byrd.

Byrd would be calling upon Arthur Collins a few years later when planning his 1933-34 expedition to the Antarctic.

The technical aspects surrounding the contacts by Reinartz with Collins and other amateur and Navy operators were followed with great interest by the world's radio fraternity. Arthur was generous in sharing the details of his transmitter and antenna designs with radio publications.

At that time Arthur was a junior in high school. As the school year started, he was still in daily contact with Reinartz and the Arctic expedition, which returned to Maine October 12. Classmates recalled Arthur frequently had to cut a class to rush home and maintain his radio schedule.

A year later, when the 1926-27 school year began at Washington High, Arthur would have been a senior, scheduled to be graduated. But he didn't stick around for much of the year, despite being elected to the honor society chapter.

Instead, he enrolled in September, 1926 at Coe College, a small liberal arts school in Cedar Rapids, and during the year completed three courses for 3.6 hours credit.

During Arthur Collins' career as an inventor and business tycoon, it was often mentioned that he never had graduated from college. The fact is that he also never formally graduated from high school because of leaving school in his final year, although he had adequate grades and credit for graduation. The only mentions of him in the 1927 Washington High annual are his membership in Sophrosyne, and in a "Candidates for Hall of Fame" feature typical of school yearbooks. That reference stated the basis of his fame would be radio, his occupation studying, and his ambition, "To be heard in Mars."

In the summer of 1927, Arthur undertook a research project with support from Dr. Taylor of the Naval Research Laboratory in Washington, following up on his keen interest in the MacMillan expedition high frequency radio findings. The trip was part of efforts by Taylor to have the Navy become proficient in shortwave communication, after the embarrassing results for the Navy on the MacMillan Expedition.

Two companions, Paul Engle and Winfield Salisbury, then a University of Iowa student and research assistant who later would serve as director of research at Collins Radio Company, accompanied Arthur on a motor trip to the west coast. They traveled in a vehicle similar to a package delivery van, which had been purchased by M.H. The cargo area of the van had been specially outfitted with radio equipment built by Arthur and Salisbury, including a transmitter and improved model of a super heterodyne receiver, to operate on 20-40 meters with an output power of 10 watts. The unit had special call letters for the trip of 9ZZA.

They made a 7,000-mile trip, leaving Cedar Rapids June 18 and returning July 29. Their route west was through Kansas, Colorado, Utah and on to Long Beach, California, then to San Francisco and Yosemite National Park, Salt Lake City, Estes Park, Colorado and home. Each evening when they stopped they threw a wire antenna over a rock or fence post, and once dangled it over a cliff for their radio operations. Contacts were made from the depths of Death Valley to the top of Pike's Peak. A number of contacts were made with Leo Hruska in Cedar Rapids. Among Arthur's mementos of the trip was a photo of Paul Engle in the buff, diving into a remote western lake. The trip, the boys told a Cedar Rapids Gazette reporter, showed that portable radio has practical possibilities.

While radio was his main interest during his high school years, Arthur tried to pursue at least one other activity which was to be equally important to him and the company which bore his name.

When about 14, he wanted to take flying lessons from Dan Hunter, owner and operator of Cedar Rapids Airways, Inc., a man credited with bringing aviation to Cedar Rapids. Hunter had been a World War I pilot who returned to Cedar Rapids and started his aviation service, which grew to offer flight instruction, joy rides, charter service and carrying air mail. He operated from a field called the Hunter Airport, located in southwest Cedar Rapids on the Iowa City Road, which later became Highway 218. The site could be identified in future years as northeast of Bowling Street SW and U.S. Highway 30.

Arthur did not fly enough to earn a license at that time, which may have been just as well. His mother was very upset with both her son and husband when she learned that Arthur had gone flying with M.H. paying the bill but neither had asked her permission.

In later years, Arthur completed flying lessons and eventually held both single and twin engine licenses.

A family living near the Collins' home had a son attending Amherst College, a school for men only in Amherst, Massachusetts, and M.H. was impressed by what he heard about the institution. He convinced Arthur that it would be a good place for him to further his education, and Arthur was enrolled and attended Amherst during the 1927-28 school year.

Arthur appeared enthusiastic about the college in the beginning, according to a letter dated Amherst, September 23, 1927:

> "Dear Mother:
>
> "The opening chapel exercises were held yesterday and were followed by the Freshman-Sophomore class 'rush.' I was very much impressed by the chapel services and had a lovely time in the gang fight that followed."

He outlined his schedule: mathematics, English, French, Latin, physical education, biblical literature, physics lab two hours a week in the afternoon and chapel every morning at 7:50.

"My math instructor is young and business-like. I am overjoyed with my English instructor. He is very young and came to class carrying a heavy walking stick and wearing knickers and a blazer jacket. He gave a delightful lecture — just my kind! The course is to consist entirely of outside reading and no formal class preparation. He is an extremely interesting teacher. We're going to get along famously.

"I am very glad that I did not go into a frat and that is not sour grapes."

At one point during the year Arthur wrote home to request radio parts be sent to him, which M.H. packed carefully and mailed.

While he stuck it out for one academic year, going back for a second year was a different story. Arthur stayed only a few days, then withdrew and returned to Cedar Rapids where he could continue to "ham" and experiment with radios.

He pursued those interests over the next two to three years, including work on transmitter designs far more advanced than most amateurs of the time could hope to have.

Arthur did not entirely abandon college studies, however, because he took electrical engineering courses at the University of Iowa.

Arthur's college experiences were not a case of him disliking school or studying. Throughout his life, he had great respect for persons who had earned engineering and other degrees. But he once told a colleague he often felt that he was spending as much time answering questions from some professors about his knowledge of radio as he did in learning what they could teach him.

He also was involved in his father's business ventures, working with Collins Farms machinery and in jobs with the Collins Mortgage Company. For several years he was listed as treasurer of the mortgage firm. Arthur put his design talents to work in various ways for the Farms Company, including a device which kept track of the time tractor drivers actually operated the machines. But he did not have much interest in the mortgage and farms businesses, preferring to spend his time on radio. He wanted to be independent rather than work for his father.

Also, during the period between his school years and when he began his first company, Arthur became married. The bride was Margaret (Peg) Van Dyke, who had graduated from Washington High in 1926. She and Arthur had dated after meeting in a young people's group at the First Presbyterian Church of Cedar Rapids.

The wedding took place on Saturday morning, January 4, 1930, at the home of the bride's mother on Mount Vernon Avenue. Peg was a young lady of considerable artistic talent. Her brother, Jack Van Dyke, was a noted Iowa artist. Their first residence was in the Commodore Apartments on Second Avenue at 14th Street.

In November of 1931 Arthur began building transmitters for other hams in the home which he and Peg soon occupied, 1620 Sixth Avenue SE. It had been the residence of his grandparents. His grandfather, Josephus Collins, had died in 1928 at age 84. His grandmother died in 1931 at age 76.

Arthur and Peg lived on the second floor, except for using the kitchen on the main floor. The office was in the living room, the supply room in a back bedroom, and the factory was in the basement.

At first the company was called Arthur Collins, Radio Laboratories, Inc. In a letter dated November 17, 1931 to Herbert Hollister, a Merriam, Kansas crystal grinder, Arthur said in part:

> "I have organized a little company and we are planning to manufacture and sell a small crystal controlled transmitter kit."

The business was described as a "sole proprietorship" company. Asked in later years how the business got started, Arthur replied that as long as he had to do something to make a living, he decided to work at what he knew about and liked. Much of the business start-up financing came from a $10,000 trust which M.H. had set up for his son. It was about the last of the family money remaining at the time, and they agreed Arthur's radio talents would be a good investment.

Arthur began running ads in QST magazine which listed the company name as Collins Radio Transmitters or Arthur A. Collins, Radio Laboratories, Inc., W9CXX. The 1932 Cedar Rapids City Directory listed the firm as Collins Radio Laboratories.

One of his QST ads was captioned, "Collins Crystal Transmitters.....Units from $33.95 up with carrier powers of 30 to 300 watts." Another was for Crystal Transmitters ranging from $37.25 to $47.50, "the smoothest, neatest little rig you ever saw — and what a kick she has! Complete kits, less tubes, crystal and power supply."

Arthur had part-time help in those first days of the company from Leo Hruska and Roy Harrington, fellow hams. Clair Miller became an employee in June, 1932, working on radios and doubling as a salesman. He remembered that Arthur had sold one or two kits to that time, and that he had the chassis made by the LeFebure Company of Cedar Rapids. Arthur was still doing not only the design but much of the other work on the transmitters, including assembly, testing, painting and shipping.

A part of his business and income came from selling radio parts to other amateur operators and even broadcast station engineers.

M.H. Collins' troubles with the impact of the depression on his Collins Farms were mounting in 1931-32, and Arthur was on his own. Despite the depression, his business was showing moderate growth, even in the face of a continuous financial struggle, both for the company and for Arthur personally.

His small company's product line soon consisted of four basic transmitters. But Arthur had other designs in mind, including equipment for more than the ham radio market, and he needed more people, equipment and space. The business was outgrowing the home, and by early 1933 he rented space in a commercial building.

Two of the first employees were John (Slim) Dayhoff, sheet metal worker, and Ted Saxon, a radio and flying enthusiast, the first Collins machinist. Both men had previously worked with the Collins Farms Company. Dayhoff later was to become a key manufacturing executive of the radio company. Dayhoff once said the first time he ever saw Arthur was at one of the farms when he saw "this young kid" driving his father's Cadillac across a field.

Dayhoff also recalled an incident of the early days in the plant when he and Arthur were putting together a chassis for a new transmitter design. Arthur continued to work late into the night after Dayhoff had gone home. When Dayhoff returned in the morning he was disgusted to find that Arthur, impatient to finish the job, had used his expensive new micrometers as clamps to hold parts of the chassis together.

Thus the Collins Radio Company had its beginning toward what would be an eventful and historic next 40 years under the direction of Arthur Collins.

# Chapter 2
# SURVIVIAL AND GROWTH

America was in the depths of the Great Depression when Arthur Collins, then 23 years old, moved his amateur radio business from his home to a commercial building at 2920 First Avenue NE in Cedar Rapids.

Arthur rented space on the ground floor, actually the basement. Most of the building was occupied by Metropolitan Supply Co., a school supplies manufacturer, and an associated printing-lithography firm, Pioneer Litho Co.

By early 1933 the fledgling Collins Radio Company was becoming well known to more and more people working with radio, professionals as well as amateurs. That came about from advertising and articles in radio magazines, from Arthur's contacts with other hams through the airwaves and at ham gatherings, and most of all by word of mouth as customers and radio buffs told one another about Arthur's superb transmitters.

In February of that year Arthur published the first issue of the Collins Signal, initially a bulletin and in later years a magazine which described various company products and applications. The first issue reviewed features of the 20B transmitter and contained an item about the Collins factory and laboratory now being located in new, modern quarters on U.S. Highway 161, easily accessible to out of town visitors.

Arthur had realized that amateur radio alone offered a limited market. There were only about 30,000 U.S. hams in those days, and Arthur's equipment was aimed at the top level of that market — a relatively small number who wanted the best and could afford it. He would have to move into more lucrative markets in order to realize sufficient sales volume and profits for his company to survive and grow.

Arthur's business at first was not a financial success. The firm lost $4,188 in 1932 and $729 in 1933.

He and his wife Peg had problems making ends meet. In their first months of marriage, they fell behind in rent payments at the Commonwealth Apartments. After moving to the Sixth Avenue house he had to pay rent to his father, and more than once was late in paying. He felt it was necessary for business purposes to have a membership at the Cedar Rapids Country Club, and sometimes had trouble paying the monthly tab and dues on time.

One field which offered the opportunity of an increased level of income and profits was commercial broadcasting. His equipment also would be used soon for a number of commercial and government applications.

Sales of Collins products began to create a few job openings. By September 9, 1933, when Arthur incorporated his company, he had eight employees. Collins

Radio Company, Inc. began with $29,000 in capital and 250 shares of stock. One share each was issued to Arthur and his father, M.H. Collins, and 124 shares each to Arthur's wife, Margaret, and his mother, Faith Andrews Collins.

Arthur was president and M.H. vice president of the company. With the Collins Farms now being dispersed by the courts, M.H. gave much of his time to the radio business.

While those first employees jumped at the chance to have a job of any type when millions across the country were out of work, they soon realized the young firm was an unusual and different company. Their work definitely was not routine factory production.

Radio is a science of utilizing various electromagnetic waves in the atmosphere to transmit signals which travel at the speed of light. How well this is done depends upon the knowledge, techniques and equipment used to generate and receive the signals. The design of the equipment is the most important factor of all.

Arthur once said, in a talk to a radio engineering group, that people should realize it is somewhat of a miracle that radio works at all, given the vast number of components, the complexity of equipment and the atmospheric conditions involved in any radio message. That, he said, was why it was so important to apply imaginative and diligent engineering to radio work.

The activities of Arthur Collins' young company were on "the leading edge" of radio communications technology. That was because of Arthur's knowledge of radio based on his research, experimentation and engineering, and the superior design and performance of his equipment.

Arthur demanded perfection of himself in radio design, and he instilled that characteristic in those who worked with him.

The ability of his equipment was to be demonstrated soon by a major event in the still young field of radio transmission and broadcasting.

Summer 1933 was a time of final preparations for the second expedition of Commander Richard E. Byrd to the Antarctic. By then a world-famous polar explorer, Byrd first became aware of Arthur Collins' radio talents in 1925 when he commanded the naval aviation detachment which accompanied the MacMillan expedition to the Arctic. He had been surprised to learn that the Arthur Collins who was able to communicate on a daily basis with the expedition was still a high school student at the time.

Byrd wanted to attract widespread attention to his 1933-34 expedition in order to raise financial support for that and future Antarctic journeys. He saw an opportunity in the capabilities of radio, combining short wave transmission from the Antarctic and commercial broadcasting in the U.S.

Byrd previously had utilized amateur radio in his 1928 and 1930 expeditions to the Antarctic, but not broadcasting.

He was able to convince top officials of the Columbia Broadcasting System of the feasibility and public relations value of his plan. After a detailed technical study by Dr. T.S. McCaleb of Harvard University, communications director for the expedition, and E.K. Cohan, technical director of CBS, the network was sufficiently confident to schedule weekly live broadcasts from the expedition, and sold sponsorship of the programs to General Foods Corp.

Voice transmission from the Antarctic to be heard on home radios in the United States was a daring and innovative broadcast engineering achievement for the time. The plan was risky, due to the uncertainties of short wave radio in those days, in attempting live broadcasts on a scheduled basis from a remote part of the world. The sponsors took "a sporting chance," Byrd would write later, when he persuaded them that the plan and equipment he had chosen would work.

It would involve a 10,000-mile radio-telephone circuit, with a two-hop radio relay transmission from Byrd's base at Little America to Buenos Aires, then on to Long Island. Telephone wire lines provided the link from the Long Island receiver to CBS studios in New York, and to radio stations across the country. In the event that atmospheric conditions were unsuitable for clear transmission on the Atlantic route, plans called for an alternate radio relay via Honolulu and San Francisco.

Byrd wanted the short wave transmitter which would play the key role in the daring scheme to be provided by Arthur Collins. Arthur loaned three transmitters to Byrd for the Antarctic venture.

The main equipment was the 20B, a refrigerator-sized cabinet. It was a standard product in the Collins line of transmitters, but custom made to fit the needs of users. The Collins Signal described the 20B as "designed primarily as a broadcast transmitter although it has found application for amateur use where it was desired to obtain the maximum possible modulated output with the limitation of one kilowatt input which is placed upon amateur transmitters. It is a broadcast transmitter which may be used by an amateur to fulfill his dream of an outfit with which he can sit down and talk, by means of either code or voice, with almost any station in any part of the world which it is possible to hear."

One of the real gambles of the Byrd scheme was in using a 1,000-watt transmitter. Most transoceanic radio telephone transmissions at the time required transmitters generating as much as 40,000 to 50,000 watts of power for consistent communications.

Also part of the Collins package were two 100-watt 150B transmitters and associated equipment for communication between different camps of the expedition. One of the 150Bs was used to drive the 20B.

The 20B designed by Arthur employed a technique known as Class B high level modulation, which later became a widely used standard in the radio industry.

An article in the October 1, 1933 Cedar Rapids Gazette reported:

> "When Commander Richard E. Byrd and members of his South Pole-bound crew tell the world about their experiences in the icy wastes, the home folks sitting in their overstuffed chairs around their radios can thank the Collins Radio Company, 2920 First Avenue NE, for the thrill of listening in on talks broadcast from the bottom of the world.

"This firm has made for Byrd the first radio telephone (voice) transmitter ever taken on an expedition. Previous expeditions used only radio telegraph."

The article stated that Collins had shipped the equipment to Boston where it would be put aboard Byrd's flagship, The Jacob Ruppert, for the voyage to the Antarctic.

Arthur Collins said the 1,000-watt transmitter was chosen because it would use a minimum amount of electricity from Little America's relatively small generators, powered by engines dependent upon the expedition's limited gasoline supply. He said Byrd planned to have a directional antenna set up at Little America, pointing back to the U.S. The antenna was expected to increase the effectiveness of the transmissions to 10,000 to 15,000 watts.

The Jacob Ruppert sailed from Boston October 11, 1933. Two broadcasts over CBS were made from the ship November 11 and November 25 enroute to Antarctica.

Arthur Collins revealed a radiogram from Byrd after the second shipboard broadcast, which stated:

"Your 20B transmitter has been operating excellently for our broadcasts. At our present location 6,000 miles from New York, with good atmospheric conditions, signals are received well in New York and San Francisco. The performance of the transmitter has left little to be desired."

On reaching Antarctica, equipment was unloaded, partially dismantled, moved inland to the Little America base and set up by the four-man radio staff. The Antarctic coast was actually an ice barrier. The main base was several hundred miles inland. The mode of transportation to reach the base was primarily dog sleds.

On Saturday night, February 3, 1934, Byrd made the first of his live broadcasts from the Antarctic to the U.S.

A story in the New York Times the following morning reported:

"Speaking from the mess hall of Little America, in Antarctica, while a blizzard raged outside, Rear Admiral Richard E. Byrd made an address last night that was carried by radio to a dinner of the Washington Board of Trade in Washington, D.C.

"His voice, which also was carried over a national broadcasting network, was heard as clearly as though he were speaking from a broadcasting studio. He described the difficulties encountered by his men in transporting food supplies from the ship to the base and the dangers they faced in fortifying the base against the approaching Antarctic winter.

"The broadcast represented the first test of Station KFC, which was moved from the ship last week and established temporarily in a tent outside the mess hall."

The Byrd broadcasts became weekly events over the next several months, heard Saturdays at 10 p.m. Eastern and 9 p.m. Central Standard Time on CBS stations. Broadcasts were opened by the barking of "Mike the Mascot," a Husky sled dog, followed by Byrd's reports on the expedition and sometimes singing by the men.

The Collins equipment served not only for broadcasts, it also was the expedition's only link with the outside world, and was used regularly by Byrd and his men for communication with the homeland.

Byrd also wrote that: "Ours was a very much traveled broadcast studio. First, on the Jacob Ruppert it crossed the Pacific Ocean to New Zealand. It was still on the Ruppert during her adventures in the unknown seas, and it came finally to rest in a small shack under the snows of Little America. Broadcasting would have been easier had the hardy explorers (his crew) been as courageous in front of the microphone as they were in the presence of danger. Knees often shook and voices stammered. There was not among us a single actor, nor did I select my men for their singing or other musical ability. We simply tried to tell of adventure in the making, and we are grateful to the millions who listened in."

The Byrd broadcasts were a tremendous success, both in the technical achievement and in that millions of Americans heard the programs from the bottom of the world. The Collins Signal magazine hailed the project as *One of the most ambitious feats of radio communication which has ever been attempted.*

Word spread quickly through radio circles about the transmissions from the Antarctic. Amateur operators could listen in directly on their short wave receivers, and some had two-way contacts with the Byrd radio crew.

One of the first hams in Cedar Rapids to pick up the Byrd station, besides Arthur Collins, was a young man named Bert Puckett. He was then an announcer for radio station KWCR, located in the Montrose Hotel. Arthur knew Puckett as a fellow ham and had helped him with his amateur gear. A few years later, after KWCR was merged into WMT, Puckett began broadcasting home games of the Cedar Rapids minor league baseball team. At first he was not allowed in the stadium because of objections by the Des Moines Register to the presence of a radio broadcaster, so he did his play-by-play from the roof of a building across the street. His ability as a sportscaster brought him an offer to work for a larger station in Indianapolis. From there he moved to Chicago, where he became famous as Bert Wilson, for many years the radio voice of the Chicago Cubs.

The success of the Byrd Expedition equipment brought wide reaching recognition for Collins Radio Company. By phone, mail and visits to his office, Arthur received a growing number of inquiries and orders. Some were coming from remote locations such as the Caribbean, Central and South America, Africa and Asia.

The extent that Collins products were being used and praised by their owners was noted in the July, 1934 edition of the Signal. Hams in New Jersey, Pennsylvania, Mexico City and Hawaii wrote to tell of contacts with other amateurs in dozens of countries thousands of miles away, with sharp, clear signals.

A U.S. Coast Guard cutter, The Northland, was equipped with a 20B transmitter identical to that on the Byrd Expedition, and it was used to provide a CBS radio broadcast heard nationwide in May, 1934. The broadcast as the vessel sailed north from Seattle described the ship's annual spring voyage to Alaska to provide medical, dental, legal and other services for Indians and Eskimos.

Also in early 1934, a Collins transmitter was flown into Coeur d'Alene, Idaho to provide the only communication with the outside world for a large area inundated by floods.

The spectacular success of the Byrd Expedition transmissions led CBS to try another major achievement in the annals of radio in mid-1934, all of it depending upon equipment designed and built by Arthur Collins.

Another 20B transmitter was installed at a temporary radio station site in northwest Alaska. On July 11, in a CBS broadcast at 9 p.m. Central time, the North and South polar areas were linked by radiotelephone for the first time. Bob Flagler, a CBS engineer-announcer in Alaska, talked for about six minutes with members of the Byrd expedition in the Antarctic and described the event to radio listeners, telling of the obstacles faced in short wave transmission over such distances and conditions. The broadcast was cut short, however, when electrical and magnetic interference drowned out the voices of the Antarctic participants.

Employees of early years at Collins remembered some unusual customers and orders, which posed tricky problems for a small Midwest company to handle. One order was from the Maharajah of Mysore in India. He bought a 100-watt 45A transmitter to accompany him on tiger hunts. While he rode on the back of an elephant, the 45A and a battery-operated power supply were mounted on improvised shock mounts in a bullock cart. The 45A was used to communicate with his four wives. They could listen to him, but not transmit, on small National Radio receivers which he had Collins supply with the 45A.

Another transmitter order came with detailed shipping instructions from an amateur operator living on a remote rubber plantation in Mozambique on the southeast coast of Africa. The equipment had to be boxed in a water-tight case, which then was sealed in a horse watering tank. The package was sent by rail to New York for trans-shipment by boat. When the cargo ship arrived off the East African coast, the tank was lowered from the boat deck into the water and floated toward the shore with the in-going tide. Plantation workers then pulled the tank onto land with oxen. The radio equipment replaced a telegraph line which natives had cut down in order to make jewelry from the copper wire.

The first government business received by Collins Radio Company was an order to build a dozen transmitters for the U.S. Coast Guard Lighthouse Service, based in Detroit. They were dispersed among lighthouse stations in the Great Lakes, and provided service for many years.

Those transmitters were built at 621 First Avenue SE, a structure known as the Modern Laundry Building, and which also had housed the Troy Laundry. While offices and engineering design work remained at 2920 First Avenue, the Modern Laundry Building was the Collins factory for several years until the site was transformed into the Rapids Chevrolet car dealership in 1936. Collins then moved the factory to a building behind its office location.

The head of the Saudi Arabian government bought a 600A transmitter from Collins, specifying that it have scrambled speech capability.

The Firestone Rubber Company had Collins provide transmitters, receivers and directional antennas for communications between company headquarters in Akron, Ohio and rubber plantations in Liberia, Africa. The receivers had to have remote tuning capability.

The Firestone installations used the Collins 30FXB 100-watt transmitter for continuous wave (code) or radio-telephone (voice) communications. The price for a standard 30FXB with microphone accessories, speech amplifier and antenna matching equipment was about $465.

While Arthur needed people to build and test radios, he also needed engineering help. In early 1934 he was describing Collins Radio Company as "Designers and Manaufacturers of Transmitters, Transformers and Speech Equipment." On April 1, 1934 the first graduate engineer he hired came to work, joining about 16 other employees. He was Robert E. Samuelson, who had met Arthur Collins at a St. Paul hamfest in 1933, and who had a mechanical engineering degree from the University of Minnesota. Samuelson also had studied aeronautical engineering and was working toward a master's degree in electrical engineering when he took a bus to Cedar Rapids, was interviewed and offered a job by Arthur.

The hiring of Bob Samuelson began a characteristic that typified Arthur for the rest of his life and career — surrounding himself with extremely talented, capable and brilliant people who learned from him, taught him and worked with him. They found in his organization opportunity and freedom for technical expression, to whatever extent they wanted to indulge.

The second engineer Arthur hired was Roy Olson, who grew up on a farm near Osage, Iowa and earned his electrical engineering degree from Iowa State College. Olson had known Arthur through ham radio contacts, having come to Cedar Rapids to purchase parts from Arthur for his amateur station. Olson recalled his starting salary was $20 a week.

Arthur also hired several other young engineers in 1934. They included Walter Wirkler, Frank Davis, Roger Pierce and Merrill Smith.

Bob Samuelson recalled that his first assignment at Collins was designing test equipment. Samuelson stayed at Collins just five years (the last position he held in a distinguished career was VP and director of R&D for Motorola's Government Electronics Division), but years later still had a sharp recollection of his experiences. He wrote about some of them in a 1989 article in Electric Radio, a publication devoted to amateur operators and vintage radio equipment.

Collins 20B transmitters, like the one taken on the Byrd Expedition, were in use for short wave broadcasting in Mexico, Venezuela and Colombia. The latter, Samuelson recalls, soon became a big customer.

A border dispute involving a jungle area at the headwaters of the Amazon River had broken out between Colombia and Peru. The dispute intensified to the point where the two countries began preparing for a possible war.

They came to the U.S. for arms, including military airplanes and instructors. Colombia approached Collins about aircraft radios to communicate with bases and between planes. The specifications called for three types of radio systems to equip about 50 airplanes.

Collins got the order without having plans on the drawing board for any of the equipment, or even much experience in the aircraft radio field. It was the largest order for the company to date, totaling $52,677.

One type of radio was for Curtiss Hawk fighter planes, another for Curtiss Falcon observation and attack planes, and the third for transports and bombers — Curtiss Condors, Bellanca Transports and JU33 German Junkers bombers.

Samuelson said that despite studying aeronautical engineering in college and starting to design aircraft radios, he still had never flown in an airplane.

With Arthur's help, an engineering team which included Samuelson, Olson and Wirkler proved equal to the challenge.

There were many technical problems, Samuelson recalled, particularly making the sets as lightweight as possible while retaining strength and rigidity. A number of new and unique approaches, electrically and mechanically, including how to tune radios to the antenna limitations of an airplane, were devised in solving the problems.

One problem was finding the right aluminum alloy for radio cases which could be bent without cracking. Related to that was the matter of welding and soldering the relatively soft and light-weight aluminum. Not a lot was known about that at the time. John (Slim) Dayhoff, who had worked with Arthur and Merle Collins since the Collins farm days, developed the basic techniques to weld aluminum which were used by the company for many years.

With the radios developed, tested and built, in February 1935 Samuelson took three of the units to the Bellanca factory in Delaware for installation in transport aircraft. He recalled that during one ground test, a fabric-covered wing caught fire but the blaze was extinguished quickly with minimal damage. They found that a worker had installed an antenna wire within an inch of an aileron, and when the transmitter was powered up a spark jumped from the antenna wire to the plane surface.

Two months later he traveled to Colombia by ship, train and airplane where he spent the next six months at a jungle air base installing and checking out equipment.

The war between Colombia and Peru never happened, the dispute being settled by a treaty, but the Colombians seemed pleased with the Collins equipment as they soon ordered more radios for Ford tri-motor aircraft.

Collins later adapted commercial product numbers to the three types of radio sets built for Colombia, but had only a few sales of the units.

The Colombia episode, following a transmitter installation in a Goodyear blimp, marked the start for Collins Radio as an avionics supplier, a field in which the company eventually would become the world leader.

After Roy Olson started working at Collins, his first job out of college, he also learned to fly, fulfilling a boyhood dream he had since seeing an airplane soar over his north Iowa farm home. Even before he owned a car he began taking flying lessons, hitchhiking rides to and from the Hunter Airport in southwest Cedar Rapids. After getting his license he took Arthur up for a ride in a three-place Waco biplane, which renewed Arthur's interest in getting his pilot's license.

When he felt he could afford it, Arthur decided to buy an airplane, and placed an order in April, 1936 with the Rearwin Company of Kansas City, Kansas for a Rearwin Sportster, a two-passenger, light cabin monoplane with a 75-horsepower Le Blond engine. It had dual controls with tandem seating. The cost of the airplane was $2,208.83, the purchase made by paying $1,562.25 down and five monthly payments of $107.76 each. The aircraft was covered with red fabric, as were all similar Rearwin models.

Arthur asked Olson to design and build a transmitter for the new airplane, and bought an existing model RCA receiver.

Roy designed a radio different and somewhat more rigid than those the company had supplied to the Colombian Air Force, to transmit on 3105 and 6210 kilocycles. He said it was the first transmitter of its type ever built.

When the Rearwin was ready for delivery in late October, 1936, Arthur, who by now had soloed, had Roy go with him to the factory to install the radio and serve as his check pilot.

Olson recalled that the weather was warm when they went to Kansas City, Kansas, but when they were ready to start home on a Sunday afternoon they learned a cold front and snowstorm were moving toward Cedar Rapids. They borrowed cold weather flight clothing from the aircraft factory and took off.

The new radio proved to be a good unit, with a trailing wire antenna, let out to the appropriate length to match the desired frequency. When they got within range, contact was made with the Civil Aeronautics Administration ground station at Davenport. At one point the station operator asked: "What type of aircraft are you? You have such a strong signal we thought you must be an airliner of some kind." Olson recalled.

As they neared Cedar Rapids, with Olson flying and Arthur operating the radio, they ran into the snow storm about 30 miles southwest of the city. Olson remembered that while Arthur was on the radio talking about a possible landing at Iowa City, he flew on, passing over downtown Cedar Rapids about the height of the tallest buildings, and made a safe landing at the Hunter airfield.

Roy Olson said it was about that time that Arthur decided Collins Radio Company should become the main source for commercial aircraft equipment, because he saw a good markup in building and selling to airlines.

One of Collins early commercial aircraft transmitters was a four-channel set which used relays for changing crystals and frequencies. The company also was supplying ground radio equipment to airlines which included Braniff and American. As the aviation industry began building sleek new all-metal transports, more advanced aircraft radios were needed.

The particular requirement was for radios which would allow the airplane pilot or copilot to make rapid and simple frequency changes. While that could be done fairly easy in home radio receivers, it was far more difficult in aircraft transmitters. They had to be of rugged construction, highly accurate and operable under extreme vibration and wide ranging altitude, temperature and humidity conditions. Parts could not be stamped out as in consumer goods, they required precision machining.

In the early days of radio various schemes were devised for changing frequencies, none as satisfactory as the inventors and the users would have liked. As a result most equipment was limited to no more than three or four frequencies. Changing frequencies was often difficult and time consuming. With many installations, a special operator rather than the pilot had to operate the radio.

Airline ground stations were equipped with several transmitters, each pretuned to a single frequency, to handle different channels needed for communication with aircraft. Transmitters then did not have the capability to permit rapid switching back and forth to different frequencies.

What the airlines wanted was reliable multi-frequency transmitters with as many as 10 channels.

Arthur said he began to think about that problem while he was flying an airplane back to Cedar Rapids from Dallas, where he had been visiting with Frank Dyer, the communications director for Braniff. In later years, Dyer became a vice president of Collins Radio.

*I decided that a new approach was needed and that if somebody could build an extremely reliable set there would be a large market for it. The idea of building a continuously tunable transmitter and shifting frequency by actually mechanically tuning the circuit appealed to me, and on my way back I began to make some mental notes as to how the job could be done*, Arthur said in a 1944 talk to the Collins Radio Technical Association.

In his talk Arthur also digressed briefly as to how people come up with original thoughts. Some of his friends, he said, told him they get their ideas while shaving. He noted that his own solutions to problems usually came while flying or riding in a car. *So far I have never had anyone tell me they were able to get an intelligent idea on a golf course*, he added.

The tuning device which was the objective of Arthur and his engineers was called the Autotune.

During their attempts to come up with a workable model, Arthur was in Dallas again, dining in a restaurant with Tom Braniff, who had founded Braniff Airways in 1930. Braniff told Arthur it was a pain in the neck to have to pay a radio operator to ride along on every flight and do nothing but tune radios. He thought pilots should be able to operate radios. Arthur made some sketches on the tablecloth to show Braniff his Autotune ideas, and when they left he took the tablecloth with him.

Arthur said a main objective was a design which would be more or less universally acceptable to any kind of transmitter.

While he had reasonably concise ideas of how an Autotune unit should be built, at no time did he have very much to do with the actual engineering of any of the models, Arthur said. He gave credit for that to Bob Samuelson, Don Holmes, Frank Davis, John Giacoletto, Roy Olson, Roger Pierce *and others.*

Arthur recalled that when development of the Autotune began, the company was very poorly equipped in facilities and experience to undertake such a program. The only machine tool the company had was *a broken down 16-inch South Bend lathe.*

*It was obvious that we needed some new equipment and probably some new talent before we could get very far with this project. I went over to Ohio State and hired Pete Morrison, then an assistant professor in the mechanical engineering department. Pete looked to me like the sort of fellow who could do a nice job of building gadgets. Then I sent Pete to Chicago to really splurge himself buying some machine tools. Pete spent a thousand dollars for a second-hand Brown & Sharpe vertical milling machine. He spent another $500 for tools, cutters, collets, etc. and a South Bend workshop lathe.* The equipment was set up in the basement of the former Troy Laundry buiilding.

The Autotune did not come about without great difficulty and ingenuity. Some two years of work, spanning a period from 1935-37, went into it before one was built into a customer's transmitter, a ground station radio.

That first Autotune went to Tropical Radio Telegraph, a Central American communications company. The firm placed an order for a group of ground station transmitters, and decided to have one of them equipped with the Autotune. Arthur said he always felt the gentleman who authorized the purchase more or less wrote off the cost as a contribution to the advance of science, being uncertain if the new device would work. The price per transmitter was in the $1,500 to $2,000 range.

The Autotune was a combination mechanical and electrical device roughly the size of a coffee mug. The principal element was a mechanical system for turning a control shaft driven by a small electric motor and stopping the shaft at any one of 10 predetermined positions. The shaft with the help of a disc clutch activated a series of slotted rings resembling washers mounted on the shaft. They were electrically connected to tuning capacitors and band switches.

The initial Autotune models employed a lead screw which moved a small metal device known as a dog up and down parallel to the main shaft to where it engaged one of the 10 slotted rings. Each ring represented a pre-set frequency or channel. The lead screw was driven by a second tiny electric motor.

A radio operator, after pre-setting the frequencies, could turn a dial on the Autotune or use a remote control to tune the transmitter to the desired frequency within a few seconds.

Considerable difficulty was experienced with the initial design, particularly in engaging a single stop ring, but by trying many different schemes we finally got fairly good results, Arthur said. One remedy was substituting coil springs for clutches.

*Quite a few transmitters were built using the lead screw arrangement and coil springs in place of clutches. The most successful models were the 17Ds, 100-watt transmitters built for Braniff Airways. The 17Ds proved after going through the headache stage to be quite reliable sets. They were the first high powered sets used in an airplane having a power something over 100 watts and they were the first 10-channel aircraft transmitters. The 17D was not particularly dainty, it weighed 60 or 70 pounds, and was built in a rather crude but substantial fashion. One of the 17Ds went through Braniff's only bad crack-up and although the airplane was completely washed out and the 17D was thrown several hundred feet* *clear of the wreck, it was found to be in operating condition after a broken tube was replaced,* Arthur said in his CRTA talk.

Those 17Ds were installed in Braniff DC2 aircraft in early 1937. Pilots liked the new transmitters because of their extra punch and because they could operate them from the cockpit. The radios employed Class B modulation, delivering a much stronger signal with less distortion than other methods in common use at the time. Initially they violated a Civil Aeronautics Administration limit of 50 watts transmitting power for aircraft radios, a rule which Braniff ignored. The rule was soon rescinded and the 17D became one of the first transmitters to receive CAA type approval.

Bob Samuelson recalled that in the first high altitude flight tests with the 17D, the oil in the Autotune's miniature ball bearings congealed from the cold and the mechanism froze up.

"We didn't have a test chamber, so ingenuity had to serve. We packed our test set-up on a big tea cart, wheeled it across the street to the Krebs Dutch Girl ice cream parlor and into their zero cold room, where we could check out various solutions.

"Then Art Collins called Admiral Byrd to find out what kind of oil worked best at the South Pole. Byrd sent us a quart sample (enough for many, many 17Ds) which worked perfectly and solved the frozen bearings problem," Samuelson said.

The extent to which Arthur was involved in his firm's equipment problems in those days is evident from a January, 1938 internal memo. It was written after an inspection trip to check out new 17D-4 transmitters on Douglas DC-3 aircraft Braniff was placing in service between Chicago, Kansas City, Wichita, Oklahoma City, Dallas and Brownsville.

Arthur noted that Braniff was generally pleased with the new 17D-4s, but there still were problems needing correction including:

> "A screw used to secure a grounding lug to the heel of the ASR relay was so long that it displaced the entire relay coil.
>
> "The spline couplings on all the Autotune drive shafts were very sloppy. This condition was serious particularly in respect to the buffer plate tuning control since in all sets I examined the lost motion was sufficient to permit grid current variation of 50 percent due to detuning. These spline couplings will have to be made much more accurately and should fit so that lost motion does not exceed 1/2 dial division and preferably less.
>
> "The width of the insulating segment on the drum switch should be reduced to improve 'selectivity' of lead screw positioning.
>
> "Relay spark suppression condensers, which were omitted due to vibration difficulties, are needed to prevent relay contact trouble.
>
> "Certain wires and cables were not properly wrapped under cable clamps."

The memo also contained instructions to engineers to take specific corrective actions.

Arthur recalled another trip to Kansas City to fix a 10-channel ground station Autotune transmitter. It was an experimental installation for TWA, described by him as *complete with all sorts of bells and whistles and automatic gadgets which it was decided were essential to airline ground station equipment which would be standard throughout their system.*

*I think everything that could go wrong with a piece of radio equipment went wrong with that set in Kansas City. I have always had a suspicion that one of the troubles was that the TWA transmitter received the helpful attention of too many engineers and not enough Ford mechanics,* Arthur said.

With him was Milo Soukup, whose first association with the Collins family was doing yard work for Arthur's parents. He started helping out in the factory in 1934 and soon was employed full-time. After the firm began building Autotunes, Milo supervised their production for many years.

"While I listened to nonsensical advice offered by a TWA engineer, Milo quietly reworked and realigned the transmitter and got it going right," Arthur said.

Arthur recalled that a major design change in the Autotune was made after about the fourth trip to fix problems with the TWA installation.

*Merrill Smith, Frank Davis and myself were driving down to Kansas City in the middle of the night and I decided while we were sailing along through the Missouri brush that there ought to be some easier way of doing the Autotune job than using two motors, which had to stay out of each other's way.*

*We talked over the problem and after we got back to Cedar Rapids, we started the gang out to build the type of Autotune which became the most successful,* Arthur said.

That unit used a single motor to rotate the tuning shaft and also to rotate a cam which actuated pawls, which were used to activate the stop rings. Also introduced was a different type of clutch and improved torque features.

The new and improved version of the Autotune caught the attention of James G. Flynn, Jr., then communications superintendent for American Airlines. Like Frank Dyer of Braniff, Flynn later was to become a Collins Radio executive.

*Jim had the temerity to order substantial quantities of radio sets from us, and in fact placed the first order for the new Autotune equipment when this device was scarcely a gleam in our eye. We built about 200 Autotune transmitters for American's fleet in 1938 and completed the job from back of envelope sketches to finished equipment in about six months. Flynn also ordered various types of ground transmitters,* Arthur once recalled. The order for those 200 American transmitters totaled about $100,000.

The Autotune proved to be one of the most significant developments in the success of Collins Radio Company.

It was a revolutionary step forward for aviation and propelled Collins toward a leading position in aviation communications. It was an example of an original equipment development which enhanced the performance of many products in years that followed. It also was to be a factor in helping bring an Allied victory in World War II.

Looking back on the development of the Autotune in his 1944 talk to CRTA, a time when the Autotune was being widely used, Arthur had this to say:

*As an invention the Autotune is not an outstandingly brilliant idea; in fact it is a very garden variety sort of idea. It makes use more or less of obvious means of performing its function. I don't think anyone could truthfully describe it as being the result of any 'flash of genius.' There have been too many headaches with it to fall in that category. The important lesson to be learned from the Autotune, as I see it, is that either through luck or good judgment we accurately defined the problem and we also set a sufficiently high goal to shoot for in respect to standards of performance and reliability.*

He noted others had developed really ingenious tuning devices, but for specific applications, not a broad based approach to precise tuning.

*What we set out to do was to develop an automatic tuning system which would be to radio communication what automatic dial switching is to telephone communication.*

Arthur said a main lesson from the Autotune project which should be applied to the design of other products was *to employ methods which are capable of giving performance greater than is necessary for the needs of the moment.*

While a number of employees had a hand in developing the Autotune, Arthur Collins was credited with conceiving it and he held the patent on it. Actually, he obtained about 30 patents related to the Autotune and Autotune components from 14 different countries.

In the mid-1930s the Collins company also got into the field of radio transmitters for law enforcement agencies. Both base station and mobile transmitter units for squad cars were designed and installed for a number of customer agencies.

Those included state police radio networks of Iowa, Oregon, Missouri and Ohio; the Cedar Rapids, Iowa City and Davenport, Iowa and Seattle, Washington police departments, and other municipal and county networks in Wisconsin and Illinois. Radios in police cars were relatively new in those days, a circumstance which some criminals apparently failed to realize. Reports filtered in about their effectiveness. An example was a letter from a police officer in Oregon. He wrote to Collins that the radio system enabled lawmen to respond to a bank robbery in time to arrest the suspected robber before he could flee the scene of the crime.

The amount of the initial contract between Collins and the State of Iowa, dated August 10, 1935, was $7,860.96 for a transmitter system. The contract was negotiated by M.H. Collins.

It is interesting to note that equipment designed by Arthur and his engineers often served multiple applications. That was the case with the 202A transmitter sold to the Iowa Police Network. Multiple applications became a characteristic of many Collins products over the years.

Sales literature for the 202A gave a clue to how Collins was advancing the state of the art in transmitter design: "Precise design methods applied to class B and class C amplifiers have made it possible to build a relatively high powered radiophone transmitter using tubes of only moderate plate dissipation. The new criteria indicate the value of high filament emission and of insulation for high plate voltages, and the improved efficiency eliminates the need for large heat dissipating capability. Several types of tubes meeting these requirements are now available, and the Collins Radio Company has developed the 202A transmitter to exploit their possibilities."

The Iowa State Police Network installation included two of the 202A transmitters operating at 400 to 500 watts of power on 1682 kilocycles for statewide coverage from the base station at the Iowa State Fairgrounds in east Des Moines.

The first four 202A transmitters were sold to amateurs. The initial installation was at station W2BSD of George C. Cannon, Rochelle, New York, who had built his station with radio pioneer Lee de Forest in 1916. The week after installing his 202A he made radiophone contacts with stations in Europe, Central and South America.

Equipment from Arthur's company continued to be the choice of various expeditions around the world. Father Bernard R. Hubbard, a Catholic priest and noted Arctic explorer, used a 40-watt 32G transmitter for a 1937 expedition to the far north.

Supplies for an expedition to Sumatra and Borneo involving the Standard Fruit & Steamship Co. of New York City and Frank (Bring 'Em Back Alive) Buck, the noted wild animal collector, included the 150HA transmitter.

A Harvard-MIT-Crufts Laboratory expedition to the steppes of Russia in 1936 for solar eclipse observations included a 45A transmitter. The unit was returned to Collins for overhaul and used on another similar expedition to the South Seas in 1937.

The 45A transmitter also was selected by Sir Hubert Wilkins, noted British aviator and polar explorer, to provide communications during a 1938 Antarctic expedition.

Phillips Lord was a well-known radio personaility who broadcast under the name of Seth Parker. He set off on a world cruise aboard a yacht called the Seth Parker, equipped with the Collins 30DXB transmitter and 7C amplifier equipment.

Collins Radio Company appeared to be doing fairly well in the Great Depression years, with sales of $128,000 for the fiscal year ending July 31, 1934, and more than doubling that figure to $293,000 by July 31, 1935. The Signal Magazine reached 10,000 readers that year.

But special ingenuity was necessary for the young company to survive.

When Arthur Collins launched his firm, one of his most vital needs was a dependable vacuum tube oscillator, a pivotal development in all forms of radio, and later television.

The story that unfolded involving Arthur and his small company and oscillator tubes in the 1930s resulted in one of the key turning points in the history of the American electronics industry.

In the 1920s and early 1930s oscillator tubes were the subject of a bitter court battle between two giants in the annals of radio — Lee de Forest and Edwin Armstrong. Both men had invented a type of oscillator tube. The court fight centered on who could prove he was the first to develop his tube.

The case had vast commercial implications. The winner could dominate not only the oscillator tube business but the entire radio industry through control of tube patent rights.

De Forest was an inventor born in Council Bluffs, Iowa who had engaged in a wide range of business ventures pertaining to wireless telegraph, telephone and other radio-communications activities over the years. Some succeeded for a time, others were disasters. By 1928 what remained of the de Forest enterprises were bankrupt and by 1933 they were in receivership. The assets had been purchased by Radio Corporation of America (RCA).

RCA also held rights to the de Forest patents, under a pool arrangement with firms including AT&T, General Electric and Westinghouse. Westinghouse earlier had gained rights to the tube patents of Armstrong, known as the inventor of the super heterodyne circuit and FM radio.

In 1934 the U.S. Supreme Court made a final ruling in the tube dispute, supporting the de Forest claim that he could document an earlier date than Armstrong as having worked on his oscillator. The date he referred to was August 6, 1912.

RCA and the other companies holding the de Forest patent rights refused to authorize any other companies to reproduce or use tubes based on de Forest's invention for any purpose except building home radio receivers. In that way RCA sought to keep all competitors from producing broadcast, radio telephone and other commercial equipment. That policy created a serious problem for other companies, as there was a limited range of tubes available and the de Forest tube was the preferred choice for a variety of applications.

Soon after Arthur Collins established his company to manufacture transmitters, he applied to RCA for permission to use de Forest tubes, but was turned down.

Emboldened by the Supreme Court ruling, RCA began legal actions against companies it accused of violating the de Forest tube patent rights.

Arthur used de Forest tubes in some of his first radios. But then, anticipating his young company was likely to be sued, and needing another source of tubes, he engaged his Washington patent attorney, John B. Brady, to do a search to determine if other patents existed for a tube suitable for his needs. He needed a patent on which the control period by any individual or company had expired, making it available for general use.

The attorney found that a vacuum tube oscillator had been invented by Dr. Robert H. Goddard, before Goddard became famous as the father of American rocket science. He filed a patent application on it August 1, 1912, making it "prior art" to the August 6, 1912 date cited by de Forest in his court battle with Armstrong.

Goddard developed the tube during advanced studies in physics at Clark University, Worcester, MA, where he had earned a Ph.D. in 1911. He later told Arthur Collins that he built the oscillator as a source of high frequency power to improve the accuracy of his measurements of dielectric materials. Goddard at that time also had a strong interest in wireless radio.

Goddard did further work on his tube in the next year while teaching at Princeton University, but soon turned his efforts toward rocket development, and made no attempt to commercially exploit his tube patent. The Westinghouse Company purchased and held rights to the patent for several years, but by the early 1930s the patent expired, so Goddard's invention could be used without restriction.

Goddard's patent was granted November 2, 1915, while the de Forest device, involving two patents, was not approved by the U.S. Patent Office until September 2, 1924.

Based on the descriptions of the Goddard tube in the patent application, Arthur had some tubes made and initiated a series of experiments to determine if the Goddard design could provide satisfactory performance. The tubes were built by Dr. Al Senauke, who Arthur described as "a genius at a Brooklyn loft making Amperex tubes in the early 30s."

Almost everything the company faced in its early days was a struggle. Such was the case with getting the tubes made. Only after considerable negotiation could Arthur get Amperex to manufacture tubes under the Collins name.

He even investigated but decided against setting up his own tube production facility. While trying to get Amperex to make its tubes, Collins approached Westinghouse about buying a line of oscillator tubes from that firm. Westinghouse was concerned about its patent arrangement with RCA, however, and balked at selling to Collins Radio. A Westinghouse executive told W.J. Barkley, a top assistant to Arthur, that he was concerned the Westinghouse action might drive Collins Radio into building tubes on its own.

The tubes based on the Goddard design and made by Amperex worked great and had a long life, Arthur recalled. "We put them in many broadcast transmitters. WMT in Cedar Rapids used one for over 12,000 hours."

"If I had not found a way to avoid the de Forest patent, Collins Radio would have been strangled at birth," Arthur wrote to a friend in 1973.

In June, 1935, Arthur was confronted with a lawsuit trying to force him out of business.

RCA, along with AT&T, sued Collins in a case involving Arthur's 4A, a 20-watt amateur continuous wave (code) transmitter. RCA at the time already was a very large and powerful corporation, while Collins Radio was just a small business. The suit was filed in the U.S. Federal District Court in Delaware, the state in which Collins Radio Company was incorporated.

While the court suit singled out the 4A, an amateur unit, the real intent of RCA's action may have been to shut Arthur down because he had gotten into the broadcast business. Collins then was small potatoes in the broadcast field, but apparently regarded by RCA as a threat. A widely held view in the communications industry was that David Sarnoff, the legendary head of RCA, had no hesitation in trying to eliminate competition.

RCA claimed the tubes in the 4A had to be infringements of the de Forest patent, that the Goddard patent was not valid, and that the Goddard tube was a totally impractical device for the production of oscillations.

The suit also claimed Collins was infringing on the de Forest patent with a receiver which the small company sold. Collins admitted that it had sold 46 of the receivers, the RME-9D, made by Radio Manufacturing Engineers of Peoria, Illinois, "as a matter of accommodation to customers and without profit," but had discontinued the purchase and sale of receivers before the RCA suit was filed and had no plans to sell more of them.

RCA requested a preliminary injunction against Collins. Arthur then decided to seek the help of Robert Goddard. In late November, 1935, he wrote to Goddard at the ranch near Roswell, New Mexico where Goddard conducted his rocket experiments. He explained his company was in litigation involving the patents, and he would like to meet with Goddard to discuss his early tube work and compare that with the tubes based on the Goddard design. Arthur said it was not his intention to involve Goddard in the litigation.

Until then Goddard had no awareness that his tube design of years before was being used commercially.

On December 31, 1935, Arthur and Mrs. Collins first met Goddard over breakfast in St. Louis, where the rocket scientist was attending a Meteorological Society meeting. Also at the meeting was William H. Barkley, who had recently joined Collins as an executive vice president.

After several more contacts by mail Goddard wrote to Arthur, "I would like very much to have an outline from you as to what you would like to have me do."

Before much else transpired in the relationship with Robert Goddard, two court decisions were handed down against Collins Radio Company.

On March 4, 1936, Judge John P. Nields of the Federal District Court of Delaware ordered a preliminary injunction be placed against Collins in the suit brought by RCA and AT&T involving the 4A transmitter.

In a letter to Goddard dated April 1, 1936 Arthur referred to the March 4 court opinions. He noted the court agreed with some of the defense contentions but that not all of the legal arguments advanced by his lawyers were successful.

Arthur also wrote to Goddard: "We have heard through indirect, yet reliable, sources that our opponents are or will shortly make an effort to interview you on the subject of your work and attempt either to draw out statements from you detracting from the importance of your work, or to place you in a position where you cannot testify in our interests....I thought I might mention this so that you could be on your guard.

"The Goddard oscillator has become so important that it is apparent that no means will be spared to prevent its application in the present day radio industry," he wrote.

Goddard responded to Arthur April 3 that he already had been visited by an RCA representative March 23, and that he refused to discuss what the man wanted to have Goddard tell him. He added that he was sending to Massachusetts for his records and early apparatus, if he should have to defend himself. It was apparent that Goddard considered RCA's assertion that his tube design was impractical and unworkable an affront to his integrity as a scientist. He was determined to help Collins. At the same time he did not wish to say anything which would reflect negatively on the achievements of de Forest and Armstrong.

The court's March 4 ruling did not go so far as to force Arthur to shut down. His lawyers quickly filed an appeal, citing use of the Goddard type tube. Arthur also apparently began to phase out the 4A transmitter. The engineering minds of Collins Radio Company made further adjustments with the Goddard tube design in an attempt to prove to the court that a clear distinction existed between that and the de Forest tube.

Deeply involved in that activity was L. Morgan Craft. He had joined Collins in 1935 from Ohio State University, where he was doing advanced studies in communications. Craft had earned bachelor's and master's degrees in electrical engineering from the University of Illinois in 1929-30, then worked two years with Bell Telephone Laboratories before going to Ohio State for additional graduate studies.

In addition to assertions about tubes, RCA had claimed Collins violated what was known as the Rice neutralization or *capacity neutralization* patent. To counter that, Craft then invented inductive neutralization, different than the technique employed in de Forest's crystal oscillator but producing the desired results. Craft and Arthur described the method in a July, 1936 article in QST. It achieved neutralization by coupling the grid and plate coils of a tube by a precise amount.

Another ploy tried by Collins in defending itself was to build some radios with tubes and tube sockets left out and shipped separately from the radios. Instructions were provided to customers on how to install and connect the tubes.

In the spring of 1936 Arthur decided to meet again with Goddard, and flew to Roswell in a rented aircraft. Flying with him as co-pilot was Robert V. Nelson, who had been his flight instructor when he was working toward his pilot's license. Arthur once recalled that because of the rather primitive navigation instruments in those days, primarily a compass, they cut a hole in the bottom of the fuselage which allowed them to see railroad tracks and other landmarks for guidance. They arrived April 26, and after landing found the tires going flat from running over needles of cactus plant seeds blowing across the runway.

Goddard had told Arthur to call him personally when he arrived at Roswell, and not take a taxicab. He suspected cab drivers were being paid by local news reporters to tip them off about his mysterious work and his visitors.

Arthur recalled that "Goddard showed me his two-man shop near his ranch house and a small gasoline and LOX rocket he would launch later from a windmill tower alongside his house. He was doing all his own design and construction on nozzles, steering vanes, gyros, etc.

"Following our visit about oscillators and rockets he and Esther (Mrs. Goddard) drove me into Roswell to visit friends. They had recently discovered a cooling rum drink called a daiquiri. I was duly introduced to daiquiris." Arthur remembered.

The friends of Goddard were Louis and Eunice Falconi, who in turn began a longtime friendship with Arthur. Falconi was a noted amateur radio operator, having received the first Hoover Cup award for the year 1921. That was an award initiated by then Secretary of Commerce Herbert Hoover in recognition of the progress of amateur radio, given to the nation's best all-around amateur station as determined by a panel of judges, with special consideration to home-made equipment.

On the return flight, Arthur and his co-pilot encountered a blinding dust storm and made an unscheduled stop in a cactus patch at Canadian, Texas.

Arthur and Goddard continued to correspond and met at least one more time.

The main tube in question in the dispute with RCA was the Collins Model C-100A.

In October, 1936, RCA filed another suit for a preliminary injunction against Collins, citing the 45A transmitter introduced by Arthur's firm. Again, although the 45A used a Goddard tube design, RCA claimed it was an infringement of the de Forest patent.

Goddard made a deposition on behalf of Collins, but RCA's attorneys and their expert witnesses continued to maintain that his invention could not work.

Unfortunately for Collins, in a decision dated April 20, 1937, Judge Nields ignored all the contentions of Collins and Goddard and ruled in favor of RCA, which immediately secured a tentative injunction against the manufacture of the tube based on Goddard's design. While the judge's decision included reference to the lengthy de Forest-Armstrong dispute which ended up being decided by the Supreme Court, there was no consideration of the Goddard tube being prior art.

The injunction, it turned out, would be in effect for only a brief period.

In order to continue producing radios, Collins then turned to use of a back-up tube which it had built and tested, based on an invention by A.W. Hull of General Electric, on which the patent had expired.

At the same time Collins was being sued, RCA also was suing a radio equipment firm called Heintz & Kaufman, Ltd. of San Francisco for patent infringement. Collins was not aware that Heintz & Kaufman was being sued, nor did Heintz & Kaufman know Collins was the target of an RCA suit. While Collins was a small firm with limited resources, Heintz & Kaufman was associated with the Robert Dollar Steamship Co., a leading Pacific ocean shipping line which had vast assets.

Heintz & Kaufman also had tubes made which were based on the Goddard patent, and used them with great success in ship and shore radios built for the Dollar Company.

President and general manager of Heintz & Kaufman was Ralph M. Heintz, a Stanford University graduate who had 30 years of experience in radio engineering. As part of his defense preparations for the RCA law suit, in addition to citing Goddard's tube as "prior art," Heintz also called attention to two even earlier oscillator developments by a Norwegian, Alfred Sinding-Larsen, and an American, Frederick Vreeland. Heintz also had retained the help of a noted Stanford University physicist, Prof. Frederick Terman. Terman, incidentally, had tried to contact Goddard in New Mexico but Goddard avoided him, thinking Terman was another RCA representative. In years following World War II, Terman headed the Stanford engineering school. In that role, establishing working arrangements for Stanford with industries, he has been referred to as the Father of Silicon Valley.

Heintz got his case transferred from Federal Court in Los Angeles to his firm's home territory of San Francisco. As an exhibit for the trial he had built operable bread board circuits which included duplicates of the Goddard tubes. These were demonstrated in advance to RCA attorneys, used in a transmission from California to the Philippines to show that the Goddard tube worked as claimed. Just before the trial the bread board circuits were taken to the courthouse in a locked cabinet. The key was given to the judge to hold until an appropriate moment of the trial for demonstrating them.

Soon after court opened for the trial, the RCA lawyers asked for a recess. After conferring for a few minutes they withdrew their suit.

Faced with the realization that the Goddard tubes worked, and the possibility of recognition by the courts that the Goddard patent preceded those of de Forest and Armstrong, RCA was forced to end the harassment of firms such as Collins and Heintz & Kaufman.

RCA dropped its suit against Heintz and Kaufman and on February 16, 1938 granted the firm licenses to use its patents.

Collins, meanwhile, had appealed the injunction ruling of April, 1937.

In December of 1938 RCA finally dismissed its suit against Collins, and granted Arthur's firm rights to use devices covered by RCA-held patents.

But that move did not come until intervention by a U.S. senator who went to the New York office of David Sarnoff, the legendary head of RCA. The senator reportedly was a friend of W.J. Barkley, and in a position to influence legislation of interest to Sarnoff.

According to an account related to a friend by M.H. Collins, the senator did not have an appointment when he insisted on seeing Sarnoff. Informed of that fact by Sarnoff's secretary and asked how long he intended to wait, the senator reportedly said, *as long as it takes to get what I want.*

Exactly what the senator said to convince Sarnoff that RCA should grant the license is not recorded, but Collins Radio received a broad license under the RCA patents. Collins had to pay one dollar to RCA for the license privilege.

Arthur had been concerned about his ability to properly compensate Goddard. While Goddard had offered to help Collins at no charge, Arthur persuaded him to accept a payment of $500, which Goddard said would cover the cost of filing for a future patent. Arthur always felt that Goddard was never properly recognized for his contributions to electronics.

Writing to Esther Goddard, widow of Robert Goddard, in 1954, Arthur stated: "It was my impression that Dr. Goddard was unaware of the basic importance of his invention in a commercial sense until I informed him of the relationship of his patent to our litigation. He certainly had a keen appreciation of the implications of his patent from a scientific and engineering standpoint."

Reflecting in later years about the outcome of the patent case which ended RCA's attempt to keep competitors from making anything but home radio receivers, Arthur wrote in a letter to a friend:

"The change in RCA's patent policy, was, perhaps, the turning point for the development and expansion of the American electronics industry generally."

While Collins Radio Company was not the only firm sued, by standing up to RCA, Arthur Collins was regarded in the radio industry as a star player in breaking up the RCA monopoly attempt. Several other small firms had knuckled under and shut down after being sued by RCA.

As a result of the RCA litigation, Collins decided to change its incorporation from Delaware to Iowa in 1937, with a stated capital value of $73,808.30. Each of the original four shareholders, Arthur, his wife, father and mother, received 250 shares of the Iowa corporation.

As business improved gradually in those hard times of the mid-1930s, Arthur continued to add more engineers and other employees.

One of the engineers he hired, but not initially as an engineer, was L.E. (Les) Bessemer, who later would head all Collins manufacturing operations.

Bessemer, a native of Florida, had become interested in radio as a boy and got his ham license in 1927. With money scarce at the time, he was able to get into Georgia Tech in 1930 under the school's co-op program, where students alternated three-month periods of work and school until completing their degree courses. His work periods were spent operating transmitters at a broadcast station in Macon, GA, a job he could have gone to full time after graduation in 1935. But he wanted something more challenging, and sent out a lot of applications. In those Great Depression days, every answer was "no" but one. That was from Arthur Collins who wrote, "We don't have anything right now." Bessemer kept writing to Arthur, even making a trip to Cedar Rapids despite Arthur telling him not to come. When they met, Arthur made no job offer but did question Les about the life of transmitter tubes at his radio station. About three months later after Bessemer continued to write and provide updates on tube performance, Arthur wrote,"Come on up and go to work. I'm tired of answering your damn letters."

Despite his engineering degree, Les was put to work assembling radios, at a salary of fifty cents per hour, less than he made at the radio station.

Head of the factory at the time was Ted Saxon, who had been a mechanic with the Collins Farms. Saxon did not have much background in manufacturing or electronics, but he was a pilot and flight instructor, and Arthur was interested in what Saxon could teach him about flying. Saxon and a brother had a small airfield called the Aviation Country Club at C Avenue and Blairs Ferry Road in northeast Cedar Rapids, a site which in later years would become a Collins plant.

Bessemer was not long in moving ahead within the company, and soon became a foreman. "We were building a little broadcast pre-amplifier, and the shortest time we could ever assemble it was 20 hours. I knew we could do better and I developed an assembly technique which we eventually called ring around the rosy. I tried it out, kept good notes on how I did it, then got a bunch of assembly operators together and showed them the idea — each one putting in a few wires or a part as it came around the table, rather than the old way of each operator assembling an entire unit. We had 25 units to build. It took us two and a half hours apiece to assemble them," Bessemer recalled.

"Art came out in the factory area one day and told me, 'You're now an engineer. But keep your drawing board down at the end of the assembly table because you'll still be a foreman also'," Bessemer said.

M.H. Collins once asked Les to describe what he was working on. After hearing the explanation, M.H. told Bessemer, "Art says you're as full of ideas as a puppy's full of pee."

Another person who was to play a key role in the success of Collins Radio Company was the aforementioned William J. Barkley. He became associated with the company through contacts of M.H. Collins and a friend of Arthur's, Dr. A. Hoyt Taylor, director of the U.S. Naval Research Laboratory. Barkley had an impressive background in radio, having formed a manufacturing company in 1907, supplying equipment to the government during World War I, later working with one of the de Forest companies and with Sylvania.

Soon named a Collins executive vice president and member of the board of directors, Barkley worked out of an office in New York City as the company's only salesman. His primary sales territory was Washington, D.C. and the government offices there, both U.S. and foreign. He maintained apartments in both the Roosevelt Hotel in New York and the Mayflower Hotel in Washington.

Because of his distinguished appearance and bearing, the factory workers referred to him as "Senator Barkley" when they saw him visiting the plant.

Another man joining the Collins staff in 1935 who had major influence with Arthur Collins and the company in years to come was Robert S. (Bob) Gates. He had been a boyhood friend and classmate of Arthur at the old Washington High School in Cedar Rapids.

Gates worked himself through Coe College, graduating in 1931. He held a job with a small firm in Cedar Rapids before casting his lot with Collins Radio. M.H. Collins liked young Bob Gates, and had provided assistance for Gates in his Coe years.

Gates quickly became a first rate business and financial manager for the Collins company. He would be known in later years for his influence in holding down Arthur Collins' spending of large sums on pet projects while still keeping the company solvent.

One longtime employee recalled that, "Art and Gates were very close in the early days, almost like brothers. Gates took care of the money, and everyone had confidence in him."

In the mid-to-late 1930s Arthur was the chief executive and chief engineer, M.H. Collins did most of the administrative work, Gates was the financial manager and did purchasing, and Barkley did much of the selling.

M.H. Collins made a point of going through the factory area every morning. He knew everyone by name, and often visited briefly with employees about their families and other topics.

Arthur usually went into the factory only when he wanted to see or find out about something or to help solve an equipment problem. But he liked to keep on top of things, and would stop to visit with machine operators about the work they were doing.

John Haberle, longtime toolmaker and later a foreman, in an interview for The

History Center of Linn County, remembered the shop people had a radio in the First Avenue building which played night and day, and Arthur once fixed it for them. He later came back and said he was going to fix it again, and that time took it away. The reason was neighbors complained about the noise, with windows kept wide open during the hot summer.

Faith Collins, Arthur's mother, sometimes visited the factory in the evening if a shift happened to be working.

Arthur's wife Peg, until the company got too big, made doughnuts for the entire company work force each Christmas.

Not only the Autotune, but several other technical "firsts" contributed significantly to the company progress in the 1930s.

One was the multi-band high frequency antenna for amateur use, developed in 1935, primarily the work of Morgan Craft. It allowed hams to operate over a wide range of frequencies with a single antenna for the first time. Collins offered seven different models of such antenna systems from $28 to $44 in cost, covering frequencies from 1.7 to 29 megacycles.

The company also became well known in radio circles for the Collins Pi Network. A pi network is a technique of power amplification for matching the electric signal generated within the transmitter to the antenna. Arthur devised a pi network circuit which was unique for his transmitters, another contributing factor to the outstanding quality and performance of his equipment.

The practice of filling unique orders continued through the 1930s. In 1936 Collins installed a 300-watt transmitter in the private railway car of the President of Mexico to allow him to communicate from where he was traveling.

Another Mexican government order was a hand-operated portable power supply, carried on the back of a mule, for Army troops to use with a Collins-built transmitter. Radios also were sold to the Mexican Navy. To handle the Mexican business, a subsidiary known as Collins Radio Company de Mexico was set up, with capital stock of 25,000 pesos, owned by a Mexican radio equipment dealer and his staff.

In the late 1930s concerns about war were growing in Europe with Germany building up its military forces. In Asia, Japan was fighting China and threatening further aggression. Some U.S. military leaders were alarmed but had little funding for new equipment.

Arthur Collins recalled that while airlines were the first important customers for Autotunes, military applications had been kept in mind from the beginning.

The Army was not receptive to Autotune equipment at first, but later became interested.

The Navy, however, liked the idea of being able to shift frequencies quickly. Two Navy pilots who also were radio amateurs had seen and been favorably impressed by Autotune transmitters on commercial aircraft. They happened to land in Cedar Rapids and visited the Collins plant to look over the airline gear.

The two pilots apparently had some influence with a Navy decision to approve a Collins proposal to design and build Autotune-equipped transmitters for use at

Navy bases. It was the company's first Navy contract. The transmitters were the 50-watt TCA, 100-watt TCB and 1,000-watt TCC.

With those projects coming in, Arthur Collins relieved Les Bessemer of his foreman duties and gave him an office to be a full-time design engineer. Les was placed in charge of the 50-watt TCA and 100-watt TCB transmitter projects.

Another engineer headed up development of the 1,000-watt TCC but had difficulty completing the job. With the Navy pressuring the company to deliver, Arthur walked into the engineer's office about 9 one night and told him to pile all the drawings on his desk. He then carried them next door to Bessemer's desk and said, "You're now in charge of the TCC." They finally got it designed, tested and into production.

Bessemer recalled that after the TCA was designed a Navy inspector came in and said, "Boy, who did you guys pay off? You don't have Navy spec parts in that radio — they're all commercial parts." Bessemer said he showed him the specifications approved by the Navy but did not think the inspector believed any of it.

Around 1939-1940, which were times of intense union organizing activity across the nation, the Collins Radio factory force of 200 or so was still all men. Many were licensed hams who had great respect and enthusiasm for the work they were doing. They had formed an organization called the Collins Employees Association. With national unions gaining increasing power and influence during those Roosevelt New Deal years, the Collins production workers began to talk of forming their own local, unaffiliated union to prevent a national union from coming in and organizing the plant.

When word got to Arthur about the movement to organize, he got everyone together. Standing on a table in the factory, he said he did not care if they had a union or not, that he was not for or against it. But he said he did not want any trouble — if there was any trouble he would just close the place. He also said he could not be certain the business would ever grow much larger than it was at the time.

The workers voted to have a union, and the company recognized their bargaining rights.

In the mid-1930s the U.S. was not yet into any meaningful military modernization or expansion. But that would change within a few short years.

Bill Barkley had developed good relationships with many Navy people in Washington. He tried to have Army people as well become aware of the unique capabilities of the small company he represented and its ingenuous founder, and also wanted them to meet Arthur Collins in person.

He finally convinced Arthur to go to Washington and make the rounds of the Army procurement offices which dealt with military communications.

Arthur went reluctantly, a feeling reinforced by his first call. He was forced to cool his heels for an hour or so in the outer office of a one-star general who purchased equipment for the Army Signal Corps. The general typified a group of peacetime officers of the 1930s more concerned with rank and privilege than military preparedness.

When he finally got in to see the general, Arthur found him seated behind his desk, cleaning his fingernails. Arthur introduced himself and explained he had a company building radios in Iowa, which although a small company, did a lot of interesting work and probably could help the Army meet some of its communications needs. He also said he realized some people might consider Iowa still to be a land where Indians roamed the prairies, but it was indeed settled and developed.

The general's reaction was a complete lack of interest. He told Arthur to drop his business card on the desk, and if the Army ever needed anything, they would call him.

Arthur was inwardly infuriated. As he left he told the general that if the Army ever wanted anything from his company, they would have to see the Navy, even though he had done only a small amount of business with the Navy to that time. He also said that while there were few Indians in Iowa, Indians were reputed to have long memories, and he was somewhat like that.

Calling at Navy offices, he received a much friendlier reception, thanks to Barkley's contacts. It was during one of his calls that Navy people told Arthur of their plans to develop a new aircraft transmitter.

However, other Army people appeared to have a greater interest in Collins. Not long after his Washington trip the Chicago District of the Army Signal Corps conducted a survey of Collins Radio, which noted that since its founding, *The facility grew in importance and gradually earned a national and international reputation of the highest order as designers and manufacturers of transmitters, transformers and speech equipment.* The survey report also estimated Collins' production totals for 1937 at about 1,500 transmitters and other equipment units.

Still a further apparent Army reaction to Arthur's encounter with the general occurred soon after the military began to build up inventories due to the threat of war in Europe. Arriving at his office one morning, M.H. Collins was told that a Mr. Smith from the government in Washington was in the lobby, desperately wanting to see Arthur or M.H.

Telling a friend about the incident, M.H. said he decided if the man had come from Washington, he should talk to him. When the visitor met M.H., he introduced himself not as Mr. Smith but a general with the U.S. Army, and apologized for such a ruse to get a top Collins executive's attention. He explained that Army people wanted to know more about Collins equipment, but their letters, telegrams and phone calls were going unanswered.

Whether M.H. made reference to Arthur's earlier experience with the other Army general is not known, but the Signal Corps soon placed an order for 15 transmitters, 500-watt units equipped with Autotunes.

The Collins Radio reputation as a "can do" shop brought the company an equipment order in latter months of the bloody Spanish civil war which went on from 1936-39. It involved the installation of mobile broadcasting and receiving systems in two trucks. One of the big problems was overcoming radio interference from truck ignition noise. There also were language problems between two Spaniards who came to Cedar Rapids with the trucks and Collins people, none of whom spoke Spanish.

When the installation was completed, the trucks went by rail to New York, then to be shipped by boat to the Spanish government. Unfortunately at that stage the war ended with the defeat of government forces by Generalissimo Francisco Franco's nationalist rebels. That caused a quandary for the two Spaniards who did not want to return to Spain, but did leave Cedar Rapids, and reportedly made their way to South America. It also posed difficulties and delays for Collins in collecting for the order from the Spanish embassy.

The decade of the 1930s was a time when Arthur Collins established a company and overcame obstacles to survive and grow. He started with amateur radio and expanded to a variety of other radio equipment for airlines, broadcast stations, government and international customers. In the four years prior to mid-1941 approximately 20 percent of Collins sales were to U.S. government departments and agencies including the Navy, Army, Civil Aviation Administration, Federal Bureau of Investigation and Forestry Service. Approximately 32 percent of products shipped were export sales. Among customers besides airlines and broadcast stations were oil and pipeline companies, fishing fleets, hydroelectric utilities, rubber plantations, exploration expeditions, county and state police agencies and railways.

Sales of transmitting equipment for the commercial broadcasting industry grew steadily in the 1930s, and by the latter part of the decade Arthur's firm was a recognized leader in the broadcasting business.

The company reflected Arthur's philosophy to design and build only the best. He did not want customers to have doubts about the quality of the product and that it would work. If it was not right, it would be made right, as Arthur's memo on the Autotune problems demonstrated.

In those Great Depression years of the 1930s, jobs were so scarce that people were afraid not to work as hard and as conscientiously as they were able. But Arthur and his company also were helped by the ingenuity and self reliance of Midwesterners to solve problems.

The men who worked with Arthur in the formative years of the company — Roy Olson, Roger Pierce, Bill Stewart, Bob Samuelson, Les Bessemer, Roger Conrad, Milo Soukup, Merrill Smith, Slim Dayhoff, Morgan Craft and others — remembered a lot of 14 and 16-hour days. But they liked what they were doing, and they took great pride in the equipment they designed and built. They remembered informal times with Arthur joining in — poker games, beer and hamburgers after work. And shooting rats with .22 rifles at the city dump.

The firm was still somewhat shaky from a financial standpoint, but in technical capabilities had a solid foundation for the years to come.

The employees had faith that the firm would grow and prosper. In 1940 about five or six of them got together and formed the Collins Credit Union, with an initial investment of five dollars apiece, one having to borrow the money to participate. Some 25 years later the credit union had become the largest in Iowa.

# Chapter 3
# War Time Boom

When the books were closed on the Collins Radio Company fiscal year ending July 31, 1939, they showed the firm started by Arthur Collins eight years earlier had $504,000 in sales for the year and about 150 employees.

It was a time when dramatic change was about to occur which would affect not only Collins Radio but all of America and the world. On September 1, 1939, World War II began as the German army of Nazi Dictator Adolph Hitler rolled across Poland. Great Britain, France and the low countries of Europe declared war on Germany and its ally, Italy. The Soviet Union jumped in from the east to grab part of Poland. On the other side of the world, Japan, controlled by militarists, was at war with China and preparing to conquer vast areas of the Pacific by armed force.

In the United States, still not fully recovered from the Great Depression, President Franklin D. Roosevelt had become increasingly concerned about the threats to world freedom, particularly from the German war machine. He knew his nation's industrial might, and possibly its armed forces despite his proclamations to the contrary, would have to help stop Hitler at some point.

But he faced a widespread anti-war and isolationist attitude among the American public and Congress. As a result, there was only limited U.S. military preparedness before 1940.

America began to get serious about a military buildup after German troops invaded and quickly conquered Denmark and Norway in April, 1940. Less than two months later Nazi air and ground forces swept across The Netherlands, Belgium, Luxembourg and France. Great Britain, which managed to rescue part of its trapped army from the French coastal area of Dunkerque, stood alone as the last major power in Western Europe to confront Hitler. The alarming events in Europe finally forced the U.S. Congress to act, with much of the effort intended to help the British.

Even before that it had been apparent to many in government and industry that they could not ignore the need to back Britain and have the U.S. better prepared to defend itself. Arthur Collins was one of those. With the help of Morgan Craft, Frank Davis, Bob Gates, M.H. Collins and other top assistants he began adding more engineers and directing the design concepts for military communications gear he knew would be needed soon.

The selection process for the hirings, directed primarily by Morgan Craft, brought in a blue ribbon core group, men who were to become top executives and program leaders in years to come. The new engineers hired in 1939-41 tripled the size of Arthur's small but exceptionally talented technical staff.

One of the engineers who arrived in 1940 was Theodore A. Hunter. A native of Dike, Iowa, he held electrical engineering and physics degrees from the University of Iowa, had worked in industry and taught in colleges.

Ted Hunter's specific challenge was to develop a more stable variable frequency oscillator, and he achieved outstanding success in the area. The eventual result was the Collins permeability tuned oscillator (PTO), which greatly increased radio frequency accuracy and stability, and was used for many years. Like the Autotune, it was one of the key inventions which helped make Collins Radio Company an industry leader in radio communications technology.

The outbreak of World War II in 1939 soon brought a contract which was the largest ever received by the company to that time. It came from the Union of South Africa, then a British commonwealth. Facing an immediate need to support the British with combat ready units, the South African Defence Force was desperately lacking in military equipment.

Major N.F. Thomas was assigned the responsibility to completely reorganize the South African Air Force communications. Making his way to Cairo, he tried but failed to get British forces there to part with some of their radio gear. He then went to England and again was turned down on requests for aid. In Canada, his next stop, it was the same story — no equipment could be spared. But while there he was pointed toward Cedar Rapids.

Collins Radio indeed could provide what Major Thomas needed, but the company was told the order had to go through the South African embassy in Washington. Thus it was up to W.J. Barkley, Arthur's east coast sales force, to work out details. Collins also required payment in advance for such a large order, needing the funds to buy components and materials.

While the South African officers knew what they wanted, getting their ambassador in the U.S. to release the funds was another matter. Barkley, after trying for several days to get him to sign the contract, finally was able to arrange an evening of drinks and dinner. With the hour growing late, Barkley followed him into the men's room of a Washington hotel and succeeded in getting the ambassador's signature and a check.

The purchase included 100 18M portable, 10-watt HF mobile transmitter-receiver units; the 32RB, a battery powered version of the 32RA 50-watt transmitter, of which 24 were ordered, and six 16E-3 transmitters, 150-watt HF ground station units equipped with the Autotune.

Also part of the order was associated equipment purchased from other suppliers, including 260 Willard 6-volt storage batteries, 130 Onan generating plants, six battery charging sets and several National Company radio receivers.

Much of the gear saw service in the WWII North African desert warfare. There were several major campaigns in which the opposing British and German forces pushed each other back and forth from Egypt to Algeria.

The South Africans were regarded as having the best HF communication capability of any fighting units in the theater. On one occasion, communications capability provided by the Collins-built radios was credited with helping save 65 airplanes from destruction when the Germans mounted a major surprise assault.

The South African order, which totaled $194,881, also provided a much needed financial assist for Collins Radio Company.

Since Arthur started in business, Peoples Bank & Trust Company of Cedar Rapids, with the help of larger Des Moines and Chicago banks, had seen to it that Collins had a line of credit to carry on operations. There were many times, however, when the shaky financial condition of the firm made the bankers uneasy. With the South African order signed, Bob Gates deposited the six-figure check in Peoples Bank which greatly improved the credit status.

As the U.S. military buildup gained momentum, the various service branches responded to their new role. Collins began to receive new contracts, mostly from the Navy. Sales for fiscal year 1940 rose to $722,000, and would reach $2,164,000 in the next year. The U.S. economy began to mobilize for war in 1940.

One of the U.S. preparedness steps was creation of the Defense Plants Corporation, responsible for building new factories and shipyards. Under that program the Navy could help Collins build a new, modern and larger plant which the government would finance, then lease to the company.

That led to a building known as the Collins Main Plant, on 35th Street NE in Cedar Rapids, at the time considered a large and highly modern facility. The site was deemed suitable after the city had rejected rezoning of another location. Construction began in late summer, 1940, and the building was being occupied by December, 1940.

Filling the growing number of military orders brought a hiring build-up. By March, 1941, the number of employees on the payroll reached 485.

With the company into government work, security procedures had to be initiated. Guards were hired, badges issued to employees, lunch boxes were checked for contents, clearances were necessary for persons working on programs classified as secret, and secure areas were set aside for sensitive projects.

Military work also brought Navy inspectors into the plant.

The first large scale military program was what came to be known as TCS equipment. With Ted Hunter the chief engineer, design work began in September, 1940. The first production came about a year later. It was an extremely rugged system initially designed for use on the Navy's famed PT boats.

Consisting of a transmitter, receiver, remote control, power supply and other accessories, TCS systems eventually found use on almost every type of Navy vessel including cruisers, battleships and landing craft, and on Marine Corps amphibious tractors, jeeps and command cars. It was a main communication system in all World War II landing operations. The system was adaptable to different voltage systems of ships and vehicles, and provided a frequency range of 1.5 to 12 megacycles. The power output was 12 watts for voice and 25 watts for telegraph operation. By the time production ended in June, 1945, some 35,000 were built by Collins and other firms licensed to manufacture the units.

The most noteworthy of wartime projects undertaken by Collins was a new airborne high frequency transmitter wanted by the Navy, for two-seat and larger aircraft. The Navy's intent was for a radio of advanced design and rugged construction, to have higher transmitting power and be lighter in weight than existing military units. Collins was invited prior to U.S. involvement in the war to submit a design in competition with such large, well-known firms as Westinghouse and Bendix.

The original Navy specification, according to one engineer involved in the project, was "messy" and impossible to follow with any satisfactory results. Finally, Arthur instructed Frank Davis, Roy Olson and others working on the design to pack up what they had built so far and ship it along with all the paperwork to the Navy.

Arthur told the Navy people that, "we think we know what you want, but we do not want to continue with this design."

Navy people decided to review their approach and issued revised specifications for the proposed airborne transmitter. They again asked Collins and three other firms to build prototype units.

Now Arthur Collins approached the challenge in his typical manner. He would break new ground, based in part on a transmitter the company had designed and built for American Airlines. He worked with his engineers to design a radio he knew would offer superior performance, reliability and advanced features, defying adherence to traditional military aircraft transmitter versions of the time.

A key element in the design was the Autotune, which since being invented in 1935 was incorporated into airborne transmitters for American, Braniff, TWA and other airlines and a variety of ground equipment. The Navy and Army also had purchased ground transmitters with Autotunes in the late 1930s. The Autotune for the new Navy aircraft radio was a newly designed Autotune, smaller with improved accuracy, controls and operational features.

Responsible for the Autotune refinements was Richard W. (Dick) May, a native of Massachusetts. May had earned a mechanical engineering degree from Rensselaer Polytechnic Institute and was doing graduate work and working part-time for a scientific instruments firm. Arthur had asked a professor friend to help him find a top young mechanical engineer, which led to the contact with May. After being interviewed over dinner by an emissary of Arthur's, May recalled, he took a train to Cedar Rapids and met Arthur, who showed him the new Main Plant then under construction. May began with Collins in December, 1940. He first helped with Ted Hunter's TCS transmitter-receiver program, then turned to designing new versions of the Autotune.

Arthur had great admiration for the work done by May on the Autotune. *Dick has combined a large amount of ingenuity with a careful and scientific approach and has obtained results far beyond anything I imagined when we started on the (Autotune) project years ago. He has made Autotunes much smaller, more easily adjusted, more accurate and more reliable than anything we had before,* Arthur once said.

The new Navy airborne transmitter was designated the AN/ART-13. A legend grew up about the radio, to the effect that the Navy had asked four companies to submit development models, three of them established giants of the electrical equipment industry, and the fourth a little company out in Iowa beginning to get a reputation for building good radios.

Arthur Collins once was asked how his firm won the contract for the AN/ART-13, and he said the part about four firms providing development models was true. Another part of the story which he said was not true, was that Collins won the competition hands down.

*What happened,* Arthur said, *was that on the Sunday morning of December 7, 1941, about eight hours before we heard about Pearl Harbor, we were running final tests on our development unit. We were supposed to take it on the train to Washington that night for the Navy evaluation and selection process the next day. Well, because of some other pressing problems for Navy folks we didn't go that night, but they finally held their screening a few days later.*

"We put it through the paces, and it met all the test criteria. As we and the other contractor people sat around a room waiting for some tough decision making, things didn't look good. One Navy captain was all for our design, but others on the panel were afraid of it. They said the Autotune concept just wasn't proven, our company was too small to handle the production, they'd have to change a lot of test equipment if they bought it and other reasons.

"Finally the admiral in charge said, 'Well, there's a war going on, and we've got to make a decision.'

"But there also was a British naval officer present. Whatever new design was selected, the first production order was going to the British. He pointed to our radio and said, 'That's the one we want.' And that was how the ART-13 had its big start," Arthur said.

The new airborne transmitter was truly different and more advanced than conventional military radios of the time. The Collins set with the Autotune had 100 watts of transmitting power and provided 10 communication channels, which could be pre-set. Then the one wanted could be tuned with the flip of a switch in a matter of seconds. It was operated by the pilot using a remote control, requiring a radio operator only if communications were in code. The runner-up in the Navy competition offered 40 watts of transmitting power with only four communication channels and lacked rapid, automatic tuning capability. The ART-13 weighed about 80 pounds with the tubes, transformer, chassis and other metal parts, still lighter than most radios of that time.

Roy Olson recalled taking the ART-13 to Anacostia Naval Air Station, just outside Washington, D.C., for its first official flight tests in an SBD dive bomber. While he was there on December 30, 1941, the nation's capital underwent its first full-scale test of a blackout as a precaution against aerial attack, with less than satisfactory results.

Accompanying Olson to the flight tests was Kenny Vaughn, a technician who had joined the Collins work force in 1936. Vaughn recalled that the Navy pilot assigned to the first test flight of the ART-13 was then Commander Arthur S. (Ben) Born. Just before the flight test was scheduled, Born and his crewman in the SBD took off on another short flight. During their landing, the crewman accidentally pulled up the landing gear and the aircraft skidded off the runway into the Anacostia River. Born was not hurt, but Vaughn remembers seeing Born in his flight gear, dripping wet. Born became well known to many at Collins after he retired from the Navy in 1955 as a rear admiral and went to work for the company as assistant to the vice president, research and development.

Collins soon received initial production contracts, followed by months of intensive effort to get parts procurement, production and test methods, training of workers and other plans worked out before deliveries of the ART-13 began. Navy pilots began using the new equipment by early 1943.

The United States was drawn into World War II with the sneak aerial attack by Japan at Pearl Harbor, Hawaii that Sunday morning of December 7, 1941, which caused heavy losses to the U.S. fleet and smashed shore installations.

With the U.S. entering the war, the Collins Radio Company became completely dedicated to military equipment design and manufacture. Work on amateur, broadcast, commercial aviation and other non-military products came to a halt.

During 1942 the Navy placed orders with Collins for some $50 million in equipment. In the summer of 1941 Collins had about 500 people on the payroll. By then the union and company had negotiated a base wage rate for men in production departments of 60 cents per hour. Right after Pearl Harbor the firm began hiring every available man to be found. But the beefed up military draft and voluntary enlistments were taking most of the younger men, including many already on the Collins payroll. As the war went on, there were more Collins people in the service than had been employed December 7, 1941.

Deferments from active service were sought for engineers, production supervisors and others considered more vital to the war effort in a defense plant than they would be in the armed forces.

Bill Popek, who started at Collins in 1937 and rose to a manufacturing superintendent earning $125 per month during the war, remembered being called to the office of Arnold Pyle, who handled a variety of personnel department functions. Pyle was a classmate of Arthur's at old Washington High in Cedar Rapids. In the early 1930s he studied art and painting under Grant Wood and helped with the stained glass window which Wood designed and installed in the Cedar Rapids City Hall. Pyle later worked for Wood in the art colony he operated at nearby Stone City. Needing more of an income than his artistic endeavors provided, Pyle went to see Arthur who put him on the Collins payroll.

"We're getting you a deferment, and under no conditions are you to enlist," Pyle told Popek.

Popek, an able-bodied male in his mid-20s, said a lot of the women workers at Collins, who had husbands and brothers in the service, wondered why he was exempted when their loved ones had to be in uniform.

Les Bessemer had been an Army reserve first lieutenant prior to the war. Pleading that he was more valuable to the war effort at Collins Radio than in the service, the company was able to keep him from being called up. The Army finally terminated his commission December 8, 1941.

The pressure was on immediately after Pearl Harbor to produce and deliver as much material for the armed forces as could be turned out, and do it as quickly as possible.

On December 22, 1941, two weeks after the U.S. declared war on Japan, Arthur Collins issued a terse memo, "To All Department Heads: Due to urgency of all work, no leaves of absence will be granted during the holiday season. It is planned to restrict operations on Christmas Day (meaning some but not all had to work) but full operation will be maintained on New Year's Day. The above applies to all departments in both factory and office." As the war went on, most holidays also were work days.

The firm began two work shifts December 29, 1941, and soon implemented a third shift. Employee vacations were canceled, with bonuses paid in lieu of vacations.

It quickly became apparent there would not be enough male workers available to meet production schedules. The very thought that women might have to be brought in to do factory work was hard to swallow for some men supervisors, but they quickly accepted that such a step was inevitable.

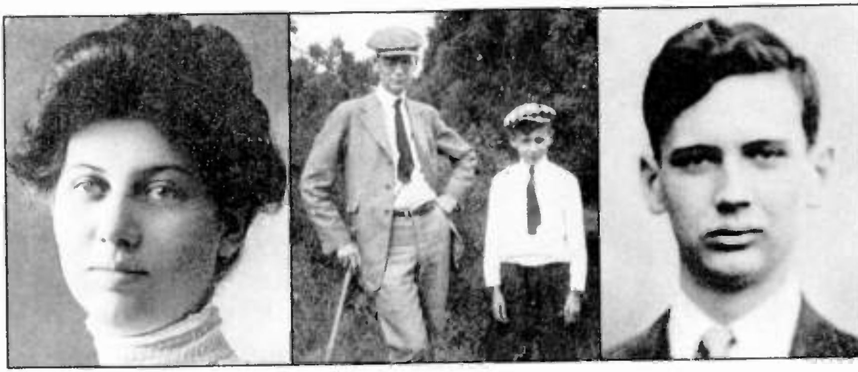
By late January, 1942, factory personnel were informed: "The increased production schedule caused by the present emergency will necessitate the use of female labor in addition to male labor for certain tasks in the near future. There will be no replacements of present male employees by women."

After training programs were set up, women began working on the production lines, putting together and soldering parts and sub-assemblies of radios. At first they were kept in an all-female group, a plan quickly dropped on being found unnecessary and inefficient. Some were placed in parts inspection and testing jobs, including electrical testing. Eventually women were trained to operate machines in what once was considered exclusively a male domain — the metal working shop. The starting pay rate for women was 40 cents per hour for a 40-hour week, and 60 cents per hour for overtime work.

Eventually women operators took over most of the radio assembly jobs. While there was apprehension at first about ladies on the factory floor, Collins production supervisors soon became aware of a big advantage to the change. Women could do certain tasks much better than men. Their smaller hands and nimble fingers, many accustomed to sewing, doing embroidery and other fine work, made them particularly talented at inserting and attaching small parts, and deftly making tiny soldering connections. They also had the patience to sit at an assembly bench and concentrate on the work for long periods between breaks.

One newly hired engineer, a city boy from the eastern U.S., marveled at the way the Iowa ladies adapted to the job of assembling radios. "They knew which end of the soldering iron to pick up and how to use it," he said.

As "Rosie the Riveter" was an answer to production problems in aircraft and tank factories, women assembly operators played a major role in Collins' ability to meet production quotas during the war. Some came to work out of a sense of patriotism, others because they had a husband, son or brother in the military service and wanted to do their part on the home front to support him. Others came for the money, and for some, it was the first wages they ever made. Women who never paid more than $14.95 for a dress soon were buying $60 and $90 frocks.

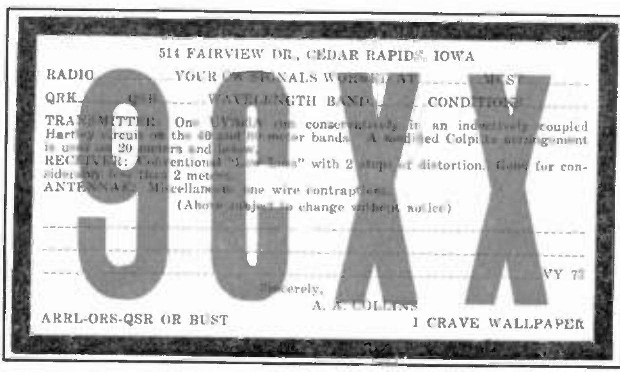


*L to R: Arthur's mother, Faith Andrews, before she married M.H. Collins; Arthur as a boy with his father, and Arthur as a teen-ager.*

*Collins Farms Company tractors with field maintenance truck.*

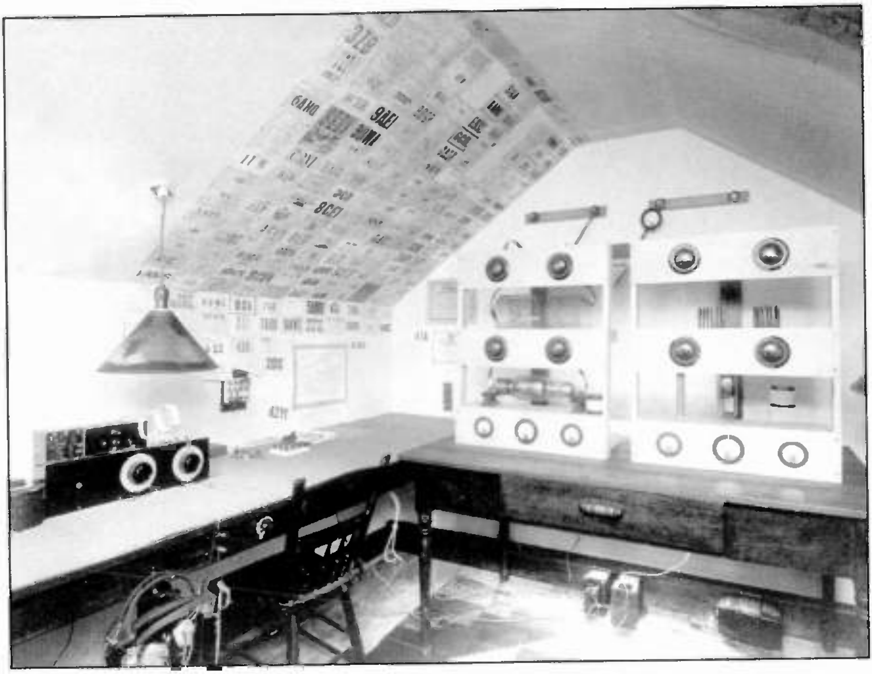
*Corn planting with the rotary hoe on a Collins Farm, early 1930s.*

The Fairview Drive house in Cedar Rapids where Arthur communicated with the MacMillan Arctic Expedition.




One of Arthur's QSL cards after he became a licensed amateur operator.


Early radio apparatus designed and built by Arthur Collins.



*The attic room ham shack in the Collins home on Fairview Drive.*


*Winfield Salisbury, Paul Engle and Arthur Collins with radio-equipped van used on 1927 trip through Western states.*

*The Sixth Avenue house in Cedar Rapids, the first Collins Radio factory.*

## Crystal Transmitters

**Radically new design suitable for Class B modulation or high output C.W. on 14 7 and 3.5 M.C.**

Consists of crystal-oscillator buffer amplifier, and Class C output amplifier mounted on polished aluminum and hard rubber chassis with plug in coils and plug-in crystal holder for quick change of frequency Complete Kits, less tubes, crystal and power supply:

**210 Output $37.25  203A Output $47 50**
**852 Output $47.25**

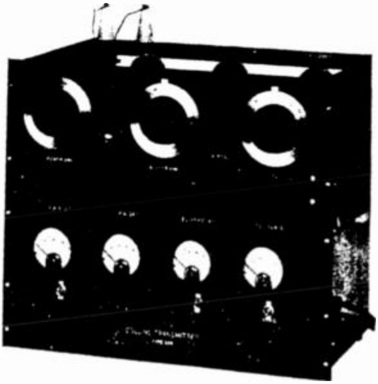
The smoothest, neatest little rig you ever saw — and what a Kick she has!

**Immediate Delivery** *Write for data sheets*

**ARTHUR A. COLLINS**

**Cedar Rapids, Iowa** Radio Laboratories, Inc., W9CXX

## Collins Transmitter TYPE 30W



The 30W is designed to meet the requirements of the amateur who wants a modern crystal controlled transmitter ready to go on the air. It is a commercial type transmitter at a price the amateur usually pays for "just the parts."

**Specifications:**

*Output*. 30 Watts *Frequency Range*. 20, 40, 80 and 160 meters. Coils for one band standard equipment *Tubes*. 247 Oscillator, 247 Buffer, 510 Output Amp. *Power*. Self contained heavy duty unit. *Keying*. Grid-Block *Meters*. Weston surface type *Construction*. Engraved Formica panel Aluminum and cadmium plated steel chassis Highest quality material throughout

*(Technical data on request)*

The 30W can be 100% modulated by the Collins 9C Unit employing type 46 tubes in Class B, making a phone that really does things.

***30W Transmitter, complete less tubes and crystal*** **$95.60**

### ORDER BLANK

**Collins Radio Transmitters**
**Cedar Rapids, Iowa**

Please ship at once one Type 30W Transmitter.
☐ Enclosed find $95 60
☐ Enclosed find $25 00, balance C.O.D.

*Name*

*Address*

## COLLINS CRYSTAL TRANSMITTERS

are fast becoming the popular choice of both the old-timer who has learned to appreciate the value of trouble-free, efficient performance on all bands — and also the beginner who wants to start right ● Write at once for full details and photographs. Units from $33.95 up with carrier powers of 30 to 300 watts. Also a complete line of power supplies, modulator and input equipment, relay racks, quartz crystals, etc.

**COLLINS RADIO TRANSMITTERS**
**CEDAR RAPIDS, IOWA**

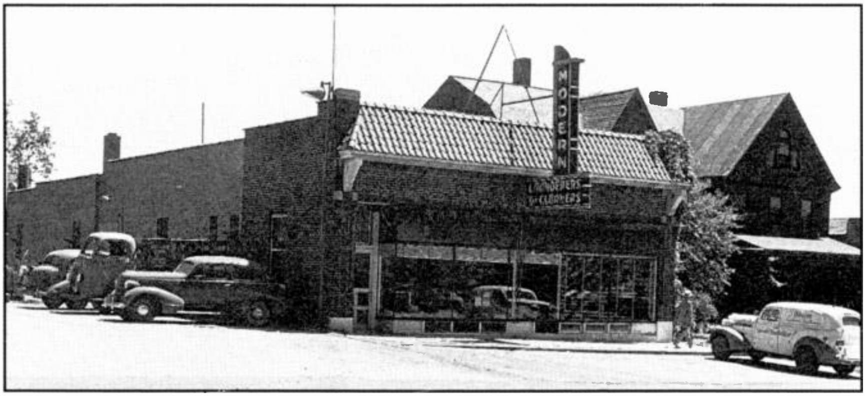
(Arthur A. Collins, W9CXX)

*Advertisements which appeared in radio journals in 1932. The name of the firm was changed later to Collins Radio Company.*

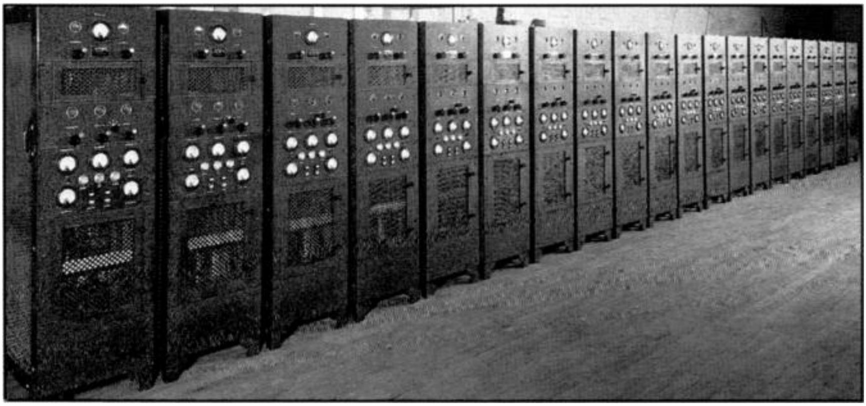
*The building at 2920 First Avenue NE, Cedar Rapids, used by Collins Radio Company in the 1930s.*

*Arthur Collins with the Byrd Antarctic Expedition Transmitters. The 1,000-watt 20B is the large unit on the right.*

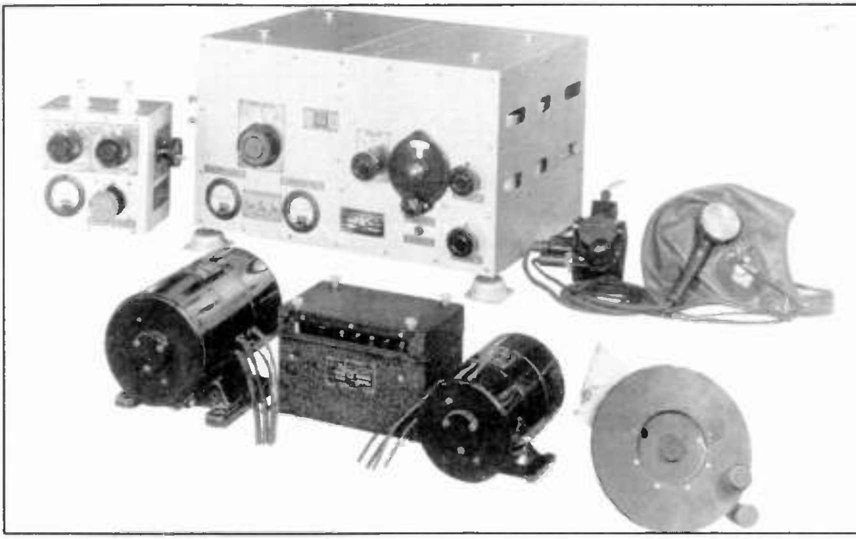
*Byrd Expedition radio equipment including a Collins 150B transmitter (tall unit) ready to be hauled by dog sled across ice shelf in Antarctica.*




*The Modern Laundry Building on First Avenue near Sixth Street SE in Cedar Rapids, used as the Collins manufacturing plant in the 1930s.*

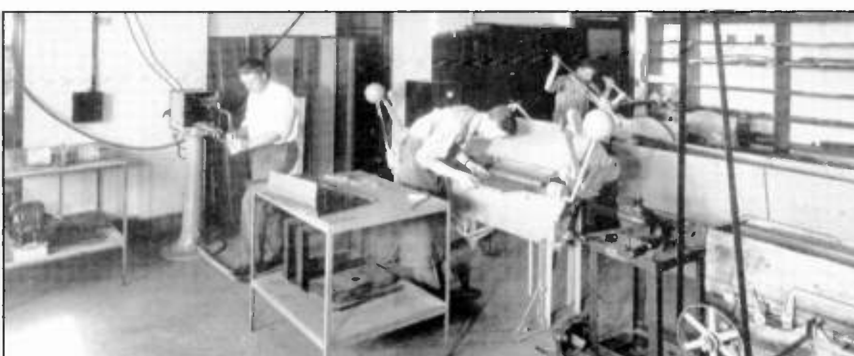


*Transmitters built for the U.S. Coast Guard in the Modern Laundry Building. The transmitters served for years in Great Lakes lighthouses.*



*Aircraft communication equipment for the air force of Colombia, part of the first large order of airborne gear designed and built by Collins about 1935.*

*The Collins factory, 1935. It was said that all male employees, whether they worked in the factory or not, were called in to pose for this photo.*



*The first Collins Radio machine shop, operated by Ted Saxon at the left and Slim Dayhoff, in the center.*


*Arthur Collins and M.H. Collins, in the mid-1930s.*


*Clair Miller, one of Arthur's first employees, demonstrating a 12X portable amplifier used for radio broadcasts from field locations.*

*W.F. (Bill) Stewart testing amplifiers, part of the Collins line of commercial broadcasting products of the 1930s. Stewart joined the company in 1935.*

*Arthur Collins' first airplane, a two-place tandem seating Rearwin Sportster, covered with red fabric.*

Milo Soukup recalled that a group of women from the nearby Amana Colonies, which until 1932 had been a communal society where everyone worked long hours, formed car pools to work shifts at Collins. A few days after several of the women had been assigned to his section, a production foreman called the personnel department and said, "Send me some more of these women from Amana. I've never seen anyone work as hard as they do."

Women who held key jobs in the process of getting goods produced and on their way to the war zones included a number of Navy inspection personnel, both civilians and WAVES (the Navy's female service corps) assigned to Collins plants.

Whether men or women, there was a "can do" spirit which permeated the Collins Radio work force. The pride which the older employees had in Collins products was passed along to the hundreds hired during the war, most of whom knew nothing about how a radio was designed and built and how it worked. Everyone was urged to do his or her part and do it well to help bring an American victory. No one wanted to be singled out for letting down the front line troops by failing to build radios on time or do substandard work which might cause a radio to fail at a crucial time.

The government supplied Collins and other military production plants with an ample variety of posters designed to promote patriotism, motivate workers, avoid security leaks and other purposes.

One poster on a Collins factory wall had this message:

> Coughs and sneezes spread diseases,
> Pleasing the Germans and Japaneses.

While the Navy was Collins' largest customer, the Army also acquired hundreds of Autotune-controlled transmitters. Also, the AN/ART-13 transmitter went on Army Air Force B-29s and other aircraft in latter stages of the war. TCS equipment also was installed on Army vehicles, but purchased through the Navy.

Arthur Collins once recalled how another problem was solved in the wartime manufacturing rush. When production began on the AN/ART-13 airborne transmitter, an immediate difficulty arose in environmental testing. Specifications required the radio to operate at temperatures encountered in high altitude flying, as cold as 40 to 60 degrees below zero. The first test chamber tried was incapable of reaching and holding the required cold levels.

Arthur contacted George Foerstner of the Amana Colonies located near Cedar Rapids. Foerstner had started Amana Refrigeration in 1934, his first order having been a beer cooler for an Iowa City tavern. Amana had crews building frozen food locker plants across the Midwest when the war started, but had to quit when the government banned the use of materials for such civilian projects. Foerstner and two engineers who came to see Arthur were confident they could build the cold chamber which Collins needed to test a large number of units at one time.

Foerstner said it was the first big freezer unit built by Amana Refrigeration. Because his firm did not have much money in those days, he had to have partial payments in advance from Collins, arranged through Peoples Bank of Cedar Rapids, to buy necessary materials while the chamber was being built and installed. The Collins order was a key step enabling Amana Refrigeration to become established, as Amana then went on to build many more freezers and walk-in coolers for defense plants and the military services during the war. After the war Amana became one of the nation's leading manufacturers of home freezers and refrigerators.

Kenny Vaughn, by then responsible for engineering oversight on the AN/ART-13, remembers the Amana people came back several times to fix problems on the cooling chamber but made it work.

In charge of the teams which did the final tests on the AN/ART-13 were two engineers, Eugene Senti and Phineas J. Icenbice. Senti remembered that when he headed the day shift, Icenbice headed the night shift, and after a month, *just about the time we got our biological clocks adjusted, we'd trade shifts.* Senti also recalled that the men who worked inside the cold chamber, testing operation of the radios at 40 below zero, wore Army air force high altitude flight gear, heavy leather, sheepskin-lined garments.

Vaughn and other technicians made a number of trips to Naval air stations around the country to talk with Navy men about any problems with the AN/ART-13. After consulting with Arthur, design and production changes were sometimes made to improve the radio's performance.

Vaughn also was the main development engineer on the AN/ARR-15, the companion receiver for the AN/ART-13 transmitter. Collins built a large number of those, although not as many as the transmitter.

One other airborne radio developed and built by Collins was the AN/ARC-2, for single pilot carrier based aircraft, a highly advanced unit for the time. The engineer responsible for it was Melvin Doelz. *I came up with the idea of a radio which would both transmit and receive on exactly the same frequency from the same oscillator. You could just push a button and convert from transmit to receive. It had one of Ted Hunter's high precision oscillators in it,* Doelz said.

Doelz was one of the engineers hired in the pre-war build-up. He, along with Dave Weber and Ernie Pappenfus, had been fraternity brothers while studying electrical engineering at the University of Minnesota and came to Collins in 1941. They shared an apartment after they began working in Cedar Rapids. Three other U. of M. graduates who joined Collins were brothers Paul and Arthur Wulfsberg and Carl Henrici. All of the Minnesotans headed up major engineering programs and were key executives during their years at Collins.

Another project undertaken by Collins for the Navy was enveloped in secrecy for much of the war. After the war it was revealed to have been an important system in helping the Allies achieve victory in locating and destroying German submarines which ravaged Allied shipping in the Atlantic Ocean. Until the Allies gained the upper hand in mid-1943, the toll by German U-boats was measured in hundreds of merchant ships, thousands of crewmen's lives and millions of tons of supplies. Most of the sinkings were on shipping lanes from America to Great Britain and the Soviet Union across the North Atlantic.

The system was a high frequency direction finder, HF/DF for short, referred to by the British as "Huff-Duff."

Much of the conceptual brainstorming which led to the direction finder was the work of Walter H. Wirkler, one of the first engineers hired by Arthur Collins in 1934.

With Wirkler's basic design, Frank Davis doing much of the electrical work and John Giacoletto the mechanical engineering and the drawings, the direction finder took shape. Many other engineers and technicians also performed important work on the project. Collins people who worked on it gave it the nickname of "Jeep."

The purpose of the direction finder was to point out from which direction radio signals were coming. The particular signals it was designed to identify were radio transmissions from German submarines.

The submarines of World War II had to surface often for ventilation and to recharge the batteries which provided electrical power for operation when they were submerged. The only times they could use their radios were while on the surface or at a shallow depth with an antenna above the water. At those times they contacted their base to receive orders and make reports, including "kills."

The Allies knew which frequencies the Germans used, in the high frequency or HF band. The direction finders could receive from 2-28 megahertz.

A Jeep consisted of two radio receivers, contained in a metal cabinet about 24 by 18 by 18 inches. Beams extended outward horizontally from each end of the receiver cabinet. A loop antenna was mounted on the outer end of each beam. Also part of the system was an oscilloscope. The unit was mounted on a vertical shaft which allowed it to rotate. The Jeep was about 20 feet in length from beam tip to beam tip.

Signals detected by each receiver were compared by means of the oscilloscope and the Jeep was rotated until the signals were in phase, meaning both receivers were getting the same signal. Then the direction of the signal was read from an azimuth scale.

The Jeeps were installed at stations along the east coast of North America and South America, also some on the Pacific coast. The stations were linked with each other and a command center in Washington by land communication lines. Others were aboard surface ships. When three different stations got a bearing on a surfaced submarine, the location could be pin-pointed. Then sub-hunting Allied ships in the area and carrier or land-based aircraft were dispatched to the scene.

Robert T. (Bob) Cox, who came to Collins in 1941 from advanced studies in electrical engineering at Ohio State, was assigned to the direction finder project under the supervision of Wirkler and Giacoletto.

In the years just before and during World War II, the company procedure was to assign new design engineers at first to tasks in production areas such as testing sub-assemblies and completed radios. That was a method of having them become familiar with the products. Cox, however, because he had a master's degree, went to work immediately in engineering.

Cox recalled going out to install some of the Jeeps up and down the east coast. On one occasion when he and Francis Malone, a Collins lab assistant, were working on an installation, signals from a German submarine were picked up by several stations including one near Jupiter in Florida. As they reported directions of the signal to get a cross bearing, their readings pointed to the sub being just off the coast in front of Jupiter.

"If it's that close, why don't you just go out and throw a rock at it," the network commander in Washington called out.

Much of the Collins development and testing on the direction finder was done in an unusual place — a structure called Fort Dearborn.

So named because its appearance resembled school book illustrations of Fort Dearborn, a frontier military outpost where Chicago was founded, it was a nearly square two-story wooden building. Nails and other metal were used sparingly in the construction to provide minimum interference with radio reception.

The "fort" was located on the Main Plant grounds as far away from other buildings as possible. As the direction finder evolved from drawing board to working hardware, engineers checking out the system in Fort Dearborn could listen to transmissions from Rome, Paris, Berlin, London and ships at sea including German submarines in the Atlantic.

While Arthur Collins did not actively participate in the design of the system, he visited the lab during prototype stages and offered suggestions.

Production and final testing of the highly classified equipment took place in a walled off part of the Main Plant called the "Restricted Area." Persons seeking admittance to the area pushed a buzzer, and soon the door was opened by a guard with pistol drawn. If they had official clearance by the Navy to get in, they could enter.

Collins built more than 100 of the direction finders.

By the middle of 1943 German submarine losses were running so high — nearly 100 sunk from January to May 1943 — that the Nazis pulled most of their remaining U-boats out of the Atlantic. Naval historians credit the direction finders as one of the reasons for the defeat of the submarine menace, along with increased aircraft and ship patrols, new merchant convoy escort tactics, new antisubmarine weapons and improved Allied radar.

Even with its new 61,000-square-foot Main Plant, the Collins company quickly became short of space. By the summer of 1942 the first of two wartime additions to the building was underway. Before the war ended in September, 1945 the size of the original Main Plant was tripled, and a cafeteria added. Until the cafeteria was built, the only food service was from sandwich and coffee carts.

Throughout the war the company was pressed to find enough suitable manufacturing, warehouse, shipping and office space in Cedar Rapids. More than 20 facilities around town were occupied in whole or part for operations. The Shrine Temple (located near A Avenue and 7th Street NE, later torn down to make room for Highway I-380) was converted to an assembly plant for radio equipment. Part of the Iowa Theater Building was turned into Collins offices.

Not only space but also finding enough people to work was a big problem, particularly with some 20 to 40 male employees called into military service every month. A rule that the spouse of an employee could not be hired was quickly dropped. Even 17-year-old girls were hired, but were forbidden by the government to work more than an eight-hour day or overtime.

The company even hired housewives willing to work four hours in the evening, and offered jobs for service people home on leave for four-hour "stub shifts." Some departments worked 10-hour days, six days a week, while others worked an eight-hour day, seven days a week. The general office force usually worked a 48-hour week. Many who ranked as senior citizens, in their 70s, were on the payroll.

Bill Zuber, a New York Yankees pitcher from Amana and in later years an Amana restaurant operator, did his part for the war effort by working in the Collins receiving department between baseball seasons.

A number of area farmers, whose food-raising was vital to the war effort, worked at Collins between the harvesting and planting seasons.

Hopes to keep an unaffiliated local union went by the wayside with the large number of workers hired during the war. In August, 1943 the American Federation of Labor won bargaining rights in an election at Collins. The company was pressured by the Navy, which wanted no interruption of production, to stand aside and refrain from objecting to the organizing effort or election between the AFL and CIO.

A tremendous effort was required by the factory workers to meet monthly production quotas. On the last day of one month a major push was needed. Phones rang all over town to have people either come back or come in early to work. Many worked their full day shift and most of the night. Others came in during the afternoon and stayed until morning. Company executives served a free lunch during the night. The extra effort was successful as the quota was reached.

As might be expected with a frantic rush to build up manufacturing rates of complex products such as military radios, woes about parts shortages frequently were heard on production lines.

Quite often the Civil Air Patrol was asked to help out, and responded by flying small aircraft to points such as Chicago to pick up parts and get them to Cedar Rapids in time to keep an assembly line operating.

A sad day for Arthur and the older company employees came on April 2, 1943 when his father, M.H. Collins, died after a two-week illness. He was 64. M.H. had known most company employees personally in the first 10 years of the company, and was highly respected by the work force. His obituary on the front page of the Cedar Rapids Gazette described him as a "friend of the man in the shop and a patron of the arts." In earlier years when his Collins Mortgage Company prospered, M.H. was among a group of prominent Cedar Rapids citizens who provided money for the support of two young and promising artists of the community, Grant Wood and Marvin Cone.

Dozens of telegrams, cards and letters expressing sympathy were received by Arthur and his mother from friends, business associates and military officers. Arthur personally responded to as many as possible. Several notes came from military men who had spent short periods in the Collins plant learning to operate and maintain radio equipment, and who gained lasting impressions of M.H. as a warm and friendly person.

John H. Brady, Washington attorney who had worked closely with Collins on many legal matters including the RCA patent lawsuits, wrote:

*Your father represented to me the fine things of life and I shall keenly feel his loss with you and your associates. His courage through the years of litigation (the RCA case) was a continuous source of inspiration to me.*

While the death of M.H. was a blow to Arthur, he was greatly cheered a week later by the birth of his and Peg's second child, Michael Merle Collins. Their first child was daughter Susan, born in 1939. Arthur was quick to tell anyone within earshot *what a fine boy* he had. *Long live the Irish*, he wrote to one friend.

On the final working days before Christmas in 1943, Arthur Collins visited every plant area and presented roses to all the female employees. Subscriptions to Readers Digest were given to all Collins employees who had entered military service.

The greatly expanded wartime production and government contract requirements brought a vast increase in paperwork compared with pre-war days at Collins.

While Arthur Collins sometimes was maligned as being a poor businessman, that was not apparent from the records and control system he implemented for material handling and routing, manufacturing schedules, purchasing, inventories, shipping, billing and other functions including payroll, accounting and personnel files. Arthur maintained close personal involvement in the system set-up and operation as his company mushroomed from a half-million to a 40-million-dollar-a-year business.

The system, run off the latest in IBM tabulating machines, was as automated and up-to-date as that of any company in the 1940s.

With meat, sugar, cooking oils and canned goods rationed on the home front, 200 "victory garden" plots near the Main Plant were provided by the company to employees wanting to raise their own vegetables to supplement food supplies.

As gasoline and tire rationing were in effect for civilians during the war, car pooling to and from work was necessary. Collins helped employees set up car pools to commute from as far as 60 miles away, and was cited by the government for the highest passenger-per-car rate, 4.2, of any defense contractor in Iowa. Many other employees rode city buses.

Employees also were encouraged to ride bicycles. New bikes, scarce items during the war, were made available for sale to workers who would use them to get to and from work.

The company also won other citations. It earned its first coveted Army-Navy "E" (for excellence in war production) award in 1942. Five renewals of the award were received, one every six months. Collins was the first Cedar Rapids company to receive the E Award. It was presented in a ceremony on the Main Plant grounds September 19, attended by a crowd of about 4,000, including most of the company's 800 employees. The E Award pennant was presented to Arthur Collins by Lt. Cdr. J.M. Bloom of the Navy Pre-Flight school at Iowa City, and hoisted up the flag pole as the crowd cheered. Brig. Gen. Charles Grahl, adjutant general for the state of Iowa, presented pins for every worker which were accepted by two employees, Alice Rindernecht and William Wilson.

In brief acceptance remarks, Arthur praised the employees for their work in building equipment for the Navy and Army. *Neatly soldered wires and brightly machined pieces fashioned by your hands have played vital roles,* he said.

A distinguished visitor to the Cedar Rapids plant during a tour of war production facilities around the nation was U.S. Secretary of the Treasury Henry Morgenthau.

In June, 1944 the federal government set up a trailer court on land across 32nd Street from the Main Plant. The purpose was to provide housing "for essential war industry workers." The facility included 106 trailers with minimum living accommodations for two to three occupants.

The products built during the war, besides the AN/ART-13 aircraft transmitters and AN/ARR-15 receivers, the TCS transmitter-receiver units for ships and mobile land vehicles and the anti-submarine direction finders, included other land and shipboard communications units. Among them were the TCZ, a ground transmitter version of the ART-13; the TDO, a 500-watt Navy transmitter and the TDH, a 5,000-watt transmitter, both equipped with the Autotune.

World War II came to an end in 1945. Germany surrendered in May, followed by Japan in August after the U.S. dropped atomic bombs on Hiroshima and Nagasaki. The Japanese surrender ceremony aboard the Battleship U.S.S. Missouri in Tokyo Bay August 14, 1945 was broadcast to the world through a Collins-built radio transmitter on the ship.

Collins' employment during the war peaked at 3,700, a nearly tenfold increase in four years.

The firm delivered some $110 million in equipment to the armed forces.

A virtual unknown as a military supplier before World War II, Collins became one of the ten top producers for the Navy.

But more important than the growth of the company was the recognition which Collins Radio now had throughout much of the world.

Often heard were comments such as one contained in a letter from an employee who had gone into the Navy, writing from his training base to friends back at the plant: "This entire company are 'radio tecks,' and consequently, a large percentage of them have worked in competition with us, but they all agree that the Collins line is second to none."

Another former employee in the service reported having seen TCS equipment in vehicles and ships, and AN/ART-13 transmitters on B-29 bombers. "In every case I asked if there was anything wrong with them." The answer he got was, "nothing."

A Navy lieutenant, writing back to Collins from his ship, reported that, "All the Navy communication officers tell me that Collins is to other equipment as a Rolls-Royce is to a Model T....perfection. The Autotune is their heart's delight, and they rave about it for hours."

The AN/ART-13, the airborne transmitter which some Navy officers were reluctant to recommend when they first saw it, became a legend in aviation radio circles. Military technicians were awed by the unit, which they called "The Collins Job."

The transmitter provided dependable operation from sea level to 40,000 feet altitude, at temperatures ranging from minus 40 to plus 122 degrees Fahrenheit. It also withstood intense vibration and high humidity without diminished performance.

Collins built some 1,200 of the ART-13s per month. Other companies also made the radios under licensing arrangements. In all, about 90,000 of the transmitters were produced before the war ended. Not only the AN/ART-13 but other Collins-designed equipment had made obsolete the radio products of other companies. With the armed forces requirements for the equipment greater than what Collins could produce, the company had to provide drawings to others to build equipment.

An estimated 60,000 airplanes were equipped with the AN/ART-13s. Initially they went into two-seat and larger Navy aircraft. Later they also went on many Army Air Force bombers (the Air Force was not yet a separate service branch in WWII) including all the large new long-range Boeing B-29s. The first message heard from the B-29 Superfortresses on their first mission over Japan, June 15, 1944, was transmitted with an ART-13. Target of the mission was the steel producing city of Yawata. In fact, the AN/ART-13 was used for communication on every B-29 mission in the Pacific.

Most of the U.S. Navy's air action of World War II took place in the Pacific theater against the Japanese.

Navy aircraft equipped with the AN/ART-13 included the Grumman TBF Avenger torpedo bomber; the Consolidated PB2Y-3 Coronado four-engine flying boat, a long range patrol aircraft; the Marine Corps PBJ Mitchell, a version of the Army Air Force twin-engine B-25 built by North American; the Curtiss SB2C-1 Helldiver, a dive bomber; the PB4Y-2 Privateer, a Navy version of the Liberator four-engine bomber, used for long range reconnaissance and bombing missions; the Martin PBM-3D Mariner, another flying boat used for patrols and bombing, and other aircraft used in the ocean warfare.

The advantage provided by the new radios became apparent at an early stage. The enemy often had been able to listen in on air-to-ground and air-to-air communication with the limited channel capacity of previous equipment.

But with U.S. airmen having the ability to switch instantly to additional channels, and being able to pre-set different channels that varied with each mission, the Japanese found it difficult to know what the Yanks were up to in combat, patrol and search and rescue missions.

After Navy aircraft became equipped with ART-13s, reports were heard of American pilots sometimes taunting the Japanese by talking on a radio frequency which the enemy could tune in on. But as they got closer and aerial combat loomed, the Yanks switched to frequencies the Japanese did not have.

Don Palmer, who joined Collins in 1951 and for many years supervised various testing and engineering lab operations, had served in the Pacific Theater as a radio operator on a Navy PBM-5, a large search and rescue aircraft with a 12-man crew. "When the ART-13 came along, it replaced a transmitter called the GO-9, which was about five feet tall, two-and-a-half feet wide and 18 inches deep. With the old unit, you pulled out a big box to change frequency ranges. Then the whole radio had to be tuned up, so we didn't change very often. The ART-13 let us preset eight separate frequencies, all loaded in and ready to use just by turning a knob," Palmer said.

Hardly any U.S. military man connected with communication or aviation was not aware of the ART-13. Not only did it bring widespread recognition to Collins Radio, it generated intense pride among employees who worked on it.

John D. Nyquist, another of the talented young engineers joining Collins at the start of the war, recalled a high Navy officer who visited the Cedar Rapids plant telling him: *The ART-13 helped shorten the war in the Pacific.*

Several years after World War II, a story was heard about a U.S. B-24 Liberator bomber being found in the Libyan desert, where it had crash-landed during the war. The AN/ART-13 transmitter aboard the aircraft, preserved by the dry desert air, was still intact. After being removed and tested, the radio was found to operate perfectly.

Former employees who had entered military service and had seen or used Collins equipment were questioned at length about how radios performed when they visited the plant while home on leave.

For many years after World War II thousands of ART-13 radios on the surplus market, retrieved from military aircraft or still in cargo aircraft converted to commercial service, were widely used around the world.

After the war Collins Radio bought several hundred government surplus ART-13s, making certain they were units which had been built in the Collins plant and not by another contractor. In time the U.S. military decided it needed some more ART-13s and asked about setting up production again, a project which did not fit with the company's post-war activities. Collins was able to convince the Navy to allow re-testing and inspection of the surplus ART-13s to fill the government order.

During the war the company continued to work on advanced equipment designs, so Arthur Collins spent much of his time in the engineering lab. Also, much of it in the office and among other work, being on the phone or meeting with top military people, with parts suppliers and with executives of firms also building the equipment which Collins had invented. One man he met with occasionally was W.W. (Bill) Roodhouse, then chief communication instructor at the Minneapolis Naval Air Station. In later years Roodhouse became the No. 2 executive of Arthur's company.

While he kept track of production, Arthur mostly left it up to others to be sure that equipment got built and delivered.

A story went around the Main Plant one day about Arthur Collins forgetting his badge, and being refused admittance by a security guard. Arthur went back home to find the badge, and later told others that the guard acted correctly, that it was right he should not be treated differently than any employee of a defense plant.

With the company's emphasis on product development, engineering got priority treatment. For example the model shop, a specialized metal machine tool area which turned out parts and prototypes of new products, had a 24-hour turn-around requirement for any item wanted by the engineers.

John Nyquist, a University of Illinois industrial engineering graduate, during the war was placed in charge of the model shop, which had about 32 employees. Among them were such unique craftsmen as a former builder of pipe organs and a master jeweler.

Ingenuity was not confined to inventing new radios in Arthur Collins' company. Purchasing specialists as well as design and manufacturing engineers were adept at finding sources for tools, materials, processes and almost anything else that was needed.

Nyquist remembers searching for a supplier, finally found in Racine, Wisconsin, to make precision stainless steel pawls for the Autotune until Collins learned how to do it. Dick May remembered getting Swiss-built machines, needed for making small precision metal parts, from Sheaffer Pen Company of Fort Madison, Iowa which had units to spare.

Among sources for precision gears needed for Autotunes were the Hammond Organ company. Suppliers of small electric motors included Emerson Electric and Hamilton Beach.

The matter of electric motors for the Autotune resulted in a problem for Collins. One manufacturer of that type of small motors was a Chicago firm allegedly linked to the Mafia. The firm also had political connections in Washington, which led to the Navy continually urging Collins to buy its motors. The motors, however, never could meet Collins' quality and performance standards. Even Navy admirals tried to pressure Collins to use the Chicago firm as a supplier, but Collins people remained firm in refusing to buy the motors.

In the latter stages of World War II, Arthur Collins began preparations for programs his company could pursue with the end of hostilities and the beginning of peace.

Among areas of activity he had in mind were advanced new communications techniques for the military and the new equipment which would be needed by the aviation industry.

He knew his firm would be able to apply key technical breakthroughs developed before and during the war to work in the postwar era.

Among those were the Autotune, the variable frequency oscillator, and linear tuned circuits, developed in 1944. The latter comprised one of the most important developments since the early days of radio. Used with the Autopositioner, another Collins invention related to the Autotune, they made complete electrical remote tuning a reality.

The Autopositioner was another idea conceived by Arthur Collins. It linked the remote control unit for an Autotune transmitter some distance away, such as in the back of an airplane, with only three wires. Before the Autopositioner some systems had as many as 10 wires running between the remote control and the radios.

Also, to raise funds that could be used in the transition from wartime to peacetime operations, Arthur went public with shares of company stock. He still maintained controlling interest, however, with 170,000 of a total of 310,000 shares of common stock "retained by company founders and directors," while 140,000 shares were sold to the public at $17 per share. Also sold were 20,000 shares of cumulative preferred stock at $50 per share. The issue was oversubscribed as soon as it went on sale.

The conclusion of hostilities in August, 1945 brought a sudden end of wartime production contracts at Collins. Nearly half of the work force of more than 3,000 had to be laid off.

One other World War II incident involving a Collins radio did not come to light until 1947, but again demonstrated the dependability of the equipment under the most trying of conditions.

It was described in a letter written by U.S. Navy Lieutenant Commander C.A. Walruff to retired Navy Captain W. E. Cleaves, who became Collins aviation sales manager after the war.

The letter explained that several months prior to the outbreak of war with Japan, the Navy had installed an emergency radio station in one of the tunnels of Fort Mills on Corregidor, the rocky two-square-mile island in the Philippines. Located three miles off the Bataan Peninsula in Manila Bay, Corregidor was the last American military outpost in the Philippines to surrender to superior Japanese forces which invaded the islands in December, 1941. Corregidor fell May 6, 1942 after more than 300 bombing raids by Japanese aircraft.

The installation, the letter noted, "was in anticipation of the probable destruction of all normal military communication facilities in the very early stages of the war. This foresight later proved to be correct in every detail. The very first day of the war saw all normal communications installations of the Army and Navy completely wiped out.

"Limited space, power facilities and antenna limitations imposed by the concrete-lined tunnels on Corregidor restricted our emergency station transmitters to relatively small and low-powered apparatus." That included a 5-kilowatt and two 100-watt transmitters, and, "a very pretty and very new Collins TCC (1-KW)." The TCC, which included the Autotune, had been developed by Collins for the Navy in 1938-39.

"After considerable experimenting and cutting and trying, we finally settled on a rhombic antenna installation with feeders running over 100 feet before leaving the tunnel, and then the rhombic built on a hillside in such a manner that it almost folded back upon itself. Any radio man, viewing our weird installation, would have been convinced that we would be fortunate to get a signal across Manila Bay. Such, however, was not the case. The antenna system worked perfectly; even during bombing and bombardments when the antenna would be down or cut, our service was not interrupted and we continued to put a Strength Five signal into Honolulu, many thousands of miles away, using only the feeder lines inside the tunnel built through solid rock. We now believe that the whole island was acting as a radiator and reflector.

"The most amazing part of the whole story is that the Collins TCC, which we all considered as very pretty in its nice enameled cabinet, very fancy with its telephone dial frequency shifting system, but probably not very rugged, turned out to be the most successful of all the apparatus available in the Far East. After our main radio station at Cavite (on Manila Bay) was destroyed the tunnel station on Corregidor took over all circuits, and the TCC was found to be the only transmitter which would work Honolulu. From that day on, until many hours after Corregidor had actually surrendered, every word that reached the United States from China, the Philippines, Singapore, Java and our Asiatic fleet was poured into Honolulu by the little Collins 1-KW TCC, keyed by high speed automatic equipment.

*It was not generally appreciated at the time, but that Collins transmitter maintained overseas communication for the Commander-in-Chief of the American, British and Dutch Naval Forces and for the Army, as well as occasionally participating in broadcast schedules for our submarine forces, which even then were causing tremendous losses to the Japanese.*

*It was not until after Java had fallen, and our forces had retreated to southwest Australia, that this tremendous responsibility was lifted from the brightly enameled frame of the very reliable, high performance Collins TCC.*

While Lieutenant Commander Walruff did not say so, it is likely the Collins transmitter played a key role in arranging the dramatic getaway by General Douglas MacArthur and his family in a Navy PT boat March 11, 1942, the first step of a perilous journey taking them to Australia. President Roosevelt had ordered MacArthur to leave Corregidor for Australia to command the Allied effort to push back and defeat Japanese forces in the Pacific. His efforts included directing the invasion operation which liberated the Philippines in 1944.

# Chapter 4
# YEARS OF TRIUMPHS AND TRAGEDY

The people of Collins Radio joined other Americans in rejoicing when Japan surrendered in August, 1945, bringing an abrupt end to World War II.

But there was worry about the future when the government suddenly cancelled all contracts held by the company for the production of military equipment.

For three and a half years the firm had been completely devoted to the war effort. The war had transformed Arthur Collins' company from a small to a large business and made it a leading government contractor.

Collins still held an order backlog of nearly $15 million in contracts to develop advanced new equipment which the armed services foresaw as needed in the postwar years.

But the company's assembly operations had come to a halt. Nor, because of the time required to get new products ready, could it immediately switch to building commercial goods.

Employment had to be pared, eventually dropping to 1,200, one-third of the wartime peak.

A determined effort began immediately to get projects underway which could bring in revenue. Priority work included resuming the manufacture of AM equipment for commercial broadcasting stations and developing a new line of FM equipment. FM radio was then an emerging new field.

Other urgent projects were to develop and build a transmitter-receiver for commercial air transports and a transmitter for business aviation, using parts and materials in stock.

Development of a new generation of amateur radios also began.

But Arthur was looking beyond the broadcast and amateur radio fields in postwar years. He saw major roles for his firm in the predicted boom in commercial aviation, as well as new generation military communications equipment. Arthur foresaw a continuing need by the Pentagon for advanced electronic equipment designs. He set a course for his company to retain a strong capability in military contracting, when many firms wanted to get completely away from that type of business.

He told stockholders the company also would look into other areas of technical competition involving innovation and new function. Consumer goods, he declared, were not in the picture. He said one interesting new field might be microwave systems for point-to-point communications.

Arthur noted that in some cases a close similarity existed between requirements of the government and the company's commercial customers, which allowed Collins to undertake projects which could be adapted to both markets.

Collins thus began an adjustment which lasted about four years until sales and earnings again turned upward.

During that time Arthur had his development engineers and technicians working on new commercial aviation equipment, and a significant new field for the U.S. military — ultra high frequency (UHF) aircraft and ground radios.

Collins had worked on airborne UHF radio designs even before the war ended. But with the close of hostilities, a significant opportunity arose, and Collins took advantage of it.

Since the early 1940s the U.S. armed forces had planned to switch from the very high frequency (VHF) to the ultra high frequency (UHF) band for short range communications requirements of aircraft and ships. The change had to be postponed until after the war but then became urgent when the government allocated the VHF band for civil functions, including television, aviation, commercial AM and FM radio.

Collins' efforts in UHF paid off with development of the AN/ARC-27 aircraft transceiver, representing major advances in that type of radio. It was selected as standard equipment for all U.S. Navy and Air Force aircraft, and was produced in large quantities, more than 1,000 per month, during the Korean War.

By 1951 Collins Radio had a military order backlog of $150 million, much of it contracts for UHF air and ground equipment, and the number of employees again topped 3,000.

The UHF business led the company's recovery and turnaround after World War II. Arthur made it known the UHF effort justified the course he had chosen for his company since WWII. In a June, 1951 talk to assembly workers, recognizing them for the production record on the AN/ARC-27, he said:

*Going back to 1945, I might remind you that our company at that time redoubled its efforts in the development of special military equipment, including work which led to the ARC-27. We stressed special equipment development when other companies in the industry were happily building television sets and other home gadgets. Many people thought we were crazy to continue with our old line of work and that if we didn't develop consumer products we would soon be out of work. As a matter of fact we did have several unprofitable years of operation, but we were successful in developing several important equipments, probably more than any other electronics company.*

Thus as the 1940s wound down and the 1950s began, the radio company founded by Arthur Collins 20 years before was poised for a golden decade. For Arthur personally, it would be a decade of great technical triumph and personal tragedy.

A buildup of additional outstanding talent had begun after World War II. Among those hired were many veterans obtaining their engineering degrees after wartime military service.

Arthur also for the first time had established a company department devoted to research. The first director of research was a colleague from an earlier time, Dr. Winfield W. Salisbury.

Salisbury had been a research assistant at the State University of Iowa in 1927 when he and Arthur, then 17, built radio equipment and installed it in a van for a trip from Cedar Rapids to the west coast and back, doing short wave experiments with the U.S. Naval Observatory. The third participant on the trip was Paul Engle, high school classmate of Arthur who became a Rhodes scholar and later a famous writer and poet. Salisbury soon migrated to Hollywood, where he worked as a recording engineer in the motion picture industry.

In the mid-1930s Salisbury obtained a Ph.D. from the University of California at Berkeley, and during World War II worked on high level, secret scientific programs at Harvard and MIT. His wartime achievements earned him the President Harry S. Truman Certificate of Merit in 1948, and in 1950 Cornell College at Mount Vernon, Iowa awarded him an Honorary Doctor of Science degree.

At Collins he brought in a group of scientists including several Ph.D.s for his research staff. While he was at Collins from 1945-51 his department initiated a number of unique projects.

One of those was the first commercial design and construction of giant machines called cyclotrons, better known as atom smashers, for the Atomic Energy Commission, later retitled the Nuclear Regulatory Commission. Starting the project in 1947, Collins eventually built several of the devices, weighing hundreds of tons, and related equipment for atomic research facilities. The first was delivered to the Brookhaven National Laboratory on Long Island, serving pure science. Another went to the Argonne National Laboratory near Chicago. Also equipped with a cyclotron was a New Mexico laboratory. Providing service for many years, their purpose was to study the structure of matter and to produce radioisotopes used in the physical, chemical and biological sciences. Salisbury and his colleagues received a number of patents related to the cyclotron.

Another interesting program was the Resnatron tube, which could generate up to 80 kilowatts of power on VHF and UHF frequencies. It was a large tube nearly three feet high, posing a major engineering challenge alone in the extensive water cooling system required to dissipate heat it created (20 gallons per minute at 200 pounds pressure.) Collins used the device in UHF propagation research.

Dr. Salisbury had helped conceive the idea of the Resnatron in 1938 while at the University of California. The tube later was developed, largely at Harvard University, and used in England during World War II to jam the radar systems which guided German night fighter aircraft. The Nazi radar had been highly effective in tracking British bombers trying to reach targets on night raids over continental Europe. That enabled German fighters to inflict heavy losses on the British. But when Allied technicians employed the Resnatron, the Luftwaffe radar was rendered so useless the Germans had to switch to other, less successful types of detection systems. The project was called Operation Tuba, a reference to a huge funnel-shaped antenna built on the English coast, used to beam the high power Resnatron signals across northern Europe.

An application of the Resnatron attracted widespread attention in November, 1951, when Collins and the National Bureau of Standards joined efforts in a moon bounce experiment. The operation had started out as a "hush-hush" government project, but soon became widely publicized.

For the project, a 75-foot-long "tapered wave guide horn" antenna was constructed along the east wall of the Collins hangar at the Cedar Rapids airport. It had four flat sides made of chicken wire, was two feet square at the small end with an opening 25 feet across at the other, and pointed slightly upward from earth. With 20,000 watts of Resnatron-generated transmitting power, a 418-megacycle coded signal was directed toward the moon, when the moon was in the right location. The moon served as a natural reflector, causing a very small amount of the radiated energy to return to earth and be detected by a NBS station at Sterling, Virginia, 800 miles from Cedar Rapids. The signal was received with a 30-foot dish antenna.

Decoding of the signal at the NBS station revealed a message, "What hath God wrought?," first used by Samuel B. Morse in 1844 on a telegraph line from Washington to Baltimore.

The Resnatron probably was the only type of tube at the time for use with ultra high frequencies which could provide the required level of power on a continuous basis.

While it was not the first time signals had been bounced off the moon, the Collins-NBS effort provided the first transmission of an intelligible radio message by lunar reflection.

The NBS noted the experiment added to knowledge needed to communicate with future orbiting space ships, and the use of natural or man-made satellites as communication relay stations. Collins in later years played key roles in manned space flight communications.

Salisbury and Arthur Collins had hoped the Resnatron would find important applications in the FM radio and television fields, but it remained mostly a laboratory curiosity.

Salisbury also expanded the Collins vacuum tube laboratory, used to manufacture the Resnatron and for research on tubes.

The moon also was the subject of other research conducted in 1949 by Dr. Salisbury and a team of engineers. It involved a series of experiments conducted from the roof of the Third Street building in downtown Cedar Rapids, at Third Street and Fourth Avenue. For many years Collins occupied all but the ground floor of the six-story building.

Using radar signals, Salisbury developed a technique of measuring the temperature of the moon before, during and after it was in the earth's shadow. He concluded from his data that the moon was covered by a six-inch layer of dust or volcanic ash, a finding confirmed in 1964 by pictures from the Ranger 7 satellite, and in 1969 by the first landing of men on the moon.

Another major program stemming from Collins' research capabilities in 1949-50 involved a structure visible for years to millions of people in the Washington, DC area.

It was the 50-foot radio telescope dish antenna on the roof of the Naval Research Laboratory, across the Potomac River from Alexandria, Virginia.

Collins contracted to build the dish, more accurately called a parabolic reflector. Its purpose was to enable radio astronomers, with the help of an extremely sensitive radio receiver, to detect and study radio waves emitted by celestial bodies such as the sun, moon and stars.

The reflector consisted of 30 aluminum sections bolted on a circular girder and a steel mount — 50 tons in all. The large structural parts were fabricated by ALCOA and Bethlehem Steel, assembled and machined to extremely close tolerances under a tent near the Collins Main Plant in Cedar Rapids. The unit then was disassembled, shipped to Washington by rail, and erected on the roof of the Naval Research Laboratory. At the time it was the largest parabolic reflector ever built, and it became a forerunner of other major antenna projects by Collins in years to come.

The scientist in charge of the reflector project for Collins, and who also had played a lead role in the moon bounce experiment, was Irvin F. Gerks, Sr. Gerks was later named a Fellow of the Institute of Radio Engineers for his contributions to the knowledge of ionospheric and tropospheric propagation. In pre-war years he had been a professor of electrical engineering at Georgia Tech, where one of his students was Les Bessemer, vice president of manufacturing and a member of the Collins Board of Directors.

Also during the years of Salisbury's direction of research activities, the initial Collins Radio work on microwave transmission began. On one occasion a development model of a microwave receiver was being tested on a company aircraft. Arthur Collins had to pay five dollars to Win Salisbury after losing a bet the receiver could not pick up a signal more than 100 miles from the transmitter. Within a few years microwave systems became a major product line.

Another program in that period was gear to provide communications with tracking stations of the Atlantic missile range, when the first U.S. Army missiles were being tested.

Also in the early post-war years the company began to apply recent scientific findings to develop the radio sextant. It detected microwave energy from the sun, used in a new all-weather navigation technique for mariners who long had been limited to visual sightings of the sun and stars in setting the course of ships at sea.

Arthur always felt a great deal of pride in the scientific knowledge generated by his company's research projects, even when they did not lead to marketable products. He kept close tabs on the research activity as well as military, amateur and broadcast equipment development in the early 1950s. And of course, he had to do his management chores while the main thrust of his effort and time went into avionics programs engineering.

In line with Collins Radio Company's growth after World War II came expansion to new locations in California, Texas and Canada. Each of those initiatives eventually grew into major facilities in Newport Beach, Dallas and Toronto.

The California connection began in 1946 with opening of a sales office in Los Angeles. That was about the time Collins was starting its R&D programs in mechanical filters and data communications. Arthur decided those activities should be located in that area, and the company soon occupied a plant in Burbank to house laboratories and some specialized manufacturing. It underwent several expansions over the next 10 years as Collins developed and began building modems and

Kineplex data transmission systems there. Mechanical filters and other components also were produced at Burbank, referred to as the Western Division.

About 1958 Collins acquired a large area of land at Newport Beach and began planning replacement of the Burbank plant with an advanced R&D operation to be called the Information Science Center (ISC). The first building, consisting of laboratories and administrative offices, was occupied in 1959-60. Melvin L. Doelz, long one of the top engineers at Collins, was appointed vice president and general manager of ISC and also named a corporate director.

ISC was described as having been established *to advance the science of communication and data information.* It was where initial work began in thin film and other miniaturized circuit developments widely used in Collins products. The year after the facility opened the first electronic switching system was developed there by Collins. In the late 1960s Arthur had ISC scientists working on advanced new circuitry for his C-System projects.

The Dallas branch of Collins began in 1951 with the opening of a plant and airport service center. The move to Dallas came both from Arthur seeing a need to avoid a concentration of all facilities in Cedar Rapids for economic reasons, and from the Pentagon wanting the firm to be spread out geographically for security reasons.

Still more expansion for the company began with the formation of Collins Radio Company of Canada in 1953. At first it occupied a sales office in Ottawa, handling a growing volume of military equipment contracts with the Canadian government. In the next year headquarters were moved to Toronto, and construction of a building began. Eventually the Collins Canada facility on Bartley Drive totaled 111,000 square feet of engineering, office and manufacturing space for 550 employees. Most of the Toronto plant's work was equipment designed for Canadian defense, but a number of products developed at Cedar Rapids and Dallas also were manufactured there.

While much attention was given to expansion in the early 1950s, the Cedar Rapids operations resembled a beehive of research, development and production activity. Engineering was centered in increasingly cramped conditions at the Main Plant and the downtown Third Street building. In September, 1952, the company announced plans for a new engineering building on a wooded 52-acre site in Marion Township, east of C Avenue between 50th Street NE and Blairs Ferry Road. That area at the time was undeveloped. The only other recognizable landmark in an aerial photograph of the area was the Cedar Memorial Cemetery to the south. The new Collins building became the first industrial-commercial structure built in that part of Cedar Rapids.

Occupied by 650 persons in 1954, it was one of the most modern and best equipped electronics engineering facilities in the nation. The company later purchased an additional 90 acres west of C-Avenue, and in 1955 built a new structure there for its metal fabrication work. That was the first phase of what became a huge complex on the site. Also in 1955, Collins opened a branch manufacturing operation in a rented building in Anamosa, about 20 miles northeast of Cedar Rapids. Most Collins amateur equipment was assembled there.

Collins Radio began the first steps in the early to mid-1950s in space projects which eventually led to providing the communication systems aboard all Mercury, Gemini and Apollo manned spacecraft, and ground tracking systems for those missions.

And Arthur Collins had the satisfaction of seeing in the 1950s the fulfillment of an objective he had set 20 years earlier — to become the world leader in aviation electronics.

The decade of the 1950s also was the period when Arthur led his firm in making high frequency single sideband a practical communication method. That was one of the most significant developments in the history of radio and perhaps his greatest contribution to radio science.

There also was another major program which reached fruition in the 1950s, a significant evolutionary step in the history of communications.

It was called transhorizon, also known as scatter, tropospheric or ionospheric communication. It became an adjunct to the various types of communication then available — radio, microwave, cables and wire lines. Collins Radio Company was the main organization responsible for the transhorizon or scatter development.

Scatter was a technique little known to the public but which proved of vital importance to American defense capabilities.

Collins, working with government and other technical sponsors, conducted R&D efforts in the scatter medium for approximately two decades, dating from 1945.

The scatter method was based on beaming a high power VHF or UHF signal toward the horizon in a specific direction. Depending on the method used, the signal rose into either the troposphere or ionosphere. Atmospheric or ionospheric conditions caused bits of the signal to be reflected or scattered and fall toward earth, while the main beam went off into space. Well beyond the horizon, a high gain antenna and highly sensitive receiver were able to detect and collect a small portion of the scattered signal. The troposphere is that part of the earth's atmosphere about six to 12 miles above the surface; the ionosphere starts about 50 miles out from the earth.

The scatter technique, coming before satellite communications became reality, in effect filled a gap between long range HF which sometimes was limited in effectiveness by whims of nature, shorter range conventional VHF and UHF limited to line-of-sight transmission, and microwave, requiring numerous relay stations. Scatter, on the other hand, appeared unaffected by atmospheric conditions and could span areas of oceans and terrain where microwave was impractical.

Collins engineers eventually developed UHF equipment and methods for tropospheric transmission and reception over path lengths of about 400 miles. Ionospheric communication utilized VHF, and could cover path lengths up to 1,200 miles. Transmitter power output ranged from one to 10 kilowatts on UHF and 20 to 40 kilowatts on VHF.

During the development phases, Collins ran tests between Cedar Rapids and

Massachusetts, Virginia, Florida and Dallas, as well as with stations in Wisconsin, Illinois, Missouri and other points in Iowa. Scatter required large dish antennas. One was visible for years on a tall tower adjacent to the Engineering Building in Cedar Rapids. A special scatter communication engineering and antenna facility was located near the Cedar Rapids airport, called the Konigsmark Laboratory.

Mel Doelz recalled an interesting phenomenon noted by those working on transhorizon development. Doelz was one of the company's top engineers in early work on the program before becoming vice president of Collins West Coast operations.

*When a meteorite appeared in the area where we were testing, it caused a cloud of ions and radio waves would reflect off of it. It was interesting to listen to — we actually could hear meteorites,* he said.

Following initial development work in Cedar Rapids and California, production of scatter equipment was done in Dallas.

While Arthur Collins did not personally oversee all of the scatter program, he contributed significantly to antenna development and transmitter-receiver designs. One story which made the rounds was told after he had a group of engineers from Cedar Rapids fly to Dallas to spend the weekend on a parteularly thorny problem. Working continuously, they did not even stop to eat, and began to wonder when that would happen. Finally, late Sunday afternoon, Arthur said it was time to get something to eat, and the engineers anticipated dinner in a nice restaurant as a reward for their extra effort in solving the problem. But instead, he sent out for hamburgers.

The major customers for scatter were military agencies, although there were a few commercial applications by mining companies, oil and gas pipelines.

The most extensive use of the scatter technique came on the DEW Line, the huge electronic warning system erected across the Arctic to alert the U.S. and Canada of any air attack from the Soviet Union during intense years of the Cold War.

DEW stood for Distant Early Warning. It was a chain of radar stations stretching in a 3,000-mile arc from Alaska to Baffin Island, far above Quebec and Hudson Bay. It was along the 70th Parallel, about 250 miles north of the Arctic Circle.

The DEW Line was a major achievement, both technically and in construction of facilities in the hostile Arctic environment. Two major technological breakthroughs were credited with making it possible from a cost and operational standpoint.

One was the capability to have automated operation of radar equipment, which minimized the manning and supply needs at the remote stations.

The other was the scatter communication systems developed by Collins.

Two factors were absolutely essential for the DEW Line to be effective: complete, continuous radar coverage of the entire DEW Line, and instant unfailing communications to alert rear base defense commanders of any hostile activity.

The scatter method provided reliable communications at all times. With the right equipment, techniques and frequency selection determined by years of research, scatter was effective despite magnetic storms, the aurora borealis and other Arctic conditions which often disrupted HF transmissions. Other types of Collins equipment also were widely used on the DEW Line, including HF radios for communication between stations. Ham gear allowed persons at remote stations to talk with folks back home. VHF equipment provided communication with aircraft flying in men and supplies and with vehicles.

Longer range VHF ionospheric equipment linked the DEW Line with command posts located to the south, providing both voice and teletype communications. The teletype channels could handle extensive volumes of data, utilizing Collins Kineplex equipment and modems, the most advanced systems available in the 1950s to move data over radio channels or wire lines.

The UHF tropospheric systems were used laterally along the DEW Line between stations. One feature was toll quality telephone transmission, over the full length of the line.

The fixed station installations of the DEW Line included both dish antennas and huge structures called parabolic antennas resembling outdoor movie theater screens. They and radar domes had to be built to withstand fierce Arctic winds, blizzards and ice storms. Living and working quarters for crews were built as modular sections and moved by sleds to station sites.

Another major transhorizon system was built by Collins in the Pacific. It provided tropospheric communications between Okinawa and Taiwan, 409 miles apart. Bill Weinhardt, who headed Collins construction operations, recalled local contractors and labor were used with Collins supervisors for construction on mountain sites of the two stations. The Taiwan site was particularly difficult, requiring mostly hand labor. Weinhardt said the big 60-foot parabolic antennas and other structures had to be built to withstand typhoons.

The Pacific system was built for the U.S. Army and became a vital communication link for the Pentagon during the years of the Vietnam conflict.

Working with the Army, Collins also designed portable transhorizon systems with inflatable dish antennas which with their towers could be hauled in trucks or helicopters and set up rapidly. The Army outfitted a number of Signal Corps and combat units with the mobile tropospheric equipment. One application provided the command and control functions for mobile missile systems.

At one period in the Vietnam theater, the Army had 14 scatter sites using Collins equipment spread over 600 miles. A Signal Corps communications officer explained that scatter was the answer to *going over the enemy's head to get messages through, because the enemy held much of the high ground in the embattled country.* Signals of 1,000 watts were pushed 15 to 20 miles above the earth into the troposphere, with a small portion received and retransmitted by relay stations along the way.

*Even with 99 percent of the signal going off into space, the remaining fragment is 99.9 percent reliable and fully sufficient to keep the relay going,* the officer said.

Another major accomplishment by Arthur Collins' company in the 1950s was modernizing communications of the U.S. Navy. Unlike World War II, when all the ships of a fleet were seldom more than a few miles apart for air defense, the nuclear age made wide dispersal of ships over hundreds of miles necessary to prevent the crippling of an entire fleet by a single atomic weapon.

The fleet strategy change also posed new communications challenges. The solution was single sideband systems. The first radio supplied was a versatile transceiver, the AN/URC-32, modified from a Collins commercial design. Installed on nearly every Navy ship, they provided greatly improved reliability and performance as well as size and weight reductions compared with earlier equipment. In later years, the initial SSB radios were phased out as Collins supplied more sophisticated and specialized systems.

Another development for the Navy in which Collins had a main role was one of the most advanced concepts of its time, the Naval Tactical Data System. NTDS utilized sensors to collect data, radio equipment to transmit data, computers to process data, scopes to display data and a variety of recording, printing and other devices. The sensors were on ships throughout a fleet, with the computers on major combat and command ships. It was a system which in the event of a combat situation performed functions such as detection, location, identity, tracking, speed and size of both friendly and enemy forces, also coordinating defenses against air and missile attacks. The information was automatically and rapidly displayed for commanders to use in deciding appropriate actions.

The NTDS data transmission techniques and equipment were Collins Kineplex systems from the company's west coast facilities. HF single sideband equipment built in Cedar Rapids was used to send and receive data between ships.

Since the late 1930s, the U.S. Navy had been the largest single customer for Collins equipment. There was hardly any Navy ship or aircraft which did not have some Collins gear on board.

Collins also built up its antenna research program in the 1950s. In late 1956 Dr. Raymond H. DuHamel came to Collins as head of the antenna research and devlopment group. He previously had been a research professor at the University of Illinois antenna laboratory, where he began theoretical work on logarithmically periodic antenna structures. At Collins his work led to breakthroughs and a wide range of new designs in log periodic antennas, offering directional and broadband capabilities.

While Arthur Collins' company had an amazing series of successes in the 1950s, his personal and family life was marred by a terrible tragedy. On December 29, 1955, Arthur's wife Margaret, usually called Peg, was preparing dinner in the family home in Cedar Rapids when she was stricken suddenly with a cerebral hemorrhage and died before she could be taken to a hospital. She was 46. The death occurred just six days before what would have been their 26th wedding anniversary. She was survived by Arthur, daughter Susan Mary, 16, son Michael Merle, 12, and her mother, Elizabeth Hall Van Dyke.

Mrs. Collins was a member of the Cedar Rapids First Presbyterian Church, the Cedar Rapids Garden Club and Junior League of Cedar Rapids, on the Board of Directors of the Cedar Rapids Art Association and a Trustee of Coe College.

She was regarded and acknowledged as a very talented artist and proficient bridge player. Among her many activities, at one time she was a den mother for the Cub scout group which included Michael.

In her work with the Junior League, she designed the Playtime Poppy symbol long used by that group in promoting and staging productions of children's stories for community groups. Marvin Moody, who served as Collins Radio patent attorney for many years, had the symbol copyrighted.

Arthur and the children were devastated by the loss of his wife and their mother. He took Susan and Michael out of school for about a month and they went to Sarasota, Florida where Arthur kept a boat. Doris Stein, who began working as secretary to Arthur about a year before Peg's death, recalled Arthur called a number of times from Florida, sometimes asking to have another suit or other items from his home sent down.

Probate information filed at the Linn County courthouse listed the value of Peg Collins' estate as $5,787,026. The largest part of the estate consisted of 137,264 shares of Collins Radio Class A common stock, valued at $3,157,022. Her share of the 8.83-acre Collins homestead on 34th St. SE was valued at $50,000. The will left one-half of the estate to Arthur, the other half to be kept in a trust with income to accrue to Arthur during his life, with Susan and Michael eventually to share in the trust and trust property.

Besides losing his wife, Peg's death was highly costly to Arthur financially. He had been advised by his lawyers sometime before that because his personal stockholdings were so extensive, his heirs would face tremendous estate taxes if he should die. They recommended and Arthur agreed that ownership of much of the stock be transferred to Mrs. Collins, which required payment of a gift tax but in the long run was intended to save money. But when she died, and the stock reverted to Arthur, he ended up paying hundreds of thousands of dollars in taxes, the result of a scheme originally designed to avoid such a tax bill.

Arthur arranged for a caretaker to stay in the family home and he resumed working as hard as ever, but often felt lonely and forlorn after Peg's death. An incident possibly related to that occurred when he went for a drive late Sunday night, March 3, 1957, in his Mercedes 300SL coupe.

Driving west toward Cedar Rapids on Old Mount Vernon Road, Arthur lost control of the car. He skidded about 210 feet and tore out a section of guard rail, coming to a stop just short of Big Creek Bridge. He escaped injury but the car was badly damaged and had to be towed away. A highway patrolman charged him with reckless driving and driving without a valid license.

He may have been driving faster than was safe on the narrow, winding road, part of the original U.S. Highway 30 built in the 1920s. He claimed some road work was being done in the area and the concrete was covered with a lot of loose gravel, which he said made control of the car, *like walking on ball bearings.*

He reportedly tried to keep mention of the accident out of the Cedar Rapids Gazette and was miffed that the Gazette ran a small story, mentioning the charges he faced. Several days later the Gazette listing of Municipal Court actions reported Arthur paid a $10 fine for no drivers license and $25 fine for failing to have his car under control, indicating the reckless driving accusation had been reduced to a lesser charge, probably due to efforts by company law firm attornies. One of the stories which made the rounds about Arthur during his career was that he never went in person to get a drivers license renewal until eye tests became a requirement.

Another reported reaction to the accident came from Arthur's mother, age 77. She told him that driving sports cars like his Mercedes was too dangerous, and he should quit doing it.

Arthur plainly did not like being a widower and single father, and mentioned that circumstance to a Cedar Rapids physician friend and his wife. As they visited, the couple told Arthur about a single lady of their acquaintance and asked if he would be interested in meeting her, if she should be interested in meeting him. Arthur allowed he would appreciate the opportunity to meet her.

Due to busy schedules, the proposed meeting proved elusive to arrange. The lady was Mary Margaret Meis, oldest of nine children in a Cedar Rapids family, a graduate of the University of Iowa and assistant director of dietetics at Mercy Hospital.

Recalling years later about the circumstances of how she and Arthur met, Mary said it finally was scheduled to happen at the Collins home over dinner. But on the appointed date unforeseen problems involving the dinner plans came up, and she ended up preparing the meal. After that they began seeing each other quite often. Arthur occasionally had lunch with her at Mercy Hospital and sometimes came to pick her up after work. Mary recalled that caused a lot of tongue wagging among the hospital staff. She said Arthur also brought flowers to the Catholic nuns who were Mary's supervisors at Mercy.

The relationship turned into a romance and plans by Mary and Arthur to be married. Mary was a devout Catholic. Arthur grew up as a Presbyterian but had little interest in church or religion. He had no intention of becoming a Catholic, but consented to visit with a priest for instruction, and agreed that if he and Mary had any children they would be raised Catholic. Mary arranged for the instruction with her uncle, The Rev. Carl F. Clems, pastor of St. Mary's Catholic Church at nearby Solon.

They were married on a Monday, June 10, 1957, when he was 47 and she was 33, with Father Clems officiating. The wedding took place at 11 a.m. at Immaculate Conception Church in Cedar Rapids, followed by a reception and luncheon for families and a few close friends at the Roosevelt Hotel.

They first went to Florida, then on a honeymoon by ocean liner to Europe. The baggage included a KWM-1 amateur transceiver.

As the wife of Arthur Collins, Mary found herself plunged into a hectic lifestyle and often uncertain schedule. She had to maintain the family home for herself, Arthur, Susan and Michael, do extensive entertaining which often was impromptu, and frequently be ready on short notice to accompany Arthur on a trip or visit to his boat. Mary also kept up ties with her family and her church activities. She also developed close friendships with wives of other company executives.

They eventually had two sons, Alan, born February 23, 1963, and David, born July 12, 1966. Alan and David did most of their growing up in Dallas after Arthur and Mary began to spend more time there and built a new home in the late 1960s.

As for Collins Radio Company, the 1950s were perhaps the most prolific decade of any in the company's history. The firm appeared to be far out in front in many areas of technology. It made major strides in commercial and military avionics, and became the leading supplier to the world's airlines of aircraft electronics equipment.

It had engaged in major research projects such as the moon bounce which brought wide recognition. Its amateur radio equipment was the world's best. In early 1955 it introduced a revolutionary advance with single sideband radios.

It was among the industry leaders in broadcast equipment, offering many engineering innovations.

It was starting to make a move in microwave systems and data transmission. It was doing important work in space communications.

Financially, too, the company was beginning to be recognized.

Collins was seen as an up and coming company spawning a steady stream of new technical developments. It was looked on by many investors as attractive, because it might someday produce a discovery which could make them a lot of money.

In the 10 years from 1949-1959, Collins Radio Company annual sales grew ten-fold, from $12 million to the $120 million range. The best year in that period was 1957, nearly $127.5 million. A not unusual situation followed the next year for a firm depending heavily upon government business, a decline to $108 million.

That was followed by a rebound in 1959 to $118 million. The 1959 fiscal year also brought the highest earnings in the company's history, triple those of the previous year.

Much of Collins' growth had come from *plowback of earnings*, in the farm terminology of Arthur's father, M.H. Collins. New development, however, often cost more than could be generated from earnings. Thus the possibility of gaining new investment from shareholders was an attractive opportunity.

In announcing 1959 results, the Collins Board of Directors voted to seek a listing on the New York Stock Exchange. Collins stock had been carried on the over-the-counter market since first being offered to the public in 1944.

Among preliminary steps required for the stock listing was certification by the State of Iowa, where Collins Radio Company was incorporated. The procedure was handled mostly by the secretary of state, and if all requirements were met, approval in such a matter was usually routine. But in the case of Collins Radio, a problem arose. Several rural legislators still harbored grudges stemming from the early 1930s Collins Farms project of M.H. Collins, and threatened to block the certification approval. Arthur solved the problem with the help of Ernest Kosek, a long-time friend and Washington High School classmate who operated a financial investments business. Kosek described Arthur as: *A very congenial person, and one of the smartest persons I ever knew*. Kosek had represented Linn

County and Cedar Rapids in the legislature for a number of years, and was a Republican party leader. *I talked to those who were raising objections, and got them to see that the son should not be held accountable for whatever ill will they held towards the father,* Kosek said.

Trading of Collins common stock on the New York Stock Exchange began December 8, 1959. The opening price was 56-3/8. There was an immediate heavy demand to buy shares.

The next day saw a drop to 47-5/8 due to profit taking, but then came eight days of steady gains, with the price hitting $72 on December 16. On December 15 it had been the most heavily traded stock on the Big Board.

During the years the stock was listed from 1959 until 1973 it made several impressive gains in price as company fortunes rose, but paid only nominal dividends. In times when a substantial profit was realized, Arthur always preferred to use most of it for one of his projects rather than pay a high dividend. There were other periods when the stock price plummeted, as low as 9, then rose into the 90s as good times returned. Investors gained most from Collins stock if they bought low and sold high.

Another significant factor for Collins in the '50s was the build-up of its International Division, directed out of Dallas following the rapid growth of operations there.

Also, in that decade, Collins began developing the first of several Jeep-mounted communications systems for the U.S. Army and Marine Corps. Each of those was a major project which required great ingenuity and intense effort achieved only by long days, night and week-end work by electrical and mechanical design engineers, draftsmen, component specialists, lab and tech technicians and many more persons.

And while it was not realized at the time, some of the most significant contributions to technology by Collins came from work in data transmission in the 1950s. Among those were pioneering achievements in modem design and speed.

# Chapter 5
# How He Worked

Arthur Collins was an exceptionally intelligent, intuitive person who had a unique ability to translate the knowledge he gained from study and research into tangible, operating equipment and systems.

He did most of his study and research on his own, and preferred doing it that way from early years of his life. He chose to leave high school early, and had only one year of formal college training. But he read extensively, ever eager to be aware of the latest scientific discoveries.

He could read or hear about a new technical finding, soon acquire a detailed understanding of it, and then envision the design of hardware to utilize its potential. He was intrigued by everything electrical, mechanical and hydraulic. He liked to see how devices worked, to examine how they were made, and to think about how they could be made differently.

He was a practical man and his ideas usually were practical. Although some people thought he was venturing into blue sky areas when he launched new projects, Arthur had complete confidence that the end result would bring an advanced new product or system.

He had a highly developed, perhaps innate ability to anticipate and perceive future trends and needs in communications and electronics.

He had foresight for the potential and direction of electronic systems, but not just general concepts. He not only could foresee a potential new development or adaptation, he also could define the steps and equipment that would make it become reality.

Persons who worked with Arthur used to say his thinking was five to 10 years ahead of others in the electronics industry. Time has proven in some instances that he may have been 30, 40 or even 50 years ahead.

An example of that was shown in an article in a 1993 issue of a specialized magazine directed at engineers who worked with mounting components on circuit boards. The article discussed how equipment designers needed to consider transmission line effects in data systems to be certain their equipment would work. Frederick W. Johnson, responsible for mechanical engineering work on many of Arthur's programs, recalled that Arthur said much the same thing 30 years before in spelling out concepts for Collins' circuit board and computer developments. He understood that controlled impedance transmission lines would be an important part of advancing technology.

John Boyle, a Collins marketing vice president, once came out of a meeting with Arthur and told a colleague:

*You and I will never have the foresight of that man. Just now I learned the* *reason for something he told me to do three years ago. At the time I couldn't understand why he wanted it, but now I know why.*

Many of the computer concepts which Arthur had his engineers develop as early as the 1950s and others he sought to develop became routine processes and applications in the computer explosion a few decades later.

Arthur had a remarkable talent for motivating, directing and organizing teams of electrical and mechanical design engineers — themselves very brilliant persons — to advance the state of the art and in many cases achieve significant breakthroughs in communication systems capabilities and applications.

And he also had the ability to instill and achieve an attitude and desire in many people — industrial and manufacturing engineers, skilled metal workers, production technicians and assembly personnel — to build his and his design engineers' creations to the quality standards he demanded. The persons who worked on production lines, inserting and soldering the components and wiring and putting together the parts which made up radios, antennas, control units, instruments and other equipment, were called assembly operators. They were mostly women, and comprised a large part of the company work force. Most were highly deft, capable and conscientious at their craft, and many had years of experience. Equally dedicated and talented were technicians who tested equipment and those who supervised assembly lines and supplied needed materials.

At the same time, Arthur allowed ample opportunity and encouragement for individual imagination and creativity by engineering department people. The company never could have grown as it did if all the ideas came from one person.

It stands to reason that a strong central leader such as Arthur Collins will have many people around him with characteristics much like his own — men who worked hard to achieve results, not afraid of trying something new, always learning. Arthur attracted many engineers with those qualities.

He occasionally made the remark, *Stay on the frontier.* He wanted to look ahead, delve into new areas, probe ways of doing things differently and try new approaches. He not only wanted to be at the frontier of new technology, he wanted to keep it moving forward.

Another of his favorite sayings was: *Never put blinders on,* referring to searching for ways to solve a problem.

Arthur always considered his company to be an engineering company, meaning its main mission was to develop new products. Collins Radio manufactured only those products, and there were many, designed and developed by its engineering staff, never from an outside source. In 1966, 35 years after Arthur began to build radios for sale, his company held 874 active U.S. patents and 880 foreign patents.

In remarks he gave when accepting an honorary Doctorate of Engineering Degree from Brooklyn Polytechnic Institute in 1968, he noted his company always had been staffed in all levels of management preponderantly by engineers. That was unusual in the 1930s and '40s, Arthur commented, but commonplace for electronics and aerospace firms in later years.

Most Collins engineers, because of the nature of the business, were electrical and electronics engineers. The next largest group was mechanical engineeers, followed by manufacturing, industrial and other types. The firm also had mathematicians, physicists, chemists and other specialists, often holding engineer titles. In the 1960s computer engineers and programmers came on the scene.

There was no doubt, in his *engineering company*, that Arthur Collins was the lead engineer. He certainly did not develop every product, but he had a detailed knowledge of them.

Everyone at Collins Radio Company knew that Arthur accepted nothing but the most advanced design that could be achieved in a product and that it had to be built to the highest possible quality standard.

He was vehemently opposed to anything that was not first rate, a main reason he never allowed his company to produce goods for a mass consumer market.

In many companies, engineers work under conditions of *don't make changes that cost money.* But Arthur's troops had no such restraints when they worked directly with him on one of his pet projects. He always wanted his equipment to be the best it could be. He did not produce goods for markets where price was the main consideration.

Arthur either was blessed with or drove himself to have an energy level beyond what most ambitious people ever could hope for. It was not uncommon for him to work 24 to 36 hours at a stretch. He could take a brief nap and be as refreshed as most people expect to be after a night's sleep.

Keith Rathjen, who directed much of the mechanical design for the Collins C-8500 computer program, said that in his career he had known a number of hard working persons, but never anyone who worked as hard as Arthur. *What we called work was his hobby, his vocation, his avocation, his job, his love. When he did what we all regarded as work it was exactly what he wanted to be doing.*

He was, simultaneously, a well-mannered, highly polite gentleman, and a demanding, inconsiderate boss, intent on achieving the immediate objective on his mind at the moment, regardless of the time of day, day of the week or whether it was a holiday when his top aides were entitled to be home with their families.

On one occasion an engineer who was instrumental in Collins amateur radio developments was summoned to Arthur's home in Cedar Rapids the afternoon of December 24. Arthur often had a development model of any new ham unit at his house. He wanted the latest engineering modifications made to his home unit so he could check it out on Christmas Day.

The engineer had planned to drive after work that day to southeast Iowa, about a three-hour trip, to join his family and relatives for Christmas.

About 9 p.m. with work on the radio still not finished, the engineer asked Arthur if he might call his family to tell them he would not join them until the next morning. Arthur said, "sure, there's the phone." It was about 11 p.m. Christmas Eve when he finished the job.

On another occasion he called Bob Cox and John McElroy, both vice presidents, in the middle of the night to come over to his house and help restore an antenna that had burned out while he was hamming.

Conversely, he always remembered the birthday of Milo Soukup, who had been with the company since early days.

And many employees received personal letters of condolence signed by Arthur when he learned of the death of a parent or other close relative.

Arthur sometimes displayed a sharply critical, debasing attitude toward other persons. But underneath such an apparent gruff exterior was a gentler personality. James Holahan, longtime editor of Business/Commercial Aviation magazine, recalled a rare interview with Arthur. He was in Cedar Rapids to obtain information on Collins avionics equipment and by chance was introduced to Arthur. *When I said something like how interesting it must have been in early days of radio, Art yelled out, 'hey, I didn't know this was going to be an interview,' and began to upbraid me for asking such a question. But then he softened up and we had a very cordial visit,* Holahan said.

Men who held key executive positions under Arthur Collins, particularly those in engineering, remember many spur-of-the-moment Sunday, evening and holiday meetings called by Arthur when he wanted to work on a problem or discuss a new idea. When he got an idea in the middle of the night, he would call and wake up one or more of his engineers to come to the plant to work with him on it.

One associate of 30 years, a senior executive with the company, recalled that, *Arthur ate, slept and dreamed whatever idea was on his mind at the time. He used to say he didn't have a watch and he didn't have a calendar and if something needed to be talked about and done, he called a meeting — even if it was New Year's Day. And we showed up.*

Dr. Gene Marner, who directed Collins' research programs in the 1960s, remembered being called to Arthur's office one morning for what he thought would be a short meeting. "He wanted to be brought up to speed on collision avoidance (system for aircraft)," Marner said. Rather than a brief session, the meeting lasted 36 hours.

Such a meeting was not considered unusual for his close associates. When Arthur wanted to know about something or solve a problem, he went at it with all his energy and concentration.

On numerous occasions Arthur would stay in the plant for 24 to 36 hours at a stretch. Sometimes he would lay down on his desk for a short nap. In the early days of the computer development program, he kept a cot in a small room which adjoined a department manager's office. Very few people even knew it existed.

Along with the demands he placed upon himself in his work and his tendency to work around the clock, family life was very important to Arthur.

During his adult life he had two marriages and two families. His first marriage was to Margaret (Peg) Van Dyke in 1930. They had two children, Susan, born in 1939 and Michael, born in 1943. Peg Collins died suddenly in 1955. Arthur then married Mary Meis in 1957. They had two sons, Alan, born in 1963, and David, born in 1966.

During the twilight years of his life, Arthur confided to a friend that as he looked back, he felt he should have spent more time with his children as they were growing up. He said he had tried hard to be close to Susan and Michael after the loss of their mother.

He had a special feeling for Michael, with Mike having a deep interest in science. He majored in entomology at the University of California, Berkeley, and eventually attained a Ph.D. in that field. After college and Navy service, Mike put in considerable time at Collins Radio, sometimes doing assignments for his father and at other times without specific duties. His presence was not always appreciated by some Collins executives.

Mike was able to get his father to take some trips during his youthful years. One journey was an outdoor excursion to the Organ Pipe Cactus National Monument area of Arizona. Don Hanson, who was the chief photographer for Collins at the time, remembered Arthur asking him to make sure his camera gear was ready for the trip. Hanson said Arthur told him: *Mike wants to go down to Arizona to look for some bugs and snakes, and I hope to God we don't see any snakes.*

Another trip was in an International Travel-All, a van-sized vehicle outfitted for recreation, to a friend's sheep ranch in Wyoming. *We camped out and fished for trout. It got Dad away from the phone, but it was hard for him to relax,* Mike recalled. They then drove to Salt Lake City, but Arthur soon decided he had been gone long enough, and had no desire to drive back over the same scenery again. He called Cedar Rapids to have a company plane come and get them, and bring a company driver along to take the Travel-All back.

Mike also remembered his father liked fishing on the Mississippi River near Guttenberg in northeast Iowa. *If we didn't catch any fish, Dad would buy some — what he called replacement fish,* Mike said.

Arthur found fishing to be a way he could relax. In 1940 he and Peg took a short vacation to Miami, which included deep sea fishing aboard a yacht called Bezo. Arthur caught an 83-pound sailfish which he had mounted at a cost of $65, plus $5 to have it crated for shipping to Iowa.

Alan and David Collins lived in Dallas except for their early years. The boys became involved in riding lessons, which Arthur thought were dangerous, Mary Collins said. Still he did go with them to several out-of-town horse shows. At their Jesuit high school, Alan competed in wrestling and David in football, but Arthur never attended any of their athletic events.

Alan enrolled at Texas A&M after high school, and later dropped out to help in the last years of Arthur's Dallas company, A.A. Collins, Inc. He completed his college studies after Arthur died, and would have made his father proud of his computer skills.

David Collins was a talented artist, quitting football in his senior year to concentrate on art. He remembered having a father son talk with Arthur about his intentions to pursue an art career. *Dad told me it would be a tough way to make a living, but also encouraged me to be the best artist I could be if that was what I wanted to do,* David said. David did go on to become a successful artist.

Arthur was not unsympathetic to David's career choice, as he had a fond appreciation for art. He purchased works he liked including several paintings that qualified as modern art.

Arthur also was very devoted to his mother, Faith Andrews Collins. She died in 1971 at the age of 93, having been a widow since 1943. During her final years, Arthur arranged for 24-hour nursing care which enabled her to remain in the family home at 514 Fairview Drive. That was the same house where Arthur made radio history handling communications for the MacMillan Arctic Expedition in 1925.

Arthur had a fetish for neatness in the office, lab and factory. He disliked messy desks and stacks of papers atop file cabinets.

A clue to his feelings is evident in a memorandum he sent to L. Morgan Craft, then director of engineering, in April, 1948. The subject was, "Housekeeping at 3rd Street Building." The 3rd Street building was a six-floor downtown Cedar Rapids building at 3rd Street and 4th Avenue. Collins leased a first floor entry area and all space on the other floors, housing engineering departments there after World War II. The memo read as follows:

I have made a thorough inspection of all floors at the 3rd Street Building and I can only report that the place is only one degree removed from an Irish pig sty. I realize that the building is difficult to take care of and also that we are minimizing maintenance expenditures, but its present condition can only be due to carelessness and indifference.

Please see that the following or equivalent measures are put into effect at once:

1. All the windows must be washed. The street-level window should be washed once a week. Upper windows can probably get by for a couple of months at a time but they appear to be covered with a winter's accumulation of dirt at present.

2. See that all floors are mopped and walls dry-brushed.

3. Each person should be asked to provide himself with a dust rag and to spend a couple of minutes each day cleaning up his desk or working space. Some procedure should be set up for collecting and cleaning the rags. That it is possible to keep working areas in decent condition in spite of the general dustiness of the building is shown by the endeavors of a few individuals who habitually keep their desks and benches neat and clean in the midst of the mess.

4. Everyone should be asked insofar as possible to clear off his desk at the end of the day so that his work does not interfere with such janitoring as we are providing. Laboratory set-ups should be thoroughly renovated at least once a week and should be covered over with wrapping paper at night or otherwise protected from dirt.

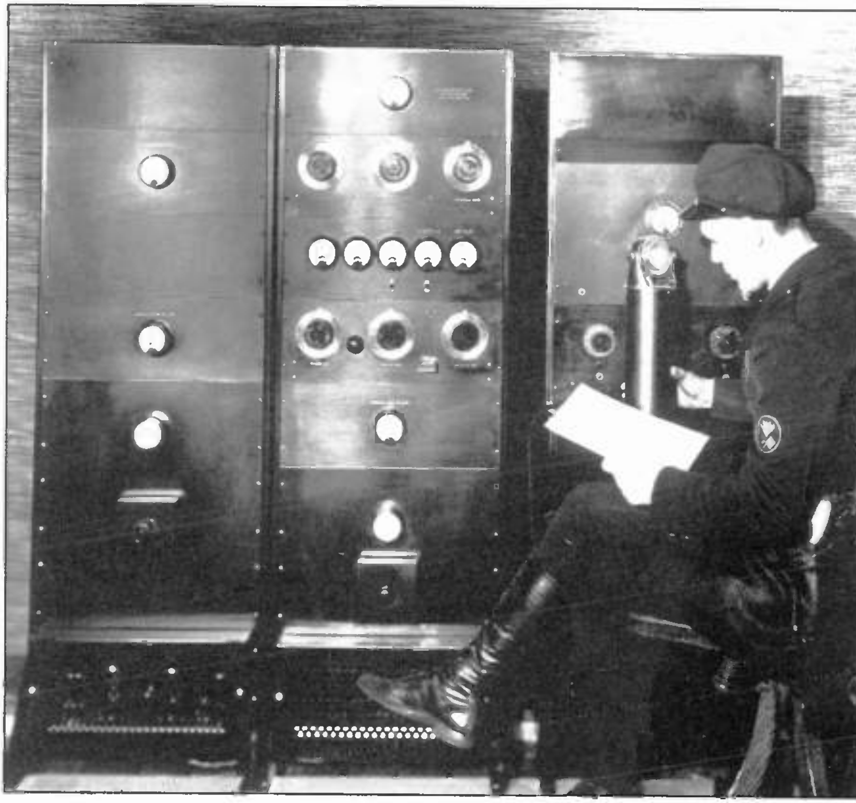
5. A considerable improvement can be made easily in the arrangement of the furniture and working areas. The rough wooden shelving scattered throughout the place is very unsightly. All of these shelves which are really required should be grouped in out-of-the-way areas reserved for storage of equipment and materials not immediately in use. Coat racks should be similarly grouped and replaced later if possible with metal lockers if we can locate some at bargain prices.

6. Walls should be cleared of posters, seldom used charts, wise cracks and sundry pornographic material and encouragement given to display of pictures of technical interest or decoration in acceptable taste.

*A collection of early Collins Radio tubes, alongside a picture of Robert Goddard, who designed a tube widely used by Collins.*

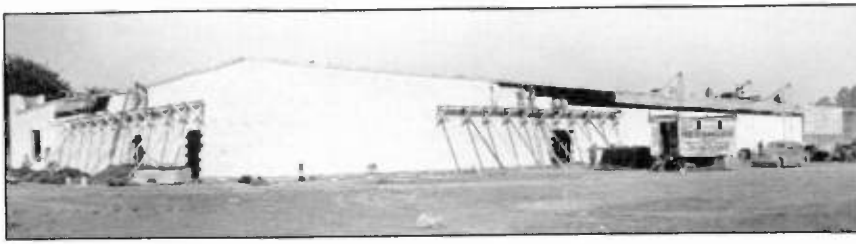

*One of Arthur Collins' early amateur transmitters, the 20-watt 4A. The listed price for a 4A was $67.*

*Roy Olson, left, and Walter Wirkler, two of the engineers who helped develop many of the Collins products in the company's first 20 years.*

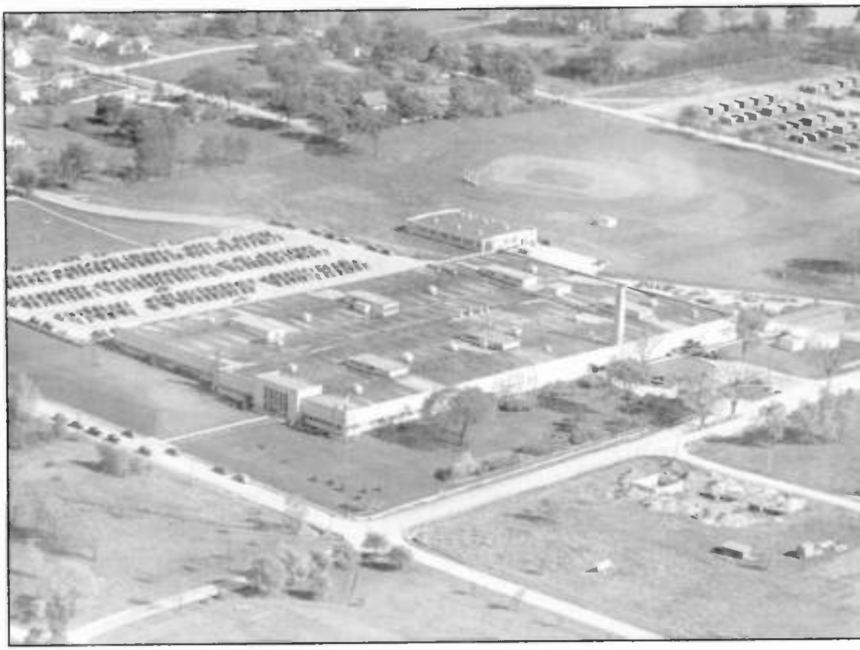


*Collins-built radio transmitters acquired by the the Cedar Rapids police department in the 1930s. The operator is Henry Nemec, who later worked for Collins.*

*Officers and their police cars equipped with Collins communication gear, in front of the Grant Wood window at the Cedar Rapids City Hall.*



*Construction of the Main Plant in 1940.*



*The Main Plant, toward the end of World War II. Buildings at top right were mobile housing units built by the government for defense workers.*

*Women operating machine tools at Collins during World War II.*

*The Collins Autotune, one of the most important inventions in the history of radio communications.*

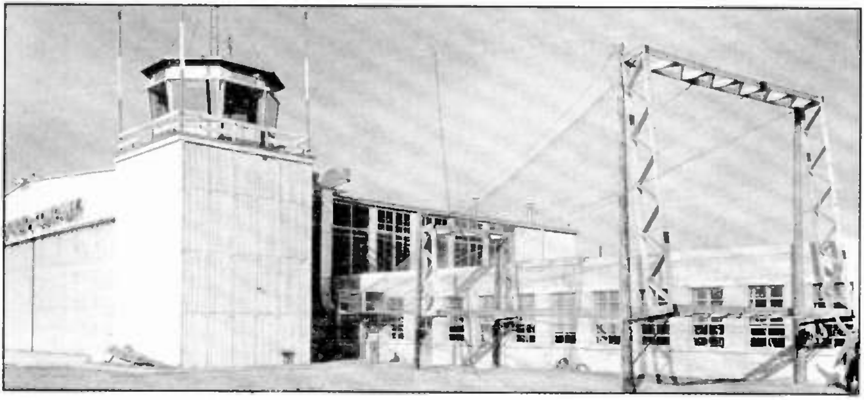
*Carts loaded with AN/ART-13 aircraft transmitter assemblies being moved into the Amana-built cold chamber for environmental tests.*

*World War II production lines, staffed by women assembly operators.*


*Workers celebrated on completion of Navy TCS system No. 1,500 in 1943. Standing behind the equipment are Elmer Koehn, left, production manager; Arthur Collins and Slim Dayhoff, superintendent.*

*Army-Navy E-Award presentation on lawn of the Main Plant, 1942.*

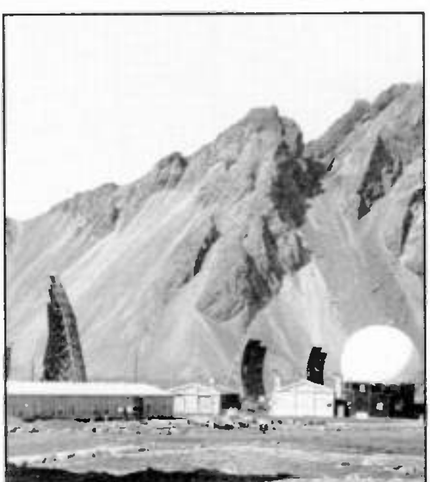
*Atom smashers known as Cyclotrons were built by Collins after WW II.*



*Collins participated in a historic space communication experiment in 1951, using the Resnatron tube and this antenna at the Cedar Rapids airport to bounce radio signals off the moon.*

*The newly completed Collins hangar and electronics laboratory at the Cedar Rapids Airport, 1945. The two aircraft are the first Collins twin-Beech and a war surplus Consolidated Vultee Navy trainer.*

*Technicians testing aircraft AN-ARC-27 UHF transceivers, radios which helped restore Collins to profitability after World War II*



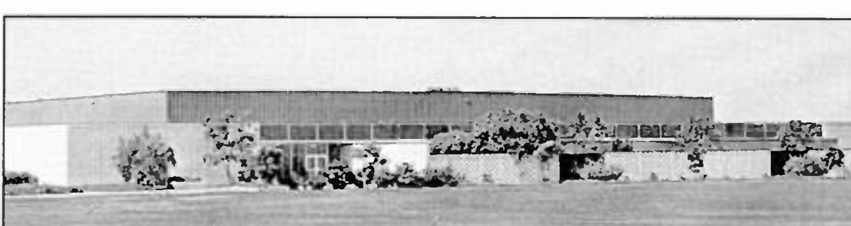
*A DEW Line installation, with radar dome and Collins-built billboard type troposcatter antennas.*

*One of several types of portable scatter communication systems, used by the Army in VietNam.*

*The Dallas complex of Collins Radio in the 1960s, actually located in Richardson. At right center is the corporate headquarters building.*

*The Avionics Systems Center at Addison Airport north of Dallas.*

*The Antenna Research Laboratory, part of the Dallas facilities. Systems tested here ranged from backpacks to deep space probes.*



*One of the Newport Beach, California plants where much of the Collins data communication and component activity took place.*

7. Nearly everyone has his desk or table surrounded with a "clutterment" of drawings, loose files, samples, old models or just plain junk. I suspect that about 50 percent of these collectors' items could be thrown away profitably. What remains should be neatly boxed in paper cartons or temporary files if we do not have enough permanent storage files or cabinets to hold it. Nothing can be left lying around in the building without collecting dirt in addition to being unsightly even if it were clean.

8. Until such time as it seems no longer necessary, it might be well to appoint some one individual on each floor to make a weekly housekeeping inspection.

Some of the areas are badly overcrowded, a subject which bears discussion separately. It need not be necessary to delay our spring housecleaning, however, until this condition is corrected.

(Signed) Arthur A. Collins, President.

At one time the company carried on a contest every week to recognize the manufacturing department which had the neatest area.

Another example of Arthur's insistence for neat, orderly working conditions came when he walked into a lab where an engineer was involved in a rush project and noted equipment, papers, charts and books strewn all over the place. Arthur said: "Glenn, let's clean up this place. When you work in a shithouse, you do shithouse work."

Such a comment was not common with Arthur. He resorted to profanity and obscenity sparingly, usually only to emphasize a point.

Robert T. Cox, who headed engineering and later managed all Cedar Rapids operations, also preached the neatness doctrine. He was known for having periodic clean-ups in engineering labs. *Throw out stuff until you miss something the next morning*, he would say. Another of his edicts was, *Nothing taped to the walls.*

To people who did not know him well, Arthur appeared to be a rather humorless person, but he often enjoyed bantering and joking with friends. Once he was piloting the company's first twin-engine Beechcraft, by no means a plushly furnished aircraft. A friend who knew him well was riding along in the right cockpit seat, and chided Arthur because the plane did not have a lavatory and he had need of such a facility. Arthur told him if he really had to go, there was a funnel attached to a tube in the back of the airplane, called the relief tube, which served the purpose. When the man was standing at the rear of the cabin using the funnel contraption, Arthur made his task more difficult by slightly tipping the nose and dipping the wings of the Beechcraft. The friend realized what was happening, and when he returned to his seat wanted Arthur to think he had been unable to use the tube due to the turbulence. He told Arthur he had relieved himself in a cowboy boot he found there — Arthur's boot, of course.

After Collins Radio began occupying buildings in the new Richardson, Texas complex in the late 1950s, Arthur sometimes entertained guests and customers at a Cattlemen's Restaurant on the nearby North Central Expressway. With some visitors, particularly easterners, he liked to suggest they try an appetizer listed on the menu, a tasty breaded beef delicacy. Only after they had finished it did he tell them, with a wry grin, they had eaten calf testicles, better known as Rocky Mountain oysters.

Through his own and his co-workers' inventions Arthur directly influenced and in many instances created new markets with products which previously had not existed.

Any product which carried his name was always of the highest quality and highest performance level possible through the creativity of Arthur and his people and the components, materials and technology available at the time. Collins engineers were constantly prodding parts suppliers to stretch the performance limits of their components. And in many instances, when the right part did not exist, the engineers or technicians invented it.

Collins products, when first introduced, were either a totally new invention or reflected major technical advances in a type of equipment.

A close look at the products Arthur or his company developed, from his early amateur radio transmitters to the complex computer controlled communication and avionics systems of later years, showed a well planned layout of the functional elements inside and a highly attractive exterior case or cabinet. They truly reflected quality, not only in appearance, but in how they worked.

Warren Bruene, a senior engineer who became well known and respected for transmitter development at Collins, noted that: "Art was a neat and orderly person who insisted that the equipment be designed well mechanically, and that the wiring be neat and professional looking. Buss wire to RF switches, for example, had to have right angle bends and wires in the laced cables had to be straight and parallel. I have known him to take a pair of diagonal cutters and cut buss wiring that wasn't up to his standards."

Roger Pierce, an engineer who began working at Collins in 1934, characterized Arthur's philosophy in equipment design and construction as: "It doesn't really make any difference how you do it as long as you do it the way I want it done."

"He was pretty much the dictator on product developments. But that wasn't bad because Art generally was right when it came to technical things," Pierce said.

Milo Soukup recalled an incident in early days of the company when Arthur gave specific instructions to an engineer as to how he wanted something done, then left town for a few days. When Arthur got back, he found the engineer had done it differently than the way Arthur told him to do it. Arthur's reaction was quick and terse. "Go get your paycheck," he said.

The Collins Radio Company facilities, under Arthur's direction, were neat and attractive — beautifully landscaped spacious grounds outside, clean and orderly inside. Stories often were told, mostly true, about Arthur — the President and Chairman of the Board — walking into a lab or factory area and finding wire clippings and cigaret butts on the floor. Rather than admonishing the foreman or technician in charge, he preferred to provide an object lesson — finding a broom and sweeping up the debris. It was a dramatic but effective way of showing how he wanted neat and clean work areas.

The Collins facilities truly were impressive. More than one visitor from another area expressed surprise at finding plants of the scope and complexity of those in Cedar Rapids. An airline executive from New York told his Iowa hosts he was surprised at seeing the attractive facilities because what he had expected to find was a concrete block building in the middle of a cornfield.

A routine occurrence several times a year involved a big semi-tractor-trailer rig from the Scott company parked by the Collins lawns. Tons of fertilizer and other lawn care materials were applied, resulting in luxuriant looking grounds. It was another costly frill which Arthur insisted upon.

Arthur Collins was a man genuinely embarrassed by praise. He did much in his life, but he was very uncomfortable if anyone congratulated him on his achievements, as he did not consider himself an unusual person. He wanted the credit for his work to come via the channels of formal scientific and technical recognition, and in the acceptance of his company's products.

Neither did he demonstrate an *I told you so* attitude when one of his ideas worked despite doubts of others. The only emotion he showed in such instances was a brief, smug smile.

He had no interest in attaining personal fame for himself, which is probably why he never received the credit he deserved for his many achievements.

Neither was he intent on using his talents to amass great personal wealth. His salary as chairman and president of his company never did match the top executive compensation level of many comparable size firms. In fact, at one time the company's executive vice president and top salesman, William J. Barkley, was paid $100,000 a year while Arthur's salary was listed at $50,000.

Arthur's homes, while comfortable, were not lavish, pretentious or big show places. When he and Mary Collins built a new home in Dallas in the 1960s, the end result was an attractive residence which fitted well into the existing neighborhood. But it appeared his main concern was the basic structure, utilizing steel and concrete to a greater extent than typical houses. Many of the household furnishings were antiques that had come from his parents or grandparents.

Arthur's wardrobe was conservative businessman, neat, good quality but not as expensive as what many top executives might have worn. His taste ran to blue or gray suits and white dress shirts, which for many years he purchased from Roy Houser, men's clothing buyer for Killian's Department Store in Cedar Rapids. Houser made trips once or twice a year to Arthur's office, bringing suits of the type which he knew Arthur preferred, for selection and fitting. Arthur once bought some suits from Neiman Marcus in Dallas, but didn't like them. For informal wear he preferred comfortable old cotton khaki pants and a sport shirt, no tie. During the coldest winter days he wore an old fleece-lined, gabardine storm coat with a fur collar.

Like many people with their minds on weighty matters, Arthur did not worry about clothes, and usually had to be prodded by his wife to buy new garments. Harvey Hop, who served as a chief pilot for Collins, recalled an incident after a flight from Dallas to Cedar Rapids.

"Art asked me to look in the airplane to retrieve a pair of trousers he had left on board. The only pants I found made me wonder if they were what he wanted — they were so worn you could see through them. But it was the pair he was referring to."

Arthur was not a laboratory recluse, as many people thought. He had a wide range of interests and was a keen observer of the human scene.

Once, after a visit to the retirement home of long-time friend Dr. A. Hoyt Taylor and his wife at Claremont, CA, Arthur recounted the event in a letter to another mutual friend.

He commented the community was populated largely by retired people, and that a popular pastime of the residents was bowling on the green. He noted that participants ranged in age from 26 to 93, the average age being 67, and said after watching several games he wondered how the 26-year-old stood his ground. Arthur also wrote that he enjoyed some excellent port which Dr. Taylor bought from a local Italian wine grower for $2.15 a gallon. Dr. Taylor for many years headed the U.S. Naval Research Laboratory and closely followed work by Arthur and Collins Radio Company on various projects.

Arthur's second wife, Mary, said he watched television occasionally, usually if he had heard there was a program that might interest him. *He liked good music and liked to watch an artist such as Horowitz or Isaac Stern. And he sometimes watched the morning news if there was something going on,* Mary said.

Arthur Collins was a born inventor, although he did not think of himself that way. He preferred to say, "We want to adapt and apply, not innovate or invent."

But much of the "adapt and apply" was innovative and inventive.

He could have stayed a small businessman with a small company if he had been content to invent and build a few products. But his mind was full of ideas, and he learned as much as he could in his boyhood about communications technology, be it radio, telephone or telegraph, and built upon his knowledge throughout his life. He was born in 1909, just eight years after Marconi first transmitted a wireless signal across the Atlantic, and three years after the first transmission of a human voice by radio. The first U.S. radio station was licensed in 1920 and commercial radio had just begun to grow across the country as Arthur became a teen-ager. State University of Iowa Station WSUI in Iowa City had limited broadcasting in 1919 and the first Cedar Rapids station began operating in 1922.

He could cite from memory even in his 70s the discoveries and contributions of early physicists and radio pioneers.

He had an insatiable appetite for knowledge about radio and other scientific topics that began when he was a child and continued throughout his life.

He gained such a thorough knowledge and understanding about how radio worked that often he could instantly solve a problem or offer a suggestion that would lead to a solution. Milo Soukup recalled an incident in the 1930s when the firm was building lighthouse transmitters for the Coast Guard. Arthur walked by the area where Bob Beetham, the project manager, was having problems getting the units to work. Arthur asked a few questions, then said, "Get me a soldering iron and some buss wire." He and Beetham started working on the units and soon had them all fixed and operating.

Don Gallagher, who became a UHF equipment engineering group head at Collins, recalled an incident during development of a UHF ground-based military transmitter.

"We had decided to use a linear PA (power amplifier). We saw advantages in doing that as we were doing a lot of linear PA in UHF equipment at that time, and we had built and were testing an engineering model.

"Art came by to check out our progress and he asked, 'What's your biggest problem?'

"I told him that getting enough drive into the final tube was tough because the input capacitance was so high," Gallagher said.

"Art then said: 'have you tried a pi network? — I think you should try it.' Then he asked, 'How are you modulating this transmitter?' We told him it was a linear transmitter chain — modulating a 6AK5 tube at a low level. Art then said, 'How are you doing that?' The answer was the audio amplifier in the transformer modulates the stream of plate voltage. Art said, 'Have you thought of using Heising modulation?'

"I told him we weren't certain we could modulate this unit 100 percent with Heising modulation. Art said, 'Oh yeah,' and took a pencil and piece of paper and showed how to drop the voltage with a resistor, then by-pass the resistor with a capacitor so as to get an audio swing higher than a B-plus level, and thus modulate 100 percent.

"Art then said, 'Have you tried neutralizing the transmitter?' and suggested doing that.

"We then went to work and tried all three of his ideas, and they all worked great," Gallagher said.

Warren Amfahr, who spent most of his Collins career in marketing, recalled his first job was that of a laboratory assistant. *Art came through the lab and noticed I was having trouble getting a transmitter tuned to 20 meters. He asked why I hadn't applied the one-degree rule. When I said I wasn't sure about it, he told me to figure it out and he'd stop back tomorrow to see how it worked. Others I asked didn't seem to know about it either. I went to the company library that evening and pored through a lot of books and still didn't find the answer. Finally about 3 in the morning it hit me — one degree at 10 meters is one inch, so each degree is one inch, giving me the formula to get up to 20 meters. That was the answer.*

Ray Ruggiero, who worked closely with Arthur in HF single sideband activities, recalled Arthur coming by where he and another technician were soldering leads on a prototype log periodic antenna and asking how they were doing.

"I told him we'd been having problems with hot spots (a situation causing radio reception interference.) Art then said, 'Why don't you come in an eighth wave and solder a bar across it?' We tried it and it worked. In 30 seconds he solved a problem that had bothered us for a month," Ruggiero said.

Ruggiero remembered Arthur stopping by his laboratory bench a day or two before the 1956 presidential election. *He asked me who I was going to vote for (Republican Incumbent Dwight Eisenhower or Democrat Adlai Stevenson), and*

*I told him it probably would be Stevenson. Art then said, 'Why don't you take the rest of the day off and think about that'.* Arthur was seldom vocal about it, but usually had Republican preferences.

"One time — about 3 or 4 in the morning — we were working on an installation in Lab 12 (the Collins high frequency, single sideband radio station in Cedar Rapids, identical to stations built for the Air Force). Art said he was hungry, and I told him I thought I knew a way to get something from the cafeteria (normally closed at such hours) if Art would stand watch at the door in case a guard came by. (This was in days before vending machines). We walked to the cafeteria and I was able to slide the covers off an ice cream cooler under a counter and get us two bowls of ice cream," Ruggiero said.

"As we were walking down a dark hallway on the way back to the lab so we wouldn't be seen, Art said, 'I don't know why we're doing this — I own this company.'"

Ruggiero also recalled another all-night work session when he came prepared to fix himself a meal. Thinking he was the only one in the area, he plugged in a hot plate under a work bench and proceeded to fry a hamburger. While kneeling to tend his cooking, he suddenly was aware of feet behind him and looked up to see the tall figure of Arthur Collins. Ray said his first thought was that he might get fired, when Arthur said, "If you have another one, put it on for me." Luckily he did.

Several years later, when Collins was installing its new C-8400 computer-controlled data communications and switching system in the same building and area, Arthur had been working all night with a group of engineers and technicians.

Wanting bacon and eggs about 6 a.m., he led several of the engineers toward the cafeteria. If any of them knew the cafeteria was not open at that hour and did not normally serve breakfast, they apparently did not have the courage to mention it. The result was that starting the next morning the cafeteria was open at an early hour to offer breakfast, just in case Arthur ever decided he wanted it again.

Another time, a group of graphics people were working on a rush project at night and Arthur stopped by to check on some illustrations which were being prepared. When he suggested to an artist they go to the cafeteria to discuss the illustrations over a cup of coffee, the artist told him the cafeteria was not open at that hour. Arthur then picked up the phone and called Karl Sorensen, the food services manager, at home to tell him there were people working who needed coffee. In a very short time the cafeteria was open and coffee was being served.

Arthur's company, through the years, showed sales and earnings results that went up and down. In the long run, it was more up than down or the firm never could have grown as it did. In 29 of the 38 years from 1934 through 1971, Collins showed increased sales over the previous year. Three of the years when sales were less than the preceeding year were the retrenchment period immediately following World War II. Only once, in one quarter of the 1960 fiscal year, did the company report an operating loss.

Some persons regarded that as an inconsistent financial performance, making them think Arthur was only an inventor, and not a businessman.

The truth is that he was both a very good inventor and a very good businessman. His problem, in the view of a financial analyst who considers making a profit the most important function of a company, was that he gave top priority to inventing rather than profits. He had an unwavering confidence that product development would produce profits, which happened most of the time but not always.

The main reasons it did not always happen were: 1. The national economy sometimes did not cooperate, as when a general slump occurred. Then business travel would be cut, the airlines had fewer passengers and did not want to buy more airplanes. That meant fewer new airplanes being built, and fewer orders for Collins equipment for airplanes. A business downturn also resulted in lower sales of executive aircraft, another major market for Collins. Aviation electronics (avionics) long was the leading money maker of all Collins product lines. An inevitable result of lower sales were employee lay-offs, occasions longer remembered by a part of the public than the growth periods.

No. 2 was when military orders were reduced. Collins since World War II had been heavily dependent on government business. In fact, government sales long provided the single biggest share of Collins business, up to 75 percent in some years. Since the level of Pentagon expenditures always has depended upon funding voted by Congress, and that amount varies from year to year depending on perceived needs and priorities, a defense contractor is not assured of a continuous high level of government orders.

3. It sometimes took several years for development of a product to the point it was ready to go into production and sold to customers. The single sideband high frequency program, for example, began with the mechanical filter development which took about five years. It was announced in 1952. Then followed a year of designing the basic circuitry for sideband, and after that came the development of the first product using the new technique, a military radio. It was 1955 before the first commercial SSB equipment was available to the amateur radio market.

By that time several million dollars had gone into the SSB dvelopment program, with little return. But within the next few years, some 60 to 100 million dollars in orders for SSB equipment were placed with Collins.

That was the way Arthur operated, counting upon his company's inventions to produce sales and profits.

Arthur could scan a business or financial report and quickly understand it. He whipped through correspondence and paper work with a speed and decisiveness that kept secretaries hopping.

Despite his lack of a college degree, Arthur had great respect for scholarship. That respect did not always carry over to academic institutions. At times he considered them to be pompous and impractical. But as an astute engineer, he had a deep appreciation for the knowledge that education could provide. He continually made certain that educational opportunities were available to employees, particularly in engineering and the sciences. His company had well equipped technical libraries which people were encouraged to use. He wanted his people to have the best possible tools and equipment to do their jobs. One example was the elaborate testing equipment available to engineers and technicians, either built in house or purchased at high cost.

Collins offered after-hours college courses in the company or nearby schools and tuition assistance for employees to work on advanced degrees.

Arthur had a sensitivity about his own lack of a college degree, but in his reserved and private manner seldom let it be known.

Once, however, working on an aircraft navigation unit problem with Glen Morris, a lab technician who had been cited in a magazine for "Patent of the Month," Arthur remarked that, "You and I are the only ones in this company to have patents who don't hold college degrees," Morris recalled. Morris eventually held nine patents. The one cited by the magazine was for a torque limiting clutch. Another of his patents was for a component used aboard spacecraft to help earth tracking stations lock onto the spacecraft. Morris said he was told it played a vital role in bringing astronauts safely home on the ill-fated Apollo 13 mission.

With his thinking concentrated on technical and business matters, Arthur gave little attention to routine details of daily life, such as whether he had any money in his pocket.

Les Bessemer, who started at Collins in 1935 and later became director of manufacturing and a member of the Board of Directors, recalled times when he and Arthur and their wives went to the movies on Saturday nights in the 1930s. Despite having an engineering degree, Bessemer's beginning salary at Collins was just 50 cents an hour.

"We'd get up to the ticket window and Art would say, "Oh cripes, I don't have any money,' so I would pay," Bessemer said.

"After about a year of that, I told him I was having some problems. He asked what kind of problems and I said, 'financial problems.'

"Then he asked what I made. When I told him he said, 'Well, that is kind of poor pickins.' After a while he asked me what was the most I ever made on overtime, and I told him about $30 a week. He did some quick mental arithmetic and then said, 'From now on you're raised to $135 a month.'"

Rolf Wollan recalled that as chief company pilot he once flew a twin-engine Beechcraft to Chicago to bring Arthur, his wife Peg and two children back to Cedar Rapids. "The weather turned pretty stormy so Mrs. Collins decided she and the children would go home on the train. Art told me to come along with them to the train station. When we got there he said, 'Hand me your wallet,' and gave it back to me after he bought the tickets. I just had to guess how much he'd spent to get reimbursed later," Wollan recalled.

John Nyquist, a longtime executive who held a variety of top managerial and administrative positions with the company, remembers being called at home one Sunday morning.

"Art wanted to go fishing, so he drove by and picked me up. We went out to the airport and flew his Bonanza up to one of the lakes in northwest Iowa. We only fished an hour or so and didn't get a single bite, so decided to go back home. The plane needed gas for the return trip, but Art didn't have any money so I ended up paying, and had to get reimbursed by his secretary the next morning."

On another occasion Arthur had flown out of Dallas on the company plane late at night for Newport Beach. He took a cab in the early morning hours to one of the company buildings, walked in and asked the security guard manning the entrance to go outside and pay the cab driver. The guard, who happened to be newly hired and had never seen Arthur Collins, asked him who he was. When Arthur told him the guard quickly checked a photo book to confirm it was Arthur, and decided he better come up with the cab fare. Arthur later told his wife about the incident, and said while he didn't let the guard know it, he was quite amused by the guard's expression.

Roy Olson, the second engineer hired by Arthur, learned to keep a suitcase with extra shirts and underwear in his office along with expense money just for the times Arthur would tell him at 4 or 5 in the afternoon they were going to fly someplace that evening.

"Sometimes it would be Dallas, back in days when we had to fly commercial to Kansas City, spend the night there and get a connecting flight to Dallas early the next morning.

"We'd end up at the Muehlebach Hotel downtown. Art would say, 'Let's go clean up,' meaning he wanted to take a shower before going out to dinner. He'd soon come knocking on my door with a towel around him and ask, 'Roy, you got any extra shirts and shorts?' I did, and gave him what he needed as we were about the same size. I never did get any of them back.

"Then we'd go down to the desk. As usual he didn't have any money on him. Sometimes he'd get some from the desk or sometimes I had to pay when we'd go out to eat."

On one occasion Arthur definitely planned to pay. Back in 1941 when his engineering staff was still small, as a reward for working hard he planned to take a group of six on a weekend fishing trip to a resort in Minnesota.

Arthur took several $100 bills with him to pay all the expenses. But in rural northern Minnesota in those days when cabins rented for a few dollars a week, there wasn't a business in the area with enough money in the till to change a $100 bill. So the engineers had to pay out of their own pockets and get reimbursed later.

Arthur always had a very independent streak. As a child he had his tonsils removed. But left alone momentarily the day after his surgery, he climbed out of his Cedar Rapids hospital bed and was walking home in his pajamas when found.

Despite being a heavy smoker, until the stroke which led to his death Arthur had few health problems, and refused to be bothered by them any longer than he thought necessary. After marrying Mary Meis in 1957 he underwent emergency surgery for appendicitis. He stayed in the Cedar Rapids Mercy Hospital only a day and a half before calling Mary on an icy winter day to come and get him, not appreciating that nurses wanted him to remain quiet and rest.

On another occasion he required surgery for nasal polyps, which he talked the doctors into doing over two weekends because he did not want to miss time from work.

The years of Arthur Collins' adult life were a period when cigaret smoking was a common and accepted practice.

He was known for often being without or running out of his own cigarets in a meeting, but readily helping himself to the packs of others.

Arthur was never one to show off just to get attention, but he had one strange habit in his early adult years. When invited to a party at someone's home, usu ally one of his company associates, he sometimes became bored. Then he slipped outside and climbed upon the roof of the house, to sit there and observe the neighborhood.

Les Bessemer recalled joining Arthur on one of the rooftop adventures. "People came out of the house, looked up and down the street and we could hear them saying, 'what do you suppose happened to Art and Les?' Art just sat there and snickered."

He also was known to climb trees. Oldtimers recalled such occurrences by Art during beer busts held by Collins engineers at the Biderman resort along the Cedar River near Palisades-Kepler State Park in rural Linn County.

Dick May, who headed Collins' mechanical engineering design in the 1940s, remembered another side of Arthur when it came to dinner engagements. Not long married, having recently moved from the East to Cedar Rapids and living in a small apartment, Dick and Alice May invited Arthur and Peg Collins over for dinner.

As they arrived, Peg went into the kitchen to help. Arthur said, "well, if you don't mind," then laid down on the living room floor and went to sleep. Alice later said she considered Arthur "a regular guy and unstuffy boss" if he could feel relaxed enough in her home to take a short nap before dinner.

Arthur and Margaret (Peg) Collins, who were married in January, 1930, turned to his working associates and their wives for social life in the early years of the company. There was a stigma associated with the Collins name in Cedar Rapids because of losses sustained by investors when the Collins Farms, the ambitious venture of Arthur's father, failed in 1933.

Peg Collins and other company wives were frequent bridge players. Arthur participated occasionally, and was known as a very competitive and astute bridge player.

With Iowa liquor laws being very strict after the repeal of prohibition in 1933, it was not unusual for Cedar Rapids residents to drive 75 miles to East Dubuque, Illinois for an evening of drinks and dinner. The Collins and one or two other couples including the Les Bessemers and Bill Stewarts occasionally made the trip. Les remembered being the designated driver for the ride home while the others slept.

Les Bessemer also recounted an occasion in that era when Arthur either instigated or agreed to a party for a group of Collins people. A room for the event was rented at the Roosevelt Hotel in downtown Cedar Rapids.

The party became increasingly livelier and someone in the group called down to the desk to ask that a record player be sent up so they could dance. When told the Roosevelt had none, Bessemer and Stewart went to Stewart's home and returned with a large console record player, which they carried through the lobby and up to the room. They also, in view of the hotel front desk staff, carried in a case of sparkling water which sold for 10 cents a bottle in stores, but cost 50 cents if bought from the Roosevelt.

During the party Stewart's wife had her lip cut when standing too close to a Murphy bed being unfolded from a closet. Arthur drove her to his family doctor for treatment, requesting the doctor "to fix this but don't ask how it happened."

Stories about the party also included an account of a secretary doing cart-wheels in the hall.

The offshoot to the affair was that the Roosevelt Hotel strongly suggested Collins Radio Company people not have any more parties there. But in later years, when Collins grew to become the city's largest company, hundreds of Collins meetings and events including parties were held at the Roosevelt, with few other facilities available to handle them in Cedar Rapids.

Arthur had some initial aviation lessons as a teen-ager, but it was 1935 before he resumed taking flight instruction and earned his pilot's license. That began a long association by Arthur with aviation, not only great contributions in aircraft electronics, but personally a number of close calls, any one of which could have brought a premature ending to his brilliant career.

Roy Olson, as an engineer and pilot closely involved in Collins' early aviation work, recalled an incident in the 1930s when he rented a plane one Sunday morning in Cedar Rapids and flew south toward Ottumwa, Iowa to find an over-cast area and practice instrument flying. Climbing out of the overcast, just as he saw blue sky he also spotted another plane headed toward him, skimming the top of the clouds. Olson quickly ducked back down into the cloud bank, and after several minutes came on top again to see it was Arthur who was flying the other airplane in the same area. A collision had been narrowly averted.

Another time Arthur had flown his Rearwin Sportster, the airplane he bought in 1936, to Chicago for the National Association of Broadcasters convention.

Flying back to Cedar Rapids alone on a hot summer morning, Arthur had taken his shoes off when the engine of the Rearwin threw a valve which went through the top of a piston. Near Dixon, Illinois at the time, Arthur shut down the engine and looked for a place to glide to a landing. The only spot he saw that he might reach and set down was behind a farm house, and although it was a small area he managed to land safely.

After finding a phone, he called Ted Saxon and Slim Dayhoff in Cedar Rapids, who rounded up a flat-bed truck and got to the Dixon area by late after-noon. Finally locating the farm and airplane, they found Arthur asleep in some shade, his shoes still off. They had to remove the wings to load the plane on the truck and get it back home.

After that, Arthur had a rule which he made his family and associates follow faithfully: to always keep shoes on when flying in an airplane. He once remarked that every time he had been in a forced landing, someone had their shoes off. His son Michael Collins said it made his father nervous to see anyone with their shoes off in an airplane, and *that was the closest thing to any superstition he had.*

He also kept the damaged piston as a decoration in his office for many years.

Michael Collins recalled hearing about another incident with the two-place, dual control tandem seat Rearwin Sportster when Arthur had taken his wife Peg up for a ride. Arthur was in the front seat flying the airplane with Peg seated behind him, when Arthur's wooden control stick broke off. The stick was much like a broom handle, which screwed into a socket on the floor of the aircraft. Arthur had just enough of a stub left to unscrew it from the socket, while he yelled back at Peg to remove the rear seat control stick and hand it to him. He was able to quickly install the other stick with only minor disruption in control of the airplane.

Walt Wirkler, a close engineering associate of Arthur in early years of the company, once related two other incidents in an interview with Art Hough of the Cedar Rapids Gazette.

On one occasion Arthur and Wirkler took off from St. Louis for Cedar Rapids in Arthur's tandem aircraft, equipped with a two-way radio. Arthur was in front where he had a desk-type installation. Following the Mississippi River as they flew north, they were enjoying talking with control towers enroute when the radio quit working, and Arthur crouched under the desk to try to fix it. He got it going, but it quit again. Arthur thought by now they must be near Muscatine. Wirkler had his doubts of that being their location, but because Arthur was the more experienced pilot he decided not to say anything. It soon became apparent they were following not the Mississippi but the Illinois River, and it was starting to get dark. They finally located an airport in west central Illinois. With the radio out, Arthur buzzed the field but could not get anyone to turn on the runway lights. He did notice there was a steam roller parked on the runway, but decided to land anyway. "He flopped it over the fence, put some brakes on and darn near turned us over," Wirkler was quoted.

Another time Arthur had Jim Wathan, longtime operator of the Cedar Rapids Flying Service, fly him and Wirkler in a single-engine plane to Wichita, Kansas to pick up a new twin Beechcraft. Wathan had climbed to 7,000 feet to get above strong headwinds when the engine swallowed a valve.

Near Excelsior Springs, Missouri at the time, without power and only an hour or two before dark, they looked for a place to land and glided safely into a pasture. After getting a farmer and his pickup truck to tow the airplane to a corner of the pasture, Arthur and Wirkler hitchhiked to Excelsior Springs, got a bus to Kansas City and a commercial flight to Wichita. Wathan hitchhiked back to Cedar Rapids.

After World War II Arthur acquired a single engine Beech Bonanza, used by him and also for company research. About that time Navy Captain W.E. (Bill) Cleaves retired from military service and began working for Collins as avionics marketing director. Cleaves had been a Navy pilot, and he and Arthur took the Bonanza on a hunting trip to South Dakota in the fall.

Flying back to Cedar Rapids after dark, Arthur was piloting and Cleaves was sleeping when the engine suddenly stopped while they were over a northeast Iowa farm area. Arthur quickly woke Cleaves and told him to take the wheel as he had night carrier landing experience. Fortunately they were at a high enough altitude to toss out flares and spot a recently harvested field for an emergency landing. Gliding in a circle, Cleaves made a somewhat rough but safe dead stick landing.

They made their way to a farm house in the area. The farmer living there drove them into a nearby town where they spent the night.

Looking over the situation the next morning, Arthur and Cleaves were discussing how they might be able to make a take-off from the field, and asked the farmer what he thought. The farmer reportedly offered several observations which he felt would help, including a comment that if he was flying the plane, he first would find out what caused the engine to quit.

Asked later what had happened, Arthur told a colleague, "Oh, something came unglued." The real reason for the problem was a valve failure due to bolts coming loose and being sheared off.

But the upshot of that incident was one of the few times the Collins Radio Company Board of Directors told Arthur what to do: No more flying in single-engine aircraft.

In late 1944 Collins acquired the first company airplane, a C-18S cargo version of the early model D-18 twin-engine Beechcraft. It was specially modified to carry up to six passengers and space to test aircraft radio equipment.

On one occasion Arthur was practicing landings in the twin-Beech at the then new Cedar Rapids airport, with a rather strong cross wind present. The twin-Beech had a tendency to ground-loop under crosswind conditions at the time of touchdown if the tail wheel was not firmly locked to prevent it from turning. Roy Olson was in the co-pilot's seat when they realized the tail wheel was not locked, and he remembered that "Art had some fancy ground guidance to do — we just barely made it."

Arthur later mentioned the incident in a letter to a friend in Dallas, a Braniff Airways executive. He noted that he tried a landing with a 25-mph, 90-degree crosswind, *with the result that I neatly filed exactly 1/2 inch off one wing tip and about one inch of the bottom of the fin by dragging it on the concrete in the makings of a dandy ground loop. By blasting one engine, stamping on the brake and rudder pedals and generally hanging on like hell I got her stopped, headed in approximately the right direction, although within about 10 feet of the ditch which parallels the runway.* He admitted it was *damned poor judgment to attempt a landing with that much crosswind.* He was able to fly the plane later the same day to the Beech factory at Wichita for repairs. Beech's bill was $425, which Arthur called *a cheap price for that kind of education,* but he was still mad at himself for having done it. His letter then added, *If you don't mind, I wish you would keep this lurid tale off the Texas grapevine, if possible. I still have my pride.* The Texas reference was because Collins frequently engaged off-duty Braniff pilots from Texas to fly the company aircraft.

Rolf Wollan was an engineer and also a pilot. In 1947 he became Collins' first official company pilot.

What probably was Arthur Collins' most embarrassing moment in his flying career occurred with Wollan the pilot and Arthur the co-pilot on a twin-Beech landing at Cedar Rapids.

It came at the end of a flight test of the company's steering computer then under development. Arthur, Wollan and three engineers were on board.

At that time the levers in the Beechcraft which controlled the flaps and the landing gear were similar. They were located on the floor pedestal, easily reached by the pilot in the left seat and the co-pilot in the right. The gear lever was on the left side and the flap control lever on the right side. The landing gear, of course, had been lowered while the plane was on final approach to the runway.

It was customary with the twin-Beech to raise the flaps immediately on touch-down to avoid a vortex effect of wind on the tail surfaces.

Wollan brought the plane down to the point where the tires had just touched the runway but the weight of the aircraft had not yet settled on the landing gear. He told Arthur to hit the flaps control lever.

But for some reason Arthur activated the landing gear lever instead of the flaps, causing the wheels to begin retracting.

Wollan said the engines were at idle speed by this time and he thought the plane was beginning its rollout down the runway. He said he first realized what was happening when he noticed the tips of the three-bladed aluminum propellors beginning to curl up like rams' horns.

"I cut the power and we skidded right on down the center of the runway until we stopped. It was relatively smooth and caused little damage to the underside of the airplane," he said.

"Everyone got out in a hurry and Art never said a word. You could tell he was really upset," Wollan said.

But Arthur managed a wry grin about the accident a short time later when the company photographer arrived to take pictures of the damaged plane for insurance purposes, and the airport manager suggested Arthur pose with one foot on the craft in the manner of an African hunter trophy photo.

Not long after that unfortunate mishap, Beech Aircraft made modifications in its airplanes to avoid confusion between the flap and landing gear controls.

Once when Arthur and several engineers including Roy Olson were enroute to New York in the twin-Beech with a professional pilot doing the flying, heavy rains from a hurricane had flooded runways on the east coast and the aircraft was directed by air traffic control to land at Dayton, Ohio. There was light snow on the ground and a light layer of clouds at the time. As the aircraft was on approach, a DC-3 was taking off about a mile ahead.

As they were about to land the aircraft suddenly rolled to the left, then to the right and back again. The pilot was able to get the engines up to full power quickly and gain altitude, then circled the field and landed safely.

They soon discovered what had happened. Frost had accumulated on the leading edge of the wings, and with the "curl" effect from the aircraft which had taken off ahead hanging in the still air, the Beechcraft had begun to stall out and very nearly crashed.

Olson recalled another close call in the twin-Beech when Arthur wanted to visit American Airlines people in New York. With heavy fog in the New York area, they landed and spent the night in Washington, D.C., where the plane was refuelled.

Shortly after take-off the next morning for New York and still climbing to reach flight altitude, a strong smell of gasoline was noticed by the pilot and passengers. The pilot declared an emergency over the radio and was directed to Baltimore, the closest major airport. The control tower had the pilot land on an outlying runway, and directed him to taxi to a far corner of the field, with fire trucks following.

The cause of the problem was found quickly. The cap of a wing fuel tank had not been screwed on securely, and a stream of gas was running across the plane surface. The scariest part of the affair was that gasoline had soaked into some unprotected electrical relays in the landing gear mechanism, but fortunately had not become ignited. If there had been a spark, the aircraft would have blown up in the air.

Arthur Collins was a workaholic, consumed by the demands he placed upon himself to continually master the challenges before him.

Despite his company growing from a small design and manufacturing facility with a handful of workers to one with thousands of employees and acres of plants, Arthur had a vast awareness of company operations, as those who worked closely with him realized.

He was particularly conscious of every detail of the company's data processing and computer operations. He once called in a vice president and two top industrial engineers to solve what he considered a problem in the keypunch operation. Collins at one time had dozens of women in a large room operating keypunch machines, in which they transferred engineering, production and business data from paper forms onto punched tape, which in turn was used to punch holes in IBM cards. The procedure resulted in long lengths of punched tape cascading onto the floor, piling up a foot or two deep around the machines. Arthur wanted something done to avoid the messy paper piles. One proposed solution was to design a device which would cut the tape into small pieces. The eventual solution was to catch it in large boxes which were emptied as they became full.

Arthur Collins was a man so captivated by his work and the many fields of technology which interested him that they were always on his mind. For him, work and play were inter-related.

Even when engaged in a time of recreation, such as operating his boat or flying an airplane, his thoughts were on how he could make the radio and navigation equipment he was using work better or differently.

He was always trying to adapt knowledge to a situation. In days before microminiature circuitry and remote controls for TV, garage and car doors, etc., he approached Clarence (Peck) Lasho, a Collins Radio mechanical engineer who had a hobby of designing houses, about an idea for his kitchen.

"Art wanted to see where things were in the kitchen without having to open all of the cupboard doors. He thought if we could wire and activate them electronically, and each door could be opened by punching a button on a control board, he could quickly find what he wanted. We then talked about what we would need and how we might do that. But I guess he had other more important problems to worry about, as he never came back to follow up," Lasho recalled.

Arthur was bothered by diminished hearing in his latter years, and wore a hearing aid in each ear. He believed the problem was caused in part at least by many hours of flying in noisy small airplanes when he was younger. Noting the hearing aids were not as effective as he would have liked, he told a friend, "I know I could make a better one if I wanted to take the time to work on it."

When Arthur wanted to know about something, he read and studied all the pertinent information he could find on the subject. That happened most often in technical fields, but he also ventured into other areas.

E.A. (Ed) Williams, who worked closely with Arthur as vice president, finance and control, recalled a Board of Directors meeting at the Cedar Rapids Country Club when Arthur told about having done extensive research on the Justinian Code. That referred to the body of Roman law codified under the Byzantine Emperor Justinian I. Arthur explained that his intent was to determine if the process used in the codification of laws might apply to ways of programming computers.

Williams remembered another incident when his office was near Arthur's on the top floor of the corporate headquarters building in the company's Richardson, Texas complex.

*One day Art walked in carrying an encyclopedia, open to pages on philosophers, and laid It on my desk. He pointed to the section about Descartes, saying that described his philosophy, and walked out.*

Williams said he was never quite sure just which of Descartes' principles Arthur had in mind. Rene Descartes, who lived from 1596 to 1650, was a noted French philosopher and mathematician. Descartes' thinking and writing covered many subjects. Two which may have interested Arthur dealt with always keeping an open mind and moving from one deductive step to another to discover and invent.

# Chapter 6
# THE CEDAR RAPIDS IMPACT

The circumstances which brought Arthur Collins as a young boy to Cedar Rapids, Iowa, where he grew up to become a radio genius and build a major company, proved indeed fortunate for the community.

In a span of 40 years his company became not only Cedar Rapids' but the state of Iowa's leading technical company, as well as the largest business enterprise in Cedar Rapids, Iowa's second largest city.

It probably was appropriate for both Collins Radio Company and Cedar Rapids that the firm was somewhat inconspicuous the first few years. Despite doing highly advanced work in radio communications, it did not become well-known to most in the community until World War II. Then growth snowballed as it emerged as one of the nation's leading suppliers of military communications equipment. After several lean years following the war, growth resumed in Cedar Rapids in the 1950s and '60s, and expansion occurred to Texas, California and Canada.

The Collins name was not popular in the Cedar Rapids area in the 1930s because of the unfortunate results of the Collins Farms experiment undertaken by Arthur's father. The failure of the farms venture and a Cedar Rapids bank closely tied to it during the Great Depression left widespread hard feelings toward the Collins family for a number of years.

That may have been one reason why some Cedar Rapids people in years that followed, while respecting Arthur's achievements, also were cautious and critical of the Collins Radio Company.

The State of Iowa and its two major educational institutions appeared only slightly appreciative — and then somewhat late — of the genius and contributions of Arthur Collins, certainly one of the greatest technical minds to live and work in Iowa during the 20th century.

The Cedar Rapids city council through the years was, on the whole, highly cooperative and supportive of Collins Radio Company. The city worked closely with the company on plant zoning, street and traffic improvements in areas of Collins facilities, air transportation and Collins' operations at the Cedar Rapids airport. Particularly remembered by Collins officials as being very helpful during growth years of the 1950s were Cedar Rapids Mayor Milo Sedlacek and City Engineer Don Canney, who later became mayor.

One measure of recognition given by the city was the renaming of 50th Street NE to Collins Road in the early 1960s, that being the main thoroughfare on the south side of the major Collins facilities in northeast Cedar Rapids.

Spawned and nurtured during the Great Depression, the Collins Radio

Company by any standards was a remarkable success, and particularly for those difficult economic times.

The company had a single purpose — to fulfill the ambitions of Arthur Collins to invent and develop new and improved equipment and applications in the field of radio communication and electronics.

There is no doubt that Arthur and his company attained lasting greatness which probably exceeded his most optimistic hopes. Many of the achievements during his 40 years as president forever will be noteworthy technical milestones in the history of radio communications.

He made Cedar Rapids the avionics, the amateur radio and the space communication capital of the world.

In 1933, the year Collins became incorporated (Arthur had started the firm in 1931), sales totaled $110,000, a quite remarkable figure when many of the products sold for only a few hundred dollars. By 1939 sales had topped $500,000 and employment was about 150.

Until that time the company had been in rented space at 2920 First Avenue NE., first in the basement and later in quarters behind the main building. Also rented for two to three years as manufacturing space was the Modern Laundry Building, once also the home of Troy Laundry, at 621 First Avenue SE. Collins Radio had to move out in 1936 when the site was taken over by Rapids Chevrolet. In the 1990s the location became the home of The History Center, museum of the Linn County Historical Society.

In the latter 1930s, storm clouds that would bring World War II began to appear over Europe. Despite the intense opposition of isolationists, President Franklin D. Roosevelt convinced Congress to begin a modest build-up of U.S. military strength.

The U.S. Navy had become aware of Arthur Collins and his Collins Radio Company. The firm was earning a reputation for equipment offering advanced design features and high quality. Arthur's company also had been commissioned to build a small number of transmitters for both the Navy and the Army.

The Navy wanted to be sure Collins would have large enough, modern facilities to develop and produce equipment in the event of war.

In 1940, after Europe was plunged into war, the Navy began pressing Collins to build a new plant, and offered to assist with financing. Collins had to find a suitable site. Planning for a new facility soon was underway.

A Cedar Rapids Gazette front page article on July, 15, 1940 described the Collins' intention:

"Construction of the first totally 'sealed' building in the state, to cost approximately $175,000, is under consideration by Collins Radio Company."

The article went on to point out that it would be a one-story building with air conditioning, light conditioning and sound conditioning, with glass brick windows, and that only two other similar structures had been built in the U.S. It would be a 340-by-180-square-foot building using oil heat.

Construction, the article noted, was contingent upon rezoning of a 28-acre tract in the Mound Farms addition (part of which later became the Regis High

School grounds adjoining the Mount Mercy College campus) from Class B residential to light industrial.

Collins officials indicated construction would begin immediately if zoning was approved, but also hinted the firm might move out of the city if the rezoning request were denied, the article stated.

The July 17 Gazette reported on a public hearing on the Collins proposal, in which the City Plan Commission, "confronted by an audience of protestors filling the city courtroom, turned down the rezoning request." Most protests apparently dealt with concerns about industrial development in a primarily residential sector. The article noted the issue then went back to the city council.

The zoning decision spurred other cities, anxious to attract jobs and industries, to action. One of those was the adjoining community of Marion. Developers there sought to interest Collins in the grounds of the financially strapped Indian Creek Country Club, located on the former Inter-State Fairgrounds and race track, as a plant location.

Officials of Dubuque and Clinton, Iowa also sought to interest Collins in their cities.

At that point the Cedar Rapids Chamber of Commerce, concerned by the prospect of having the firm leave Cedar Rapids, launched a high gear effort to help Collins find a suitable location. One of the most instrumental chamber members involved in the effort was William (Bill) Crawford, who ran what was then King's Crown Plaster Co., later called King's Concrete.

Crawford, interviewed years later about the event, recalled that "Art Collins himself settled the controversy and picked the site.

"I happened to be on the (chamber) committee. After searching the area over and all the abstract companies looking for a site, I walked into People's Bank one day and said, 'the only site they're really interested in is the old Leonard farm on 32nd and 34th streets, and it would take too long to get it because it's in an estate.'"

Crawford recalled that a bank employee then told him, "'Well, that isn't right because the real estate man was just in here this morning and he has it listed.' So we got in touch with him and he got in touch with Collins. By the next Monday morning, Collins owned the site. It was a cornfield."

Eleven days after the plan commission's rejection of Collins' earlier request, the July 28, 1940 issue of the Gazette carried another article:

"While other Iowa cities dangled lucrative offers before them, officials of Collins Radio Company have agreed to retain the plant in Cedar Rapids if a 26-acre tract southeast of the Kenmore golf course (which later became Elmcrest Country Club) is rezoned from A residential to light industrial." The article further identified the site as between 32nd and 35th Streets NE, bordered on the west by Eastern Avenue, and noted the Chamber of Commerce had been working to help find a site for Collins. Even though part of the site was a somewhat swampy area, it was deemed suitable for an industrial plant with adequate grading and drainage. The city council referred the rezoning request to the plan commission and asked for a yes or no answer.

The plan commission quickly voted unanimously in favor of the rezoning. By August 15 the council completed three required approvals of the ordinance to rezone.

Thus the way was cleared for Collins to stay in Cedar Rapids. Contracts were awarded immediately and construction proceeded rapidly on what became known as the Main Plant. Occupancy was underway by December, 1940.

Collins had to raise $102,500 to help finance the original Main Plant building. The money was obtained with the issue of 41 first mortgage registered notes for $2,500 each to banks and individuals, at five percent interest. The money was repaid by September, 1944.

The area around the Main Plant in 1940, with the exception of the golf course to the northwest, was a mixture of agricultural fields and scattered housing. Many of the homes were of a type familiar in the depression years, where a family bought a lot and dug a basement, but lacked the money to build more than a foundation with a floor over it, so lived in the basement. When the war ended five years later, veterans returned and home building took off. In the next decade property values soared both for existing and new housing developments in northeast Cedar Rapids, helped greatly by the presence of Collins Radio.

The Main Plant became part of even larger facilities when Collins expanded further in northeast Cedar Rapids.

When the Collins Radio Company was first incorporated in 1933 with about a dozen employees, the population of Cedar Rapids was 56,500.

Thirty-five years later, in Collins' peak year of 1968, the company had nearly 12,000 employees in Cedar Rapids, and the city population was 103,000. In 1932 the value of Cedar Rapids' industrial output was estimated at $120 million, in 1968 nearly a half-billion.

How much did Collins Radio Company have to do with that growth of the metro community?

By 1968 the Collins payroll in Iowa (that included a small plant at Anamosa) was about $90 million per year. The company paid a million dollars a year in property taxes, $100,000 in sales and use tax and $85,000 in state unemployment tax.

Of the 12,000 employees, 2,500 were professional engineers and other technical specialists, and hundreds more held college degrees in business and other fields, which meant they were in medium to upper income brackets.

But statistics such as those do not tell the story in terms of the number of homes built and housing areas developed, smaller companies and vendors supplying materials to Collins, retail and service businesses, schools, hotels, churches, hospitals and others benefitting from the dollars which Collins generated. The firm also helped bring major growth in air and surface transportation services. Hundreds of visitors came to the city every year to do business with Collins, patronizing local hotels and restaurants.

Since its early years Collins was a big contributor to Cedar Rapids' reputation as a major export center. Cedar Rapids long has boasted of having the highest volume of export business per capita of any city in the nation. In the peak years

Collins' export business was near $100 million per year in equipment shipped to foreign airlines and governments.

The adjoining community of Marion owed much of its growth in post-World War II years to Collins. Marion grew from 6,000 people in 1950 to 11,000 in 1960 and 18,000 by 1970. In those peak years of Collins, up to 10 percent of wage-earning Marion residents were employees of the company.

Thus Collins Radio Company can be credited with a major contribution to the second growth spurt in the history of Marion, founded in 1839. The city's first boom came from the railroad expansion west after the Civil War. Yet Marion as a community never did anything significant to honor the memory of Arthur Collins.

Not only Marion but other east-central Iowa communities had residents commuting to Collins. Hundreds of employees came from areas as far as Manchester to the northeast and Marengo to the southwest.

With such a large employer in their midst, almost everyone in the Cedar Rapids-Marion community who did not work at Collins knew someone who was employed there.

Most residents were proud of the accomplishments of Collins — its wartime and space contributions in particular. Still, many residents derided the company and Arthur Collins for the periodic unstable business performance, notably times when business volume and profits were down, necessitating layoffs.

Many regarded Collins Radio as a factory almost entirely involved in producing equipment for the government under fixed price contracts. It was true during many years that a majority of work at Collins involved government contracts, and the plant always had to be operated under government security regulations.

But a large part of engineering development and manufacturing at Collins was in commercial equipment, primarily for air transport and corporate aviation. That work reflected Collins' position as the world's leading avionics company.

All because of Arthur Collins, his firm provided employment at good wages for thousands of area people through the years, and brought into the community hundreds more hired off campuses and from other companies and the military services.

Collins was one of the first area companies to employ women on a large scale in good paying jobs. That began with the need to meet World War II production demands when large numbers of area males were called up for military duty. In 1952 the firm promoted 19 women as production foremen.

Collins, as with most firms which grow to be large, had its share of departments with somewhat padded personnel rosters which empire-building department heads considered essential.

As the company experienced major expansion in the 1950s, Arthur came out of a barber shop in the Kenwood shopping center near Main Plant one day and encountered a classmate from high school days. The friend remarked about the great success of the company and asked, "How many people you got working out there now?" Arthur's reply was, "I think about half of 'em."

But for the majority of employees it was not a comfortable place to work if they did not want to give a full measure of effort. A full measure of effort usually meant more than a 40-hour week. Except for hourly paid employees, late night, Saturday and Sunday work in addition to their regular weekday schedule often was normal for many, particularly those involved in engineering design. Arthur demanded much of himself and his top people, and that dedication was held by many in the ranks. Many wives were not as pleased about their husbands' choice of an employer as were their mates doing the creative work they liked to pursue.

But Collins Radio Company was not an unhappy place, nor was it a formal, structured atmosphere. Most employees called their bosses by their first names, and many were on a first name basis with top executives. While the firm had its share of jobs which involved routine repetition, many persons found opportunity, based on their abilities, to rise to supervisory and executive level positions. Most were friendly and helpful to others with whom they worked. Unlike many corporations, most executives were approachable to employees who wanted to talk to them.

Around 1960 or '61, when the first addition was built on the Fabrication building west of C Avenue, hard surfacing of the parking lot did not get completed before winter weather set in. The gravel base was a muddy mess with many large water-filled potholes. Employees had to don rubbers and overshoes to walk between the building and where they parked, distances up to several hundred yards.

Such a situation was not to be overlooked by the creative minds of a small group of office workers.

Making a trip to an auto salvage yard in southwest Cedar Rapids, they acquired the roof of a Volkswagen bug automobile. Making sure the lot was free of any onlookers, they strategically placed the car top in one of the larger potholes.

The desired results of their prank soon unfolded. Another employee rushed into the building and informed the guard at the entrance that a car had been swallowed up by a pothole. A flurry of activity followed, with maintenance supervisors quickly arriving to look over the scene, until realizing a hoax had occurred. The hole soon was filled with a truckload of rock.

One of the most remarkable factors in the success of Collins Radio Company over the years was being able to attract exceptionally talented engineers and other technical specialists to live and work in Cedar Rapids.

There is no doubt that the reputation of Arthur Collins and his company's products was one of the primary reasons many joined the firm. Another reason was the opportunity which Collins offered for engineers to create and experiment, and to grow professionally.

Robert L. Cattoi, who headed Collins computer development and later was senior vice president, research and engineering under Rockwell International after that firm took over Collins, recalled a factor in his decision to accept an employment offer with Collins:

"Those of us who were engineers at Collins Radio went there because of Arthur Collins. I can remember some advice given to me by a professor when I was a senior at the University of Wisconsin. He told me, 'If you want to get 10 years of experience in 10 years' time, try the companies on this list. If you want to get 25 years of experience in 10 years, go to Collins Radio.'"

There was a saying within the company, "A new Collins man is new for a very short time," indicative of the pace of on-the-job learning and responsibility for those willing to accept the challenge.

It also was apparent in the ages of supervisory people. In the early 1960s the average age of engineering group heads was 31.

Collins recruiters found there was no problem in selling prospective engineers on Collins, once they had toured the facility. But there was a problem selling them on Cedar Rapids.

It was not that the Cedar Rapids area was undesirable. It was an outstanding community for raising a family, with excellent schools and attractive housing. It did not have the commuting, pollution or crime problems of large cities. Most Collins engineers living in or near Cedar Rapids and Marion had only a 15-to-20-minute drive to and from work.

But it did not offer the glamour of metro areas, with their shopping, cultural and entertainment features and big airports, nor the mild winter climate and recreational attractions of the south and west. Neither did the farms and woodlands of Iowa provide the breathtaking scenery of some locales.

In addition, there was an antipathy toward Iowa and the Midwest in general by many who were interviewed about working at Collins.

In fact, nearly two-thirds of all offers made to engineers and other high ranking professionals for jobs with Collins in Cedar Rapids were rejected. With some salary was the reason, but the main objection of most was location. More than once Collins recruiters talking to young, single engineers were reminded that, *Cedar Rapids is not a bachelor's town.*

Still, the Collins company was able to attract hundreds of extremely knowledgeable and talented technical people to Cedar Rapids. The fact that Collins became the best in the world in such areas as avionics, amateur, high frequency radio, data communications and many specialized military electronics areas was proof that it had some of the world's top engineers and scientists on its staff. Most of the Cedar Rapids technical staff had Midwestern roots, coming from prestigious schools of Indiana, Illinois, Wisconsin, Ohio, Minnesota, Missouri, the Dakotas, Iowa and other central states.

The engineering organization and climate which Arthur created, particularly in Cedar Rapids, was unique.

*Arthur may not have known he was doing it, but he stimulated people to think, causing a large number of good thoughts to be created and taken advantage of,* was a comment of John C. McElroy, who was vice president of engineering in Cedar Rapids for a number of years.

*Collins Radio in Cedar Rapids was a hotbed of mental stimulation when it came to technical ideas,* McElroy said.

In the 1960s, the community of Cedar Rapids was regarded as having more engineers per capita than any city in America. With many other industries in the city, Collins Radio alone was not responsible for that, but it was the biggest contributor.

Arthur Collins built his company to develop new products in specific areas relating to communications and aviation, and to manufacture only products which it designed.

More than 20 percent of all employees were engaged in research, design and development of new products.

The 20 percent consisted not only of engineers but many technicians, technical writers and other specialists representing a wide range of aptitude and abilities. They came from trade and technical training schools and military services. Lab technicians were the backbone of the engineering laboratories, often equally or more skilled in many ways than graduate engineers.

The other Collins operations established in Texas and California had nowhere near the difficult problems of the Cedar Rapids facility in attracting professionals.

It was not only Arthur Collins but also other brilliant assistants hired by him who were able to both recognize and convince highly capable people to take jobs at Collins.

The late L. Morgan Craft, for many years one of Arthur's chief assistants who headed up both engineering and manufacturing, did much to build the engineering capabilities of Collins from 1935 to the 1960s. Another was Frank Davis, who served as chief engineer for several years before an untimely death at age 34 in 1946. During the boom years of the 1950s Collins hired Dr. J.A. Greenlee, a dean at Iowa State, to direct the recruiting of engineers. It was still part of the job of engineering managers, however, to be on recruiting trips quite often.

Despite the problems of professional staffing, the Cedar Rapids operations always remained the largest of any Collins facility, and the heart of Arthur's company even when he moved corporate offices to Dallas in the 1960s.

There was a unique spirit and work ethic in the Iowa hinterland community which was not equalled in the other geographic divisions. Cedar Rapids was the operation making the money which carried the others.

The Cedar Rapids facilities grew far larger than the original Main Plant, with expansion in the 1950s on both sides of C Avenue north of 50th Street NE, later renamed Collins Road. Initially a 52-acre site east of C Avenue was purchased, and ground broken there in 1953 for the Engineering Building. Later 90 acres west of C Avenue were bought, where a series of new structures were built starting in 1955.

With those sites, there was none of the zoning controversy that occurred with the Main Plant in 1940. The areas were still wide open spaces, and city fathers were more than happy to cooperate with the Collins expansions.

As Collins Radio Company grew from a small to a large business and made numerous contributions to technology, under Arthur's leadership or by him personally, recognition finally came to Arthur in 1953 when he was elected a fellow of the Institute of Radio Engineers (later renamed the Institute of Electrical and Electronic Engineers.)

He served from 1945-51 as a director of Coe College of Cedar Rapids, where he had taken courses in 1926-27, and in June, 1954 Coe awarded him an honorary degree, Doctor of Science.

However, he was refused recognition by Iowa's leading engineering school, despite hundreds of the institution's graduates being hired by Collins and many distinguishing themselves with their work at Collins.

At least twice, Morgan Craft sought to have Iowa State College (later renamed Iowa State University) confer an honorary doctorate degree on Arthur A. Collins.

Iowa State officials, adhering to long-time tradition to honor only holders of college degrees and primarily those in academia, rejected the suggestion.

While Arthur never sought recognition for himself, he felt slighted by the Iowa State rebuff. He told his family and close associates that Iowa State cared only about honoring academic people, and ignored industries. The radio genius who did not have a college degree noted that if it weren't for industries there would be few places for the school's graduates to be hired.

The University of Iowa finally got around to recognizing Arthur in 1967, presenting a Distinguished Service Award. He was cited as "a classic profile of industry, ingenuity and commitment in Iowa...an inventor, technical author, manufacturer and lay leader in a variety of educational and institutional causes. He is a pioneer on the vast frontiers of the modern age."

Arthur and Mary Collins attended the awards ceremony in Iowa City and a lunch hosted by the university president.

The University of Iowa award was still a step down from what the man who built one of the greatest companies in Iowa deserved. Arthur originally was nominated for an honorary doctorate of engineering degree by a senior professor in the university's college of engineering. But like Iowa State, the University of Iowa reserved such honors for others, many of whom had long before left Iowa and did little of their achieving within the state.

In 1962 Arthur received one of the most significant honors of his life, the Distinguished Public Service Award, the highest award a civilian can receive from the U.S. Navy. The presentation was made at a banquet for about 200 invited guests at the Roosevelt Hotel in Cedar Rapids.

Arthur was cited for his and his company's role in providing World War II and Korean War equipment which became the standard for Navy aircraft and ships, and for continuing to make "very significant technical contributions to all phases of naval communications and flight instrumentation."

"In fact," the citation noted, "there is no naval ship, aircraft or shore station that does not have equipment made possible by the inventive genius of Arthur Collins."

Also mentioned was that from 1946 to 1956, the Navy had some 30 electronic contractors supplying aviation electronic equipment, but only seven of the 30 had the capability to design equipment which they and the others produced. *Arthur Collins' company designed 45 percent of that equipment.*

"What makes Collins' designs unique above all others is that they have been useful over long periods of time and are the last to become obsolete. It can be fairly stated that Arthur Collins' contribution to naval communications has been of national significance," the citation stated.

In 1966 Arthur received the Distinguished Service Award of the Iowa Broadcasters Association. William B. Quarton, then president of WMT Radio and Television of Cedar Rapids and longtime acquaintance of Arthur, recalled it took a good deal of persuasion to get Arthur to agree to take a day off and go to the association convention in Davenport to accept the award in person, but he did.

Arthur made a brief but impressive acceptance speech.

*Like everybody else, I think it is great to receive kind words — especially from some of my customers.*

*I am sure that all of you have contributed more to community and public affairs than I have. I have always been so engrossed in my work that, unfortunately, I have found little time for this — and I regret very much that this is so.*

*And so I realize that your award to me for public service has a different meaning than one usually associated with the phrase. I am sure that in my case you are not thinking of any really public activity or accomplishment or, in fact, of my individual accomplishment at all.*

*Instead, you are recognizing and pointing out the remarkable freedom and opportunity that exist in our state and in our country. We live in a place where it is possible to build new things — to make mistakes and try again. I feel that this opportunity and freedom have greatly increased rather than lessened over the years, in spite of the troubled temper of the times.*

*All of us here have been able to take part in building new industries — radio, aviation, television, electronics and others — which didn't exist when we were kids.*

*I think that what you want to say — and I join heartily in saying it — is that there are plenty of new things left to do. And the opportunity and freedom — and responsibility — are here for the younger fellows who will do them.*

The elusive Honorary Doctor of Engineering Degree that was denied to him in his home state finally was awarded to Arthur in 1968 by the Polytechnic Institute of Brooklyn, New York.

Also in 1968, Arthur Collins was elected to the National Academy of Engineering.

A local honor, the Community Builder Award of the Cedar Rapids Lodge of B'Nai B'Rith, was conferred on him in 1969.

Then he was singled out for a second Honorary Doctor of Engineering Degree from Southern Methodist University in Dallas in 1970. The award came at a time when Dr. Thomas L. Martin, Jr., dean of the Institute of Technology at SMU, was a member of the Collins Radio Board of Directors.

Mount Mercy College, another Cedar Rapids four-year school, awarded an Honorary Doctor of Science Degree to Arthur in 1974.

In 1977 he received the Armstrong Medal, one of the two highest awards presented annually by the Radio Club of America. He was cited for his work in aircraft communications and control systems. The award is named after radio pioneer Edwin Howard Armstrong, who Arthur knew as a fellow scientist.

Recognition from the State of Iowa finally came to Arthur in December, 1982, when he was awarded the Governor's Science Medal at a ceremony in Des Moines. The citation described him as "a tremendous asset to Iowa through his pioneering work in communications and electronics."

Also in 1982, Arthur received what was one of the most meaningful awards of his life, because it reflected recognition by his peers. It was the Pioneer Award conferred annually by the Aerospace and Electronics Systems Society of the Institute of Electrical and Electronics Engineers. He was cited "For Pioneering Contributions to Radio Communications," and his name was added to a long list of distinguished scientists and engineers receiving the award since it was inaugurated in 1949.

Arthur joined organizations if he had a personal or professional interest in them. Those in which he held memberships included the Institute of Electrical and Electronics Engineers (since 1926), American Association for the Advancement of Science, Navy League of the United States, Association of the U.S. Army, American Ordnance Association, Armed Forces Communications and Electronics Association and the Cedar Valley (East Central Iowa) Amateur Radio Club.

At one time he was a Cedar Rapids Chamber of Commerce member, but later had other Collins executives represent the company and serve on the Chamber board. He served briefly on the board of Junior Achievement of Cedar Rapids.

He also maintained membership in a number of clubs for social and business purposes. They included the Cedar Rapids Country Club, Cedar Rapids Elks Lodge, the Kansas City Club, Balboa Bay Club at Newport Beach, CA, National Aviation Club, Washington, DC and Kona Kai Club, San Diego.

In addition to serving six years on the Coe College Board of Trustees, he was on the Board of Directors of the Graduate Research Center of the Southwest in Dallas and the Herbert Hoover Foundation associated with the Hoover Presidential Library and birthplace at West Branch, Iowa. He also served on the International Sponsors Committee of the Goddard Library Program at Clark University in Massachusetts. In Arthur's later years he launched attempts to bring increased recognition to Robert Goddard for his contributions to the development of electronics. Goddard, of course, was best known for his work in rocket science, but also had invented a radio tube used by Arthur in early years of his company.

While the official company biography of Arthur never mentioned it, he also served briefly on the Cedar Rapids Airport Commission in 1958-59. His letter of resignation stated he quit "for business reasons." But during his short time as a commissioner, Arthur became upset that fellow commissioners and other city officials did not share his urgency to undertake airport runway repairs.

His company pilots had told him that parts of the runways were crumbling. Arthur even had his own company construction supervisor accompany him on an examination of the areas and confirm the deteriorating conditions. Unable to convince others on the airport board to act, Arthur decided he could put his time to better use than trying to fight city hall.

Still miffed at the Cedar Rapids Gazette because of the Gazette's coverage of his 1957 auto accident, Arthur called George Mills, veteran reporter for the Des Moines Register and Tribune, and asked Mills to do a story on the airport problem. Mills remembered coming to Cedar Rapids, interviewing Arthur and writing an article on the runway situation. A runway renovation project eventually was approved.

Arthur Collins was never one to toot his own horn and demand recognition for his good deeds or his achievements. He did not consider himself to be a great man and was not flattered by praise. He avoided rather than seeking personal publicity. He preferred that his company, not himself, get the credit for the many great works that resulted from the business which he founded.

But he was responsible for many impressive inventions and developments in communications and electronics.

His big disappointment was that his last major project, the Collins C-System, did not achieve the goals he envisioned for it, and that it cost him control of the company which had been his life.

# Chapter 7
# SPREADING OUT TO DALLAS

Until 1951, 20 years after he began building radios for sale, Arthur Collins' company had a plant in only one location, Cedar Rapids, Iowa.

And by 1951, the business he started in his basement had become a world leader in several important types of communication technology. It had grown from a small to a large company, and was one of the United States' most important defense industries.

By 1951, too, the Soviet Union had switched from American ally in World War II to an increasingly antagonistic attitude toward the U.S. In addition, in 1949 it became the second world power to have nuclear weapons.

The fact that a single Soviet atomic bomb could wipe out an entire community such as Cedar Rapids and all the Collins Radio facilities alarmed U.S. defense officials. In the case of Collins, the Navy was particularly concerned because the firm was one of its top 10 contractors. Arthur Collins was pressured to open a second plant in a different location, to avoid having all the company engineering and manufacturing in one place.

But even before the prodding came from the Navy, Arthur was planning to have Collins Radio open a major branch elsewhere. He was concerned about the company becoming such a dominant factor in the Cedar Rapids economy that a major downturn could seriously harm the community. And he did not want the Collins name associated with another black eye, as when the Collins Farms venture of his father folded.

Thus motivated by two main reasons to spread out, Arthur and his top aides began a search which was narrowed down to two possible sites — southern California and the Dallas-Fort Worth area of Texas. Both were attractive from the standpoint of being centers of aircraft manufacturing and headquarters of several major airlines. Those factors tied in with the growing role of Collins in avionics. The Dallas-Fort Worth area at that time was headquarters for two airlines, American and Braniff, plus airplane builders such as TEMCO, Consolidated Vultee and Chance Vought.

Dallas was selected, mainly because of advantageous tax and depreciation arrangements extended by the city for new plants to locate there. Announcing the decision, Arthur said the need for a second facility was *in line with the current practice of separating plants geographically for security reasons.* Another factor was the federal government encouraging such moves by granting tax breaks on new plants and equipment.

In those years Iowa did not yet have liquor by the drink. Neither did Dallas or Ottawa, Canada, another city where Collins was beginning to set up operations.

That circumstance was lamented by Collins people who noted they could not buy a drink in Cedar Rapids or in the other locations.

Early in 1951 Collins occupied a 25,000-square-foot plant in the Trinity Industrial District of south Dallas, built by and leased from the Dallas developer, Trammell Crow. Also leased to be an avionics service center was a hangar at the Red Bird Airport on the southwest edge of Dallas. One of the Collins Dallas veterans remembered how Arthur *worked alongside all the other guys, helping to sweep up* in a hurry-up effort to get the Red Bird facility open for business.

Joining the company to serve as general manager of the new Texas operations was James G. Flynn, Jr., a former airline executive who had known Arthur since buying Collins Autotune transmitters for American Airlines in the 1930s.

The Dallas facility had about 100 employees when it opened, including a group of supervisors and managers transferred from Cedar Rapids. Other persons were hired locally, many of whom had to be trained. Employment was projected to reach 500 after one year. The facility was in operation only about three months when plans were announced to build a second Collins plant of 50,000 square feet in the same area.

The initial Dallas manufacturing activity included production overflow from Cedar Rapids. Some avionics equipment soon was produced there, including the AN/ARN-14, military version of the VHF navigation receiver.

The Dallas facility also became the engineering and production location for a new Collins activity, microwave systems.

The Dallas operation experienced rapid growth. Within six years there were 2,250 employees working in eight Trinity River area buildings.

*We had to have more space,* said W.T. (Bill) Weinhardt, who headed Collins construction activities. *That was when we went up north (to Richardson) and put up a building on the south side of Arapaho Road. Soon after that we bought about 240 acres across the road to the north. It was wide open spaces at the time — Richardson was still a small community with a volunteer fire department and the idea of developing that part of the community had not yet occurred to anyone. The area had no water mains or sewers. Collins had to put those in, which was expensive. Then we got the City of Richardson to pass a law that said everyone else who hooked into our sewer line had to pay a tapping fee — that helped pay for it,* Weinhardt said.

In 1957 construction of a 128,000-square-foot engineering and office building began on the newly developed site. It was occupied in early 1958. As more Richardson facilities were added, Collins eventually moved all activities there from the Trinity district.

About that time, too, a new business aviation airport was built at Addison, seven miles west of the Richardson plant. Collins then moved its Avionics Systems Center work from Red Bird to Addison. Although most avionics equipment was produced in Cedar Rapids, the Addison Center became the site of many special service and installation projects, including work on Air Force One.

The main activities of Collins Radio's Texas operations evolved into a category called telecommunications — a term generally describing land-based point-to-point, fixed station communication systems. That included microwave, transhorizon scatter and multiplex carrier equipment.

In addition, ground-based space communication and tracking antennas and stations, along with detailed antenna research, became another major area.

Also, the Collins commercial broadcast equipment product line and associated work in high powered transmitters was transferred to Dallas from Cedar Rapids in the mid-1960s.

Dallas was where the company's extensive international activities were managed, and it also became a major player in Arthur Collins' last big endeavor as head of Collins Radio Company, the C-System.

Microwave systems work, however, was the largest development and manufacturing activity in the Dallas Division.

The initial use of microwave was by the military during World War II. The public first became aware of it after the war when big communications firms such as AT&T began building networks across the U.S. to transmit long distance telephone and television signals. Microwaves are much like other radio waves but short in wave length. They are easy to manipulate in that they can be focused and beamed like light, can be bounced off small objects and be reflected in new directions. They are virtually free from natural or man-made interference. However, they travel in straight lines only as far as the horizon before shooting off into space. To overcome that requires a series of relay stations every 30 or so miles to catch signals, rebuild the power and retransmit to the next station. A basic microwave system consists of two terminals with as many relay stations as needed between the terminals.

Collins' work in microwave was an outgrowth of research started in Cedar Rapids about 1946 by Dr. W.W. Salisbury. By 1951, the same year Dallas operations began, the company saw microwave as a major new market opportunity. Dallas Division engineers then did a detailed analysis, studying communication needs of telephone and pipeline industries. From that came the decision to design and manufacture some of the first commercially available microwave equipment.

Full scale development began in late 1952, and resulted in an installation between Dallas and nearby Irving to test the new equipment in early 1954. The first system sale came later that year to California Interstate Telephone Co.

Most of the nation's early commercial microwave systems were built by the big telephone and telegraph firms and used for their own communication networks.

Collins, however, found a niche serving others not aligned with the big phone companies but with a need for microwave. Collins' customers were independent phone companies, industrial, government and military users. In time the company became the world's largest independent supplier of microwave systems.

Not only did Collins build all the equipment to transmit and receive microwave signals, but also provided the buildings, antennas and towers, power generating and remote control systems, even the roads and other facilities which were needed. The company referred to its total capability as a *turn key* system, meaning the customer had only to open the door and walk in to begin using a newly constructed system.

Over the next two decades Collins built enough microwave installations which in total miles covered would stretch around the world nearly twice. The Collins systems did more than transmit telephone and television signals, high speed data and facsimile. They were used to control pumping equipment at remote, unmanned installations along pipelines, and to operate switches at remote points along railroad lines.

An early project was a 27-station, 708-mile-long system for the Continental and Sinclair Oil Companies serving pipelines between Houston, Texas and Ponca City, Oklahoma. It featured a unique application of batteries for standby power at stations along the line.

One of the largest of Collins' microwave programs came when the Federal Aviation Agency began setting up nationwide radar coverage for air traffic control in the late 1950s. Eventually those systems provided ground communications links for more than 100 major U.S. air traffic control centers. Some 630 microwave repeater stations were required, spanning over 16,000 miles.

Numerous military installations used Collins microwave, including the 6,000-mile Pacific Missile Range. Single sideband radio, Kineplex data transmission and other equipment by Collins also served the missile facility.

One pipeline installation stretched from Longview, Texas to Lima Ohio, over 1,000 miles. A New Mexico and Utah system required relay stations atop 10,000-foot mountains.

A system built for Continental Telephone of California included service to the Goldstone Space Tracking station near Barstow. When Apollo TV pictures from the moon were received by the Goldstone antenna, they were relayed to NASA by the Continental microwave network.

All in all, Collins microwave installations could be found from Korea to Taiwan to South America to Syria, and of course in many areas of the U.S.

One system built for oil companies in Venezuela combined microwave and transhorizon scatter communications. One unusual phenomenon of the Venezuela system was an extremely long microwave hop of 176 miles. Most such hops were in the 30-mile range. Engineers were puzzled to find it worked.

Collins' scatter communication work, started in Cedar Rapids in the 1940s, also became located in Dallas, with dozens of systems produced there.

As the Dallas operations grew rapidly in the 1950s, and an increasing number of corporate management functions were being handled there, the question was frequently raised as to where Collins Radio's headquarters were located — Cedar Rapids or Dallas.

While Arthur began to move in the direction of making Dallas the corporate headquarters, he apparently was concerned about reaction in Cedar Rapids to that change, and did not want to make any public admittance of his plans.

Around 1960 a Dallas newspaper speculated that Dallas had become Collins headquarters, which was firmly denied by the company. The story stirred up a hubub in both communities, which forced Arthur to have a statement prepared that there was no change in the status quo.

*It is extremely flattering to have two progressive cities worrying about where* *we are. The Dallas folks are just becoming aware of the fine growth we have been experiencing in their city and jumped to a conclusion. While a number of important corporate functions have been assigned or transferred to Dallas, equally important management responsibilities remain and will continue to be directed from Cedar Rapids. The Cedar Rapids Division is the largest by far in terms of employees and business volume and will remain so in the foreseeable future.* Arthur was quoted.

Through 1960 Cedar Rapids was still considered to be the corporate office. Then the 1961 and 1962 annual reports showed the company as having a Midwest Headquarters in Cedar Rapids and a Southwest Headquarters in Dallas. By 1963 Dallas was officially acknowledged as the corporate headquarters.

The 1960s saw numerous construction projects for Collins Radio. New buildings were added in Cedar Rapids, Dallas and Newport Beach, much of the space intended to be used for Arthur's massive development program, the C-System.

Also, an elaborate corporate headquarters building began to take shape on the Richardson complex, a futuristic-looking concrete and glass edifice.

The concept behind the corporate office center, officially known as Building 407, actually originated with another of the mid-60s Dallas construction projects. That was Building 406, erected with a maze of plumbing underneath and very heavy concrete floor to provide a stable platform for fabricating microelectronics circuits.

Bill Weinhardt recalled the Building 406 plan then was adapted for a similar new building at Newport Beach. But in Southern California, an area of potential earthquakes, building codes required the concrete base, floor slabs, columns and connections between slabs and columns be made even stronger.

Weinhardt said that Georges Pujak, the Los Angeles architect of Polish origin retained by Arthur for the building projects, noted the floor slabs used at Newport Beach were so strong they could be cantilevered out. He suggested using that technique for the new corporate building. Arthur picked up on that idea, he and Pujak both being free thinkers, Weinhardt said.

The new building had large, rectangular towers at each end, containing elevators and other utility functions. Stretching between the towers were huge horizontal slabs of steel reinforced concrete for the first, second, third and fourth floors. The walls were reflective glass in metal frames, placed in from the edges of the slabs. The glass exterior formed the outside wall of offices, giving occupants spectacular views of the Collins campus and surrounding area of the flat Texas countryside. At night, with interior lights on, the building was a brilliant site. The executive offices on the top floor were spacious and lavish.

When completed in early 1967, Building 407 presented a definite avant-garde appearance which aroused a full range of emotions from expensive monstrosity to highly creative yet functional architecture.

Another of Arthur's construction projects was a new home, *probably like no other house around it*, Bill Weinhardt said. It had a steel frame , a lot of concrete, and an industrial steel roof. Stone for a fireplace and interior wall came from an Iowa quarry at historic Stone City northeast of Cedar Rapids, near where famed artist Grant Wood had an art colony in the 1920s. To try out the construction techniques, a building slightly larger than a double garage was built on the property first. It served primarily as an office.

Arthur had bought two lots containing existing houses in a north Dallas neighborhood near Alpha and Preston Road. He used one of the homes for a residence temporarily until having both of them torn down to begin construction of his new house.

Arthur decided to have the house erected by the construction division of his company, which had been formed in the late 1950s to build numerous installations such as microwave repeater stations, space tracking antenna structures, remote radio bases and other projects. Arthur always had specific ideas when it came to design and construction, and conveyed those to the construction engineers and a company architect who, after consulting with him, prepared detailed plans according to his instructions.

Whenever Arthur had a private project not related to company work undertaken for him by a company department, he insisted on a strict accounting of all charges and expenses to pay them personally.

Bill Weinhardt recalled that Arthur was adamant about having a basement for at least part of the house, a difficult challenge for builders in that area. The main problem was the Texas soil — with rock near the surface.

*You go down three feet and hit shale, and another two feet you find blue rock prevalent in the area,* Weinhardt said. Because they could not use explosives in the residential area, construction workers had to drill holes, drop expandable wedges in the holes and crack the rock apart to remove it.

While Arthur still had a home in Cedar Rapids, the Dallas house became the main residence where he, Mary and their two sons lived. It continued to be his home until his death in 1987, and Mary lived there until she died in 1998.

The Dallas operations also became headquarters for Collins Radio Company's extensive international marketing and service activities.

From early days of the company in Cedar Rapids, Collins products were used in many parts of the world. In the 1930s the firm had dealers in Europe, Africa, Asia and Central and South America selling its radios. All commercial activity ceased during World War II, but picked up rapidly after peace was restored. By 1954 Collins had 58 overseas dealers selling equipment in dozens of countries. Those sales were handled through what was called the Collins Export Sales Department, headed by Bob Parsons until 1956.

Many sales also were made directly by Collins to foreign customers, particularly avionics equipment. *It was avionics that really built up Collins' international sales,* said T.A. (Tommy) Campobasso, who in later years headed that company activity.

The first postwar expansion outside the U.S. was the establishment in 1953 of Collins Radio Company of Canada, Ltd., a wholly-owned subsidiary, in Ottawa. It was moved later to Toronto. The main role initially was sales of equipment to the Canadian armed forces.

Robert C. (Bob) Frost, a Collins vice president and legal counsel for international operations, recalled how another subsidiary began. *In 1954, Max Burrell (then a company vice president) and I had been in England about three weeks negotiating a military contract when Burrell got a call from Art to return home. Then Art had me get on the phone and said, 'you've got $50,000 to set up a sales subsidiary in England'.* Frost said after he was able to find a helpful British attorney and they succeeded in getting approvals from the Bank of England, the Board of Trade and the British Navy, a Collins Radio Company of England, Ltd. subsidiary was authorized. *Getting the British Navy's okay was the key, as they wanted to buy Collins equipment,* Frost said.

In 1957 Collins set up a subsidiary, Collins Radio International C.A., in Caracas, Venezuela. The main reason was that Venezuela allowed a corporation located there to own other foreign operations, but taxed only transactions within its borders. For several years the Caracas office had branches in Paris, Frankfurt and Tokyo selling equipment, with the revenues coming back into Venezuela untaxed.

By the early 1960s the France and German offices were subsidiaries, along with others in Italy, Australia, Mexico and the Far East.

J.G. Flynn, Jr., the first general manager in Dallas, moved from that post to be vice president of sales for Collins, and about 1961 became vice president and manager of the International Division.

Flynn supervised the build-up of International to include service centers as well as marketing offices. The managers and staffs of the various facilities around the world were mostly natives of those areas. Collins also maintained a coordinating office in London overseeing European, Middle East and African activities, with a number of Americans on the staff.

The growth of the International Division was evident in sales figures. In 1949 the total was $1.2 million. That grew to $16 million by 1960. In 1968 the total reached $72 million, roughly 20 percent of total company sales.

As Collins Radio Company became a major firm in Dallas, it and Texas Instruments were regarded as the two big electronics firms in the north Dallas-Richardson area in the 1960s and '70s. They were considered pathfinders for an explosive growth of the telecommunications industry in Richardson in the 1980s, making that community one of the leading telecommunication centers in the U.S.

Probably one of the most interesting places to be a Collins employee was the Avionics Systems Center at Addison Airport, a few miles west of Richardson.

The facility often had work being done with aircraft involved in special or unusual military and space projects. For example, after the Mercury spacecraft flight by Astronaut Scott Carpenter in May, 1962, NASA wanted additional communications systems. Carpenter's space capsule had overshot the planned ocean landing area by 250 miles, causing great anxiety until he was located and rescued. For the next Mercury flight of Astronaut Wally Schirra in October, 1962, the Addison facility modified two C-130 aircraft, providing equipment to track and communicate with the spacecraft during orbit and after re-entry.

Work was done at Addison on military command post aircraft and the U.S. fleet of presidential aircraft. After John F. Kennedy became president in 1961, the

Boeing 707 aircraft which would be Air Force 1 was flown to Addison for systems engineering and avionics installations. Reportedly First Lady Jacqueline Kennedy wanted the interior of the aircraft decorated in a red and black Spanish motif, including a glass chandelier in the living quarters section. When told a dangling chandelier would be a safety hazard and unacceptable, she lost interest in the matter and let Air Force people choose the decor. It ended up traditional Air Force blue and gray, and no chandelier.

With Collins Radio Company being a foremost company in radio communication technology, a vital part of the mix was antenna capability. The firm's early antenna endeavors had been for amateur and aircraft radios, and to a limited extent for radio broadcasting. In the 1950s came the first space tracking antenna project for the Naval Research Laboratory, and the massive antenna installations for the Strategic Air Command single sideband communication network. Another project was a huge antenna installation in North Carolina for the Voice of America, used to beam short wave broadcasts to Europe, the Middle East, Africa and South America.

Soon came space tracking antenna stations to serve the first U.S. satellites and the early manned spacecraft flights. *Collins eventually built 31 big dish antenna stations,* Tom Campobasso recalled. Functions ranged from listening posts for signals from space to satellite communications to tracking manned and unmanned satellites.

One station was part of Collins' own antenna research facility on the Richardson complex grounds. It included a 60-foot dish, one of the most accurate space tracking antennas ever built, tied in with a multi-million-dollar antenna laboratory.

The work performed there was vital to the Apollo unified S-band tracking network, to microwave and scatter communication antennas, and to deep space probe facilities such as the giant antenna installations at Arecibo, Puerto Rico.

Collins built several large dish antenna stations in Australia for commercial and government satellite communications and space flight programs.

One of the laboratory's unique projects was an antenna encased in an underground silo near defense missile sites. It was designed to push up through tons of debris and assure radio communications in the event of an enemy attack.

Among the most visible of all Collins antennas over the years were those on air transport and business aircraft. Thousands of airplanes were equipped with Collins blade and deer-horn type avionics antennas, easily identified by the company logo imprinted on them.

# Chapter 8
# The Amateur Champion

Arthur Collins and Collins Radio Company were to amateur or ham radio as Rolls-Royce is to automobiles, Rolex to fine watches and Dom Perignon to champagne — top of the line, the ultimate in quality, held in esteem by generation after generation.

Many companies have built ham equipment, but none has equalled the stature held by Collins during its 40-plus years in the amateur radio business. Collins did not sell the most amateur radios, because there were many competitors, and the Collins line usually was the most expensive. But Collins gear was what most amateurs aspired to have, if and when they could afford it. It was considered the best on the market in terms of advanced features, quality and reliability. And, there was great prestige in having Collins equipment.

Years after the last Collins amateur gear was made, the reverence for it continued to grow among virtual cults of users and admirers. According to an article in QST Magazine, a group called the Collins Collectors Association had more than 1,000 members in the late 1990s and was still growing.

To many devotees familiar with the equipment, Collins ham radios are legendary, considered all-time classics.

How that came about started with Arthur's boyhood years after World War I. Amateur radio became a hobby for him as it did for many boys and young men. One big difference between Arthur and most hams, however, was the depth and intensity he gave to learning about and experimenting with radio.

Once he began to be interested about age 9 he had an insatiable passion to absorb everything he could learn about the subject. He was capable of building and operating an amateur station at 10 years old, but because of his age had to wait several years to obtain his license.

Another difference was that he had advantages not available to many boys who were fascinated with ham radio in the 1920s. Arthur's parents, M.H. and Faith Collins, at first were not impressed by their son's new hobby, but soon recognized his unique talents. Being well off financially, they bought tubes and other equipment for him which many young hams could not afford.

Even at that tender age, Arthur contacted State University of Iowa physics professors and men who were experienced amateur operators for explanations to help him better understand wireless communications.

Bob Miedke, a longtime engineering associate, looked back on some of his own youthful experiments as similar to Arthur's except for one factor. "When I was 12 years old, fooling around with crystal sets, I wound coils on oatmeal boxes. I took those out to the Moline airport and connected them to the fence which ran around the airport, and that was my antenna. I could tune into the airport station, which was around 2.5 megahertz, and copy on my crystal set.

"Now Art was doing some of the same things, but he had tubes to build real radios," Miedke said.

The main difference between Arthur and others was what his hobby led to. He turned it into a $500 million-a-year business (in 1960s money), which became the leading company in the world in radio communication technology.

Arthur Collins' start in the radio business was in the design, manufacture and sale of amateur transmitters.

But before he ever gained commercially from his talents, he became known for doing advanced work in the still young field of radio.

After getting his amateur license at age 14 he made radio contacts with amateur operators across the U.S. and in Europe, South America and Asia. He had a growing collection of QSL cards to show for his efforts.

His call letters at the time were 9CXX.

One of his early QSL cards, printed on a one-cent postcard, described his station as follows:

Transmitter: One UV203A run conservatively in an inductively coupled Hartley circuit on the 40 and 80 meter bands. A modified Colpits arrangement is used on 20 meters and below. Receiver: Conventional "Low Loss" with 2 steps of distortion. Good for considerably less than 2 meters. Antennae: Miscellaneous one wire contraptions. (Above subject to change without notice.)

His early card contained the familiar "I crave wallpaper" phrase, meaning he liked to receive QSL cards from other hams with whom he had radio contact. He had many cards pinned to the wall of his ham station, including a number with foreign postmarks.

As a 15-year-old in 1925, between his sophomore and junior years in high school, Arthur's home-built equipment in his attic ham shack served as the main communication contact for a major exploratory expedition to the Arctic.

It wasn't supposed to be that way for the Arctic trek, one of many explorations to the far north led by Lt. Cdr. Donald B. MacMillan. The intent was to have the U.S. Navy provide the primary radio link, through Navy equipment on the expedition and a Navy station in Washington, DC. The use of amateur radio was expected to be on an experimental basis.

The Peary, a Navy vessel on the trip, had transmitters to communicate on wavelengths longer than 500 meters. But from the northern latitudes and lacking suitable antennas, the effective range of the Peary's signals was found to be limited.

The other ship, the Bowdoin, had John Reinartz as its radio operator, using short wave amateur gear. Reinartz, then in his early 30s, was, like Arthur, a self-taught radio expert. His main occupation was that of electrician at a New England power station.

Reinartz was one of the best known American amateurs. In 1921 he developed a tuner using vacuum tubes to permit continuous wave operation. Plans for the tuner were published in radio magazines and the design was widely adopted by hams. His design was the predecessor of most receivers built for many years.

Another of his achievements was being part of the amateur radio team which conducted the first successful trans-Atlantic two-way voice communication in 1923, contacting an operator in France.

Reinartz had developed techniques and equipment to communicate on short waves in the 20 and 40 meter range. He theorized there was an ionized layer above the earth which reflected short wave signals.

His ideas were derided by some because of widespread scientific theory of the time that the shorter wave lengths were useless. Reinartz, along with other amateurs of the time, proved them to be wrong.

MacMillan had been convinced by Eugene F. McDonald, president of the Zenith Corporation, to try short wave communication on the 1925 journey. McDonald, a lieutenant commander in the Naval reserve, also was an investor in the expedition. That combination of circumstances allowed him to command the Peary while MacMillan commanded the Bowdoin on the voyage.

McDonald had Reinartz work with Zenith engineers in the design and construction of the Bowdoin short wave station.

Also a major part of the MacMillan voyage was a Naval aviation contingent of three airplanes, pilots and crews commanded by then Lt. Cdr. Richard E. Byrd. Byrd hoped to prove the value of aircraft to explore the Arctic and also wanted to make the first attempt to fly over the North Pole.

Byrd and his men made several flights, but unfavorable weather curtailed his objectives.

Arthur and Reinartz had become acquainted through radio contacts. Before the voyage to the Arctic they experimented with daylight transmissions in the 20-meter range, and worked out a plan to run tests once the Bowdoin reached northern latitudes.

Reinartz' radio log reported the results:

"August 2 (1925) — Etah (northern Greenland) at last. Had a great time today. Heard many 20-meter amateur stations and worked 9CXX, Cedar Rapids, Iowa, on 16 meters."

That Sunday afternoon, August 2, Arthur was at 22 meters and Reinartz at 21 meters when Arthur first heard WNP (Wireless North Pole, the Bowdoin station). Then both switched to 16 meters. That was the first time either had used 16 meters with any success.

Reinartz' message then continued: "Great work, old man! Glad you should have been first to work me. It's fitting glory for your help a while ago (referring to earlier assistance by Arthur). Reinartz then asked Arthur to relay by telegraph the message of arrival at Etah to the National Geographic Society in Washington and to K.B. Warner, secretary of the American Radio Relay League at Hartford, CT. The term, "old man," was a common form of greeting by hams.

He also requested Arthur to send a message to his wife at South Manchester, CT: "Love via 20 meters from Etah for first time in history of radio at 3:40 p.m." He signed the message, "Kewpie," a nickname Reinartz carried because of his home call letters, 1QP.

That was the beginning of a daily schedule for Arthur over a period of several weeks, receiving from and transmitting to the Bowdoin. Working in the sweltering heat of a third floor attic room in August, Arthur would take down the coded messages from Reinartz and transmit others to him. Each evening he bicycled downtown from the family home, 514 Fairview Drive SE, and sent the information via Western Union (collect) to the National Geographic and Navy Department in Washington.

Arthur kept a meticulous log of contacts with the MacMillan voyage, a habit he would follow throughout his life. On August 15, 1925, his message to the National Geographic included this information:

*Voice from the Bowdoin was heard for the first time on sixteen meters this noon at 9CXX, Cedar Rapids. The voice of Mr. Reinartz and the anthem, America, were both received very clearly.*

The fact that a 15-year-old ham located in Cedar Rapids, Iowa could communicate with the expedition when the sophisticated equipment of the U.S. Navy was inadequate for the task captured the imagination of the radio world. Radio at that time was still a new and fascinating subject in the public mind.

In the true spirit of amateur radio, Arthur willingly shared information about his transmitter and receiver construction and antenna set-up in interviews with various radio publications. The December, 1925 issue of Popular Radio carried a photo of Arthur in his attic ham shack, with the caption stating:

"A YOUTHFUL AMATEUR MAKES A RECORD ON A UNIQUE HOME-MADE SET. Arthur Collins, a fifteen-year old amateur of Cedar Rapids, Iowa, has the distinction of being the first to pick up the low-wave signals from station WNP, aboard the MacMillan ship Bowdoin in the Arctic. Collins' home-made equipment includes pieces of coal and coke used as rectifiers, a coil taken from a Ford car and glass towel racks for insulators."

The October, 1925 QST Magazine carried a picture, circuit diagram and article describing Arthur's station and his work with the MacMillan expedition.

Arthur's transmitting and receiving equipment was spread out in bread board fashion, the way hams constructed their stations in those days.

Armstrong Perry, writing in the November, 1925 Radio Age, noted that a visit to Arthur's station in Cedar Rapids "showed me that his apparatus is simpler and less expensive than the average radio bug would think possible.

"While broadcast listeners are using receivers with five to nine tubes, Collins hears signals from distant countries with three tubes. He made his receiver.

"Using two stages of audio-frequency amplification, he brought in the voices of the men on the Bowdoin when they were broadcasting from north of Greenland. They were so loud and distinct that they could be heard 10 feet from the phones and all over his radio room.

"Collins has two transmitters, one rated at 50 watts and the other at 1,000 watts. Even the 50-watt outfit was used successfully in working the Bowdoin. Both were designed for high electrical efficiency, convenience and flexibility of operation, as he likes experimental work.

"It was the day after the tube for the big set was installed and tested (it cost $135, purchased by his parents) that Collins became the only connecting link between the explorers and the folks back home. For 22 days he was the only operator in communication with the expedition. He worked from 8 a.m. to 5 p.m. daily and handled a great volume of traffic, including personal and official messages and articles for the newspapers. The National Geographic Society, which sponsored the expedition, sent and received numerous messages through this station, built and operated by a boy, with complete satisfaction.

"The 1KW tube uses 4,000 volts on the plate. The only source of supply was the circuit which supplied light and power for the house. That carried raw AC, which is not ideal. Pulling 1,000 watts from the lighting circuit every time the transmitter key was pressed stole most of the juice from the lamps around the house and the family led a flickering existence until Arthur ran a heavy 3-wire BX cable up from the main entrance box and thus put the 21-ampere load of the transmitter on a separate circuit.

"The 1KW transmitter uses what is known as the 1XAM circuit. When working amateur stations in Australia and New Zealand, as he frequently does, Collins tunes it to 40 meters. While working WNP, MacMillan's flagship Bowdoin, he used wave lengths of 15, 16 and 21 meters.

"His antenna, during the time he was handling traffic with the Arctic, was a single wire inefficiently lying in a tree. Having built a dream of a house, on colonial lines, his parents were thinking more of architectural beauty than of scientific achievement, and poles are likely to be unsightly. But since Arthur established his remarkable record there have been erected on the roof two 30-foot masts. At the top is a 50-foot single wire aerial and 20 feet lower a 48-foot counterpoise. There is not much radio territory left for Arthur to reach, unless it might be the moon and Mars," Perry wrote.

When it came to simplicity in design, Arthur told one interviewer: *I have it doped out that simplicity is one of the important features in short wave work. If you leave out some of the nickel plate and some of the bric-a-brac, you will also leave out some of the losses.*

During those teen years Arthur described his equipment designs in articles for radio journals, and also wrote articles which appeared to have the intent of stimulating others to undertake research and experimentation.

When he was 16 an article under his authorship, "Full Details of a Short Wave Transmitter," appeared in the May, 1926 Radio Age. The article read as if it had been written by a professional electrical engineer, with Arthur describing the meticulous research and various steps that went into his equipment.

Another article, "A Full Wave Oscillator for High Frequencies," explained the advantages to be gained by introducing a second tube into a conventional single-tube transmitter circuit.

Arthur continued to experiment with equipment design and performance over the next several years, and spent hundreds of hours on the air.

A fellow ham of that period once wrote the following in recalling Arthur's activities: *Arthur's experimenting continued unabated. He tried out every innovation known to the radio art, in never ending endeavors to bring his transmitting and receiving equipment to a higher state of efficiency.*

He was regarded as a resident expert by other Cedar Rapids area amateurs. His ham shack was a popular gathering spot for fellow hams and he frequently helped them with their questions and problems, as well as radio parts they needed.

Arthur did not claim that all of his ideas were entirely unique with him. As he explained in his full wave oscillator article, "I have recently developed a circuit at my station, 9CXX, which seems to possess some advantages over the more common circuits in use for high frequency work. Although I have studied this circuit quite independently, I claim no originality for it, since a number of other experimenters have also made use of it."

Such a statement revealed a characteristic of Arthur throughout his career. While his creative thinking resulted in many new ideas, his voracious reading on technical and scientific subjects led to many of the activities he pursued. He had a unique ability to recognize the merits of a particular new concept, whether he or someone else had first thought of it, then experimenting and testing to turn the idea into a practical advance.

His 1926 Radio Age transmitter article included the following observation (Arthur was 16 at the time):

"Even if not pursued seriously, the amateur game is an avocation decidedly worthwhile. A high frequency transmitter can gain you lasting friendships with young fellows all over the world. It can be a novel, yet effective means of studying that ever-interesting abstraction, human nature, or it can be a substantial foundation upon which to base later scientific work."

The article concluded with a paragraph which offered insight into Arthur's enthusiasm for amateur radio:

"The real thrill in amateur work comes not from talking to stations in distant lands, nor from receiving multitudes of QSL cards from all over the world — although these are things that stir the imagination — but comes from knowing that by careful and painstaking work and by diligent and systematic study, you have been able to accomplish some feat, or establish some fact that is a new step toward more perfect communication."

Amateurs in the late 1920s built their own sets, from scratch or from kits. They had numerous sources through catalogs and radio shops to obtain kits and parts.

While home receivers for commercial radio broadcasts were being built in attractive wood cabinets, the typical amateur setup was an exposed conglomeration of wires and gear constructed on but not necessarily confined to a chassis. That type of breadboard rig gave amateurs of the time the access to experiment with the layout and to make modifications to their circuitry.

Arthur, on the other hand, not only had a fetish for radio performance but also for appearance. To him, the two went together, key elements of the quality designed and built into his radios. As a result the layout and mounting of parts, the wiring and soldering in his units were as neat as they were functional.

That revealed a philosophy of Arthur's which permeated his products and his company from the start — electrical and mechanical engineering went hand in hand in the design and construction of all Collins products.

Arthur's approach to radio design incorporated what came to be known in later years as systems engineering. It involved solving problems which included controlling radio frequency within a transmitter; ways to supply sufficient drive and power for transmission, a particularly tough challenge for voice operation; how to match the radio output to the antenna, and how to build the equipment in a package which could be shipped to a customer and still arrive in working condition.

By 1931, when he was 22 and recently married, Arthur went into business. He and his bride Margaret, usually called Peg, soon moved into a small two-story house where his paternal grandparents had lived, at 1720 Sixth Avenue SE in Cedar Rapids. Except for using the kitchen, Arthur and Peg lived upstairs. The living room was the office and the main floor bedroom the stock room. The basement became a production area for his amateur transmitters. In June, 1932 Arthur hired Clair Miller as his first full-time employee. Miller was considered to be a salesman, but he doubled at any other job which needed doing. During the two years the house served as the factory, Arthur also began building broadcast transmitters. Some of his equipment served for either amateur or broadcast transmitting.

When he went into business, Arthur Collins brought unprecedented standards to amateur radio. He studied diligently to understand the scientific principles involved in radio. He sought to attain the highest possible level of quality in equipment design, construction and performance, and demanded those characteristics be followed by those who worked with him.

Arthur never gave more than a passing interest to the building of receivers in his early years, devoting his efforts to transmitters.

The first products known to have been advertised were crystal transmitter kits. An ad appearing in the January, 1932 QST was headlined, "Crystal Transmitters." It stated: "Radically new design suitable for Class B modulation or high output C.W. on 14, 7 and 3.5 M.C. Consists of crystal-oscillator, buffer amplifier, and Class C output amplifier mounted on polished aluminum and hard rubber chassis with plug-in coils and plug-in crystal holder for quick change of frequency. Complete kits, less tubes, crystal and power supply." Prices were listed as, 210 Output, $37.25; 203A Output, $47.50, and 852 Output, $47.25. The ad also claimed: "The smoothest, neatest little rig you ever saw — and what a kick she has!" Arthur identified his firm as Arthur A. Collins, Radio Laboratories, Inc. W9CXX, Cedar Rapids, Iowa.

While his first product offerings were in kit form, Arthur already had begun to experiment with and saw a marketing opportunity in ready-assembled, neat looking transmitter units which would not have to be confined to a workshop location.

By March, 1932, he dropped the kit idea, changed the business name to "Collins Radio Transmitters," and ran another QST ad offering "Collins Crystal Transmitters. Units from $33.95 up with carrier powers of 30 to 300 watts. Also a complete line of power supplies, modulator and input equipment, relay racks, quartz crystals, etc."

One of the first Collins Radio Transmitters product bulletins, actually a catalog, contained this statement:

*Collins Transmitters offers to the amateur and experimenter a complete line of transmitting equipment — complete transmitters — standard interchangeable units — and parts. Every item listed has been selected from an engineering standpoint and has been thoroughly tested in the laboratory and on the air. Quality alone is the criterion. The 'ham' who buys from us does not have to select his equipment from pages of apparatus, nine-tenths of which is of inferior quality or is not suitable for his purposes. We list only parts that should go into a modern, high quality, high performance transmitter.*

His units made Arthur one of the first to offer complete transmitters which required minimal effort on the part of customers to begin operating.

His success in that led to a comment years later by one old-timer in the amateur fraternity: "Collins gear brought our ham shacks up from the cellar and put them in the living room."

His first transmitters had separate functional chassis, mounted in relay racks about 20-1/2 inches wide. The racks were made of 16-gauge die-formed steel channels. Like all of his equipment, they were painted in black satin duco enamel. Customers had a choice of racks either 60 or 72 inches tall, priced at $9.50 or $10.50.

One chassis, 10 inches by 7-7/16 inches, was the 10A Crystal Control unit. It had a 7 by 19-inch front panel. A companion to the 10A was the 500AX Power Supply. Stacked together, they made the 30W, a 30-watt transmitter. The price was $95.64, without tubes. A 9C Class B modulator could be added for $31.60.

The 30W was advertised as, *Designed to meet the requirements of the amateur who wants a modern crystal controlled transmitter ready to go on the air. It is a commercial type transmitter at a price the amateur usually pays for 'just the parts'*. Specifications included: *Output, 30 watts, frequency range: 20, 40, 60, 80 and 160 meters. Coils for one band standard equipment. Tubes: 247 Oscillator, 247 Buffer, 510 Output Amp. Power: self-contained heavy duty unit. Keying: Grid-block. Meters: Western surface type. Construction: Engraved Formica panel. Aluminum and cadmium plated steel chassis. Highest quality material throughout.*

In May of 1932 he ran an ad with a picture of the rack-mounted 150B, "150-watt phone transmitter, Class B modulated."

The 150B was created by adding more chassis to the 30W. The first was a 3A Power Amplifier using a UV203A tube to provide 150 watts output. That also required a 1200A Power Supply. Another addition was a 30B modulator to create the 150BW phone-CW Transmitter, total cost $285.67.

By November of that year a full page ad identified the firm as "Collins Radio Company."

A glimpse of the firm's operations in those early days was described in an article entitled, "From Little Acorns, The Great Oaks Grow," written by E.H. Marriner, W6BLZ, which appeared some years later in CQ Magazine.

"Here is a success story which had amateur radio for a beginning as viewed by Mr. Benton White, W4PL. This is the story as he told it:

"Some time in 1931 or 1932 the XYL (spouse) and I found ourselves in the course of an auto trip, spending the weekend in Cedar Rapids, Iowa. I had bought a 'QST' enroute and leafing through it came across the first Collins Radio ad that I remember seeing.

"That Sunday afternoon we set out to drive around the city a bit, and I decided to go by the Collins factory and see what it looked like. Idle curiosity entirely — it was Sunday afternoon and I had no idea of buying anything anyway.

"The address brought me to a stop in front of a comfortable home on a shady residential street. 'There must be some mistake,' I said to my wife, 'but I'll step in and ask anyway.' Going to the door, a dark-eyed, pleasant looking party answered the bell. Yes, this was Art Collins and this was where the Collins transmitters were made — would I like to see one? Yes, I would, but just a minute while I go back to the car and tell the XYL that I would be inside for a little while.

"As I again approached the front door I overheard — I could not help but overhear — Mr. Collins excitedly calling over the land line to a Mr. Miller (who turned out to be another ham associated with Mr. Collins) that he better call off that date and hurry over. 'I think we got a customer.' This man Miller appeared almost at once, with a squeal of brakes from an old jalopy in front of the house. We all went down into the basement which was the 'factory' I had been hunting all afternoon.

"Let me hasten to say that it was a nice place to work. There were benches around two sides on a nice smooth concrete floor, with good lighting. There on the bench stood a nearly completed transmitter which was explained and examined. All being brother hams, we sat sociably on stools while they fired up soldering irons and did a little work. I liked both of them and I liked the way they worked. I also liked what they were building. Mr. Collins made a good guess and they got a red hot customer.

"I offered to buy if I could have the transmitter on the bench; take it right now and pack it into the car and carry it back to Chattanooga with me. They already had in mind selling it to another customer, but with me figuratively waving the cash under their noses, they decided it would be a shame to let good money get away. In short, I got this transmitter and the other party got the next. There is no serial number on it and this is therefore purely a matter of memory, but I definitely understood at the time that was the second transmitter that the now great Collins Radio Company had made and sold.

"Cashing some travelers checks, I carefully packed the rig into the car and drove off with it."

The article concluded by noting that Benton White used the transmitter for many years, with few modifications. He replaced an electrolytic condenser with coils, the 47 tube became a 46 and the 510 a 901. The original coils were wound on bakelite forms and were replaced with ceramic.

The transmitter which White purchased was the 30W, for which he paid $95.

Clair Miller, Arthur's first full-time employee (the *associate* referred to in the account), recalled Arthur was reluctant to sell the transmitter to Benton White because he had promised it to a customer in Minneapolis. Telling a friend about the incident years later, Miller said he had to take Arthur upstairs to the kitchen to convince him they should sell it to White and build another one for the other buyer.

An issue of the Collins Signal dated April-August, 1933, included this item in a column about activities of hams: *Mr. Benton White, W4PL, reports that he is working K6's regularly on both 40 and 80 meters with his 30W and that he is beginning to make contact with VK stations.*

In the 1930s the Collins amateur and broadcast transmitters were known for their use of pi output networks to match the transmitters with antennas. Arthur's acquaintance with pi networks stemmed from a 1931 article in the Proceedings of the I.R.E. written by W.L. (Bill) Everitt, professor of electrical engineering at Ohio State University. Arthur then experimented and developed his own pi network circuits. Professor Everitt was highly respected in the field of radio. Arthur often called upon him for his help on technical questions, and listed him as a consultant at one time. Everitt was influential in having several of his promising graduate students join Collins Radio Company, where they later became top executives. Other Collins engineers took leaves of absence to study under Everitt.

By early 1933 the business was moved into rented space in a commercial building, and soon grew from two to eight employees.

Amateur radio was the foundation on which Arthur's career and his company were built, and a stepping stone to the broadcasting, aviation, space and other product lines of later years.

While the majority of amateurs were individuals of average means, the hobby of amateur radio also appealed to persons of prominence and affluence. They could afford the best, and many purchased Collins equipment.

One such customer was Edward C. Crossett, who had extensive lumber business interests. He had a summer home in Cape Cod, an apartment in Chicago and a residence in Pasadena, California. Each of those sites was equipped with Collins amateur gear, and Crossett had separate call letters for each location. The March, 1933 Collins Signal featured a photo of the Pasadena station showing the 150B Transmitter, 7D Speech Amplifier and 5A Condenser Microphone.

With amateur gear a main product line for Arthur's firm in the 1930s, the enthusiasm and tributes by customers helped enhance the company's reputation. It was not unusual for customers to write and give glowing endorsements.

Partial quotes from a few such letters included:

From an Army medical officer at Carlisle Barracks, Pennsylvania: *Just a few lines to let you know how pleased I am with my 4A Transmitter and 2A Antenna Coupler. I have operated various types of 'ham' transmitters since before the war, and have never found one which gave me more pleasure than the 4A. The biggest satisfaction is possessing an attractive looking and reliable outfit always ready when I find a few minutes to go on the air. You can bet I always tell the gang what kind of a transmitter I have, and they usually come back with, 'I thought that sounded like a Collins — Boy, what a rig!'.*

From Hung Dau Ching, K6IDK, Hilo, Hawaii, describing a contest entered four days after putting a new 30FX transmitter on the air. "Enclosed you will find my official log of the Sixth International Relay Competition. Being comparatively a novice in the game, you will see that I did fairly well (nearly 400 contacts in eight days, working stations in all but five states). Mr. Collins, I can spend a day telling you about that baby of yours. The 30FX is going great on 20 meters. I assure you that I have nothing but wholehearted recommendations for it."

From John E. Preston, W2GOX, North Arlington, New Jersey, "The Collins 300A Transmitter has been giving excellent satisfaction and the results obtained have far surpassed my expectations. The note is always reported T-9 and the signal is frequently reported R-9 in Europe."

Dr. James M.B. Hard, described in the Collins Signal magazine as "a distinguished amateur of Mexico City — well known to amateurs across the United States and abroad." In 1934 he commissioned Collins to design and build a special 600 or 700-watt transmitter that could be loaded into his custom Packard automobile in two sections and used during travels. Dr. Hard was the wealthy head of a large pharmaceutical house in Mexico City and also maintained a suite at the Waldorf-Astoria in New York City. He wrote:

"It gives me pleasure to say that I have tried out the special 30DXB semi-portable transmitter and it has proved very satisfactory. I have used it on 20 meters and on 75 meters. In general the 30DXB is as nearly fool proof as a transmitter can be, and I heartily recommend it to any who wish to put a good signal on the air and be able to reach 2,000 to 3,000 miles."

A Fort Worth, Texas operator wrote: *I have been the proud possessor of one of your Type 32B transmitters for nearly a year and a half and I can truthfully say that never in my 15 years of radio experience have I enjoyed my hobby as much as the times I have had your transmitter in operation.*

Reports such as those confirmed the simple philosophy behind every one of Arthur's products: Design it right and build it right to work right. There was no design which had not been thoroughly tried out, no use of a shoddy part or mediocre workmanship for the sake of profit. There were no shortcuts in the quest for reliability.

Those who worked with Arthur in equipment design not only for amateur gear but all other types of products learned quickly what he would and would not accept. If it carried the Collins name, it not only had to look nice and work right when it went out the door, it had to keep working right over a long lifetime.

It was not only the buyers of ham gear who contributed to the Collins' reputation. Other amateurs were impressed with the strong and clear signals they heard coming from Collins transmitters.

Arthur's amateur gear was aimed at a selective part of the ham market -- persons knowledgeable about short wave, who recognized quality and could afford to buy moderate to upper price range equipment.

Early on, dual function became a feature of the amateur products. An example was the 20B, a 750-to-1,000-watt primarily high frequency broadcast transmitter, but also for amateurs wanting high power radiophone equipment. It was a large floor-standing unit, about six feet high and three feet wide.

Arthur wrote this in a 1933 company publication: "The first installation of the 20B was made at W9BHT, the station of Mr. W.P. Ingersoll of Canton, Illinois, an old-time amateur. Mr. Ingersoll's desire to have a station which would be the 'last word' in appearance and performance led to the creation of the 20B. W9BHT now operates on 3905 kc and 14224 kc and Bill's voice has become familiar to amateurs and short wave listeners all over the globe."

Ingersoll was a well-to-do amateur operator fascinated with Arthur's equipment, and able to pay the price. He was from one of the families which founded Parlin and Orendorff, a Canton farm equipment manufacturing firm purchased in 1919 by International Harvester. He also was a co-founder of Canton's first gas and electric utility, and is remembered in the Canton community for his philanthropy.

Ingersoll used his 20B well up into the 1950s, when he purchased new Collins equipment. He then gave the 20B to Bradley University, which used it as a teaching aid in its electronics technology department several years after that. By 1967, a Bradley professor noted in a letter to Arthur, *not much more is left of it but the main frame, transformers and chokes.*

Arthur designed and built the first 20B in 1932, when he was still working in the Sixth Avenue house. One Collins old-timer recalled that the width of the 20B was determined originally by whether it could be taken up the stairs from the basement and out the door. But Arthur apparently decided it was easier to build that and other large broadcast transmitters in the living room rather than the basement.

The 20B was custom built for each user. One of the 20Bs brought world-wide acclaim to the young Collins Radio Company when it was taken on the expedition of Rear Adm. Richard E. Byrd to the Antarctic, and used to send live radio broadcasts back to the U.S. in 1934. Other 20Bs were used for shortwave broadcasting in a number of countries.

A 20B and 150BW transmitters owned by the U.S. Coast Guard were used in 1937 at the National Jamboree of the Boy Scouts of America in Washington, D.C. The transmitter station, W3USA, was located in a tent at the base of the Washington Monument. It was used for sending more than 1,000 messages from the Jamboree, and also to relay a radio broadcast from the top of the monument.

Among Arthur's other early amateur transmitters was the 4A, a 20-watt CW (code) unit.

The price quoted for a 4A complete installation was as follows:

| | |
|---|---|
| 4A Transmitter, complete with coils for 1 band | $56.00 |
| Kit of Tubes — 1-47, 2-46, 1-80, 1-83 | 4.14 |
| 1 BCS Mounted Crystal (Amateur Frequency) | 7.50 |
| Total | $67.64 |

The 4A was described in a Collins ad as a *low-priced* amateur rig, probably the only Collins unit ever portrayed that way. It still was a quality transmitter revered for many years by amateurs who were familiar with it.

One such ham was I.W. Lyle, Jr., W4KKG of Jeffersontown, KY. In the early 1960s he sent to Collins a photo of a 4A along with current vintage Collins equipment he had. In an accompanying letter he said the 4A originally was purchased by a friend of his about 1933 or 34, and he was highly impressed with the signal it put out. Some 30 years later he learned another friend had the unit, stored in a barn for many years. The friend gave the 4A to Lyle, who cleaned it up, checked it out and had it working again after only having to replace a filament winding on the power transformer.

In early 1933 Arthur announced two new transmitters, the 32A and 32B, "in cost and size a marked contrast to the 20B." Each had an output of 20 to 25 watts. The 32A was a CW unit priced at $85; the 32B a radiophone unit selling for $125.

Until mid-1934 all of the Collins Radio offerings were designed entirely by Arthur. In that year he hired his first engineers, and they began contributing to the equipment development.

Two such developments, announced in 1935, were the 45A transmitter and a multiband antenna for high frequencies. The 45A was described as a general purpose transmitter but with particular appeal for amateurs. Output was 40 watts telephone and 125 watts telegraph, with a 1,500 to 30,000 kc frequency range. It was considered small sized for the time, 22 inches wide, 18 inches deep, 12 inches high and weighing 130 pounds.

The multiband antenna was designed to solve the problem in radio operation at that time of needing a separate antenna for each HF band such as 20, 40 and 80 meters. A multiple antenna set-up was impossible at many radio station locations due to space limitations and the costs, making the new multiband antenna and its associated transmission line a welcome innovation. Various models ranged in cost from $28 to $44.

Another innovation from Collins in the 1930s was the practical introduction of crystal microphones for amateur operators.

The 45A proved to be one of many Collins radios of lasting quality and dependability. In 1946, a letter was received from Henry T. Littlewood, a long-time amateur and dealer in fine furniture and carpets under the firm name of Rothwells Ltd. of Leeds, England. He wrote:

Back in 1938 you were kind enough to assist me by supplying 28mc coils for my 45A Transmitter, and now, in 1946, here I am again asking you for further assistance with the same 45A Transmitter. This 45A was requisitioned from me by the Post Office and used in war service until a few months ago when I was given the opportunity of re-purchasing it. Quite apart from the fact that it was an advantageous buy, I could not resist the chance of again possessing a Collins transmitter, even if it was of the 45A vintage! When I came to apply the 110-v AC through my 1KW transformer, a number of R.F. faults appeared and I feel helpless to rectify them without the Blue Print Circuit Diagram and the Schematic Layout. I had these originally, but unfortunately I cannot get them back from the Post Office.

If you could let me have them, I would be very willing to pay any charge for the service, and be very grateful to you.

I may add that this transmitter, from the time it came into my hands up to

September 1939 covered the entire world in amateur communication CW and telephony. What service it did during the war will probably never be told. It is sufficient to say that it is going back to work again looking in every way as good as new. The instrument No. is 2863-3.

Collins Radio marketing people, in 1946, were able to find copies of the 45A schematic and circuit diagram and provided them at no charge to Mr. Littlewood.

Arthur's company grew gradually during the 1930s, surviving an attempt by RCA, AT&T, General Electric and Westinghouse to run him out of business with patent infringement suits involving radio tubes.

While Arthur's company did not produce receivers in the early days, the lawsuits claimed he also was in the receiver business.

The truth was that for a short time he sold about 46 receivers built by another company, "as an accommodation to our customers, at cost and without profit." The receivers were RME-9Ds, providing reception from 550 to 23,000 kilocycles. They were made by Radio Manufacturing Engineers, Inc. of Peoria, Illinois. Arthur apparently gave some thought to a Collins amateur receiver in the mid-30s, as one of his engineers designed several development models, but none were put into production and marketed.

Many who sought employment with Arthur's company were hams, anxious to be associated with the Collins equipment. With jobs scarce in those depression years, it was a double plum for a ham to have a job and have it with Collins. Even many production workers were hams.

Arthur noted that in advertising copy which he wrote in the 1930s:

*We derive a lot of pleasure from our work, mainly because we are dyed-in-the wool hams ourselves! And there is great satisfaction in receiving countless letters from users in all parts of the earth telling us that they never knew what real hamming was until they installed Collins equipment. Such response gives us a genuine thrill and we feel amply compensated for the labor put forth in developing Collins equipment to its present high state of efficiency and dependability.*

Arthur once was remembered as saying the philosophy behind the amateur line should be:

*Build it based on quality and need.*

With so much interest in amateur radio, there was more or less of an ongoing development program in the plant. At times it was an official program aimed at developing and introducing a new unit. Between those times it was a matter of engineers and technicians playing around with ideas for improvements or advances, usually on their own time.

Any new idea, though, had to meet Arthur's criteria: was it a practical and significant enough advance to justify its use?

Arthur's personal interest in amateur radio always remained strong, but his on-the-air activity level did not.

In the early 1930s he was active in as many hamfests as he could attend and regional and national radio association meetings. In 1933 he was a panelist at the World Wide Radio Amateur Convention in Chicago, which had a number of prominent amateurs on its program. One of those was John L. Reinartz, by then a Naval Reserve lieutenant, doing research at Connecticut State College and a consultant for RCA.

Arthur also continued in the early 1930s to help amateurs better understand principles of radio through articles in various publications. One was "Getting Quality Performance With Class B Modulation" in May of 1933. An accompanying editor's note informed readers: "Here we present the long awaited practical information on Class B modulators using a variety of suitable tubes." Also, that the article contained "previously unavailable answers" and "will clear up a number of misconceptions concerning Class B that seem to be prevalent."

Another article was entitled, "A Universal Antenna Coupling System for Modern Transmitters," in the February, 1934 QST. It led to a flurry of mail with many questions. To handle the flood of inquiries Arthur had a sheet printed which answered most of the questions.

Another article, "Grid-Bias Modulation of the 100-Watt Type Power Amplifier," co-authored by Arthur and Walt Wirkler, one of his engineers, was published in 1935.

But too much personal attention began to wear on Arthur. Every time he went to a ham event or whenever he got on the air it seemed like everyone wanted to talk to him. As a result he dropped his amateur license in 1936 and did not renew it again until 1949, when he got interested in single sideband. During those interim years it is obvious that Arthur, even though not operating personally, carefully monitored the amateur scene.

The Collins company introduced several more amateur units in the late 1930s, ranging from the 600A, a 600-watt CW/250-watt radiophone transmitter to the 32G, 40-watt phone radio and 30FXC, 200-watt transmitter operating in the 10 meter band. One innovative development of the late '30s offered transmission on five meters.

One purchaser of a 32G was King Carol of Romania, who bought the radio for his son, Prince Michael, then a teen-age lad. Michael, who became the last Romanian monarch until World War II, had a QSL card which showed a medieval castle with a ham sky wire protruding in an incongruous manner above the ramparts.

Another royal connection involved King Ibn Saud of Saudi Arabia. Collins provided a transmitter equipped for speech scrambling to the Middle Eastern ruler.

In the late 1930s, after Arthur Collins invented the Autotune, the company began producing some commercial aviation and military radios equipped with that unique automatic tuning device. Several wealthy amateur operators also wanted transmitters with the advanced new feature, and were willing to pay a steep price for them. The Autotune enabled an operator to store up to 10 pre-selected frequencies, turn a switch to the desired frequency, and within seconds have the transmitter tuned to that frequency.

One of those ordering a custom-made transmitter with the Autotune was M. Grumbacher, who headed the firm with his name which made artists' brushes and other graphic arts supplies.

Grumbacher, described as having a deep interest in innovative technology, also had a special remote control unit. With rotary dial telephones coming in at that time, he could place a call and activate his transmitter from any place in the New York City area.

By 1940, with Europe already at war, Collins began switching emphasis to military radios. Immediately after the U.S. was drawn into World War II in December, 1941, the company committed all its resources to work for the armed forces. The wartime equipment orders placed with Collins, mostly by the Navy, transformed the firm from a small to a large company.

The government suspended ham radio activity across the nation for the duration of the war. One reason was that ham radio could be used by spies. Another was that amateur radio signals could be used by enemy bombers to home in on targets. Many amateur operators complied with a government request to donate their equipment to the armed forces.

With the surrender of Japan in August, 1945 and the end of the war, speculation began immediately as to what Collins would come up with for the amateur market. The only hint was that there soon would be the first Collins receiver and a new 250-watt voice transmitter.

Arthur acknowledged the intense interest in his amateur line in an item he wrote for the company employees newspaper, the Collins Column, in January, 1946:

"A short time ago I visited one of the Signal Corps laboratories where I was shown one of the latest long range search radar equipments — a 60-ton machine of unbelievable technical complexity. At the end of his explanation of the inner mysteries of this device, the Army engineer in charge paused and with a sly grin asked me what new ham equipment Collins was going to make for the amateur fraternity now that the war was over. From that point on we were a couple of hams, W2LAL and W9CXX, exchanging ideas on old and friendly ground. Hams everywhere are extremely interested in what Collins will do for them and we are going to do our best. Amateurs may not be our biggest customers, but I think in many ways they are our most valued ones," he wrote.

Roy Olson was an Iowa State College graduate who joined Collins in 1934, the second engineer hired by Arthur. Roy had grown up on a farm near Osage in northern Iowa, and learned about ham radio from an older brother who survived Army service in France in World War I. The brother had call 9LO, among the earliest issued to U.S. amateurs. Roy always said he liked building amateur radios better than operating them. His assignments at Collins had included amateur as well as aircraft and police radios.

Olson recalled that when Arthur began thinking about amateur again after the war, he said, "Roy, I want you to build the best amateur receiver that exists. I don't care what the price of it is, or about the time it takes — just do it!"

"Needless to say, there was no budget," Olson said. "We (Olson, Lou Couillard, another engineer who did much of the development, and lab technicians) worked on it about six months. The result was the 75A — which set the format and construction pattern for the rest of that line (30K and 32V transmitters and 310A Exciter Unit.)" Development was completed in the spring of 1946.

"I took the first 75A home with me on a Friday night, and planned to try it out Saturday morning. But Art showed up the first thing Saturday morning with Mike and Susan (his son and daughter) and said, 'I want to take it home and ham with it.' I never saw it again," Olson said.

There had been rumors before World War II that Collins was about ready to market a receiver. As a result, many hams delayed buying any other manufacturers' receivers. With the war halting production of all amateur gear, a pent-up demand greeted the 75A when it became available.

The 75A was indeed a hot receiver, covering broadcast as well as ham bands, with one-kilohertz accuracy and stability previously unknown in ham receivers.

There was a special reason for including the broadcast bands. Because of the price of the 75A (about $375), there was concern that many wives of hams would object to such a purchase. However, if the set also could be used to listen to their favorite radio programs, the ladies might be more agreeable.

A main reason the 75A was such a leapfrog advance in receivers was the application of ideas developed by Collins during wartime work. One of those was the new permeability tuned oscillator (PTO), also referred to as a variable frequency oscillator. It was far superior to previous PTOs, providing new accuracy and stability levels in receiving and locking onto a specific channel.

The 75A once was described in a major communications journal as "one of the few receivers that have been milestones in amateur history."

Credited with developing the permeability tuned oscillator was Theodore A. (Ted) Hunter. With Collins Radio being a company where engineers held esteemed status, Hunter was one of an elite group regarded as superstars. He came to the company before the war and made major contributions in military equipment programs. He also was an organizer and first chairman of the Cedar Rapids Section of the Institute of Radio Engineers (IRE), later called IEEE. Hunter left Collins soon after the war to return to the University of Iowa at Iowa City as an engineering professor. He earlier had received his engineering degrees there. It was said he felt somewhat burned out from working with Arthur Collins, and wanted a change. In later years he also marketed a ham product of his design called the Hunter Bandit.

During the 75A development, Hunter, an avid ham (WØNTI) as well as an engineer, helped adapt the PTO to the new receiver.

Collins Radio Company had advertised that its 70E-8 PTO was accurate within .015 percent of normal operating conditions.

During an amateur radio convention, Hunter was demonstrating the oscillator to a group of engineers. His demonstration consisted of independently setting two pieces of equipment to the same dial frequency, then showing frequency separation by means of the resulting beat note. He liked to start with the audio output off, then turning it up gradually until the beat note was audible. Other Collins persons who were watching observed one man wanted to try it for himself. After repeating the test three times and always getting the results which Hunter intended, he was heard to mutter as he walked away, *By gosh, I guess that ad was right.*

The 30K transmitter was an all new design also reflecting the latest in engineering advances, one being a speech clipping feature which improved voice clarity.

Warren Bruene was the main engineer on the 30K design, which provided coverage on the 80, 40, 20, 15 and 10-meter ham bands. The 10-meter band also had the capability of covering what was then the newly assigned 11-meter band. The 30K utilized a separate PTO-controlled exciter, the 310A. The 75A receiver and 310A exciter were table top models while the 30K was a floor standing unit.

The delivery of the first post-war amateur radios off the production line occurred January 8, 1947, at the Cedar Rapids plant. The recipient was Clyde Hendrix, WØHBG, a Pillsbury Mills executive from Clinton, Iowa. He had bought one of the first crystal controlled transmitters built by Arthur, and a 30FBX transmitter in the 1930s which he turned over to the Army during WWII. With his new 75A and 30K, Hendrix planned to go on the air for 25 hours straight.

After using the 30K for a couple of months, he wrote: "It's everything they say for it and a lot more. The VFO is so accurately calibrated that I can spot my signal on top of the station I am working and then tell him his exact frequency with surprising accuracy. The 75A Collins receiver is far superior to any other amateur receiver at this time, and I have used the best of them."

Collins continued to update and augment its amateur products in the late 1940s. Notable units were the 75A-1 receiver in 1947, the 32V-2 transmitter and 51J-1 receiver in 1949.

Another was the KW-1, KW standing for kilowatt, in ham lingo referred to as a "full gallon" or 1,000-watt transmitter. Arthur decided there was a need and a market for the unit, even at a $3,800 price, which approached the cost of a luxury car when it was introduced in 1950.

Despite the price, orders were on hand even before the KW-1 went into production. Among the customers were university engineering schools, electronics laboratories and the military. A number of KW-1s were still in service more than 40 years after they were built. In the late 1990s, collectors were paying more than $40,000 for a Collins KW-1.

There have been countless stories told, some of them recounted in various amateur radio journals, about innovative design breakthroughs which went into Collins equipment, and how radios were developed from a rough idea stage to a new product.

The linear variable frequency or permeability tuned oscillator, considered one of the most significant advances in the history of radio, was the subject of such stories. Accounts have related the many hours of painstaking efforts by engineers in the lab, winding coils of different gauge wire a certain number of turns per inch, making other precision parts, checking out materials and the relationship of parts until the right combinations were found. Then the manufacturing techniques had to be developed to produce units to exacting quality standards.

The Collins post-war A-Line units were radios of superior quality to anything else on the market, and many have stood the test of time — still giving service into the 21st century.

When television began spreading across the U.S.A. in the late 1940s and early 1950s, and most TV signals were received via antennas on roofs, the chatter of ham operators sometimes was heard through TV sets.

The 1952 Collins Radio annual report made note of that, stating that a contributing factor in record amateur transmitter sales for the year, *is the fact that in current models interference with neighboring television receiving sets has been minimized.*

When commercial television came to Cedar Rapids in 1953, Collins took steps to prevent any interference its factory radio testing could create for home TV sets in areas near company plants. Technicians used a vehicle equipped with receiving gear and antennas to drive around and listen for signals.

Later in the 1950s came single sideband, as significant an advance in a given area of technology as ever occurs. The technology to which it applied was short wave radio, at the time the only method of long range wireless communication.

Arthur Collins did not invent single sideband, a scientific phenomenon discovered before he was ever involved in radio. A technique had existed for many years that allowed the use of single sideband in limited fashion. But it was through experimentation and developments by Arthur and his colleagues that single sideband was made practical and affordable for wide-scale use.

Single sideband refers to one part of the high frequency AM signal, which consists of a carrier and two sidebands. Only one sideband is needed to transmit voice. With conventional HF amplitude modulation (AM), used since early days of radio, all three parts of the signal are transmitted. The only known exception to AM was in some trans-oceanic communication, employing large and expensive equipment to filter out the carrier and one sideband. By the 1940s, the growing volume of HF/AM traffic caused the HF spectrum to become crowded, with users encountering widespread interference. Single sideband, requiring less frequency space, offered a solution to that dilemma.

Hams being the curious and creative types they are, single sideband communication was an intriguing challenge for some when they were allowed to get back on the air after World War II. SSB equipment began appearing on the market.

To keep abreast of what was going on, Arthur Collins boned up on his code skills, re-applied for his ticket and resumed his active amateur status in 1949.

In a letter dated January 20, 1949 to the Federal Communications Commission, Arthur requested the reinstatement of his amateur license. He mentioned that he held license W9CXX from 1924 to 1937, had allowed it to lapse due to preoccupation with business matters, and regretted it very much. *It would be a great satisfaction to me if possible to be assigned call WØCXX, which would correspond to the old number,* he wrote. The FCC granted his request.

Between April and September, 1949, following reinstatement of his ham ticket, Arthur's log book reflected a torrent of on-the-air activity. Contacts were listed with operators from more than 60 foreign countries or remote islands in addition to hundreds of U.S. hams. Soviet Union contacts alone totaled several hundred.

One QSL card that came in was from Fred J. Elser, TA3GVU, writing from Ankara, Turkey: *Dear Art — I have realized two ambitions as a ham — to have Collins equipment and work W0CXX! Ever since I saw your 'replaceable bread-board' transmitters in QST in the '30s I've admired your equipment...keep up the good work for us serious hams.*

Another card was sent by Manuel Cenalmor, EA8MC, of Spain. He wrote, *Hope to contact you again soon. I need two radio tubes — 807 or 6L6. I will send bottle of Spanish cognac.*

Warren Bruene, who worked with Arthur on many projects, recalled that Arthur modified a KW-1 transmitter so the power amplifier worked as a linear amplifier as one of the steps enroute to his single sideband program. Arthur also acquired another firm's exciter to drive his KW-1, part of the early SSB equipment then available from other companies, units using phasing systems to achieve sideband capability.

Bruene had joined Collins in 1939 after earning his electrical engineering degree from Iowa State College. He was to play a key role in the Collins development of single sideband, and was the lead engineer on a number of high power HF transmitter programs over the years.

Bruene has said, in retrospect, that it appeared Arthur Collins began leading up to sideband as early as 1946 with the 75A receiver.

Arthur also was looking at different techniques to attain sideband capability than conventional phasing systems. He soon had the main element in hand for his approach. It was the mechanical filter, another of the key breakthroughs in the history of radio.

The mechanical filter was perfected by Melvin Doelz, during five years of painstaking and tedious effort to develop the filter and the methods to manufacture it. Doelz was a University of Minnesota electrical engineering graduate who joined the Collins staff in 1941.

Compared with other methods and expensive, shoe box-size filters in use to achieve sideband capability, the mechanical filter was a relatively low cost component about a half inch in diameter and three inches long. It employed mechanical resonances to filter out unwanted parts of the HF signal. The Collins mechanical filter made desktop size and mobile single sideband communications equipment possible.

The initial amateur radio application of the mechanical filter was to incorporate it into the 75A-2 receiver in early 1952, which provided a measure of sideband capability for an operator.

But for single sideband to be fully effective, further complex and challenging developments still had to be undertaken.

Sensing the time was right in November, 1952, Arthur gathered up a hand-picked task force of engineers and technicians on short notice, and isolated them in a small building where they worked under his personal direction. Arthur worked with them full-time for the first four months of the year-long development effort.

The results they produced comprised the basic circuitry on which single sideband was developed from that point on.

With the new single sideband tools in hand, one of the first assignments coming from Arthur was a new line of amateur products.

Arthur had foreseen that an extensive testing effort would be essential for a new concept of the magnitude of SSB, and the most logical, practical and economical test bed available was amateur radio. No other part of the communications field is as large in numbers of practitioners, more discerning and more candid than the amateur radio fraternity.

As the single sideband development project was winding down, several rack mounted units were built which consisted of a receiver, an exciter and a 500-watt linear amplifier. Those were consigned to Arthur, Ernie Pappenfus and others to implement testing and evaluation. Pappenfus, like Doelz, was a University of Minnesota electrical engineering graduate who joined Collins at the beginning of World War II. He headed up high frequency engineering during the sideband development days.

The initial amateur SSB production units, ready in early 1955, were the 75A-4 receiver and the KWS-1, a 1,000-watt transmitter for voice communication on single sideband and code transmission. It also could transmit to people with HF/AM receivers.

Single sideband was a type of advance which comes along rarely. Compared with much of the HF/AM communication gear and sound quality of the time, it was like going instantly from a DC-3 aircraft to a Learjet, or from a 1940 Chevy to a modern vintage Corvette.

The improvements in voice quality, the range a signal could be heard clearly, and the minimal interference were amazing. SSB also required less transmitting power than HF/AM.

The Collins Radio breakthroughs opened the door to widespread use of single sideband, and ushered in a new era for amateur radio.

Even before the mid-1950s when Collins brought out its first single sideband gear, the company had been well ahead of its competition in new technology and quality of amateur equipment.

Single sideband gave Collins an even greater advantage over the competition. Amateur operators the world over wanted SSB capability, and those who could afford it wanted Collins gear. A 1956 Collins service bulletin reported the results of a customer survey in which 240 amateur operators returned a questionnaire. Twenty-eight already had SSB equipment, and 144 others said they planned to have it in the near future.

One who was early to recognize the advantages of SSB, particularly to communicate at all times with U.S. Air Force bombers around the world, was the legendary Gen. Curtiss LeMay, commander of the Strategic Air Command. LeMay, a licensed ham earlier in his career, went so far as to run flight tests using the Collins ham gear to prove the effectiveness of SSB. He then created a world-wide network of ground stations with Collins amateur radios in order to have SSB capability for SAC before military spec equipment became available.

About two years after introduction of the first amateur sideband units, Gene Senti, a Collins engineer who helped develop amateur and other high frequency equipment, was trying some experiments with a 75A receiver engineering model in the basement workshop of his home in Cedar Rapids. Senti was a 1939 Iowa State College electrical engineering graduate who worked for Interstate Power in Dubuque before coming to Collins early in World War II.

"I was thinking, here I have this receiver with such excellent frequency stability and calibration, wouldn't it be nice if I had a transmitter with that same accuracy," Senti recalled.

"The frequency stability of the receiver was determined by a crystal oscillator and the PTO (permeability tuned oscillator) and the beat frequency oscillator. So I decided I was going to try to re-use those oscillators. I brought outputs from the receiver oscillator circuits to a little breadboard chassis and into some mixers, and recreated by mixing these oscillators to come up with the same output frequency of the transmitter that the receiver was tuned to.

"In other words, as I tuned the receiver across the ham bands, the fact that I was using the same oscillators in the transmitter meant it also tuned across the ham bands, and I came out on exactly the same frequency.

"At first the set-up was all haywire but I got it cleaned up and working," Senti said. He tried it out over a period of time by contacting a number of hams. *It was a great feeling to pick up the mike and make a call and have them come right back*, Senti said.

He mentioned his home workshop activity to Ernie Pappenfus and Bob Cox, vice president of engineering for Cedar Rapids, and word got to Arthur Collins about Senti's discovery.

*Art called me and asked about this thing I'd been playing with, and he said he'd like to see it*, Senti recalled.

"He came over to the house one evening soon after that and I demonstrated it. He said, 'Boy, that's a pretty nice way of doing your transmitting. You know, it would be great for mobile (ham radio mounted under the dashboard of a car) because without taking your eyes off the road you could tune the receiver to a station you want to talk to, and immediately your transmitter would operate on the same frequency.'

"So we began putting this idea into the KWM-1 — the first mobile transceiver. At the time we decided to use only the top three amateur bands — 20, 15 and 10 meters — because on a car it was hard to get a big enough antenna for the lower frequency bands to work very well. Art did not want a mobile unit that did not put out a nice strong signal. So we limited it to the bands that worked the best," Senti said. An 8-foot whip antenna was used for most vehicle installations.

The KWM-1 development, like most Collins projects, took place in the company's engineering laboratories which were well furnished and had access to specialized testing gear and other equipment. There was no special security imposed other than not revealing to outsiders what was going on.

Another interesting story during development of the KWM-1 involved a noise blanker for the receiver section. This was for reducing or eliminating electrical ignition noise from car engines which could interfere with radio signals, a problem with the automobiles of that period.

The type of signal blanker switch found to work best was a set of matched balanced diodes. The noise amplifier frequency, 42.5 megahertz, was described as a compromise, working well for frequencies near 42.5 but less effective with lower frequencies.

Work on the noise blanker was done partly in the lab and partly on the highways. The lab setup was on a bench near an outside wall. A wire ran through a hole in the wall to the outdoors and under the hood of a 1950 Ford which provided the ignition noise.

Arthur Collins and Bob Cox often visited the lab to check on progress and make suggestions for various tests and setups. The lab workers always marveled at how Cox, a very tall man, would stand on one leg, his other foot resting on a 34-inch-high lab bench while he, Arthur and Ernie Pappenfus discussed the project.

Arthur was pleased with the noise blanker development, and one day showed the work to a SAC communications officer. It turned out to be an answer to a problem at SAC headquarters near Omaha. Antennas for the SAC SSB system were located near the headquarters parking lot. A lot of service people and civilians at the base drove Volkswagen beetles in those days, and the VW bug was generally considered to generate more electrical engine noise than any other model of car. When cars were started as people left the building for lunch or at the end of a work shift, there was considerable interference in the SAC radio system. Installing noise blanker circuits in the SAC radios fixed the problem.

Ed Andrade, long one of Collins' top HF engineers working on amateur and other products, recalled the KWM-1 was built under less than ideal conditions in the Cherry Building, an old rented structure just south of the Cedar Rapids downtown area. *There was no air conditioning, train tracks ran alongside it, and soot came through the windows*, he said.

The KWM-1 was a compact unit, 6-1/4 inches high, 10 inches deep and 14 inches wide, a size made possible with the new smaller tubes then coming onto the electronics industry scene. The KWM-1 also broke a long pattern of Collins ham equipment being painted black. It was gray.

It provided 175 watts of transmitting power for code or 100 watts for voice. In performance categories such as frequency stability it was equal to other Collins single sideband amateur gear. A basic application, as Arthur intended, was as a mobile unit in a car, mounting it below the dashboard of the big, wide American autos of those days. Mounts allowing easy installation and removal were designed for the most popular makes of cars.

The KWM-1 was a sensation when it was announced in the spring of 1957. It was the first true transceiver (combination transmitter and receiver) on the amateur market and Collins' first mobile equipment for amateurs.

In the first week of selling, before any production units were available, more than 500 orders were taken by phone for the new radio, the buyers never having seen one and not yet knowing the price or delivery date. The basic price turned out to be about $770.

KWM-1 applications were not confined to just amateur radio contacts from automobiles. The small size and weight (18 pounds) made it highly portable for use as a fixed station rig as well as for operation in a vehicle. It immediately drew the interest of the military services.

A convenient way of transporting the KWM-1 transceiver and its associated units including the power supply was in medium size suitcases.

When Arthur Collins married Mary Meis in June, 1957, he took a KWM-1 along on their honeymoon, traveling to Europe on the ocean liner S.S. United States. Mary said Arthur tried different places on the ship for the best operating conditions. The best location, with the blessing of the ship's captain, was the bridge, from where he also strung an antenna.

The KWM-1 soon was being used on a number of scientific and exploratory expeditions, often serving as their only means of communication while in remote areas of the world. It also served to reach the outside world from areas stricken by floods, earthquakes, bloody revolutions and other happenings.

One example occurred in May, 1958 when Richard M. Nixon, then vice president of the U.S., was on a fact-finding tour of South America.

During the trip Nixon and his party were the targets of several hostile demonstrations staged by communist agitators. In most of the countries the demonstrations were broken up by local police and militia.

But in Caracas, Venezuela, rioting mobs overwhelmed police and seriously threatened to harm or kill Nixon and his wife, Pat. They were trapped inside limousines surrounded and being shaken by the mob before troops finally rescued them. During the incident all normal communications in and out of the country were cut off, the rioters also believed to be responsible for that situation.

The commander of the aircraft flying Nixon around South America, Col. Tom Collins, was in a Caracas hotel, some 18 miles away, when word came about the riots. He had with him a KWM-1 transceiver and power supply, which he had carried into the hotel in two suitcases resembling ordinary luggage. Colonel Collins, a licensed ham, plugged in the power supply and threw an antenna wire out the window.

Within minutes his call was picked up by Strategic Air Command headquarters near Omaha, which kept Washington and President Dwight Eisenhower advised of the situation. For the next 24 to 48 hours Colonel Collins' amateur set provided the only contact between Washington and the Nixon party, while Eisenhower launched B-47 bombers and naval units to South America as a show of force to protect Nixon.

Colonel Collins later reported he had made more than 700 contacts with the KWM-1 during the South American tour. The KWM-1 soon became a standard fixture for the U.S. VIP aircraft fleet and in embassies around the world.

One other notable application of the KWM-1 transceiver remained a security secret for many years.

An early phase of the episode occurred when Lt. Gen. Francis W. Griswold, vice commander of the U.S. Strategic Air Command, called in Lt. Col. Joe Beler, SAC communications officer. Beler had worked closely with Griswold, Gen. Curtiss LeMay and Arthur Collins on testing and implementation of single sideband radio for the SAC fleet.

The U-2 was the highly secret, long-range, high flying aircraft developed by the U.S. for intelligence gathering flights across Russia, Cuba and other problem areas during the intense Cold War years of the late 1950s and early 1960s.

Beler was briefed on the U-2 and given security clearance to go to the Lockheed Aircraft "skunk works" in California to determine how a KWM-1 could be installed in the U-2. He called Arthur Collins for a rush shipment of several radios. At the time there was no military radio that could fill the role of HF SSB communication for an aircraft like the U-2.

Beler, who later worked for Collins after leaving the Air Force, said the radio had to be installed on a shelf behind the pilot's head. It was not pressurized like the military avionics radios mounted in aircraft equipment bays. It fed a tuned wire antenna which stretched from the canopy to the tail. There was concern that such a compactly constructed non-avionics radio might cause arcing problems at high altitudes, but it apparently worked well enough.

The U-2, of course, triggered a Cold War crisis when one piloted by Gary Powers was shot down during a reconnaissance flight over the Soviet Union in May, 1960.

Three years after the KWM-1 was born another new line of Collins amateur gear was introduced. It became known as the S/Line (S as in sideband), comprised of four equipment units, all reflecting Arthur's thinking and his personal stamp of approval in the many steps of the design process.

The S/Line was an equipment grouping engineered as a system, representing new advances in component technology, frequency generation and stability, heat dissipation, compact design and other features.

The S/Line units were the 75S-1 receiver, 32S-1 transmitter, 30S-1 linear amplifier and 312B-4 speaker console. The units were designed to sit on a desk or table, except the amplifier, mounted on a small cabinet.

The S/Line had a sleek and special appearance for radios of their type. One of the unique features was a metal textured surface front panel, painted medium gray.

How that panel came to be was the subject of many stories making the rounds of Collins Radio Company, indicative of Arthur Collins' often detailed involvement in his firm's products, and reactions within the company to carry out his wishes, regardless of any obstacles.

During progress review meetings on the new line Arthur had made it known he wanted a distinguished appearance for the front panel, but did not like any of the suggestions offered by the design staff.

Finally he brought in his Hasselblad camera, which had a leather case with a sculpted pebble grain surface, to illustrate what he had in mind. That set off courses of action by a large number of persons trying to determine how to duplicate the pebble grain pattern which Arthur wanted on a sheet of aluminum.

The solution began by photographing the camera case. Then an artist delicately spliced the resulting prints to make a panel-sized artwork. Collins had its own industrial photography and graphics art departments to handle such chores.

Different techniques then were tried to translate the pattern onto metal. The problem finally was solved by company metal fabrication specialists using an aluminum etch process to provide the desired texture when painted.

Close on the heels of the S/Line introduction came the most fabulous and versatile of all Collins amateur units over the years, and what may well be the greatest radio in the history of amateur radio.

It was the KWM-2 transmitter-receiver. Like its predecessor, the KWM-1, it was a true transceiver, ruggedly built and easily portable at less than 20 pounds weight. While the KWM-1 had represented a major advance as the first amateur transceiver, it had limited band coverage.

The KWM 2 changed that, providing single sideband operation on all bands from 80 to 10 meters, with 100-watt output.

The KWM-2 was one of the last of the "tube" radios. Over the years the KWM-2 and a military version, the KWM-2A, accumulated a performance and reliability record seldom equalled in mobile equipment subjected to a wide range of operating conditions.

One prominent ham, also a frequent contributor of articles for amateur radio publications, once wrote this about the KWM-2:

*With the advent of a truly mobile amateur radio that was ruggedly built and would perform under such conditions as military operations or exploratory expeditions, a new era of amateur history was born.*

Arthur insisted the KWM-2 have a resemblance to the S/Line units. While he offered numerous suggestions and closely followed the development, he let the HF/amateur engineering team do its job. Ed Andrade, who headed the development group and did the block diagram for the KWM-2, said one of the main challenges was finding the right tubes to squeeze into the required box size. Finding room for tubes was not the only challenge — ingenious methods also were devised for mounting resistors and other components in the limited space. Thought had been given to a design based on transistors, but in 1959 available transistors did not meet required quality and reliability standards. Also playing key roles in the KWM-2 development were Gene Senti and Fred Johnson, who headed up mechanical design.

The KWM-2 was designed for automotive operation with special under-dashboard mounts, also other mobile and fixed station use. Arthur was one of many operators who had KWM-2s in their boats, and some were installed in aircraft. The radio weighed 18 pounds, 3 ounces, and measured 7-3/4 inches high, 14-3/4 inches wide and 13-1/4 inches deep. The price of the radio when it was introduced in 1959 was $1,095.

Many, many stories of KWM-2 and S/Line uses during crisis situations and other unordinary purposes have been noted, and many more untold.

Those radios followed a pattern that began for Collins with the transmitter supplied to the Byrd Expedition in 1934. They were not just amateur radios, rather they also met many military, commercial and expedition communications needs.

In February, 1960, an earthquake and tidal wave devastated the Moroccan coastal city of Agadir. Within 36 hours a U.S. Air Force communications team from a SAC base 150 miles away had set up an S/Line station at Agadir and for several days provided the main communications link for the beleaguered city with the outside world.

In July, 1960 when the Belgian Congo went from colonial status to that of independent nation (which became Zaire), civil order was replaced by bloody conflict and near anarchy prevailed. All communications from inside the country were shut off, except for messages from a storeroom of the U.S. Embassy in Leopoldville. An operator who went by the handle of Frenchy first used a KWM-1, then switched to a KWM-2, for contact with the North Atlantic Treaty Organization headquarters in Brussels, the United Nations and the Pentagon. Frenchy's radios stayed on the air around the clock for 30 days. He reported "no propagation difficulties, solid contacts night after night."

Sir Edmund Hillary, the New Zealand mountain climber and adventurer who was the first to conquer Mount Everest in 1953, used a KWM-2 during another Himalayan expedition in late 1960. On that trip Hillary's objectives were high altitude survival tests and to search for the legendary "abominable snowman," of which no trace was found.

The KWM-2 also provided communications during a successful climb of Mount Everest by an American expedition in 1963.

Movie making sometimes takes place in remote areas, as when much of the epic "Lawrence of Arabia" was filmed in Jordan in the early 1960s. A KWM-2 kept the film party in touch with the outside world while on desert locations.

KWM-2s also were the main communication link for the U.S. Navy and Army during Operation Deep Freeze in the Antarctic in 1961. "The KWM-2 was used by trail parties, on expeditions across the ice fields in weasels and snow cats and in various outposts," said a Collins field service engineer assigned to the expedition. Another important purpose was providing the means of conversing via radio link and phone patches with wives and sweethearts for men on the scientific expedition in the Antarctic.

The radios also were installed in Air Force C-124 aircraft providing equipment air drops to Operation Deep Freeze stations. Single sideband capability for communicating with ground bases was needed for the aircraft, which were not yet equipped with standard aircraft SSB gear. KWM-2s were installed on the radio operator's table of seven aircraft, with manual antenna tuners connected to external wire antennas. *At times the KWM-2s were the only means of satisfactory communication available*, an Air Force report stated.

Before being updated with KWM-2s, all seven U.S. Navy Deep Freeze bases in Antarctica were equipped with the first Collins amateur single sideband radios, the KWS-1 and 75A-4. Some of those, too, had been air dropped including the units for Station KC4USN, located just yards from the geographical South Pole.

Another Air Force application of KWM-2s was in C-119 transports used to make airborne catches of special film capsules from Discoverer satellites. The radios helped maintain contact between aircraft crews over the Pacific and the Hawaiian Control Center.

Demonstrating the ruggedness of the KWM-2, an Army general and his radio operator sergeant frequently carried the units between their legs on parachute jumps at Fort Bragg, North Carolina. They dropped them when they were about 10 feet above ground. After the first such jump, to see if they worked, the KWM-2s were fired up and communication was established between Fort Bragg and Eglin Air Force Base, Florida. The general's objective was to have communications instantly at hand after landing, as military field radios often ended up some distance away from the commander in a parachute jump involving a large number of troops.

Throughout the 1960s the roles and fame of the KWM-2 mounted. While it had not been developed as a military radio, the military services had no mobile communications equipment with the rugged construction, versatility and capability of the KWM-2. With the American involvement in the Vietnam War, the military ordered thousands of a special version of the radio, the KWM-2A. The KWM-2A was identical to the KWM-2 except it had an additional crystal board covering frequencies outside the amateur bands.

KWM-2As were widely used in the field in Vietnam, transported in specially built suitcases. Operators often used the term *blue suitcase* to describe the radio sets, which weighed just 42 pounds including transceiver, carrying case, power supply, coiled antenna, microphone, headset and key.

The military had wanted an antenna for the radio that would be easy to set up, a different type than a whip antenna which was impractical to carry around in field operations. Collins, with the help of another supplier, came up with one resembling a metal tape measure. An unforeseen problem occurred at first in combat areas — the tapes were made of shiny stainless steel which attracted sniper fire. Ingenious radio operators soon dipped the tapes in brown paint.

The radios served a broad range of missions including communications from the ground to direct air strikes and contacts between operations centers and forward units. They also helped in the rescue of downed airmen and troops calling for support. The size and weight of the KWM-2A made it easily adapted for field pack roles.

An Air Force technician noted in a report: "These KWM2-As are really getting a workout here. Many are on the air 24 hours a day in long haul nets. The rest are set up in the field from knee deep rice paddies to carried up in the mountains on strikes."

It was apparent the KWM-2As filled definite needs for the armed forces, despite not being designed as military gear. Ed Andrade reflected on that in later years. *If we'd known it was to be that important to the military, I'm sure we'd have done a few things differently,* he said.

Another application of the radios was by the Military Affiliated Radio System (MARS), an Army service section using amateur equipment and operators to handle non-military message traffic to and from troops overseas. Many of the messages involved family news or emergencies, but five-minute personal calls from service people to the folks at home also were allowed.

Calls went via a MARS station, often equipped with an S-Line or KWM-2A radio in Vietnam, to a MARS station in the U.S., or they may have been received by a friendly amateur operator. The final step was to link the radio transmission to the destination over a phone line. The MARS network handled thousands of messages every month.

One of the busiest U.S. ham stations handling MARS messages was that of Sen. Barry Goldwater at his home on the edge of Phoenix. While Goldwater was in Washington, his station, equipped with a full Collins S/Line, was manned by Phoenix area volunteer hams to handle MARS traffic.

Arthur Collins, several times when hamming at night, received and phone-patched calls from Vietnam servicemen. He quit, however, after handling a call in which the soldier and his wife got into an angry domestic argument.

The KWM-2 filled at least one other urgent military requirement for the Army in the 1960s. In conjunction with the development and testing of a critical new weapon system, a special communications terminal for command and control functions was needed. It required five HF/SSB transceivers installed in a truck-mounted shelter, for communication both when the vehicle was moving and parked, and simultaneous operation on five frequencies. The KWM-2 met the need.

When Dag Hammarskjold, secretary general of the United Nations, was killed in a plane crash in the jungles of Africa in 1962 while on one of his many diplomatic missions, news of the tragic event was relayed to the outside world with a MARS suitcase KWM-2.

When the U.S. began Project Mercury manned space flights in 1962, there was no reliable communication system in place as in later years for the broadcasting networks to report news about the flights from remote points around the world. All three major networks at that time — ABC, CBS and NBC, used KWM-2s to help in their news coverage efforts. Some of the KWM-2s were purchased by the networks, others were loaned by Collins on consignment. Interestingly, some of the loaned units mysteriously disappeared and ended up reported as *lost.* NASA also had some KWM-2s to help augment communications with downrange tracking stations.

Gus Browning was a DXer (DX is ham lingo for distance), an amateur operator striving to make as many contacts as possible with hams in foreign countries, and to operate his radios from foreign lands. In the 1960s he traveled much of the world, first with a KWM-2, then switching to the S/Line, on what was called the grand daddy of all DXpeditions. From March to October, 1962, he made 150,000 contacts from 46 locations across Africa and Asia. He even sneaked over the border into Tibet, controlled by Red China, to transmit.

Gus traveled and carried his ham gear on airplanes, ocean freighters, small boats, Jeeps, buses, trucks, yak caravans and on foot. Hitchhiking on a 30-foot boat used by natives to hunt turtles in the Aldabra Islands area of the Indian Ocean, his equipment was drenched several times by huge waves, but still functioned. Gus sometimes operated 20 hours a day, and once had 2,300 contacts in less than five days, about equally divided between single sideband and CW. One of Gus' main contacts and sponsors was E.C. (Ack) Ackerson, owner of Ack Radio Supply, Birmingham, AL, a Collins distributor. Two girls working for Ack were kept busy full-time sending out QSL cards to hams who had contacts with Gus.

Mozambique was another African country plunged into bloody conflict with the end of Portuguese colonial rule in the mid-1960s. Part of the turmoil was instigated by Soviet-backed communists even before Portugal pulled out of Mozambique.

An interesting story involving KWM-2As was revealed to have happened in the last months of Portuguese presence. A number of the radios were being used by the military intelligence service of the Portugal-backed Mozambique government. It became apparent that the radio communications were being monitored from ships just offshore. They were ostensibly Russian fishing trawlers but displayed arrays of antennas which indicated their true purpose.

Lacking sophisticated secure voice systems, the Mozambique operators connected commercially available telephone scrambling equipment to their radios to thwart the Soviets.

The Mozambique KWM-2s, incidentally, had been ordered by the Portuguese government from a longtime Collins dealer in Lisbon, who arranged the sale and delivery through Collins' South African sales office in Johannesburg.

KWM-2s provided communication from the North Pole as well as the South Pole. When the Plaisted Expedition traveled to the North Pole by snowmobile in 1968, KWM-2s were used during the journey and to let the world know the explorers had reached their destination. Their main contact was with the Collins SSB station in Cedar Rapids. When they reported in from the North Pole, the Collins station linked them with a Navy base at the South Pole, providing a historic first of people on the ground at the North and South Poles being in radio contact. The Plaisted group said the KWM-2s allowed them "to communicate at any time we chose," with the radios operating reliably despite being subjected to severe beating from bouncing over rough ice.

In the summer of 1967 bloody rioting broke out in Detroit due to racial tensions. The Federal Bureau of Investigation under Director J. Edgar Hoover became concerned that the rioting could spread to other cities and lead to a major insurrection.

Wanting to have communications for observers monitoring potential trouble spots, the FBI called on the Air Force for help in obtaining up to 75 KWM-2s within 24 hours. Once again, Col. Joe Beler of SAC was involved. The only source for that many radios was Collins in Cedar Rapids. Beler put in a call to Collins, where the wheels were put in motion to gather up all available gear in finished goods stock and divert all units destined for shipment, some already on the loading dock. Collins was able to supply about 50 radio sets, which were loaded on a company plane and flown that night to Ft. Huachuca, AZ.

Charles S. (Chuck) Carney, amateur equipment product line manager for

Collins, recalled customers wanting Collins to supply custom suitcases to carry radios such as the KWM-1 and KWM-2. Military people were very interested, some having adapted suitcases for the purpose. Carney was told the engineering department had no time to look into the matter, so he contacted the Samsonite company which finally agreed to design a carrying case. He wanted to place a trial order for 50 of the suitcases, a number questioned by the marketing department head. "But about that time, Bob Cox (Cedar Rapids Division general manager) happened to walk in and said, 'I wondered when someone would pick up on my idea for a KWM-2 suitcase.' Needless to say, the requisition for 50 was quickly signed and the Samsonite portable was born. We ended up selling thousands," Carney said. Suitcases also were produced for other S/Line units.

Carney recalled being told by King Shwayder, president of Samsonite, that during a flight with General LeMay, he was shown the KWM-2 in a suitcase carried on the SAC commander's airplane. A short time later Fortune Magazine carried a Samsonite ad with a picture of the radio in a suitcase.

During the 1960s all U.S. embassies and legations, except the largest ones which had standard military HF equipment, were furnished with suitcase KWM-2 or S-Line radios for emergency back-up communications.

Carney was the Collins amateur product line manager from 1957-66, after having been in engineering a number of years where he helped develop the first Collins airborne computer and worked on DEW Line equipment. The product line was a somewhat unique department in the company organizational structure. Its function was to serve as an interface between engineering, manufacturing, sales, advertising, service and repair. As such, Carney's group determined the products to be manufactured, build rates, pricing, sales and dealer networks (U.S., foreign, military), and had responsibility for profit and loss. *But one of our toughest jobs was putting out fires, because Art Collins did not like any aspersions cast on our equipment — none!*, Carney remembered.

Arthur Collins was proud of the KWM-2, although he probably had many thoughts about ways it could be improved. One feature he did not like was the instruction manual.

In a meeting in 1969 with a group of his computer engineers, the discussion turned to the amount of paper generated at Collins Radio.

*I am reminded of that situation every now and then,* Arthur said. *Recently, I wanted to see what was going on in the two-meter ham band, so I got Herb Blaker and Chuck Carney to get me a KWM-2 with a 62S-1 set up in my house. (The 62S-1 was a unit which enabled the KWM-2 to operate on two meters.) Well, after I got on the air, I discovered I had forgotten which knob did what on the KWM-2, so I started looking at the manual as a last resort. Well, that's the damndest book you ever saw. It's got more information about the KWM-2 than I wanted — I just wanted to know where the right knob was.* Arthur concluded by saying he thought a simpler manual could be designed.

The 30L-1 linear amplifier, which became part of the S/Line, was another amateur product that began in Gene Senti's home workshop. Senti had an innovative idea for an amplifier and built a breadboard version of it. Ernie Pappenfus, the HF equipment engineering department head, saw the potential in the concept and set up a project to develop a prototype of the unit in less than a week. Electrical and mechanical engineers, technicians and draftsmen started Wednesday morning, worked until midnight for three days, and by Saturday evening had a working model on the air. It operated with no flaws. The project set a record for design time.

The 30L-1 activity also instigated what became a famous tradition with Collins Radio Company. Pappenfus needed to have a location for the 30L-1 team where they could work without interruption and interference. A suitable room was found which had light green walls. From that time on crash programs at Collins Radio were known as Green Room projects.

The Green Room, in retrospect, was a unique and highly advanced concept, another example of Arthur Collins' forward thinking.

The team assembled for a Green Room project included both electrical and mechanical design engineers, draftsmen and lab technicians. Available to them were specialists with a wide variety of skills including components and materials technology. Also involved in the product development team were production engineers who would have to manufacture the new equipment, quality control specialists and maintenance engineers, who offered their ideas on how the radio parts could be repaired or replaced if necessary. One engineer who participated in several Green Rooms remembered them as, *A place where Art Collins owned you if he was involved, because they went on day and night, and you worked that kind of schedule.*

Some 25 years after Green Rooms began at Collins Radio, the U.S. Department of Defense called upon contractors to implement a process known as Integrated Product Development. The guidelines were almost identical to the procedures of the Collins Green Room.

Just how highly regarded the Collins KWM-2 has remained through the years was demonstrated during the Desert War in 1990-91, when the U.S. and allied nations built up a large military force in the Mideast to confront the Iraqi army of Sadaam Hussein.

MARS operations again were part of the military presence. By this time, nearly 20 years after Collins amateur radio production had ended and the last of the tube type KWM-2s and S/Line radios had been built, the preferred MARS equipment was new generation solid state, integrated circuit gear.

The newer type equipment did not always perform satisfactorily, however, particularly during desert sand storms. The storms generated high levels of static electricity which actually burned out the front end (RF amplifiers) of the solid state radios.

KWM-2s, more specifically the military version KWM-2As, again were pressed into service. Operating with vacuum tube front ends, they could handle the high static voltages which were encountered at times.

During the 1950s and 1960s the Cedar Rapids metro area population probably had the highest percentage of amateur radio operators of any city in the U.S. The reason, of course, was Collins Radio Company, where hundreds of hams were employed. Employees could buy ham gear through the company at two-thirds of the list price. The amateurs at Collins were not all in engineering, nor were they all men. Ham license holders included test technicians, technical writers, contract managers, computer operaters, factory foremen, salesmen and vice presidents. One ham was a female records clerk, another a lady working on the assembly line.

Arthur Collins' own amateur radio station at his house was equipped with the latest products his company was building and any gear under development that he wanted to test.

It was, in Arthur's style, a neat and efficient layout. Any gadgets he had were functional, not for show — a clock to tell times anyplace in the world, a typewriter designed for copying weather forecasts.

Arthur's home in southeast Cedar Rapids, built just before World War II, was on a plot of ground covering about 8-1/2 acres, mostly hilly terrain. He had three antenna towers located about 100 feet from his house.

Most amateur operators in the upper Midwest, frustrated when rotator mechanisms atop their antenna towers froze up during winter ice storms, could do little about it except wait for a thaw. But they weren't Arthur Collins, with the means and resources to overcome the problem.

Frederick W. Johnson, a brilliant and innovative mechanical engineer who became a Collins vice president, was responsible for much mechanical design work on numerous products including amateur radios over the years, and worked closely with Arthur Collins on some key programs. He recalled how Arthur approached him on his rotator reliability problem.

"One day in the midst of other activities, Arthur stopped by my office to discuss the possibility of rotating an entire 80-foot tower, with antennas solidly attached at the top. I admit to a somewhat less than enthusiastic initial response. But further thought showed it would not be a tough job — just unconventional. I had to convince myself the tower could withstand the torque of available simple driving mechanisms. The start and stop jerks now would have to include the inertia of the tower in addition to the antennas. That turned out to be okay — the decision to go ahead was made," Johnson said.

After necessary stress calculations, a 12-inch diameter iron pipe, eight feet long with a plate at the bottom, was encased vertically in concrete in Arthur's back yard. Nested inside that was a 10-inch pipe, with bands welded around it to allow it to rotate without binding. The space between the pipes was filled with diesel oil. A round platform was gusseted to the top of the inner pipe, serving as a lazy Susan on which the antenna tower was erected. Antennas were attached at the top of the tower. A large gear reduction electric motor drove a large chain sprocket under the lazy Susan to rotate the tower.

"At that point we tried it, and the scheme worked!", Johnson said. He then climbed to the 40-foot level on the tower, computed strain points and provided further gusseting "so the tower could handle anything short of a tornado."

Johnson remembered "one unfortunate incident in this exercise. A construction truck backed into soft sod on the lawn of Arthur's next door neighbor. You can't believe how fast that got fixed.

"Over time a few more rotary towers were built and installed for high level Collins engineering and marketing folks. I suspect some of them thought of their towers as status symbols."

On a couple of occasions, Arthur became very concerned when hurricanes ravaged Florida, and wanted to be personally involved in communications for the stricken areas.

Ernie Pappenfus remembered Arthur calling a hurry-up meeting of a group of company people in 1955 and wanting to fly to Florida with equipment to help out. When they called Florida, however, they were told that the local people had all the radio gear and operators they needed.

Several years later after another hurricane Arthur did go, and that time provided communication assistance for the area where the storm had struck.

Harvey Hop was chief pilot for Collins at the time. He remembered Arthur calling him to get ready on short notice for the trip and getting the radio gear loaded on the company airplane, a twin-engine Convair.

Enroute, Harvey called the Florida airport by radio to get hotel rooms and a rental car lined up for Arthur and himself.

"I was connected to a motel and told them we needed rooms for the president of Collins Radio Company and myself. When we arrived late at night to check in, the clerk thought I was the company president because I was wearing a coat and tie and Arthur was wearing old grubbies," Harvey said.

Arthur operated amateur equipment out of the airplane for the better part of two days, handling communications for the local sheriff and others involved in the disaster relief effort.

Pappenfus also remembered another time when around-the-clock single sideband testing was going on, and Arthur was operating at his home. "He called me at 3 a.m. and said, 'come on over and run this station — I need some sleep.'"

For many years Collins Radio Company operated a surplus store in Cedar Rapids, selling electronic components, a variety of radio parts, wiring, sheets of metal, test equipment no longer needed and many other items, even used typewriters and office or lab furniture. The components were left over from manufacturing runs, when the company had too many in stock and for other reasons.

Sometimes the store was located in a company building, but most often in rented space somewhere in Cedar Rapids. The store moved a number of times.

To hams, the surplus outlet was their type of toy store, full of gadgets galore at very low cost. It was a place they could find much of what they wanted for experiments, to modify current rigs or to fix old radios.

In 1969 Arthur received a letter from E.A. Pelton, WØZLL, of Waterloo, Iowa. Pelton wrote that for years he had purchased components from the surplus store to send to hams in remote Pacific countries and islands who had great difficulty obtaining radio parts.

His purpose in writing was to say thanks to Arthur. "You have made a lot of fellows very happy by having the store you have," he stated. Along with the letter was a woolen shirt, a gift from an amateur in New Zealand who had received surplus store items from Pelton.

Pelton also mentioned that Arthur had given him a few parts when he lived in Marion in the late 1920s.

Just what was it that made Collins amateur radios legends in their time and classics in years since they were the ultimate state-of-the-art equipment?

A main factor was that they were just about as dependable as any man-made assemblage of parts and materials designed to send and receive radio signals could be.

They worked when they were supposed to, as they were supposed to, and often under the most extreme conditions. One such instance was during Operation Deep Freeze in the Antarctic. A KWM-2's only protection from temperatures of 60 degrees below zero and blowing snow was a wooden packing case.

"Navy men just shook their heads in disbelief when we dusted the snow off that KWM-2, fired up the set and made contact," said Bob Beatty, a Collins field service engineer.

An example of the rugged construction in a Collins unit was once noted in a letter received by the company from an unfortunate but still proud owner of a 75S-1 Receiver.

*On February 21, 1960, my house burned out at a very early hour in the morning. During the fire, power hoses were used, which had so much force they could practically punch holes in the roof. A stream of water from one of the hoses hurled the 75S-1 out of a second floor window to a concrete walk below. It was picked up and stored in the cellar of a ham friend of mine, and when it dried out was examined. The casing was smashed; one of the i-f cans was dented; there was still moisture in the meter casing; the power transformer was out of alignment because one of the supports was sheared, but the wiring underneath was intact and did not appear to be damaged in any way. Gravel and sand were in all moving parts.*

*The receiver was plugged in, and believe it or not, every tube lit and the calibration, when checked against the 100-kc standard, was 'on the nose.' However, the audio stopped functioning and the receiver has not operated the way it did before it was damaged. The chassis is slightly out of alignment, also.*

*I think it is a testimonial to your product that this receiver could be hurled by such force and smashed against a concrete walk and still come out with exact calibration*, the letter concluded.

Another equipment reliability experience happened in 1962 to Vere Ogilvie, ZE4JØ, of Gwelo, Southern Rhodesia. He had purchased a 75A-4 receiver in the U.S. and had it shipped by boat to a port in east Africa. The radio, in a crate, was then placed aboard a smaller boat used to transfer cargo to shore. That boat was tied to a wharf, waiting to be unloaded, when a hurricane blew in, upsetting the craft. The receiver lay on the bottom for about five days until it was pulled out of the water, then remained in the wet crate for six weeks until the owner was allowed to collect it.

Ogilvie said he washed out the unit with a garden hose, then painted it with water soluble oil and washed it again. After replacing a few parts he received *fairly strong* signals on 80 meters. He added that he probably had the cleanest A-4 in the world.

Fred Johnson, years after the last of the radios designed under Arthur Collins' management had been built, wrote a summarization recalling "The Elements of Collins Quality." While he described primarily the design process as it applied to Collins amateur gear, the same principles were standard for all products of the company.

Among key points he emphasized were:

In recent years many industry observers have advocated statistical certainty and reliability methods outlined by Deming and others (W. Edwards Deming, the statistical guru who helped in Japan's post-war industrial resurgence) as a means of attaining desired quality levels. While such principles may have merit to uninitiated engineers, they had been long in practice and were second nature for Collins people involved in ham equipment design and manufacture. All designs had to qualify statistically, and all components had to meet "worst case" scenarios. That meant the final product should be designed and built so it not only would work as expected in normal operating situations, but also under more extreme vibration, weather and environmental conditions.

The Collins design engineer was part of an extensive team having elaborate support systems, an organizational scheme which keeps being rediscovered by enlightened managements. Besides his own broad based technical abilities, he could get advice and assistance from a number of specialized support groups, each staffed by people with expertise and facilities unique to their areas.

One such group was made up of specialists in oscillators, who had vast capabilities when it came to knowledge of the characteristics, intricacies and variables of the many types of oscillator designs.

Components and materials specialists comprised another group. Their responsibilities included the sources, testing and qualifying of parts used in Collins products. All components underwent extensive testing before being qualified for use. When a new component was approved for use in production models of radios, at first there was 100 percent testing. That applied to both electronic and mechanical parts such as springs. Later, as the component reliability became proven, testing was done on a sampling basis. Collins worked closely with component suppliers to assure the parts met desired quality and performance standards. A project engineer was not allowed to use an unproven component in a design. Another part of the materials test operation was a chemical and plastics laboratory, providing Ph.D. level help to the project engineer.

A special engineering group was responsible for all engineering test equipment, including procurement, maintenance and calibration to assure accuracy. This group often built special test equipment to accommodate new or special equipment designs. For example, they developed special wide screen video display spectrum analyzers which were widely used in Collins single sideband engineering programs.

One of the most vital functions involving Collins products and an essential element in assuring quality was environmental testing. The primary intent was to be certain that products would operate in extreme heat or cold conditions and widely varying dryness or humidity, and when subjected to severe shock and vibration. The engineering design laboratories had portable chambers to test heat and cold extremes, and Collins had a large environmental testing area serving both engineering and manufacturing. Products were tested under even tougher conditions than they were likely to encounter in the field.

Even the packaging of radios for shipment to a customer was subject to environmental testing. Table top models had to remain undamaged and fully operable after being dropped to the ground from a truck bed in their shipping cartons. More than once a design change was made after such drop tests. Before the KWM-2 was introduced, a special test was arranged to check out shipping containers and procedures. Ten units from the first production run were packaged and shipped to the company's four widely separated regional sales offices. Without opening the cartons, personnel at each location shipped them to another office, and then they were returned to Cedar Rapids. The shipments covered a wide range of transportation routes.

Thermal lab testing of components, subassemblies and complete equipment units was another essential step, particularly as to how heat affected performance and longevity. Much effort went into inventing new blower designs and other techniques to dissipate the heat generated by an electronic product, and an even greater effort was made to deaden noise from equipment parts.

Collins design engineers also had the support of a wood model shop where skilled craftsmen built mockups to show what the final product would look like, a forerunner of three-dimensional computer design capabilities which became available a few years later. A metal model shop produced the precision metal parts proposed for a new design, making as many revisions as necessary during the development program. All such parts had to be compatible with known manufacturing techniques for the time they would be produced in quantity.

Throughout the design and development process for a new radio, manufacturing engineers were involved to assure that the manufacturing capability was in place when the new unit went into production. Collins even had a group known as *maintainability engineering*. Its role was to offer inputs in the design cycle to assure products could be disassembled and repaired with a minmum of difficulty.

There was never a shortcut to thorough testing at all steps of the design and development cycle. Completed equipment units were subjected to intense reliability tests, being operated from a few to many hours under varying conditions. That requirement dealt with the fact that if a product is going to fail, it is most likely to fail at an early period in its operational life, and the problem should be found before it got into the hands of a customer. After a new product had as many bugs as possible worked out of it and had been tested in the labs, field testing took over, usually in the home ham stations of Collins engineers.

Detailed records were kept at all stages on the building and testing of products. Also, there was extensive follow-up on performance and any problems with new products when customers began using them.

The objective of so much testing was to be as certain as possible that the radio had been subjected to both normal and "worst case" operating conditions, and surprises in the form of major problems would not show up when equipment went on the market.

While not all unpleasant surprises were eliminated, the Collins system worked to get rid of most of the bugs in a new equipment design.

Ernie Pappenfus and Ed Andrade, who had been the lead design engineer on the KWM-2, writing on "The Evolution of the KWM-2" in Electric Radio magazine, recalled the initial production run in 1959 of the radio at a Collins assembly plant in Anamosa, about 20 miles northeast of Cedar Rapids. The plant was managed by Elmer Koehn, a longtime Collins manufacturing supervisor, who had helped develop some of the first Collins assembly techniques in the early 1930s.

"Everyone liked Elmer, and when engineers like a manufacturing man, it is saying a great deal. Many of the production assembly folks were farm ladies who came to town to supplement their farm income. Needless to say, their ingrained work ethic, and their interest in 'doing it right,' had a lot to do with the quality of Collins equipment.

"The marketing department had decided that the most economical first build quantity should be 100 units. Naturally, this gave the engineers a near nervous breakdown. Remember, to this point we had built only one breadboard and two engineering models.

"Elmer set about with a vengeance, and in fairly short order he had produced 100 KWM-2s, and, you guessed it, none of them worked. Just about every one had serious spurious responses and oscillation problems in both transmit and receive.

"After a look at four or five of the culprits, we decided that wiring lengths (service loops to the tubes and components) were getting out of hand. So on a hunch we tried taking about one inch off each wiring service loop. It worked. We cleaned up the wiring in five or six production units and delivered them back to Elmer with instructions to remove about one inch from the many service loops in the radio. He groaned. Remember, he was thinking about the 100 units that had to be reworked. He tried the modification on 10 more units and they all worked, which made him a believer. In later visits we often would see him with one of the transceivers on his desk, ruler in hand, making sure the service loops were not growing again," according to the account.

Probably no amateur operator ever did more thorough testing of Collins equipment than Arthur Collins himself.

That once got him his one and only pink ticket from the FCC.

Operating an early production model KWM-2 from his home in Cedar Rapids and hamming with Jim Flynn, a Collins vice president in Dallas, Arthur was monitored and soon learned he was accused of transmitting CW signals which were A-2 — in excess of established FCC limits.

The KWM-2 design, because of single sideband, used a keyed audio tone oscillator for CW instead of a conventional carrier tone arrangement. That apparently resulted in a spurious emission interpreted as too strong a signal.

Arthur avoided a fine by writing an explanation which the FCC considered plausible.

*But we of course heard about that right away and racked our brains until we came up with the fix,* Ed Andrade remembered.

Chuck Carney recalled a letter once received from a doctor in Atlanta, writing about a KWM-2 mounted under the dashboard of his station wagon. The vehicle was sometimes used to transport his young children. One July morning, the doctor wanted to operate the radio while driving to work and noticed wrappers of several candy kisses laying on the lid of the KWM-2. The radio would not work because the candy had melted in the hot Georgia sun and dripped into a group of relays inside the unit. The doctor tried to clean up the mess with a solvent and burnished the contacts. That helped, but the radio still did not work satisfactorily. At that point he had to go out of town and the car stood idle for several days. When he returned, he found the radio covered with ants. He discovered the ants had done a complete cleaning job on the sticky parts and the KWM-2 again worked perfectly. He headlined his letter, *Ants fix bugs.*

Another letter once received in the amateur marketing department was from a person asking if Collins could build him a small receiver to tune into the brain waves of other persons and allow him to know what they were thinking.

During 20 years of production, Collins built nearly 35,000 KWM-2s and KWM-2As.

It would be folly to think that, out of thousands of products built, all were perfect. The Collins amateur product line department received many letters from customers each day, including complaints about equipment and service by unhappy hams.

Still, it was not due to lack of conscientous effort in design and production if a product failed to work as intended.

As Fred Johnson described it: "Collins design engineering was broadly based, and all design engineers were backed by sufficient resources to be sure every design was thoroughly understoood as it went into production. Where in a few cases something slipped through the cracks in this system, Arthur Collins set the absolute standard of response to anything that was not right. This philosophy permeated the organization to the point that Arthur really didn't have to watch everything with an eagle eye. His inputs were less than the legend — parsimonious is a term he occasionally used to express this kind of thought — but his inputs were amplified by everyone's desire to do the best that could be done. One example of how Arthur instilled a sense of direction is illustrated by what he explained to someone worried about a tight schedule. He said, 'Look, I want you to do it right as fast as you can, not fast as right as you can.'"

"Those of us who worked in this environment (the last of the major Collins amateur equipment engineering programs of the late 1950s and early 1960s) found it stimulating....a tremendous learning experience which made everything that followed a little better. We all learned at a rapid rate. It's hard to overestimate the long term value of working in the Collins environment at that time. It was a culture!," Fred Johnson wrote.

*We worked our butts off,* was how Ed Andrade and most other Collins design and development engineers remembered their time with the company. But almost universally those veterans of association with Arthur Collins express great satisfaction and a sense of achievement from their experiences.

Except for early years of the company, amateur equipment was not one of the major product lines and was never a big money maker for Collins. But it was still expensive to buy.

The one time it did make money for the company was during the Vietnam War, due to the huge volume of KWM-2As purchased by the military. *That paid for all the development costs of all the amateur equipment in the history of the company,* according to Bill Roodhouse, Collins executive vice president.

It was sometimes said there were two kinds of hams — those who had Collins equipment and those who wished they had it. Some of those who did not have it referred to a top line Collins transmitter and receiver as the "gold dust twins." For some hams, those two units cost as much as their salaries equalled in a year.

Following introduction of the KWS-1 and 75A-4 single sideband units, Collins wanted to get as many of the SSB radios as possible into the hands of amateurs. To help overcome the *sticker shock* factor, the Collins marketing department offered a time payment plan to let hams buy the new SSB radios in 18 monthly installments.

Despite being expensive to the end customer, the price of Collins amateur gear still did not accurately reflect the true costs of designing and building the products.

A story went the rounds about a Chicago businessman asking S.J. Storm, a longtime friend and the Collins corporate secretary-treasurer, if he could get him a certain ham unit at cost. The deal was quickly cancelled when the man was informed the "cost" was \$100 more than buying the equipment from a retail distributor.

One amateur who got a real bargain on a KWM-2, either free or for a token payment, was a young man with the family name of Alessi, from Brooklyn, NY. Not yet 12 years old, he was believed to be the youngest licensed ham in the U.S. The incident apparently originated from a contact with Collins' New York office, headed by William J. (Bill) McKnight. That led to a visit by the family to Cedar Rapids, where Arthur set up a visit to the amateur radio development labs. Arthur always had a soft spot for youthful technical achievers, which may have been why he authorized the KWM-2 transaction. In any event, even though the family's picture was taken by a company photographer, Arthur decreed absolutely no publicity or comment by anyone who knew about the incident, obviously to avoid requests by others wanting a free radio from Collins.

Most company managements would eliminate a product line which does not pay its own way. Rockwell finally did shut down the Collins ham business after taking over Collins Radio Company in the early 1970s.

But in the 40 years Arthur was in charge of the company, amateur radio played a unique role. It had special and vital importance for a company whose main customer base was not the everyday consumer, but the buyer of high tech communications and electronics systems for government and industry. Arthur often used his amateur line to try out new electronic circuitry and mechanical design techniques before they were applied to other military and commercial products.

While many of Collins' amateur radio customers were not communications professionals in their occupations, many others were. Their knowledge and use of Collins amateur gear was a key factor in many large scale equipment system sales for the company. In fact, one major communications equipment competitor felt the amateur line gave Collins an unfair advantage. "I know it's not, but Collins equipment is perceived by the military to be a cut above its competitors because of the ham equipment line," the competing firm's president once told a Collins executive.

Amateur radio remained highly important to Collins Radio Company despite being a low volume product line which barely made a profit. Its significance was evident in the level of advertising and trade show participation. One of the activities to help promote the new single sideband radios in 1956 was equipping a house trailer with ham gear. It was toured around the country to provide demonstrations for hamfests, club meetings and Collins dealers. In the 1960s Collins equipped another vehicle, a full size van, to promote the S-line and KWM-2.

Competitors worked hard to come up with state-of-the-art advances in amateur radio, and sometimes introduced interesting new features. But Arthur Collins was not one to be stampeded into a design change or new development just to respond to a competitor's latest model.

Arthur alone was the decision maker on what would be designed and built in the amateur equipment line and when.

He marched to his own drum beat. New models were brought out only when he and his engineers were certain they could offer a significant advance in amateur radio technology, or to fill a niche in his product offerings.

He had an uncanny ability to see what the amateur market would go for. In his mind it was no gamble to push forward with an innovative new unit — he knew it would work and it would sell.

Collins amateur products often remained industry leaders for years, still widely used and in demand long after newer, more technically advanced models were introduced.

The Collins customer list included a number of famous personalities who during their lives had been bitten by the amateur radio bug. They included Arthur Godfrey, a well-known radio entertainer of the 1940s and '50s; Freeman Gosden, the *Amos* of the Amos 'n Andy radio show of the 1930s and '40s; Sen. Barry Goldwater of Arizona, the Republican presidential candidate in 1964; Herbert Hoover, Jr., son of the former president who once was president of the American Radio Relay League, and Bert Wilson, who for many years was the sportscaster for Chicago Cubs baseball games.

After the S/Line and KWM-2 developments, Arthur began putting most of his attention into the computer programs which he saw as the company's major thrust for the future. But amateur radio was never out of his mind, as he noted in a 1970 memorandum before the massive investment of resources in the computer programs finally cost him control of his company.

The memorandum, distributed to a number of key engineering and marketing people, offered insight into what might have happened if Arthur had launched a next generation of ham equipment.

It was entitled, "Hams vs. the Technological Establishment."

"This is as good a time as any to recall that inspired amateurs have consistently ventured ahead of the 'establishment' throughout the years. A few names come to mind:

G. Marconi - surface wave propagation.

W. and O. Wright - powered flight.

R.H. Goddard — space rockets, vacuum tube oscillator.

Reinartz & Willis - HF ionosphere communication.

Grote Reber - radio astronomy.

Doug Smith, et al - moon bounce communication.

Early group SSB experimenters — extensive use of SSB.

"Many more individuals who have contributed significantly to the advancement and application of science and technology could be listed. All but Goddard and the Wright brothers in the above list were hams. All but Marconi and the Wrights were good friends of mine and of Collins Radio. Collins' close relationship with hams has been a dominant factor in its progress throughout its history.

"We have not done anything to enhance this relationship since we introduced the S/Line — we have only 'coasted' for several years. I fear that we have drifted into the attitude that our recent work in computers, communications networks, integrated processes, etc., etc. is just too sophisticated and expensive for hams. Ridiculous!"

He then listed several articles in amateur journals by and about hams using advanced electronic techniques, and noted: "These are only examples of current ham ventures alongside which we might well measure our company's ponderous progress. I think it is high time to return to our past practice of telling hams what we are doing and to offer our 'latest and greatest' to them."

The problems which Arthur was facing at the time, however, precluded any further amateur developments by Collins Radio Company.

It would be interesting to speculate what types of amateur equipment might have been developed if Arthur and his engineers had been allowed one more opportunity. Several years after Arthur parted ways with his company in 1971, some of those engineers helped develop the the KWM-380, using circuits and techniques which had evolved over the years. It was the first and last amateur radio developed and produced after Rockwell International gained control of Collins. It did not reach the success level attained by ham gear of the former Collins Radio Company.

Arthur remained an active ham until his death in 1987. He still used S/Line equipment, but also tried out newer generation Japanese radios which came on the market in the late 1970s and 1980s. A visitor to his home in Dallas in 1982 found him using the S/Line to tune into high frequency communications between British navy ships engaged in the Falkland Islands conflict with Argentina.

Arthur Collins will be long remembered for substantial and lasting contributions to amateur radio. He probably did not have himself in mind but he certainly qualifies for a statement he once made in a letter to a student:

*Many indirect benefits to society can be found in the history of amateur radio and in the work of individual amateurs.*

# Chapter 9
# No. 1 in Avionics

Cedar Rapids, Iowa may seem an unlikely place for the world's leading avionics company, but the location was no accident.

Back in the mid-1930s, Arthur Collins set a goal for his company to become No. 1 in air transport radio equipment. Along the way to achieving that objective, the firm also became a world leader in the design and production of military aviation electronics gear, and in equipping business aircraft. It all came from Arthur seeing the vital dependence of aviation on radio, which increased with the growth of aviation, and from his intense interest in flying.

Arthur's infatuation with aviation began at an early age. He tried to become a pilot in his early teens, taking a few flying lessons, but those ended abruptly when his mother found out about them. He waited until 1935, after his company became established, to earn his pilot's license. After that he flew often both as a means of transportation and for testing equipment, first in single and later twin-engine aircraft.

Around 1934-35 he and his small engineering force custom designed a transmitter installation for a Goodyear blimp, and developed airborne radio sets for the Republic of Colombia Air Force. Those jobs marked the beginning of Collins Radio's entry into the aircraft equipment business.

Next came transmitters for air transports such as DC-2s and DC-3s, built around one of the most important inventions in the history of aviation radio, the Autotune. Incorporated into military aircraft transmitters in World War II, the Autotune gave U.S. and Allied pilots a major advantage with its multi-channel and pre-set tuning capabilities.

Collins devoted all its efforts to military design and production during the war, but even before hostilities ended Arthur was looking ahead to the company's post-war aviation role.

A hint of what he had in mind was outlined in a talk given by Frank Davis, then chief engineer, to a group of underwriters when Collins made its first public stock offering in late 1944.

Noting most of Collins' aviation work to that time had been in communications equipment, Davis said:

*We expect to expand our work in this field, but airplanes and their associated ground control stations need electronic equipment for purposes other than communication. This may include direction finders, beacon receivers, marker receivers, localizer receivers, blind landing equipment, altimeters and many types of radar and related equipment. Some or all of these may be carried in the airplane. In addition there is corresponding equipment for the ground part of the* *system. We plan to develop and manufacture such items of equipment where we feel we can make some improvement in performance or worthwhile contribution to the design.*

World War II brought tremendous growth in the technology and public awareness of aviation. The advances in size, speed, range and payloads of aircraft were staggering. It was the beginning of jet engines and rocket power. There is no doubt that most of the progress resulted from the urgency of war, but the new technology soon was to be applied to commercial aviation. The United States was the first to make the transition. Then it was only a matter of time until economies of war-ravaged nations recovered for the aviation industry to begin massive growth and expansion, as aviation became an essential part of world commerce.

Among the first preparations by Collins Radio for the aviation boom to come were acquiring a twin-engine airplane and building a hangar and engineering facility at the new Cedar Rapids airport.

The aircraft was a C-18S Beechcraft with twin 450-horsepower Pratt & Whitney engines and a conventional landing gear with tail wheel. It could haul six passengers plus pilot and co-pilot, but Collins had it modified to use much of the cabin space for testing radio equipment. The company took delivery of the plane in December, 1944. At first it was kept in Wichita until the Cedar Rapids hangar could be built.

The City of Cedar Rapids tried several times from the 1920s to have a new airport. Finally a bond issue was approved in 1942 to build a modern airport with a paved runway to accommodate the largest commercial aircraft. Construction of the new facility located southwest of the city was completed in the summer of 1944.

In January, 1945 Collins and the city agreed on a long-term lease for eight acres at the new airport. By October the new hangar and laboratory were built and ready for use.

When the war ended in August, 1945, the Collins Radio work force scrambled to switch from filling war production orders to turning out a mix of commercial and government equipment.

The changeover brought several lean and unprofitable years for Collins.

But prosperity finally came back in a big way, the result of a military development program which the firm began in latter stages of the war. That project had led to the AN/ARC-13 and AN/ARC-19, the first ultra high frequency aircraft radios for the U.S. Navy. They were used for testing and evaluation, but never put into production.

With the war over, the U.S. armed forces prepared to adopt UHF as the primary frequency band for short to medium range air-to-air and air-to-ground communications. UHF at that time was not widely used but offered many advantages including the availability of channel space, being static-free and relatively unaffected by man-made interference. Collins had previous UHF experience in building commercial broadcasting transmitters, but compact, lightweight and rugged aircraft radios were a much stiffer challenge. Also, the military was moving into next generation higher performance jet aircraft, posing new requirements in radio designs.

The Navy soon sought a more advanced UHF airborne radio. Three contractors, Bell Laboratories, Bendix and Collins Radio were chosen to develop models for testing and evaluation.

The Collins entry was selected after an intense competitive evaluation, the radio being designated by the Navy as the AN/ARC-27. It was truly a major advance in the state-of-the-art of aircraft radios. It combined the transmitter and receiver in a single unit with 1,750 communication channels, an unheard of number for equipment at that time (the WWII AN/ART-13 HF transmitter provided only 12 channels), and was ruggedly built for military aircraft service. The weight of the transceiver was less than earlier transmitters alone.

Collins introduced an array of technical innovations in the new unit. The design was based on a principle of using a relatively small number of crystals to produce the hundreds of channels. Incorporating various Collins-designed mechanisms including the Autotune and Autopositioner, the AN /ARC-27 allowed channels to be changed as fast as the pilot could switch them.

One of the most important engineering contributions in the ARC-27 came to be known as the Hubbard Tank, developed by Merle Hubbard. Tank is a term given to tuning circuits. Having to tune each of 1,750 frequencies instantly, accurately and uniformly, compared with the much smaller frequency range of previous airborne radios, was an essential requirement. The Hubbard development was believed to be the first practical variable circuit for tuning over that wide of a frequency range.

Heading up the AN/ARC-27 program was John P. Giacoletto, who had been a lead engineer on the WWII automatic direction finder used to detect German submarines. Giacoletto joined Collins in 1935 after earning his EE degree with high honors from Rose Polytechnic Institute in Terre Haute, Indiana. About 25 persons were on the project team, including engineers, lab technicians, draftsmen, test personnel and others. Merle Hubbard was in charge of radio frequency design. Other engineers included Horst Schweighofer, responsible for mechanical work, John Goetz, Fred Holm, E.K. Vick, Emil Martin, Gordon Nicholson and Harry Lehman.

Giacoletto recalled that Arthur Collins was not directly involved in the program but kept a close watch on it. He did make a number of suggestions, one being the design of a front casting to house the heat exchanger which cooled the radio, Giacoletto said.

During the Navy program which led to the AN/ARC-27, the U.S. Air Force, by then an independent service branch, sponsored development of its own UHF radio by another contractor. But prior to the outbreak of the Korean War the U.S. Defense Department decided all service branches would use the same UHF equipment. The Collins-designed AN/ARC-27 also won out in that competition, and production began on the new radios which would go into almost all military aircraft.

Collins also was selected to provide the compatible ground radios to work with the ARC-27, after another contractor was unable to deliver acceptable equipment. That radio was the AN/GRC-27.

Thus Arthur Collins' company, already the acknowledged leader in high frequency communication technology, also became the nation's top firm in ultra high frequency radio.

The onset of the Korean War in July, 1950 and U.S. involvement in the conflict, officially as part of a United Nations force, created an urgent demand for the new UHF equipment. Collins was under pressure to deliver the air and ground units as fast as they could be turned out. The millions of dollars in UHF contracts was the main factor in the company's turnaround after World War II. More than 80,000 ARC-27 transceivers were built eventually.

While the AN/ARC-27 and AN/GRC-27 in the end represented a huge success for Collins Radio, mountainous obstacles loomed at various stages of the project. During final stages of the Navy selection process, Arthur wrote a lengthy memo to his top people, prodding the engineers to exert extra effort in overcoming knotty technical problems, and urging marketing personnel to make certain the Navy people understood the benefits and advantages of the ARC-27. He noted other contractors, most of them much larger firms than Collins, were trying to convince Navy officials to purchase conventional radio designs which did not offer the advanced technology or capability of the ARC-27.

The Korean War triggered a huge and rapid build-up in military contracting. Firms which had left the business in 1945 suddenly were demanding a part of it, and some told the Pentagon that Collins Radio was getting more than its share. Arthur found himself spending a lot of time defending his company's new radio and its abilities to meet development and production schedules. He personally conducted a number of tours of the Cedar Rapids plant for military brass who had to be convinced his company could live up to its promises.

While the UHF program received major emphasis in the late 1940s, Arthur also had his company gearing up for the role he planned for it in commercial aviation.

A year after the war Collins could offer just 10 products for airline and business aviation, all communications units. Five of those were ground station transmitters and receivers. The other five were radios for installation in airplanes. Three airborne units were transmitters, one a receiver and one a combination transmitter-receiver.

Two of the ground units were the 231D-13, a 3,000 to 5,000-watt transmitter, and the 16F, 300 to 500-watt transmitter. Both had been developed before World War II, both were equipped with the Autotune, and both had been produced in quantities before and during the war. They were described as versatile units widely used for ground to aircraft, shore to ship and point to point communications.

One of the aircraft transmitters was the 17H-2, commercial version of the famous AN/ART-13 military radio.

The transmitter-receiver was the 18S-1, 100-watt, 20-frequency, crystal controlled, Autotune-equipped unit. It had been specially designed using available parts immediately after the war to provide high frequency communication for airline and corporate aircraft. The 18S-1 was the first combination transmitter-receiver ever developed for commercial aviation, and the grand daddy of a line of Collins radios which long dominated the HF equipment market for airlines.

The 17E-2 was a 100-watt, two-channel HF transmitter weighing 44 pounds for executive airplanes. It had the reputation of being designed, developed and put into production in the shortest length of time of any Collins radio gear, reflecting the urgency of getting new commercial equipment on the market. Development began in mid-November, 1945 immediately after Arthur Collins returned from a meeting at Beech Aircraft in Wichita, having learned of the urgent need for such a radio. Bill Popek, then a manufacturing superintendent, recalled being told to *get some work benches cleared off right away for a priority project!* and that engineers showed up to begin work even while the area was being made ready. Within 10 days a model had been designed, built and tested. Production started in late December, with orders already on the books. Collins advertised it as being available by February, 1946. The ability to get the product on the market in such a short period was attributed to the experience of engineers and technicians who worked on it, basing the design on circuits used in earlier radios, and the availability of mostly in-stock parts.

Following World War II the airlines of the U.S. and other nations, working with government aviation agencies and various industry technical groups, began planning for standardized navigation and air traffic control techniques across the world.

The United States' air traffic control system had its beginning around 1930, when several airlines set up landing procedures at a few big city airports. Also about that time two-way air-ground communication began. With carriers soon offering regular commercial aviation passenger service, air traffic control became a federal government responsibility, and a small number of ground stations were established. They transmitted radio signals in the very low frequency range which helped pilots to navigate, but covered only a few major air routes. The technique spawned a popular phrase, *flying the beam*. Also, some larger airports began to install equipment to guide aircraft on runway approaches.

With big growth looming in air travel and larger, faster airplanes on the way after World War II, a modernized and greatly expanded air traffic control and navigation system would be needed.

Arthur Collins and W.J. Barkley flew to London in September, 1946 to observe one of the major planning sessions on the subject. The world's aviation interests acted quickly, deciding upon basic requirements of the system by late October, 1946.

In accordance with the international recommendations the United States established what was known as the VOR system for domestic enroute navigation and approaches and landings at airports. VOR is an acronym for very high frequency omnidirectional range beacon.

VOR is a system of radio beacon transmitters covering large areas of the U.S. They are unmanned ground stations which operate continuously, sending out signals in all directions on the very high frequency band. Pilots have maps showing the locations of VOR stations across the country, and the radio frequency transmitted by each station. A pilot follows a course by tuning the aircraft navigation receiver to stations along the flight route. The effective range of a VOR station is up to 200 miles, depending upon the aircraft altitude. Unlike the earlier low frequency system, VOR offered pilots an infinite number of courses. The VHF radio band also was relatively free of static interference, which had been a problem with the low frequency system.

With adoption of the new VOR system, one of the aviation industry's first needs was a VHF aircraft navigation receiver, providing pilots with both VOR and localizer signals. The localizer signal is used near airports, a vertical radio beam for lining up the aircraft with the runway, part of the instrument landing system.

Several electronics firms including Collins, Bendix, ITT and Wilcox set out to develop a navigation receiver according to specifications of Aeronautical Radio, Inc. (ARINC), the organization established by the airlines to determine equipment standards and provide joint communication services to the industry.

Providing key expertise in the design and development effort was Francis L. Moseley, a former Army Air Force colonel who recently had joined Collins with the title of Director of the Special Products Division. From 1941 to 1945 Moseley was chief of the Radio and Radar Section of the Air Force Communications and Navigation Laboratory at Wright Field, Dayton, Ohio. While there he headed development of the Air Force instrument approach system for blind landing. Before the war he had developed the first commercially used automatic radio compass for aircraft while with Sperry Gyroscope Company, and also worked for ARINC.

*Collins was literally betting its bank account that we could win that competition,* recalled John C. McElroy, who was an engineer on the project and in later years became vice president of engineering in Cedar Rapids.

*There was hardly a single step in the development that Art Collins was not involved in. A lot of flight testing was required. Rolf Wollan did a lot of the flying, and Art flew a lot — critiquing both in the airplane and the laboratory. Working so closely on the project, sometimes he was a help and sometimes a hindrance.*

*As was his method on many programs through the years, more often than having the answer to a problem, Art would ask questions which we could not answer. That led the engineers to dig a little deeper and find the answer, which probably was what he was trying to do anyhow,* McElroy said.

In January, 1947 Collins conducted highly successful flight demonstrations of the new VHF receiver system for airline and government officials at the Indianapolis test center of the Civil Aeronautics Administration (CAA), predecessor to the Federal Aviation Administration (FAA).

The system also included cockpit instruments providing magnetic heading information and an automatic direction finder presentation, along with localizer information. The demonstrations were conducted over several days when fog, snow and low clouds prevailed in the area, ideal conditions to prove the effectiveness of an instrument flying system. The Collins system, the 51R-1, was the first to receive approval for use in air transport operation. That was a historic step for Arthur Collins' company in striving to become the leading supplier of aviation electronics equipment, and in the quest for all-weather flying capability.

The 51R-1 received both navigation signals and VHF voice communications. A companion unit on the aircraft, the 17L-1, provided voice transmissions for a pilot.

By 1951 the company had delivered more than 1,600 of the 51R series navigation-communication receivers to every U.S. and several foreign air carriers, equipping most of the nation's airliners and many executive aircraft. One of those was the twin-engine airplane of Entertainer Arthur Godfrey, who also operated Collins ham equipment. A military version, the R252A/ARN-14 also was developed. One installation was in the Independence, the DC-6 operated by the Air Force as the personal aircraft of President Harry S. Truman.

As of 1954, 6,000 of the 51R series had been sold, and 12,000 of the military models had been ordered. Eventually Collins captured 80 percent of the airline VOR receiver business.

Another piece of equipment needed for the VOR system was an antenna on the aircraft to receive the VHF signals.

Marvin Moody, longtime Collins patent attorney, recalled that Arthur and John Shanklin, an engineer whose expertise was antenna design, were discussing their ideas for such an antenna at the Collins hangar one day and began sketching rough ideas as to the size and shape on a paper sack.

As they talked, Arthur grabbed a Coca Cola bottle, one of the old style, eight-ounce types. He used the bottle like a ruler to measure out the approximate length, height and width of the antenna. A draftsman later made a clean rendition of the design drawn on the sack, converting the rough measurements to milimeters.

The design became the famous 37J antenna called the *Deer Horn* because of its shape. After Shanklin completed the electronic design of the unit and it was thoroughly tested, manufacturing techniques were worked out. The 37Js have been installed on the top of thousands of aircraft fuselages, usually seen above the cockpit. Shanklin held the patent on the antenna.

Moody said that several years later a patent suit involving the antenna design arose. In his court defense of Collins' rights to the original design and patent, he cited the Coca Cola bottle incident. He even was able to show the court the original paper sack with the drawing, which had been kept in company files. Collins won the court case.

John Nyquist, then a Collins industrial and manufacturing engineer, recalled he was invited to Francis Moseley's home for dinner one night, and Moseley showed him the start of a wooden model of another antenna to work with the VHF communication transmitter. *We spent most of that night down in his basement workshop finishing the model,* Nyquist said.

Moseley reportedly had a number of ideas for new aviation products, not all of them blessed by Arthur Collins. When Collins set up an operation at Burbank, California later in 1947, Moseley was sent west as the manager. He left Collins soon after that and started his own business. Eventually his firm was bought out by Hewlett Packard, and it was said Moseley became the third largest stockholder in that corporation. He once told a former colleague from Cedar Rapids visiting him in California: *When I lived in Cedar Rapids, I couldn't afford to join the country club. Out here, I could buy my own.*

Other developments from Collins laboratories concurrent with the navigation receiver were the 17L-1 communications transmitter, automatic direction finder equipment, a glideslope receiver, enabling a pilot to descend toward the runway on a radio beam, and marker beacon receiver. The latter were other key components for aircraft to make accurate approaches and landings.

Those commercial aviation products of the early 1950s were the first of a continual series of new and different types of systems which the company developed over the next several decades. The advance planning by Arthur Collins for the emerging aviation market positioned his company to be the leading supplier for a number of air transport and business flying equipment needs.

One of those equipment areas was the long range communication capability needed for trans-oceanic airline operations. That required high frequency communications, in which Collins had vast experience from early days of the company. The radio which most airlines used for that function was the Collins 18S transmitter-receiver.

By 1950 the version in production was the 18S-4. Collins was building about 15 of those units per month when Communist North Korea invaded South Korea in July, 1950, and the United States suddenly found itself involved in a war again.

The outbreak of the conflict placed an urgent demand on the U.S. Military Air Transport Service (MATS) for long-range four-engine aircraft which could fly men and materials across the Pacific. Every suitable military airplane was being used but MATS needed more, and put out a call to airlines for all the transports they could spare. About 70 were made available, not all of which had the necessary long range radios. Collins responded to that need, boosting production of the 18S-4 from 15 to 90 in one month.

While developed for commercial aviation, the 18S-4 once met a need of the U.S. Army Signal Corps for a compact, rugged, mobile radio for ground forces. To see if it could do the job, the corps tested the 18S-4 and its companion antenna loading unit, the 180K, by installing them in a Jeep which was air-dropped by parachute, roughly the equivalent of a fall from a second floor. Three test drops were made, and the radio worked perfectly after each one.

Collins Radio updated the HF equipment in 1953 with introduction of the 618S-1, a 144-channel transceiver which worked with the 180L antenna tuner. Over the next few years many airlines adopted it for their fleets.

About mid-1951 Collins began demonstrating a revolutionary new flight instrument system to airline, corporate and military pilots and aviation executives. The system had been in development for about three years.

Called the Collins Flight System, the most visible feature was a pair of cockpit panel instruments which displayed information to pilots in a clear and easy-to-interpret manner.

One instrument, the Approach Horizon, gave the pilot the aircraft attitude information required for guiding the airplane down through an overcast to a safe landing. The other instrument, the Course Indicator, provided a map-like display of the aircraft's position and magnetic heading while enroute and while executing instrument landings.

Ingenious and a major advance for their time, the new instruments comprised the first in a long series of Collins flight director systems which have served aviation since. They were key components in enabling air transports to fly routinely in adverse weather.

One of the most remembered features of the first system was how it combined a number of functions in only two instruments — basic aircraft attitude, course and heading readout, plus bank and glideslope (landing descent) information. In a conventional cockpit array at that time, a pilot had to scan six or more instruments to obtain the same information. The Collins display made a pilot's job easier and allowed him to determine flight and landing conditions much faster. Instrument panel space was saved with only two rather than several instruments needed.

The system's black boxes in the aircraft electronics rack automatically computed information displayed by the instruments for executing a smooth turn to line up the aircraft with the runway, and to compensate for cross winds.

Arthur Collins was personally responsible for much of the work and for directing development of the new instruments, spending hundreds of hours in the engineering lab and running flight tests.

He had help to be sure, from teams of Collins engineers and technicians, and considerable guidance from Siegfried Knemeyer, then working with the Air Force Aeronautical Systems Laboratory at Wright-Patterson Air Force Base in Ohio. Knemeyer, one of the German scientists who came to the U.S. after the defeat of Germany in World War II, was highly regarded as an expert in aircraft instrumentation.

Knemeyer was given much credit by Collins people for his role in the new system. In fact, Arthur Collins once wrote when asked to help recommend Knemeyer for an honorary degree: *The horizontal situation director was based on concepts suggested by Mr. Knemeyer in 1949.* But Knemeyer elected to have his role be one of consultant rather than direct involvement. Neither did he care to pursue any patent claims for his part.

Knemeyer had an interesting background as a scientist and aviator. He was born in Germany in 1909, the same year as Arthur Collins' birth. He studied physics and aeronautical engineering, and learned to fly in his teen years. After Adolph Hitler came to power in 1933 and began to build a German air force, Knemeyer taught many military officers how to fly, including future Nazi generals. In 1936 he invented a small circular slide rule computer enabling a pilot to estimate time, distance and speed when flying. It was known as *The Knemeyer,* and was long used by most European pilots.

With the start of World War II in 1939, Knemeyer had to become a German military pilot. He did not fly combat missions, but had other assignments including reconnaissance. One plane he flew was a special version of the twin-engine Junkers-88 equipped for long range. It could fly at 37,000 feet, too high to be reached by enemy fighters or anti-aircraft fire. Reportedly on one mission Knemeyer's JU-88 crew photographed a large group of British Navy and merchant ships in the Suez Canal, which led to German forces inflicting heavy losses when the ships entered the Mediterranean. Later he headed German air force technical development, including early jet airplanes. Coming to the U.S. after the war, he was allowed to be a consultant to industry on commercial projects while also working for the Air Force. He was retained by Collins as a consultant for more than 20 years.

Arthur Collins, because he performed the lead role in the design and development of the flight director system, filed as a co-patentee on both of the instruments. Co-holder of the patent with him on the approach horizon was Rolf W. Wollan, then Collins' chief pilot. He had previous experience working with instruments and hundreds of hours of flying time testing equipment for the Army Air Force during World War II.

Sharing the patent with Arthur on the course indicator was Horst M. Schweighofer, a highly regarded mechanical engineer. He also was of German birth but came to the U.S. with his parents before World War II, and was hired at Collins after the war.

Les Bessemer, then vice president of manufacturing for Collins, was not a pilot but recalled Arthur asking him to come out to the Cedar Rapids airport and see the new flight instrument system.

*He took me up in the twin-Beech, told me to take over the controls and fly the compass course. I did, and I didn't deviate much, but because we'd often gone boating together Art said, 'You've been in a boat too much. Now follow the directions on the instruments.' This time I kept my eyes glued on them and everything lined up just as he told me until he said, 'Now look up.' I looked — there was the runway stretching right out in front of us and we were just about to land,* Bessemer said.

Rolf Wollan recalled that when experienced pilots tried the new system for the first time, they had trouble trusting instruments to perform computations which they always had done mentally. *The pilot would try to out-guess the system, and he'd goof up the approach. Then we'd put someone in the co-pilot's seat who had never flown an airplane, like a radio technician who came along on the demo flight. We'd show them how to keep the instruments lined up, and they'd make a perfect approach.*

Most pilots were intrigued by the new system but it was quite different from what they were accustomed to when flying. One of the big differences was that the flight directors gave commands to the pilot rather than just providing information — in effect, telling the pilot to put his trust in electronics equipment and do as the system instructed him on an approach. As a result, it was not an immediate best seller, although it attracted wide interest in the aviation trade press. Airlines were not yet specifying flight directors as standard equipment. Initial installations of the first flight director models, the FD-101, 102 and 103, went on business aircraft. Collins sold about 400 of them in the first few years. A few of those instruments remained in use nearly 50 years later, having been switched from older to newer aircraft.

In 1954 the first air transport order for Collins flight directors came from Capital Airlines for new Vickers Viscounts, four-engine turboprops. The sale launched Collins' dominance of that market for many years to follow. Air France and Air Canada were among other early customers.

By the mid-1950s a military aircraft flight director system had been developed, based on the FD-103. President Dwight Eisenhower's four-engine Super Constellation airplane operated by the Air Force included FD-103 integrated flight systems as well as a full range of Collins communication and navigation equipment. The military version of the flight director system was called the MA-1.

With the flight instrument project well underway, Arthur had his engineers begin the development of an automatic pilot, which with the instruments would provide a complete automatic flight control system, AFCS for short.

Credited with key concepts which went into the AFCS was Walter Wirkler, an engineer who had helped Arthur on a variety of projects since he joined the company in 1934. He worked out the mathematics which made instrument approaches possible.

Also a key Wirkler contribution was the complementary filter, which he patented. The complementary filter utilized information from the localizer radio, the magnetic compass and the attitude gyro bank signals to effectively reduce undesirable radio noise and perturbations, and provide a *clean* signal for the integrated autopilot-flight director system.

Another technical innovator, a famous name in aviation, also became involved in the autopilot project. He was Dr. Alexander Lippisch, a man with a colorful and distinguished aviation background, although his main achievements occurred in Germany before and during the Hitler regime.

Lippisch, considered the father of the delta wing aircraft, was another of the noted German scientists who came to the United States after World War II. Arthur brought him to Cedar Rapids in 1950.

*That was the time we were first introducing our integrated flight system and began work on the autopilot. We needed to know about response and flight characteristics. You can't control an aircraft unless you understand response to control. He (Lippisch) was extremely helpful to us in analyzing flight response to our new systems,* Arthur said in a newspaper interview years later.

An automatic pilot system included such devices as a gyroscope and servomechanisms linked to aircraft control surfaces, along with a control, amplifier and other units. The Collins mechanical as well as electrical engineering expertise was evident in the system, providing smooth operation and keeping weight and size at a minimum.

But other than sales for Vickers Viscount and Vickers Vanguard transports flown by Air Canada, Collins was unsuccessful in cracking the airline autopilot market in the 1950s.

There was a period when autopilot sales dwindled to the point that Collins considered getting out of the business. Then a market opportunity began to develop in business aviation. In the years following World War II many of the aircraft being used in business aviation were surplus military aircraft converted for that function. By the mid-50s, however, a variety of new planes specially designed as corporate aircraft came on the scene. They also required high performance communication, navigation and flight control equipment.

The majority of the turbo-prop and jet-powered corporate jets, both U.S. and foreign makes, eventually were equipped with Collins autopilots.

Collins was the first in the industry to integrate its flight director and autopilots for a complete flight control system. That became widely accepted in the business aviation sector.

The pace of technical innovations which came out of Collins starting in the early 1950s was dazzling, considering the technical talent and man hours that went into the design and development of any new electronic product for aviation.

Flying was replacing railroads and ocean liners as the primary means of long distance passenger travel. As the commercial aviation industry grew to meet the demand, flying became more complex and more dependent upon electronic aids.

Aviation equipment became the number one product line for Collins, with more engineering talent devoted to aviation gear than any of the other Collins product lines.

Eventually, aviation products comprised half of all Collins Radio Company sales, and Collins became the largest manufacturer of aviation electronics equipment in the world.

The main factors which gave Collins its leadership role were the size and extent of its engineering effort, which led to innovation, and insistence at all levels on quality and reliability. Throughout the Collins organization and all phases of activity which went into the basic design, the development, the testing to prove the design would work and the manufacturing of a product, was an ingrained emphasis on quality. The Collins organization not only developed reliable and high performance products, but also earned a reputation of being scrupulously honest and of taking care of its customers. It was this attention to details which helped Collins equipment become known as the premier line of aviation products and which allowed higher retail prices to be charged.

Over the years Collins Radio developed extensive programs utilizing detailed statistical analysis and testing to assure the reliability of products. Any problems or failures in equipment were thoroughly investigated and remedial steps, even redesigns, were implemented.

Extensive testing was required for all materials and components. Avionics units coming off the production line were operated for dozens or even hundreds of hours, under hot and cold and vibration conditions before being considered deliverable to customers.

Another program was known as a product audit — taking a sampling of assembled boxes already approved for shipping to customers, dis-assembling and retesting them.

Arthur had his company concentrate on three market areas. One was commercial air transports, the second hardware for military aircraft, and the third business or corporate aviation. He never would get into another major market area — the field of lightweight single or twin-engine aircraft, most of them privately owned. He looked upon that market as one of lower cost products, where Collins could not compete in price without lowering quality standards, which he refused to do. After Arthur was forced out of his company in 1971, attempts made to offer products such as the Collins Microline designed for the small aircraft market showed Arthur was right. Trying to decrease quality and support standards proved incompatible for an organization driven to make its product offerings a level above the competition.

Air transport radio equipment became a unique business in that cost and price were not the driving factor as with many products. It has to meet quality, reliability and performance specifications which airlines agree to through Aeronautical Radio, Inc. (ARINC) and are required by federal regulators. Meeting such standards leaves little leeway in pricing by manufacturers. They compete mainly on features, service and reputation for performance in selling products. In many instances chief pilots decided what equipment to buy, with airline financial officers having little influence on their choice.

Despite the emphasis by Arthur on quality, he was very conscious and had a deep awareness of costs which went into a product. Engineers remember product review sessions where Arthur cautioned them to *avoid those gold brick components* in their designs.

By 1954, only eight years after Collins offered a commercial aviation product line of just 10 equipment types, all of them communications units, the company could boast of having a full complement of communication, navigation and flight control systems for air transport and corporate aircraft.

They included both HF and VHF communication radios, VOR navigation, glideslope and marker beacon receivers, automatic direction finders, three versions of Collins flight director instrument systems, the recently developed automatic pilot, magnetic compass system, a number of aircraft antennas with antenna couplers and about a dozen types of ground station radios for aviation.

In many instances, aircraft have two of each type of equipment installed, assuring that one always functions if a problem occurs.

More Collins equipment than that of any other company competing in aviation electronics was being purchased and installed on the world's air transports, except those of the Communist bloc nations.

The company estimate was that 75 percent of air transports had Collins equipment aboard, some aircraft almost completely Collins-equipped, others with varying mixes of Collins and competitor equipment. The 75 percent Collins equipment figure would continue or even increase through the 20th century.

In addition there was the growing executive, or business aviation fleet, mostly high performance twin-engine aircraft maintained by corporations and flown by professional pilots. Companies used those to provide transportation for busy executives, to haul vital cargo, and because they could be based at or fly to airports which had no commercial service. The number of business aircraft grew to about one and one-half times that of airline aircraft in the 1950s, comprising a major market for Collins. The medium to heavy twin-engine planes had to be equipped similarly to air transports to land at major air terminals, and to fly a wide variety of routes.

Eventually Collins had a network of nearly 90 aviation equipment dealers around the U.S. handling its avionics gear for general aviation.

The origins of electronics equipment on aircraft have been based on safety needs, the desires of pilots, airline officials and aircraft manufactuers for specific equipment, government agency decree, or adapting military equipment for civil aviation.

But Collins as well as other manufacturers have come up with ideas for equipment. Some have been highly successful, such as the Collins flight directors. Another product which originated with Collins in the early 1950s looked like a very desirable system, but was far ahead of its time. It was the NC-101, NC standing for navigation computer. The heart of the system was an analog computer, one of the first computers built by Collins. The intent was to provide a pilot with all the reference data needed to navigate from a departure point to a specific destination on VOR routes, utilizing a technique known as area navigation. The data was contained on punched cards, fed into and read by the computer, then displayed on cockpit instruments. It is believed that only three of the systems ever were sold, all for private, corporate aircraft. Area navigation did not become a viable aviation technique until about 15 years later.

Around 1950 a new word began to be used to describe aviation electronics equipment.

The word was avionics, derived from aviation and electronics. Several persons have been credited with originating the word. One of them was Philip J. Klass, longtime senior avionics editor of the prestigious Aviation Week & Space Technology magazine, also well-known as a critic and author for his debunking of UFO claims. *I did not coin the term avionics,* Klass said, but he explained how it came about.

Around 1948, McGraw-Hill Publishing Co. merged three aviation publications into one which was named Aviation Week and Space Technology. The advertising manager of the new magazine, Robert Martin, who later became AW publisher, sought to have aviation equipment firms such as Collins, Sperry Gyro, etc., run ads in Aviation Week. That brought a protest to top management from the publisher of another McGraw-Hill magazine, Electronics, who thought those firms should give preference to his publication when running ads. Electronics, however, was devoted to a more general content than Aviation Week, which was designed to appeal to readers in the aviation and aerospace fields.

To get around the dispute, still get his publication off to a good start and position it as different, Martin came up with the word avionics to describe subjects being covered in Aviation Week. Klass said when he joined AW as a writer in 1952, he was forbidden to use the word electronics. *If Texas Instruments introduced a new transistor, it was an 'avionic device.' If IBM introduced a new digital computer to handle company payrolls, it was an 'avionic system.' Similarly, editors of Electronics were forbidden for many years to use the word 'avionics'.*

Klass said. Thus avionics came into being and eventually became a dictionary word to describe aviation electronics. Klass, incidentally, was born in Des Moines, graduated from high school in Cedar Rapids and earned an engineering degree from Iowa State College.

As Collins built up its engineering staffs, it turned out a continuous flow of new and improved avionics products to replace existing models. Some critics referred to the practice as *accelerated obsolescence*, but more accurately most new products reflected the rapid advances in electronic technology such as smaller tubes, new components and materials, and in time transistors and other solid state devices. They were meant to be responsive to the continuing demands of aviation for products of lighter weight, smaller size, increased capability and reliability.

It also was a prudent business practice to prepare for the future, as when Collins had a new line of equipment ready for the first commercial jet airliners of the late 1950s. In addition, specialized lines of equipment were developed for various classes of business aircraft.

W.W. (Bill) Roodhouse, who had an avionics background and became the No. 2 company executive under Arthur in 1965, said this: *We had to anticipate what the airlines would need because it took two to three years to develop products, and they had to be available when customers were ready for them.*

Roodhouse, while not a development engineer, was a major force in helping build up Collins' overall avionics capabilities. He was an electrical engineering student at Oklahoma University when World War II broke out, then joined the Navy, which allowed him to do further studies at UCLA and MIT. He served as chief communications instructor for Naval Air Stations at Hutchinson, KS and Minneapolis. During that time he made trips to Cedar Rapids to learn about equipment being built by Collins for the Navy, and became acquainted with Arthur Collins. After the war, Roody, as he was known, was communications director for Chicago and Southern Airlines. He joined Collins in 1953, built up the company's field service operation, and was appointed manager of aviation sales in 1955.

On June 30, 1956, the most casualties in the history of U.S. aviation to that time resulted when two airliners collided in mid-air over the Grand Canyon of northern Arizona and crashed. The planes were a TWA Super Constellation with 70 aboard and a United DC-7 with 58 aboard. Both had taken off from Los Angeles, heading east. Both were at about 20,000 feet altitude.

The tragedy pointed up the growing air traffic congestion on the nation's flight pathways, and immediately brought widespread demands for action on some type of system to prevent aircraft collisions. It was not, of course, the first time such demands were voiced or that serious consideration was given to the problem. In fact, the Air Transport Association (ATA), comprised of the nation's airlines, had concluded a major study a year before and provided electronics equipment manufacturers with an analysis of collision problems and requirements for a solution. Many observers then believed technology had advanced sufficiently that a workable system, even though expensive, could be developed.

Collins was one of the companies selected to submit proposals for a system. In September, 1956, ATA announced Collins had the *most satisfactory* of the various proposals, and teams of Collins scientists and engineers began intense efforts to convert theories into hardware.

Collins said it hoped to have equipment ready in two to four years. In anticipation of a successful system, most major airlines placed orders to be sure they could equip their fleets as soon as possible. The planned purchase by United Airlines alone was valued at $1,750,000. The total of all orders exceeded $10 million, covering about 900 systems.

But as they moved deeper into the program and attempted to solve many technical obstacles, Collins managers realized that existing technology would not allow them to achieve their goals. In months of consistently trying, equipment designed and tested to return signals from targets did not prove sufficiently reliable to always warn a pilot of another plane approaching from the front, rear, right, left, above or below.

From the beginning of the project Arthur Collins had not been enthusiastic about it. Colleagues said he felt he had to let the company go along with it because of industry pressure and the urging of the Air Transport Association.

John McElroy said it was *a holiday morning — a lot of things seemed to come to a head on holidays,* when a final decision to end the collision avoidance project was reached in a meeting that included himself, Dr. Dave McCoy, then head of research, and Arthur Collins.

*Art concluded, 'it is not the right time to do this. We'll give the airlines their money back and postpone it'.*

*In doing that, he demonstrated the very essence of Collins Radio,* McElroy said.

Joe McCaddon, who in later years headed Collins avionics marketing, then was working for Pan American Airways. He recalled some of the industry reaction when Collins shut down the collision avoidance project. *People could hardly believe a company would do a thing like that — admit it was wrong and give money back,* McCaddon said.

Announcement of the program termination was made in January, 1957. The company did refund the money, and the decision proved to be correct. In years that followed, Collins and other parties continued to investigate the problem, without achieving an effective collision prevention system.

But numerous other steps soon were taken by the Federal Aviation Agency and aviation industry to improve safety in the skies. One of those was requiring control and monitoring of air traffic throughout the country with ground based radar surveillance. The Collins Dallas Division played a major role in that program, providing microwave communications links between air traffic control radar stations.

And two new avionics systems, distance measuring equipment and transponders, soon came on the scene to further enhance safe flying.

From the time it got heavily into avionics, Collins always had engineering teams working on both commercial and military equipment. In most years a majority of Collins' sales and income came from government contracting. Military avionics products comprised a large share of those sales.

One product which followed the AN/ARC-27 UHF communications transceiver was the AN/ARA-25, a UHF automatic direction finder system. It was the highest production quantity radio in the history of Collins, with nearly 100,000 of them built. They were installed on nearly every U.S. military airplane.

In the early 1950s Collins began a program which produced major benefits to military aviation and major contracts to the company. That was a time when new, high performance aircraft such as the McDonnell F2H, forerunner of the famous F4 Phantoms, were entering the Navy and Air Force inventory.

The program was known as CNI — a functional designation for communication, navigation and identification. The latter refers to electronic identification, enabling a Navy carrier or military airport to know if the aircraft is friendly and what type it is. CNI systems comprise a major part of required avionics on military aircraft.

The name, however, did not describe what a CNI system represented in new technology, particularly for single pilot fighter or two-place aircraft, which have limited space for electronics gear. Until the system was developed, individual units of varied sizes and shapes had to be fitted into an airplane the best way possible. Much of the equipment available at the time was larger and heavier than desirable, and was not designed for the rigors of a jet installation. Heat from jet engines and vibration created special problems for radio gear.

The CNI system changed that with advanced new equipment to operate in the environment of the jet aircraft. Collins engineers worked with airframe engineers to design gear to fit into the tight space confines of nose and fuselage equipment bays.

Collins' objective was a commonality of design and flexible packaging for equipment of varying functions, sizes and shapes. The base unit was a module consisting of circuit boards and components, encased in a lightweight aluminum frame. These were attached to a chassis with an appropriate cover for pressurized or non-pressurized operation, with several equipments placed side by side on special shockmounts. The building block and flexible packaging approach resulted in equipment that met the high reliability performance requirements of the new jets and offered reduced size, lighter weight, improved resistance to shock and vibration and easier installation and maintenance. Manufacturing economies also resulted for Collins with the commonality technique.

Another highly important engineering breakthrough came in finding ways to have equipment be maintained at proper operating temperatures. Those included dissipating heat generated by electronic components, and having to perform reliably in the jets' high temperature environment, sometimes well over 200 degrees Fahrenheit.

The experience of Dr. Alexander Lippisch and his Aeronautical Research Laboratory staff proved valuable in designing CNI techniques providing a carefully controlled level of forced air cooling.

Collins ended up literally capturing the CNI market in the Navy and Air Force for a number of years, having far more work than its competitors.

A CNI complement included radios, amplifiers, antenna couplers and other units in equipment bays, and control units and instruments in the pilot compartment.

Dozens of humorous stories have been told involving the work and people involved in Collins avionics equipment.

Bob Cattoi, a key engineer on CNI and who later headed Collins computer development, remembered a civilian who monitored Collins work on Navy programs in days when radios still had knobs and meters on the outside.

*He was a dial twiddler, who could not resist trying out every knob and switch. We sometimes put some extra knobs on the lab models which didn't do anything but were just for him to twiddle. I don't think he ever caught on that we were pulling his leg,* Cattoi said.

For a time in the 1950s Collins leased a DC-3 aircraft used in equipment demonstrations. One trip was to Long Island. Rolf Wollan did the flying with John McElroy explaining systems to the customers.

As they completed their business, it looked like they would fly back to Cedar Rapids with McElroy the only passenger. McElroy saw that as an opportunity to buy a canoe from the Grumman company of Long Island and haul it back to Iowa. DC3s, of course, were fairly roomy, serving as cargo aircraft during World War II and having 20 or more seats when used as commercial transports. Even though the DC-3 had a fairly wide door, getting a canoe into the airplane was difficult and it was a tight fit once inside. It rested atop seats from the front on one side to the rear on the other side.

Just before the aircraft was ready to take off from Long Island, Wollan got a call to stop in Washington, DC and pick up three company executives needing a ride back to Cedar Rapids. They were Morgan Craft and Robert Gates, vice presidents, and John Tuthill, an assistant vice president. Having to share space with a canoe, the passengers found the normal comfort of an executive aircraft quite limited on the flight west, particularly Tuthill, a very tall man. The struggle to get the canoe out of the DC-3 on the ramp of the Collins hangar was as difficult as loading it and attracted an audience, some of whom offered not altogether helpful suggestions.

Collins had a number of types of aircraft in its corporate stable over the years for equipment testing and transportation, including the DC-3.

Twin Beechcrafts, more advanced versions of the first plane acquired by Collins, were workhorses of the Collins fleet. They proved to be well adapted to avionics testing and as transports, able to fly about 200 miles per hour with a 1,000-mile range, carry up to seven passengers, and were relatively economical to fly.

Along with the first twin-Beechcraft, soon after WWII the firm also had a single-engine Beech Bonanza, owned by Arthur, and a war surplus single-engine Consolidated Vultee Navy trainer. Other aircraft in the Collins fleet at various times included Beechcraft twin Bonanzas and an Aero Commander 560.

Around 1960 the firm owned a Convair, similar to airliners of that period, outfitted as an executive aircraft. The plane had a special panel in the rear of the cabin which duplicated all of the instruments and controls found in the cockpit. In the mid-60s the first of two Grumman Gulfstream twin-turboprop executive aircraft was acquired. The Gulfstreams and four twin Beechcrafts comprised the fleet in the last few years Arthur Collins remained in charge.

Soon after Collins opened a plant at Dallas in 1951 and leased a hangar, first at Red Bird and later at Addison Airport, regular flights between Cedar Rapids and Dallas by company planes became routine.

Arthur Collins piloted both single and twin-engine aircraft for many years, but tapered off that activity by the late 1950s. Arthur had the final say on types of aircraft the company purchased or leased. He always kept a close watch on flight operations and was informed of the flight and maintenance schedules and destinations of all aircraft, as well as daily lists of crews and passengers. The flight operations people had to manage the fleet with a great deal of flexibility to serve multiple needs. Engineers needed hundreds of hours of flight time to test equipment, and marketing departments often requested demonstration flights for customers. There also were regular and special passenger transportation needs, and flights to pick up electronic parts for critical projects or make special equipment deliveries.

Then there was always the possibility of having to fly Arthur someplace, often on very short notice. And between all flight needs downtime had to be provided for aircraft repairs and maintenance and new equipment installations.

Collins aircraft were, of course, equipped with the most up-to-date avionics equipment of any civil aircraft in the world. Even the relatively small D18 and E18 twin piston engine Beechcrafts, which could carry up to seven passengers and a crew of two, were outfitted better than many air transports.

Collins pilots flying the twin Beeches, relatively small aircraft compared with airliners of the mid-1950s, sometimes were questioned by aircraft controllers in those days about the advanced equipment they carried. Some controllers appeared to have trouble believing the craft had gear such as weather radar, DME and transponders when only a few airliners had such advanced systems, until the pilots explained they were from Collins Radio which made the equipment.

Military avionics as well as non-avionics communications and data equipment was tested on the aircraft. The Collins planes were meticulously maintained. They were flown by highly qualified pilots who also helped test equipment and demonstrate it to customers, and who had excellent safety records.

When Collins obtained its first twin Beechcraft in 1945, an arrangement was made to have off-duty pilots from Braniff Airways, based in Dallas, fly the plane. But in the next two years the development of airborne equipment increased significantly, and engineers became impatient waiting for Braniff pilots to arrive in Cedar Rapids and run test flights. They began to call more and more upon Rolf Wollan, a Collins engineer who also was an experienced and licensed twin-engine pilot, to fly the aircraft. Wollan had learned to fly in 1940 at North Dakota State College, where he earned his EE degree. During the war he began working at Wright Field in Ohio as a radio engineer, under Francis Moseley. In 1943 he joined the Army Air Force and was assigned to Wright Field as a test pilot in the radio section. Wollan said that after being discharged in 1946 he was driving back to North Dakota and stopped in Cedar Rapids to visit a friend. Learning that Collins was hiring engineers, he applied and was offered a job. With Collins soon getting into the VOR receiver flight tests, he found himself flying almost full time.

In 1947 he was named the first full-time Collins pilot. Wollan remembered flying a lot with Arthur in those days. *Art was a very good pilot. When it came to work, Art was a taskmaster. Sometimes we would fly all night. And there were times with no advance notice when we would take off and be gone for two weeks. But the company was a fascinating place to work — always on the cutting edge of everything*, Wollan said.

*We (himself or Clayton Lander, another Collins engineer-pilot) went around on a lot of demos to airlines — from LAX (Los Angeles) to New York, also to Seattle, Atlanta, Miami and other places. Clayt did much of that. When we went to New York, we'd land at LaGuardia, then fly over to Idlewild (later named Kennedy Airport.) Idlewild had an ILS (instrument landing system). We'd shoot approaches and landings at Idlewild — there was little or no traffic in those days*, Wollan recalled.

Another of his remembrances involved the Korean War. *When it came on, the Navy and Army were literally begging Collins for all the equipment it could turn out. We flew trips to Chicago almost every day to get parts to keep assembly lines running.*

Wollan later was transferred to Dallas, and others including Bill Stephens succeeded him in supervising the Collins aircraft fleet.

In 1959, Arthur hired Harvey N. Hop, who had just retired from a distinguished Navy aviation career, to head flight operations. Hop was a decorated veteran of Pacific bombing and other missions during WWII, had been a Navy test pilot, headed electronics testing projects and had flown dozens of types of aircraft. One of Hop's assignments was to make the Collins flight operations a model for corporate aviation. He also flew thousands of hours and did extensive flight testing on new generation flight directors and autopilots, Doppler navigation and other systems. He was highly respected for the way he ran flight operations and in helping develop new equipment. But he left the company in 1967, feeling he had been made the victim of an unpleasant incident involving travel arrangements for a member of the Collins family. Like many other Collins alumni, Hop fared well. Within a few years he founded Hop-A-Jet, a Lear Jet charter service at Fort Lauderdale, FL, and flew many notable people to points around the world. He also compiled the most flight time of any pilot in Lear Jets, more than 22,000 hours.

Clayton Lander was the next to assume responsibility for flight operations. He had been an Army Air Force pilot during the war, much of the time at an air base at Liberal, KS, instructing others how to fly the giant B-29 bombers. After the war he completed work for his electrical engineering degree at Iowa State College. He joined Collins in 1947 as an engineer and pilot. Lander had a long tenure as a Collins pilot, and a record in miles flown. He earned several

Meritorious Safety Awards from the National Business Aircraft Association for consecutive accident free air miles. One cited him for 983,000 air miles, covering approximately 5,000 flight hours.

Also chief pilot for a number of years was Richard J. Johnson. He, too, had military flying experience as a Navy pilot and though he was an accountant, he elected to pursue flying as his career.

Another military program for which Collins made leading contributions was TACAN, standing for Tactical Air Navigation. The TACAN system provided pilots with bearing information obtained from ground transmitters, and also computed the distance of the aircraft from ground stations at a range up to about 200 miles. Under what remained a classified program until the mid-50s, Collins developed the airborne TACAN set, AN/ARN-46, which was widely used in military aircraft.

The civil VOR navigation network, which at first offered only bearing information, was in need of having a type of TACAN distance measuring capability as well. That would tell pilots their exact positions relative to VOR stations and airports, important for safety as aircraft numbers and speeds increased. With only the VOR navigation signal to rely upon, pilots had to estimate distance. By 1957 VOR ground stations were being modified to provide the new dual capability, called VORTAC.

Anticipating the move, and utilizing TACAN experience in the development, Collins soon introduced its first airborne distance measuring equipment, the 860E-1.

A DME airborne unit sent pulses to ground facilities which received the signals and automatically transmitted a reply. The aircraft DME computed the distance by measuring time between pulses sent and received, and displayed that information to a pilot in nautical miles, shown on a small cockpit instrument. The accuracy of DME in measuring distance was within two tenths of a nautical mile. DME was one of the more electromechanically complex units in the avionics rack, in part due to the stringent accuracy and reliability requirements. In 1962 Collins developed a more advanced solid state unit, the 860E-2, followed later by the 860E-3. The development group was headed by Keith Fletcher, with Bruce Majerus and Ed Tuthill among the key engineers.

Another new and vital avionics system which became necessary in the late 1950s was the transponder, filling a need similar to the identification function of the military CNI package.

A transponder is the aircraft electronic box which responds to ground-based air traffic control radar, enabling controllers to track an aircraft on their radar scopes despite rain clouds and ground clutter. It works by automatically replying with a coded signal when receiving a signal from ground radar sweeping the skies. Transponders enable control centers to follow and identify all aircraft in their sectors, knowing their location, heading, speed, altitude and type of aircraft.

DME and transponders were significant new avionics systems helping improve air safety when commercial aviation was experiencing big growth in numbers of aircraft and larger, faster, higher flying jet aircraft.

Collins Radio dominated the DME business, equipping nearly 90 percent of air transports and also saw its 621A-2 transponder become the choice of most airlines.

One of the major advances in the history of radio occurred in the 1950s when Collins shrunk high frequency single sideband communications equipment to a size which made it practical for airborne and other mobile uses.

The top avionics priority was HF/SSB radios for the Strategic Air Command. Collins did that with the AN/ARC-58 transceiver, installed in all B-52 bombers and KC-135 tanker aircraft. It had a frequency range of 28,000 channels and 1,000 watts output power. Single sideband allowed SAC to have reliable communication with its aircraft any place in the world, even polar regions. It was an important asset for the U.S. in the midst of the Cold War.

In 1960 a HF/SSB radio was ready for the commercial market. It was the 618T transceiver, with 28,000 channels and 400 watts transmitting power. It delivered greatly improved long range voice communication, especially important on overseas flights. The 618T became a versatile radio for many mobile military as well as commercial applications. Thousands were built by Collins.

Among other avionics products of the 1950s, Collins sold a number of VOR ground station transmitters to airports, airlines and the government. The company also developed its version of airborne weather radar, equipment which helps pilots to see and avoid intense storms. The Collins radar was a C-band. It sold well for business aviation but saw limited use by airlines, as they mostly preferred what was called X-band radar.

Another system which had considerable success was Doppler radar navigation. When jet transports flying at higher altitudes and faster speeds came along, Doppler was seen as a desirable navigation technique for those aircraft, particularly in flying across oceans which had no surface reference points. The technique was based on the scientific effect known as the Doppler shift, with aircraft equipment directing three microwave beams toward the earth at different angles. Energy reflected back from the signals was used to compute the aircraft ground speed and drift angle, enabling the crew to maintain the planned flight path. Collins leased a Convair 240 aircraft which could fly at 30,000 feet altitude for Doppler tests. Among early users of the system were Trans Canada and Iberia Airlines.

By the late 1950s the flight director systems conceived by Arthur Collins and his engineers 10 years earlier had gained acceptance as essential for flying. Numerous modifications had been made in successive models to add features and improvements, up through the FD-105/107 series. Starting with the first commercial jets placed in service in 1958, Boeing 707s, flight directors became standard equipment.

The jet fleets grew rapidly, in numbers and types of aircraft. In 1961 carriers were contracting for new Boeing 727s. Sensing a big new market in flight director systems for the jet era, and the continuous move toward lower minimum ceiling requirements for landings in which flight directors played a key role, Collins began showing a radically new flight director system to the airlines.

The new system consisted of two four-inch-wide instruments, a flight director indicator and a course indicator. The flight director indicator in effect provided a three-dimensional presentation, and for the first time made extensive use of color in a display on the aircraft instrument panel.

What a pilot saw was an orange delta wing symbol, representing the airplane. Behind it was a moveable tape background, blue for sky and black for earth or approaching runway, separated by a white line, the horizon. Tape movement indicated a change in pitch or roll of the aircraft. Between the orange delta wing and tape were yellow bars, resembling a wide inverted letter V. The V bars moved when directed by a computer, serving as commands to the pilot to fly the delta wing into the V bars to make pitch and roll corrections. Also displayed during landings was localizer and glideslope information, and a runway symbol for lining up with the runway, which moved up under the delta symbol as the aircraft touched down.

The pattern which made any new avionics system acceptable to the aviation industry usually was based on finding a major customer who decided they liked it, wanted it and would take the bold step of placing the first order. Then others who were interested but wanted someone else to be the first to try it would fall into line. That was the case with the new flight director.

The first major airline to adopt it was TWA, and that opened the door to most other carriers ordering the new systems, both for new aircraft on order and to retrofit many existing aircraft.

As the Collins engineering and marketing people showed their new concept to airlines, many changes were suggested, and many revisions were made in demonstration models. It quickly became apparent that every airline wanted a different version. A long list of persons contributed to the Collins effort to respond to what each customer wanted. Three of those credited with key roles were Harry Passman, directing mechanical engineers, Ed Fritze, whose engineering division was responsible for flight directors, and Harvey Hop as chief pilot. Fritze, a Collins vice president, had long been a valued and trusted associate of Arthur Collins until his death in a 1970 auto accident.

*We had to develop a bag of tricks to be able to supply all the variations,* was how Engineering Vice President John McElroy described it. Collins eventually built more than 40 versions of the basic V-bar presentation, all precision instruments manufactured in a clean room environment. The four-inch flight director system was the FD-108. A five-inch model, the FD-109, soon followed. Many of those flight director systems remained in use on aircraft well into the 21st century.

Being able and willing to do what the customers wanted made the prediction of a big surge in flight director sales come true for Collins. Yearly sales increased from $2 million in 1958 to $20 million in 1966, and continued to grow.

After much effort to get the Air Force to see the benefits of the FD-109, Collins realized major sales for military aircraft, including the entire SAC KC-135 tanker fleet. B-52 bombers eventually were equipped with FD-109s. Even the space shuttle had a version of a Collins flight director aboard.

From the time the Wright brothers, who incidentally had lived in Cedar Rapids briefly as small boys, made the first successful powered aircraft flights, technology brought continuous advances in airplanes and airports.

But the one bugaboo which hampered flying for many years was weather. World War I movies showed pilots waiting for a patch of blue sky in order to fly. Airmail pilots of the 1920s and 30s either did not fly or took a chance of finding a hole in the overcast to land safely.

With the advent of commercial air travel, flight cancellations and delays because of weather became an economic problem. They were extremely costly to airlines.

The answer was an instrument landing system (ILS), using radio signals between electronic equipment both in an aircraft and on the ground to make a safe descent through clouds and be lined up with the runway for landing. The military started working on such systems in the 1930s. The first civil ILS was placed in use in the early 1940s, at only a few major airports and by only a few airlines. It provided three signals. One indicated if the aircraft was lined up with the runway for an approach (the localizer); the second indicated the proper angle of descent (glideslope), and the third was the marker beacon — a radio beam indicating when the pilot crossed a point a fixed distance from the end of the runway, a point from where final descent to the runway began.

The VOR system which came along about 1948 added another capability, utilizing ground radio signals to follow a desired flight route and direction to an airport. The Collins 51R navigation receiver was widely used in implementing VOR.

Then Collins introduced its flight director system, combining all VOR and ILS signals on two instead of several instruments, and giving the pilot electronic *commands* to execute proper maneuvers for landing safely.

In retrospect, it could be seen that what Arthur Collins had in mind with successive models of flight directors combined with automatic pilots was a building block approach to ever lower landing minimums.

By 1960 many aircraft had the capability of what were called Category I landings — a cloud ceiling at least 200 feet high and one half mile horizontal visibility. That meant, under those conditions, when the plane broke through the overcast, the pilot could land the aircraft as he would in clear weather. The pilot still made the final decision on whether to land, however.

The next objective was Category II — a 100-foot ceiling and visibility of one quarter mile. That required the equipment for Category I plus additional electronics, one being a radio altimeter for precise determination of the aircraft altitude during landings. Collins worked with various airframe companies to have their aircraft certified for Category II. Among the first were the Jet Commander, a twin-engine jet aircraft, and Collins' own twin turbo-prop Gulfstream I.

The final step which aviation sought was Category III, zero ceiling and zero visibility. The capability was attained eventually as Collins worked with air transport and business aviation operators and manufacturers. Another key requirement, besides aircraft electronic equipment, was proper ground equipment installations at airports.

Despite the availability of Category III capability, it has been used sparingly in commercial aviation. Airlines have remained reluctant to completely trust hundreds of passenger's lives to electronic systems, and few airports have ever been equipped for it.

While Collins supplied more flight control systems which included autopilots for business and general aviation aircraft than any company did for air transports, it was unsuccessful in having its systems on the first commercial jets, primarily Boeing 707s and Douglas DC-8s. It was said the big airframe firms rationalized that Collins lacked field experience in big airplane systems or did not understand the dynamics involved. Also a possible contributing factor in that may have been the strong personality of Arthur Collins. He had his own ideas of what a transport autopilot should be like, while the airframe people had their own ideas.

Most of those first jets, however, were loaded with other Collins equipment — communication, navigation and flight director systems.

In the late 1960s Lockheed Aircraft, builder of the huge C-141 and C-5A military cargo jets but away from the commercial transport business since the 1950s, announced plans to re-enter the market with a new three-engine wide-body jet. It would offer a number of advanced features, including an automatic flight control system (AFCS) for all-weather landings. The aircraft was designated the L-1011 TriStar.

Joseph F. McCaddon, then Collins avionics marketing vice president, recalled the L-1011 program attracted all major avionics suppliers including Collins. *About that time Bill Roodhouse was speaking for Art Collins when he said, 'it's time for us to get on a big airplane.' The only program available at the time was the L-1011. The DC-10 was not yet ready. So the decision was made to go after it and that was the start of an all-out effort,* McCaddon said.

Despite its extensive avionics engineering capability, Collins lacked some specialized expertise that would be needed for the advanced technology system which Lockheed had in mind. The solution was to team up with Lear Siegler, Inc. of Santa Monica, CA, which had wide experience in a number of related areas including military blind landing systems.

*It turned out to be very important, too, that Lear Siegler was part of the West Coast aviation community, and that gave us a presence we needed there,* Joe McCaddon said.

The Collins-Lear team was chosen to work with Lockheed to develop the avionics flight controls, with Collins as the prime contractor. Ed Fritze was the senior engineer directing the program, which came at the time of Arthur's massive C-System computer effort. While the C-System did not turn out as planned, it did produce advanced circuitry and new computer technology applied to the avionics equipment.

The L-1011 AFCS was truly the most advanced system ever installed on a civil jet transport, coming after three years of development and thousands of hours of testing and simulations. Functions of the AFCS included control of the speed and stability of the the aircraft during flight. It was referred to as a dual-dual system, in effect having two autopilots — one for operation and one for backup during normal flight or cruise mode, and the availability of four autopilots during landings.

The system could provide *hands off* automatic landing, with the pilot moni toring but not touching the controls. Its performance was described as *outstanding* by Lockheed and airline test pilots after initial test flights.

While the AFCS was a big success, the L-1011 ended up competing against the Douglas DC-10 and met with limited acceptance among the world's airlines. The DC-10 had a Bendix flight control system and the huge Boeing 747, also a new aircraft of that era, had a Sperry system. Ironically, the Collins-Lear Siegler AFCS on the L-10ll was the only one to achieve a Category III rating as part of the basic certification program.

The project did, however, help Collins Radio get into future air transport automatic flight control system business. It was a step toward equipping new Boeing aircraft with even more advanced systems later in the 1970s. Arthur Collins was no longer in charge of the company by then, but his early work and direction helped make those achievements possible.

Through the years Collins continually upgraded the primary military aircraft radios, and remained the leader in providing communications gear for Navy and Air Force aviation. The AN/ARC-27 UHF transceiver of Korean War vintage was succeeded by the AN/ARC-51 and 52 and about 1970, the AN/ARC-109.

In the HF area, successive military versions of the 18S were used on many Navy and Air Force aircraft. Another highly successful HF transceiver was the 618S-1, introduced in 1953. It provided 144 channels compared with the 20 channels of the 18S, and was used extensively on both commercial and military aircraft until the single sideband AN/ARC-58 development.

While Collins Radio was not the only company involved in high frequencv radio, its dominance in that area was an accepted fact. Most competitors were highly reputable, competent firms, but there were occasions when other companies tried to get into the HF business with costly and unrewarding results for the Pentagon and taxpayers. One example involved an Air Force jet bomber where the airframe manufacturer succeeded in having its electronics division win the contract for the HF radios. The bomber was built and became operational. But even after several years while the company sought and received more money to fix problems with the radios, they failed to perform as promised. The cost of the radio program reportedly climbed to $52 million. A senior Air Force officer literally put his career on the line to have the program ended, despite the company's political clout, and finally won his case. A contract of about $3 million then was awarded to Collins to retrofit the bombers with 618T HF/SSB transceivers. After one of the first test flights with the 618T, an Air Force communications officer told a Collins engineer: *That's the first flight ever made by one of these planes where the HF radio worked as it's supposed to from start to finish.*

Just how extensive the Collins penetration of commercial air transport avionics became could be seen in a chart which was compiled for the year 1970.

The equipment use covered 15 types of aircraft flown by the approximately 125 U.S. and foreign airlines then operating, except those of the Soviet Union.

Types of Collins equipment and the number of airlines using them included:

ATC Transponder, 91.
Radio Altimeter, 44.
Automatic Direction Finder, 84.
High Frequency Communication Transceiver, 72.
VHF Communication Transceiver, 51.
Distance Measuring Equipment, 118.
Flight Director Systems, 81.
VOR/ILS Navigation Receiver, 98.

Another activity pursued by Collins which utilized the firm's C-System technology was area navigation. Its engineering and marketing people saw area navigation as enhancing the accuracy of other navigation methods. An advanced system called the ANS-70 was developed under the direction of George L. Benning, engineering vice president. The system received certification for use in then new wide-body DC-10 transports, but had only limited commercial success. However, it became an outstanding system for certain military operations such as search and rescue missions. The equipment included a 4-by-6-inch CRT display screen and a small C-System computer. Tied in with an autopilot and other avionics, the system allowed an aircraft crew to fly a grid pattern consisting of accurate passes approximately a mile apart back and forth over an area of ocean.

Collins also offered another advanced technology system called inertial navigation, which utilized gyroscopes, accelerometers and computers. It was a system providing highly accurate navigation on long range flights without the need for ground stations as reference points. Collins did not make the *platform* as the gyroscope part was called, but provided and coordinated the other system components. During development and check-out its accuracy was demonstrated on numerous short and long range test flights.

Another avionics instrument developed by Collins was, in Harvey Hop's estimation, *one of the greatest little tools we ever invented.* It was the Peripheral Command Indicator, or PCI, consisting of two small glass tubes, one inside the other. They had black lines on them to create a white diamond pattern which moved up, down, right, left and combinations such as down and right. The PCI was about 7-1/2 inches wide and 1-1/2 inches high and mounted above the flight director units on the instrument panel. The PCI was intended to utilize a pilot's peripheral vision to notice the diamond pattern movement even while his eyes were glued on the flight director during critical stages of approach and landing. The movement of the PCI indicated a pitch or roll change moving the aircraft off course, and requiring a correction to comply with the flight director commands. Despite the ingenuity of the unit, it was shunned by most airlines, but was installed in a number of corporate business jets.

In the last few years before 1971 when Arthur Collins was deposed as head of his company, the firm had started adapting its avionics expertise to the emerging field of satellite communications. One major program was TACSATCOM (standing for tactical satellite communications) involving the three major U.S. military services. It included development of airborne as well as shipboard, vehicular and manpack equipment utilizing satellite radio links.

The Collins Radio avionics story had its beginning in the early 1930s, when Arthur Collins saw the opportunities which lay ahead in the growth of aviation. From that he created an engineering, testing and manufacturing capability which made his company the world leader in avionics.

# Chapter 10
# SINGLE SIDEBAND — HEROIC ACHIEVEMENT

It did not take long for Arthur Collins and the Collins Radio Company to become one of the preeminent firms of the world in the field of high frequency (HF) radio.

From the early 1930s the innovative, high quality, reliable HF equipment made by Collins was in demand for a broad range of applications.

The 1934 Byrd Expedition broadcasts from the Antarctic, using a Collins 20B transmitter, gave the company wide ranging recognition as a leader in HF.

The success of the Byrd equipment brought a spurt of new business to the small Cedar Rapids, Iowa radio manufacturer. There soon was a growing list of customers including other exploratory missions, airlines, oil and pipeline companies, fishing fleets, large agricultural plantations, U.S. and foreign government agencies and military services, and of course ham operators. The latter were Arthur's first customers, and very important to him.

The HF band radio frequencies are well suited for medium to long range communication with minimum amounts of transmitting power. From the early days of radio many applications were made of the HF band, causing it to become widely used throughout the world and highly congested by the 1940s. Concerns were heard within the communications industry that high frequency faced a limited future because of the growing congestion.

HF also is known as short wave. While it often works well, it is subject to fading out and static due to a variety of reasons including atmospheric conditions. Sun spots can cause major disruptions.

The term "propagation" is used to describe short wave transmission conditions. Studies and predictions are made daily on propagation conditions that can be expected, and which HF frequencies will work best for varying conditions of day and night. Collins Radio Company did much to enhance the accuracy of propagation predictions.

Transmitted HF signals travel out from earth and on reaching the ionosphere in the earth's upper atmosphere, are bent and refracted back to earth.

That makes HF work well for long range communication. The signals are not lost in space because of the curvature of the earth as are line-of-sight signals in the VHF and UHF frequency bands. With sufficient transmitting power and multihops from earth to ionosphere to earth, etc., HF signals can travel around the globe.

Early in the 20th century a Bell Laboratories mathematician discovered the radio wave actually consisted of three parts. One part was called a carrier wave. The other two are called sidebands, which came to be known as upper and lower sidebands. Conventional high frequency amplitude modulation (HF/AM) signals consist of all three parts.

Because all of the voice information in the signal is carried on a sideband, it was recognized that a technique whereby just one sideband could be transmitted (eliminating the carrier and the other sideband) would offer substantial advantages over conventional HF/AM transmission.

Single sideband (SSB) could eliminate much of the distortion due to selective fading and interference associated with HF. If only one sideband had to be transmitted, less frequency space would be required, thus helping ease the congestion within the high frequency spectrum. A single sideband signal would require less transmitting power than a conventional HF/AM signal. Conversely, increased signal strength and range could be realized by boosting the power of the SSB transmission.

About 1915 the single sideband transmitting technique was discovered, but the first application did not come until the mid-1920s. Used for radio-telephone communication across the Atlantic, it required literally a roomful of equipment to transmit the HF/SSB signals because of the huge vacuum tubes and filters available at that time. Thus it was a costly transmission method.

Arthur Collins was well aware of the potential of single sideband to conserve frequency space and boost transmitting power when he started building radios, but also knew the technology was not yet available to have it become practical for wide scale use.

A history of amateur radio published by the American Radio Relay League in 1936 contained the prediction that single sideband someday would bring revolutionary change in radio communication.

As early as 1937, Walter Wirkler, an engineer who worked closely with Arthur Collins, had conceived and patented a design for an SSB transmitter using what was called the phasing principle. While it was never developed into a product, the patent demonstrated the Collins company's knowledge of sideband.

In the years following World War II, single sideband activity began to pick up within the radio industry. Several companies, primarily in the amateur radio field, introduced sideband equipment based on various techniques.

Warren Bruene, an engineer responsible for much of Collins' single sideband high power transmitter development, recalled how Arthur modified his own ham gear to work with some of the sideband equipment then coming on the market. He was part of a group of 100 or more amateurs using sideband. They became a source of frustration for other hams unable to correctly tune their radios to receive single sideband transmissions and understand what the group was saying over the air.

An article on sideband history written by Jim Musgrove in the December, 1991 Electric Radio magazine reported that Arthur Collins was included in a 1951 "Grandpappy List" of pioneering amateur radio sidebanders. The article also contains an account of Arthur buying a 10A exciter, an early sideband transmitter, from Central Electronics of Chicago.

Arthur's early sideband hamming was done from his home on 34th Street SE in Cedar Rapids, a place where much radio development occurred over the years. He considered his home lab just another place to carry on the project of the moment, particularly handy when he felt like working or hamming in the middle of the night, which was often.

In November, 1952 Arthur decided the time was right for him and his company to make their move in sideband.

He soon would be transforming high frequency, short wave communications to an extent that few innovators ever achieve in an area of technology.

Several factors influenced his decision. One was the sideband equipment being introduced by others at the time.

Another was a contract Collins received, to do testing of a radio developed by another company for the Army. The radio had a type of single sideband capability and Arthur became very interested in the project.

More significant was the development by Collins Radio Company of a key component essential for sideband — the mechanical filter. A filter is a device which in effect selects a narrow part of the frequency spectrum desired for use in a radio and blocks out the rest.

The sideband approach which Collins would take demonstrated a characteristic of Arthur and his company in advancing radio technology — a different path than others were trying.

Most ham sideband equipment at the time used the so-called phasing principle — a version of which Wirkler had conceived in 1937. The other method of SSB generation (used in commercial radio telephone transmitters) required crystal filters. The crystal filters were both too large and too expensive to be widely used.

Arthur did not see such systems providing a level of performance or practicality which would satisfy him, nor at a cost which permitted widespread use and flexibility.

Another approach was based upon a version of a mechanical filter conceived by an RCA components engineer — using a vibrating piece of metal as a filter element.

Collins began working on its own mechanical filter in 1946. The primary objective was to design and build a mechanical filter which would be small enough, reliable and low enough in cost to be adapted for widespread use.

The development was directed by Melvin Doelz, at the time an engineer working in Cedar Rapids. Doelz was one of the highly talented group of young engineers who came to Collins shortly before the U.S. became involved in World War II. The filter project was moved to Burbank, California when Collins opened a Western Division there in 1948. (Doelz later was to become vice president and general manager of Collins' R&D and production facilities on the west coast, which were relocated to Newport Beach in 1960.)

It was in Burbank where the development was completed after about five years of effort, and where Collins began a filter manufacturing operation, both for company use and as a product sold to other customers. Eventually Collins would be producing several million of the filters a year.

Doelz came up with the idea of using several small metal disks having identical resonance qualities, resembling coins standing on edge with a slight space between each one, and connected by tiny wires welded to their edges. The disks were mounted between two small transducers (devices which convert electrical energy to mechanical motion and then back to electrical energy again.)

Doelz spent hundreds of hours cutting and grinding different metal types and sizes of disks, and testing each for its resonance properties.

The objective was a disk which would vibrate at 455 kilohertz per second. Coming up with the right disk was initially a trial and error process. A way had to be found to produce those disks consistently.

Helping to solve that problem was a native of India, Roshan Sharma, who had been studying physics and mathematics at UCLA. He wanted to stay and work in the U.S. and applied for work at many high tech firms. Most would not even talk to him, and he could find only menial jobs such as fruit picking.

Finally in 1952 he got an interview with Collins, then launching its new West Coast research division. Sharma told Mel Doelz about an acoustics course he had just completed and was hired to work on the mechanical filter project.

Tapping into research done by a Columbia University professor on vibration, Sharma's contributions led to the engineering equations for the mechanical filter disks.

Once that was solved, building a few engineering models was fairly easy, Doelz recalled, compared with problems of quantity production of the filters. Special production and testing equipment had to be designed, special steel alloys found, operators and technicians had to be trained.

The result of Doelz' project was a component contained in a case about 1 x 1 x 3 inches, with the ability to filter out the unwanted parts of the HF signal and concentrate full power on one sideband. It could be produced at a cost allowing it to be used in a wide range of equipment. The first filters cost about $50 to $75 but volume production soon brought the cost down to about $25. By comparison, the filter being used at that time in trans-oceanic sideband transmissions was about the size of a shoe box and cost about $750.

At first Collins could make only about 15 mechanical filters per month which passed all tests, but in time the monthly production was in the thousands.

The scientific principle used in the mechanical filter — more precisely a electromechanical bandpass filter — is known as magnetostriction. In essence it converts electrical (radio signal) oscillations to mechanical (sound) oscillations through a series of small resonant metal disks, as Doelz had done. This also is where filtering takes place to suppress the carrier and unwanted sideband, after which the remaining clean signal is converted back to electrical oscillations. The term bandpass refers to attenuating, or reducing in strength, that portion of the frequency band to be suppressed, and passing the desired sideband.

In typical fashion Arthur hand-picked a team of engineers and technicians and called the group together on short notice to begin a crash program for development of single sideband circuits. They took over one of the metal Butler buildings near the Main Plant in Cedar Rapids, called Butler 3-1/2, which became their home away from home for the next four months. Arthur moved in with the group to direct the effort.

In addition to the filter, main objectives included developing better linear amplifiers and greatly improved frequency stability. Collins already had made major progress in the latter area with the permeability tuned oscillator invented by Ted Hunter just before World War II, and subsequently modified and improved.

The technical challenges which had to be overcome to make single sideband work as flawlessly as Arthur intended were enormous. Radio transmission and reception with the single sideband signal was an entirely new ball game.

It was not only a matter of developing the ability to produce, modulate, filter and amplify the SSB signal, and to assure a clean signal without distortion. There were special requirements in making the technique work over a wide range of frequencies and from a few to many thousands of watts of power. Transmission and reception systems posed separate and unique challenges.

The technical problems were solved by trying one approach after another until the desired result was obtained.

As they started their work Arthur said it could result in a desk top size radio capable of 28,000 channels, with the 2 to 30 mehahertz HF spectrum divided into 1 kilohertz channel increments. Until that time the top limit was 280 channels.

Assignments were given to the various engineers to investigate, experiment and develop the circuit designs and equipment configurations that would be needed.

Ray Ruggiero, then a laboratory technician assigned to the SSB development, recalled that his first job on the project was to cut the wires which brought the Main Plant public address system announcements into the Butler building. Arthur wanted no distractions for his team such as the calls for inspectors and parts expediters usually heard on the PA speakers.

One of Arthur's fetishes was to have a neat desk and a neat work area. The SSB development team engineers remember it was almost a daily ritual for Arthur to pick up a broom and sweep wire clippings, cigaret butts and other debris into a pile.

While almost but not quite a chain smoker, Arthur was a heavy user of cigarets — either his own or from the pack of anyone who had a supply. Early on in the sideband project he gave his secretary a five-dollar bill so she could keep him in cigarets, which could be purchased in the company cafeteria. Faithfully she would bring two packs to him every morning. After about three months Arthur asked her how the money was holding out (cigarets cost about 25 cents a pack in those days). "Oh, Mr. Collins," she said, "I used that up a long time ago, but I got some more from the front office" (cash supplied by the company controller, no doubt).

Arthur also had given instructions that he did not want to be disturbed while working in the sideband project lab, but his secretary still had to interrupt him occasionally to get his signature on papers and take phone calls.

Arthur originally had wanted his own secretary relocated to the sideband lab, but the personnel department convinced him she should stay in the executive area, and another secretary could be assigned to work in the lab.

The first one chosen, while perhaps competent enough for the work required, was also stunningly attractive and shapely.

Arthur had his first look at her as he happened to walk by her work area. After turning his head for a second look and when well out of hearing range of the young lady, he said to one of his senior engineers, "Whew!" Because she usually had several men around her who probably should have been doing something else, she soon was transferred.

Vince DeLong, one of the engineers on the SSB development team, said he never learned as much in any comparable period of his career as he did during that time in Butler 3-1/2. "Art kept checking back on each experiment. While it was a lot of trial and error, he made us do it right. I was totally impressed at how much progress we made, all because he really knew how to direct a group of engineers."

One of those involved in the program recalled how Arthur sometimes called in Walt Wirkler, whom he long had depended upon to help solve problems. Wirkler would mull over the matter at hand, then outline schematics and mathematical equations on a blackboard, after which Arthur and other engineers would return to their desks and lab benches to try out Wirkler's suggestions.

Bob Miedke was an engineering group head who worked closely with Arthur on a number of programs including the single sideband development. He remembered "a lot of long days and long nights in Butler 3-1/2."

"We had a lot of radio relay racks with special panels for each type of circuitry. As we tried different tests Art worked right there with us, changing resistors."

"One time he literally exploded. He came back to my desk and said, 'I want you to get that thing fixed like the schematics we have for it. I try to make a change and the resistors and capacitors that are supposed to be there are not there. Fix that!' Then he walked out," Miedke said.

"I soon realized we had no regular routine for updating our engineering documentation, and we were working a day or two behind what he was doing with the radio rack. We got it fixed and I told him to try out any part of it. He did and said, 'it looks alright to me.'"

Bill Roodhouse, who in later years became executive vice president and No. 2 man in the company under Arthur, remembered that: *Art would literally spend days in that Butler building, and finally come out for air, but just for brief periods. He'd talk to Morgan Craft and Bob Gates and ask, 'how's it going?', take care of a few quick matters and then go back to work on sideband.*

While the single sideband development program lasted about a year, Arthur felt the basic elements were in place after about four months of concentrated activity, and he no longer had to work on it full-time.

Besides Miedke and DeLong, the sideband engineering development team included Warren Bruene, Dale McCoy, William Perkins, Kenneth Rigoni, John Sherwood, Richard Uhrik and Walter Zarris.

With the mechanical and SSB circuitry developments, Collins Radio stood at the threshold of a new communications age, ready to make a big leap forward in short wave radio. For the first time, relatively small, lightweight mobile single sideband equipment was possible. Until then, all SSB transmission and reception was confined to fixed stations.

In April 1953 an engineering group was given the assignment of developing a single sideband transmitter wanted by the U.S. Army. Warren Bruene recalled that the Army initially favored a suppressed carrier technique, different from the Collins approach, to achieve sideband capability. But subsequent test results proved the superiority of the Collins design.

In September, 1953 work began on a general purpose receiver with SSB capability for commercial use, and another group began the task of developing Collins' first SSB amateur radio equipment.

From that program came the 75A-4 receiver and the KWS-1, a 1,000-watt amateur transmitter. Arthur named it KWS, which stood for kilowatt, sideband. They were introduced in March, 1955 after extensive on-the-air testing by Arthur and several of his engineers. He had towers with rotating antennas installed at the homes of those participating in the tests.

The new units used the Collins mechanical filter, in the transmitter to filter out the carrier and one sideband, and in the receiver, to select the narrow band of frequencies occupied by the incoming SSB signal.

The performance which users experienced with the first Collins single sideband radios was far superior to other ham sideband equipment on the market at the time, and an even greater leap forward compared with conventional HF/AM. Voice transmission over HF bands had never been as consistently clear in the five decades of radio's history.

Users quickly discovered there was minimum interference and less background noise with the sideband signal. The KWS-1 transmitter, the most compact one-kilowatt transmitter ever designed to that time, also had a feature called voice operated break-in. Unlike conventional ham sets, that allowed two amateurs to converse as they would by telephone, without having to flick a switch when changing from talking to listening.

Looking back on the Collins development efforts which made single sideband practical for widespread use, and is recognized as one of top achievements in the history of radio, Mel Doelz said it was not a smooth ride.

*When Art started it a lot of Collins management doubted such a large-scale effort would succeed. The fact he made it happen only made him certain he could do whatever he wanted in other areas — like computers in later years,* Doelz said.

Arthur Collins always wanted the recognition for his company's achievements to come primarily through reputable technical journals and forums. The recognition given to Collins' single sideband development was apparent in a 1956 issue of the Proceedings of the IRE (Institute of Radio Engineers), which contained nine papers by Collins engineers who worked on the sideband project.

The middle 1950s were a period of growing international tension, early years of the Cold War. The Soviet Union had kept and modernized its military capability after World War II, and posed an ongoing threat to world peace. The. U.S. advantage as the world's only nuclear power had ended in 1949 when the Soviets exploded an atomic bomb. Neither the Soviets or the U.S. and its NATO Allies trusted the other. The threat of a nuclear holocaust was serious enough to stimulate the widespread construction of residential bomb shelters in the U.S.

The Air Force Strategic Air Command (SAC) was the main U.S. deterrent to any Soviet threat against North America. This was still years before intercontinental ballistic missiles were effective weapons, and before there were communications satellites.

Long-range SAC aircraft, carrying atomic bombs, were in the air at all times near the Soviet border, ready to turn toward Russian targets if ordered to attack. The first SAC aircraft of the Cold War were propellor-driven B-29s and B-36s. In 1951 an early jet bomber, the B-47, began service, and in 1955 the advanced new B-52 joined SAC.

It was a scenario which required highly reliable radio communications between SAC commanders and far ranging aircraft. A main concern was avoiding any mistakes that could start a nuclear war.

The system for long range communications in the mid-1950s was still conventional high frequency AM. The limited range of voice transmission made telegraphy the primary mode for long distances. Coded messages frequently had to be relayed from one point to another through radio operators, creating the possibility of a garbled signal or an error in copying. The Arctic regions, where SAC bombers often flew, posed special radio problems such as fade-out and interference due to the auroral phenomena and other weather conditions. Frequently there were periods when SAC aircraft were totally out of touch with commanders in the U.S.

Heading SAC was Gen. Curtis LeMay, who had shaped and built the huge service arm into a highly efficient and ready force since assuming command in 1948. During World War II LeMay had led combat missions in both Europe and the Pacific and gained recognition as the nation's top air war strategist. It was under his command that the missions which dropped atomic bombs on Hiroshima and Nagasaki were carried out.

In April, 1954 he brought in an old friend, Maj. Gen Francis W. Griswold, as vice commander of SAC. LeMay and Griswold both graduated in 1928 from Ohio State University, where they had gone through the ROTC program. They then joined the Army Air Force together, took pilot training, and began military careers.

Griswold served at various U.S. bases before World War II, then was in England with the Eighth Air Force during the war. He later served several stints at Air Force headquarters in Washington and commanded the 20th Air Force in Guam. Before joining SAC he was commanding general of the Third Air Force based in England.

SAC headquarters were at Offutt Air Force Base just outside Omaha, Nebraska.

LeMay regarded the existing SAC communication system and all its shortcomings as highly inadequate and unreliable for the role SAC was assigned to perform.

Arthur Collins had known General Griswold for a number of years through amateur radio contacts. Informally, Griswold was called Butch, which was how other hams knew him.

Following Griswold's assignment to SAC, he and LeMay became involved in single sideband and a close association with Arthur Collins.

When LeMay decided to provide a briefing for a select group of top U.S. business executives on the implications of strategic air power and the role of SAC, Griswold sent a special invitation to Arthur Collins. The briefing was held at Omaha November 15, 1954. Arthur flew a Collins twin Beechcraft to Offutt for the meeting, with Griswold arranging for his landing at the military airport. He found himself hobnobbing with top officials of such firms as General Motors, Ford, Chrysler, Firestone and others.

Following that introduction, Arthur began to acquaint the SAC commander and vice commander about the potential of single sideband radio and the sideband work in his laboratories.

LeMay was no stranger to amateur radio but at the time was not an active ham. He and Griswold soon became aware of a small but growing number of avant garde amateurs already into single sideband.

Arthur loaned models of the fabulous new KWS-1 transmitter and 75A-4 receiver to the SAC generals. LeMay eventually got his amateur license, qualifying June 13, 1956. While on the ham bands LeMay identified himself as Curt, KØGRL, and Griswold went by his nickname of Butch, KØDWC.

The SAC leaders quickly saw how single sideband might be the answer to the SAC communication problems. Arthur had stated that voice communication with single sideband basically offered the same range as telegraphy. It also provided more effective transmitting power and greatly improved performance, particularly in adverse atmospheric conditions which caused problems with conventional HF/AM.

Air Force technical people also had been made aware of Collins' sideband work. Through the Rome (New York) Air Development Center, the Air Force awarded a contract to Collins in 1955 to begin the planning, development and testing of an air-to-ground and point-to-point SSB communication system. The development program, which would go on for many months, was named "Birdcall."

But LeMay and Griswold did not want to wait for results from Birdcall to find out if single sideband would work as they hoped under SAC flying conditions. They arranged a 15,000-mile demonstration flight using the new Collins amateur radios.

A KWS-1 transmitter and two 75A-4 receivers were installed in a C-97A Stratocruiser aircraft under Griswold's command. The only modification required for the radios was adapting to the aircraft power supply by replacing the 60 Hertz blower motor on the KWS-1 with a 400 Hertz motor. A wire antenna was stretched from the top of the fuselage to the vertical stabilizer. The C-97A was a transport version of the huge four-engine, propellor-driven C-97 aircraft used as tankers for in-flight refueling of SAC bombers.

The fact that the amateur equipment installation was against Air Force regulations was ignored. Officially the flight was a routine inspection of SAC bases in the Pacific.

Flying along as a passenger and operator of the amateur station would be one Arthur Collins, using his own call letters WØCXX/Airborne Mobile.

After extensive advance planning and studies of the propagation conditions they could expect in the high frequency band, the flight began March 25, 1956.

Under the command of Major General Griswold, the plane flew from Offutt AFB to Great Falls, Montana, to Fairbanks and Anchorage in Alaska, to Adak in the Aleutian Islands chain, to Tokyo, to Okinawa, then back eastward across the Pacific to Guam, Kwajalein, Honolulu, Travis AFB in California and Offutt. Operating the equipment on the aircraft, besides Arthur, were General Griswold and Tech. Sgt. Garland C.A. (Willie) Wilson, one of the most active hams in SAC.

One of the preparations for the flight was to have five ground stations, equipped with the new amateur sideband radios and manned by Collins people. At Cedar Rapids operators were Ernie Pappenfus and Bob Miedke. The Dallas station operators were Jim Flynn, Ben Roberts, Theil Sharpe and Garth Johnson. The Offutt AFB MARS station was manned by Bob Boller, W.H. Crumbaker and Joe Knowles. The Burbank station operators were Preston Simms and Bill Miller, and at San Francisco the operator was Reg Tibbetts.

While the C-97A was airborne, radio checks were made with the stations every half hour around the clock during the 71 hours of being on the air. In between the radio checks contacts were made with other hams in 26 countries around the world on sideband. A total of more than 1,000 radio contacts were made, including one with the U.S. Navy amateur station in Antarctica. The airborne station achieved what is known in amateur radio as WAC — Worked All Continents.

One of the more interesting contacts was with an amateur operator in Moscow, Russia.

Another contact was recalled in later years after he retired from the Navy by Nelson Denison, WICVU. In 1956 he was an E-3 Seaman in charge of the Amateur Radio Station at the U.S. Navy's base at Adak Island in the Aleutians.

Denison said he remembered speaking first with Arthur Collins. *Art inquired as to what I was doing on Adak Island. I informed him I was the enlisted man in charge of the base amateur radio station. Art then told me he was with a military man who also was in charge and his handle was 'Butch.' Butch and I then exchanged signal and equipment reports. I recall asking Butch what he was in charge of and his reply was, 'Vice Commander, SAC.' As a lowly E-3, I actually stood up at the radio position while completing our QSO!*

In the biography of LeMay entitled "Iron Eagle," Author Thomas Coffey quoted the general as saying about sideband: "It was so much better than the standard stuff we had, there was no comparison."

Despite the success of the radio demonstration, showing virtually continuous contact with the U.S. from Alaska to Japan and points in between which never had been achieved with conventional HF, the Air Force communication experts still would not concede that tests using amateur radios proved conclusive.

So LeMay and Griswold, again with communications assistance by Arthur Collins, planned a second flight. This time an Air Force communications officer who was not under SAC, Lt. Philip Ferrell of the Rome Air Development Center, was told to go along, participate and observe, reportedly to find out if the amateur single sideband equipment really was effective.

The flight got underway June 29, 1956, again with Major General Griswold in command and Arthur Collins as chief operator of the on-board amateur station. Besides amateur radios, the C-97A this time also carried a prototype of a military aircraft radio under development by Collins as part of Birdcall, a single sideband transceiver. It later became known as the AN/ARC-58.

The route went to Andrews AFB outside Washington, DC, then to Air Force bases in New York, New Hampshire and Maine, to stops in Newfoundland and Laborador. The plane reached Thule AFB in Greenland, just 900 miles from the North Pole, on July 2.

After a night's rest the crew went on a local flight out of Thule over the Arctic wastes, and at that time Arthur had radio contact for three hours with KC4USA, Navy amateur station at Little America in Antarctica, near the South Pole.

On the next leg of the flight the aircraft was flown from Thule to Anchorage, Alaska via Prince Patrick Island and Point Barrow. The route took the aircraft halfway between the magnetic and geographic north poles. Arthur and his fellow operators on the plane had seven hours of contact with both KC4USA and another Navy amateur station in the Antarctic, KC4USV. The two stations were part of the Navy's Operation Deepfreeze in support of U.S. participation in the International Geophysical Year at the time. Both were equipped with the Collins SSB KWS-1 and 75A-4.

In all, more than 10 hours of radio contact was logged between the North Pole and South Polar regions during the flight. The Arctic was in summer daylight at the time, and the Antarctic in 24-hour winter darkness. Contact also was maintained again with U.S. stations as on the previous flight. Both direct ham radio and phone patch conversations occurred between operators on the aircraft and General LeMay.

Ernie Pappenfus, Collins' engineering division head responsible for HF equipment, recalled that prior to the flight Arthur had two telephone lines run into his ham station at the Pappenfus residence in Cedar Rapids. Those were in case they would be needed in setting up a radio-telephone relay to achieve North and South Pole communications, Pappenfus said. But with direct voice contact between the aircraft and Antarctica they were not used.

By the time the aircraft had flown from Anchorage to Travis AFB, California and back to Offutt on July 7, more than 1,200 contacts had been made with radio operators in 25 countries.

Radio operators on the C-97A besides Arthur and Maj. Gen. Griswold were

Col. John Bestic, chief of SAC communications, Lt. Ferrell and Lt. Col. Joe H. Beler of the SAC communications branch. Beler, who went to work for Collins after retiring from the Air Force in 1960, recalled working the prototype AN/ARC-58 transceiver between Goose Bay and Thule and having trouble retuning the unit. "Art came back and asked what was wrong, and I told him it would not retune. He then said, 'Get me a big screw driver or a small hammer.' After I got a small ball peen hammer from the crew chief, he got down on his knees and tapped the bottom of the radio a couple of times. We tried it and it worked — Art said a relay was stuck. And it worked fine the rest of the trip."

Also passengers on the Polar flight were Leo Meyerson of World Radio Laboratories, Collins amateur distributor in Council Bluffs, Iowa, and two staff members of National Geographic Magazine, Associate Editor Melvin B. Grosvenor and Gil Roberts. They were preparing an article on SAC for the Geographic.

At no time during the flight was the aircraft unable to maintain loud and clear single sideband radio contact with some area of the continental United States. Transmissions tried on AM frequencies sometimes were difficult to understand because of auroral disturbances.

At the time of the SAC test flight over the North Pole region, radio performance in that area was often an uncertain thing. Much effort by Collins, SAC and various scientific and technical agencies contacted for help went into planning for the flight.

Looking back on the event a few years later, Arthur also noted that an analysis of radio contacts made by Wireless North Pole, the shipboard amateur station operated by his friend John Reinartz during the MacMillan Expedition to the Arctic in 1925, served as a model for SAC's HF/SSB system.

*John showed in 1925 that reliable communication was possible across the auroral zone. Through a combination of circumstances, the knack of using HF in the Arctic was lost in the military during intervening years. But recently the things which John discovered in 1925 have been used to meet a vital requirement of modern air power*, Arthur said during a tribute to Reinartz in 1960.

Arthur, Griswold and others made a third SSB test flight in October, 1956. The route took them across the Atlantic to North Africa, to Germany, England, Greenland and back to Offutt. They made 1,059 contacts with hams in 31 countries.

A comparison test also was made between the new Collins-developed AN/ARC-58 airborne unit and another single sideband radio being proposed to the Air Force by a competitor, a much larger firm than Collins Radio. The Collins unit maintained communication better than 99 percent of the time it was operated; the competitor's unit was effective only about 20 percent of the time.

A further test also was arranged to mollify some lingering concerns by SAC people about communication in the polar regions. Arthur again offered the use of a 75A-4 and KWS-1. They were taken on a C-97 on a flight around the North Pole. Contacts were made with Operation Deep Freeze stations at the South Pole, which in turn were relayed to Collins operators in Cedar Rapids, with the transmission then relayed on to SAC communicators at Offutt. That test convinced the last skeptics that SSB was indeed effective to reach polar areas.

The proof was now in that HF single sideband offered a superior communication technique for SAC's requirements.

But it would take time before the Birdcall program resulted in equipment specifically designed and built for the military, and General LeMay was an impatient man. To have sideband capability as soon as possible, he used SAC operating funds, reportedly from recreation equipment budgets, to buy Collins amateur single sideband radios. Those were installed in a network of ground stations at SAC bases across the U.S., in Greenland, England, Africa and Guam, an exercise known as Big Talk.

Collins engineers designed antennas that could be used at each station. Vern Jones, a longtime Collins field service engineer and program manager, recalled being one of several field service engineers transferred from Dallas to work on the Big Talk project.

"We sat in a meeting in Cedar Rapids with Art Collins presiding and telling us how we were going to do the SAC installation," said Jones, who was sent to SAC headquarters near Omaha to supervise the equipment work there.

"An underground control console to tie in with the SAC stations around the world was being installed, and we put up antennas despite ice, snow, freezing concrete and all the other problems of working outside in the winter," Vern said.

He also worked on similar installations at other SAC bases in the U.S. and Europe, flying to the jobs in a huge C-124 aircraft carrying all the gear needed to set up a station.

The SAC ground station network equipped with the modified Collins amateur units was completed on a rush basis.

By January, 1957 the Big Talk network was ready to take on a stiff test. Three SAC B-52 jet bombers were sent on a non-stop, round-the-world flight covering 24,325 miles in 45 hours and 19 minutes. The B-52s were refueled from tanker aircraft while in the air.

By means of SSB links between the ground stations including SAC headquarters, and conventional HF/AM for air-ground, voice communication was maintained at all times with the aircraft.

During the time he had Collins amateur radios installed in his C-97A command aircraft, LeMay made a flight to Guam. Heading back to the continental U.S., he used the amateur single sideband equipment to contact the Collins engineering lab radio station in Cedar Rapids.

LeMay asked the operator to set up a radio-telephone patch for him by placing a call to the Arlington, Virginia home of Admiral Arleigh Burke, Chief of Naval Operations.

It was about 2 a.m. in the Eastern time zone when Burke was awakened and answered the phone, to be greeted by "Hello Arleigh, this is Curt LeMay."

LeMay asked, "How do you read me?" and Burke said, "Loud and clear — where are you?" LeMay answered that he was in the air about 400 miles east of Pearl Harbor.

Burke then asked what kind of radio LeMay was using, and was told it was high frequency single sideband. After chatting briefly they ended the call.

The story which went the rounds of Naval circles was that when Burke got to his office later that morning, he told a meeting of his staff about the call from LeMay. He said he didn't know what single sideband was, but that he wanted a lot of it and he wanted it fast.

Within a few weeks a Navy Super Constellation early warning aircraft, a Navy blimp, a ground station and several ships were outfitted with Collins amateur gear for a special test program. Arthur Collins, Engineering Vice President Bob Cox and A.S. (Ben) Born, a retired Navy rear admiral who had gone to work at Collins, were invited to witness the tests while aboard the Navy carrier USS Forrestal.

Butch Griswold also liked to show off the advantages of SSB.

Joe Beler recalled being along on an inspection flight to the Far East. The SAC headquarters contingent landed at Japan and was met by U.S. officers stationed there, including a three-star general who was commander of the Far East Air Force and a longtime friend of Griswold.

Chatting beside the aircraft, Griswold asked about the general's wife. The general said she was a patient in Bethesda Naval Hospital near Washington, and that he had not been able to contact her for three days because of poor conditions on conventional HF/AM short wave radio.

Griswold looked at his watch, and said, "I'll bet you twenty dollars we can get her in the next five minutes." When the general was willing to take the bet, Griswold told Beler to get back aboard the aircraft and fire up the ARC-58 SSB communication set. Joe said the first to answer his call was the Collins station at Cedar Rapids, and he asked for a phone patch to Bethesda.

Connected with the general's wife, Joe explained who he was, calling from an aircraft on the ground in Japan, and that her husband wanted to talk to her.

Beler said he then handed the microphone to the general and at the same time handed Griswold the forty dollars he was holding from the bet.

In 1957 Collins came out with another single sideband amateur radio, the KWM-1, a compact 100-watt combination transmitter-receiver unit which could be mounted under the dashboard of a car. It also could be carried around in a suitcase to function as a portable communication set.

Bob Miedke remembered in that period getting a call from Arthur around 1:30 a.m. Arthur told him the radio propagation conditions across the U.S. were very strange, so bad that none of the SAC stations could talk to each other. Arthur was at home, and asked Miedke to come over and help study the situation.

"We tried every way to combine the SAC nets and our Cedar Rapids station, but it seemed like the U.S. was covered by a blanket blocking all short wave radio. Finally Art made contact with a radio operator in Colombia, a member of a scientific expedition equipped with one of the new KWM-1s. We could talk to him.

"Then Art called LeMay by phone and said he wanted to take over the SAC network and run it through a station in Colombia.

"LeMay's answer was, 'Hell no, we're not running the SAC network from any foreign country.'

"But Art convinced him to do it, and we ran the SAC network through a suitcase station in the jungle all night. All the stations could check in through there. The propagation problems were due to sunspots," Miedke recalled.

LeMay took one of the KWM-1 suitcase transceivers with him on a SAC flight which included a stop in Australia. Apparently to needle some of the Air Force brass still critical of his use of amateur radios, he took the portable unit up on a mountain side and called the Pentagon. The clarity of his radio message again proved the validity of HF/SSB to communicate around the world.

Through their many associations Arthur became a close friend of LeMay and Griswold. All three were men of few words when it came to small talk, but they found common ground in their love of radios and sports cars.

On one occasion General LeMay was due to fly to Cedar Rapids for a progress review on the sideband work at Collins. Arthur recently had purchased a sporty Mercedes 300SL coupe, and wanted to show it to LeMay.

He also wanted him to see the car from the vantage point of a grease pit in the garage of his home. The grease pit, however, did not yet exist and the LeMay visit was just a few days away. The company maintenance department was responsible for the hurry-up job, not an easy task because it was no ordinary grease pit. It had to be dug out, have concrete poured for the walls and steps and tile installed. It had tool compartments in the walls and recessed fixtures for lighting the underside of a car. With a lot of overtime hours by the maintenance department workers and a group of Cedar Rapids contractors the grease pit was ready.

Arthur had purchased the Mercedes directly from a source in Germany. His friends at SAC, the commander and vice commander, arranged for delivery of the vehicle to the U.S. It arrived at the Cedar Rapids airport one day aboard a huge Air Force transport plane. Arthur was there when the aircraft ramp was lowered and the Mercedes rolled down onto the runway.

LeMay eventually was booted upstairs from SAC commander to be Air Force vice chief of staff at the Pentagon. About the time he left SAC, he was quoted in an interview as saying: *Each day I am becoming further impressed with the value of single sideband techniques to the operation of this command.*

In 1957 the Air Force began taking deliveries of the KC-135, a four-engine jet similar to the Boeing 707 airliner then about to enter commercial service.

The primary role of KC-135s was that of jet tanker aircraft for in-flight refueling, but some would become utility transports. One of those was to be outfitted as an airborne command post called Speckled Trout. The equipment included a number of Collins HF/SSB systems. On its debut flight November 1, 1957, Speckled Trout narrowly missed setting a new transcontinental speed record from the Boeing Aircraft factory at Seattle to Andrews AFB near Washington, DC.

Just 10 days later, with LeMay at the controls, the KC-135 lifted off from Westover AFB in Massachusetts for a record-breaking flight to Buenos Aires.

Argentina. The dog leg route to the eastern tip of Brazil and on to Buenos Aires covered 6,350 miles non-stop in just over 13 hours. The non-stop return flight direct to Andrews AFB took about 11 hours. Aboard the aircraft were Air Force personnel, several newsmen and technical representatives including Bob Miedke of Collins. He helped man the radios along with Air Force operators.

Recalling the flight, Miedke said: "Art had asked me if I wanted to go on a long distance, non-stop, world record jet flight. At that time jet flying was still new and considered somewhat risky. I said 'yes, I wanted to go.' We weren't told the destination until after we took off."

The radio operators called in position reports to the SAC ground network every half hour and communication was considered good throughout the flight. Miedke recalled just one instance when a problem arose.

"On the return flight as we started across Brazil suddenly the static was just unreal. LeMay had been piloting the plane until that time, then came back to my station and said he wanted to talk to his office in Washington. The static was so bad I couldn't get Washington, so I started working the Air Force stations all around. It was early in the morning, and I got a beautiful contact with Guam. I knew there was a telephone line (ocean cable) from Guam to Washington. They ran a phone patch to Washington. I handed the phone to LeMay and said, 'Here's your office.'

"That proved, for an Air Force commander, that no matter where he flew, he could talk to whoever he wanted."

With Collins continuing to work on the Birdcall program, the Air Force and its Strategic Air Command soon would have the most sophisticated and effective radio communication system in the world for the time.

Teams comprised of dozens of engineers and technicians at Collins plants in Iowa, Texas and California helped shape the system, but the architect of the grand design was Arthur Collins.

The value of the Collins single sideband equipment to U.S. national defense was cited in a 1959 Time Magazine article. Gen. Thomas Power, successor to LeMay as SAC commander, was quoted as saying:

*If I don't have communications, the only weapon I have is my desk...and I can't throw it very far, and it's not very lethal.* The article noted how SSB equipment enabled Power to carry on a conversation with the pilot of a SAC plane anywhere in the world while seated at his desk near Omaha.

Warren Bruene was selected by Arthur to write the official company report documenting the SSB investigation project. He recalled a controversy which arose in radio circles.

"A big debate flared up in the radio communications industry about standards for SSB. General Electric promoted double sideband suppressed carrier very hard. It lost out because it took twice the bandwidth as SSB. Another contender was 'compatible sideband' which wasn't SSB at all but but a hybrid form of AM in which most of the sideband energy was confined to one side of the carrier. It could be received by conventional AM receivers. It had none of the advantages of SSB except reduced bandwidth. The largest debate was whether or not a pilot carrier about 15 db below PEP (Peak Envelope Power, the method of measuring SSB signal strength) would be transmitted with the SSB signal to be used for phase locking the BFO (beat frequency oscillation) in the receiver to the exact frequency for demodulation. This scheme was being used by the commercial trans-oceanic radio telephone transmitters."

Bruene traveled to many committee meetings promoting suppression of the carrier (no pilot carrier) called SSBSC. The military chose that because it would be less susceptible to jamming. Many called SSBSC "Collins sideband" because Collins strongly promoted it. Arthur thought it would be best to spend money on better frequency stability than on the AFC (automatic frequency control) circuitry. The SAC aircraft flight tests proved the Doppler frequency shift resulting from aircraft speed created very little distortion due to inexact carrier frequency insertion.

Bruene was in charge of designing the ground station transmitters which SAC would use to communicate with far-ranging aircraft. The units were a 45 kilowatt automatically tuned transmitter and a 10 kilowatt manually tuned transmitter. With six of the 10 KW transmitters at each SAC station, the base station operator could come back instantly on the frequency of a calling aircraft.

Also developed were tuners required to link transmitters with antennas, and huge, elaborate antenna systems. The latter posed many challenges and incorporated many technical innovations utilized in steerable beam and omnidirectional antennas. They were the most elaborate antenna systems ever developed to that time.

A complex matrix system of coaxial cable lines contained in pipes pressurized with air or helium connected ground transmitters with antennas.

The aircraft system was the AN/ARC-58, comprised of five black boxes ranging from the small cockpit control unit to transmitting-receiving and antenna coupler units. The ARC-58 had 1,000 watts of transmitting power, 28,000 channels, and could operate on either single sideband or AME (AM Equivalent -- consisting of full carrier and one sideband). Both voice and teletypewriter communications could be transmitted and received. The one kilowatt of effective communicating power represented a 10-to-1 power advantage over previous military airborne radios.

The Air Force was phasing in the new Collins single sideband systems by 1958, in aircraft and ground stations. The Strategic Air Command established four strategically located stations for its communications network, called Short Order.

The stations were at Offutt AFB near Omaha; Barksdale AFB, Louisiana; Westover AFB, Massachusetts and March AFB, California.

Each had a transmitter, receiver and headquarters site separated by up to 20 miles to avoid interference from radio signals. Several operator consoles were also a part of each station. The stations were nearly identical except for a special antenna at SAC headquarters in Nebraska.

Short Order was designed for simplified control but with an array of command override and intercept features. For example, under normal operation an operator dialed only two digits on a telephone to set up a communication channel with a far distant aircraft.

Each station had three 45-kilowatt and six 10-kilowatt transmitters. To assure communications at all times, an operator at any station could go by phone line through any of the three other stations to contact an aircraft.

The ground antenna configurations were known as Wullenweber antennas, with towers 172 feet high and spaced in a circle 500 feet in diameter. The huge antenna systems were a vital and major component of Short Order.

SAC said the purpose of Short Order was to exercise *Positive Control*, the procedure insuring that U.S. bombers, even when airborne, would not attack an aggressor unless specifically ordered to do so by the president.

Short Order increased the power of SAC's ground-to-air communications system from 500 to 45,000 watts, with much greater reliability than the previous system. An elaborate series of back-ups and double-checks were built into Short Order to support the *Positive Control* strategy. Under peacetime conditions, the systems were tested several times each hour.

When the Offutt station was completed, with its main control center deep underground for protection from any damage short of a direct nuclear bomb hit, General Griswold wanted a special type of inauguration ceremony.

Lt. Col. Joe Beler was in charge, and polled his troops for suggestions.

When the day came for SAC headquarters to show off its new sideband station, dozens of press representatives and dignitaries were present. Beler had arranged for a special way to open the doors to the control center with a radio signal.

At the appropriate moment, the station operator contacted a B-47 bomber on alert over England, and told the pilot to "open the door." The pilot then transmitted a signal which opened the SAC control center doors.

Beler recalled that same pilot happened to be at SAC headquarters some time later, and wanted to know what the "open the door" command had meant.

The SAC network was a massive communication program, equipping hundreds of aircraft with the most advanced radios ever developed, and building and equipping highly complex, sophisticated ground radio stations. Seldom has a single company been given the assignment of such magnitude. Collins Radio completed it and made it work, a tribute to Arthur Collins who initiated the development and provided direction for the many steps involved.

While the SAC installations were being constructed, Arthur set up a very special radio station in his company, based on the design of those at the Air Force bases. It was a unique facility for an industry to have. The control center and transmitters were located in a new engineering building in northeast Cedar Rapids, in an area known as Lab 12, with antennas several hundred feet away. In time additional antenna systems were established at Collins' plant in California, which could be remotely operated from Cedar Rapids.

The station became a backup to the SAC network, the Tactical Air Command and other Air Force operations, as well as handling communications for all presidential and other top government VIP flights. Dwight D. Eisenhower was the first of a line of U.S. presidents and their official parties able to stay in touch with any place in the world through the Cedar Rapids station. Eisenhower had previously known about single sideband, as his special presidential railroad car had been equipped with a KWS-1 and 75A-4 since October of 1956.

HF SSB capability using Collins equipment was quickly adopted for Air Force 1 and other VIP aircraft and the home base of the VIP fleet at Andrews AFB near Washington.

The Cedar Rapids station was a pet toy of Arthur Collins. He had equipment in his home about four miles away from the Cedar Rapids plant which allowed him to utilize or take control of the Lab 12 station. Just by dialing a phone, he could control a 45,000-watt transmitter and direct radio transmissions.

Arthur was personally involved and had the final say on every detail of the station, even the specifications for the emergency generator which could kick in instantly if normal electric power sources were cut off.

The station had at least two and often three operators on duty at all times. They had instant access to and control of 14 radio frequencies.

The operator control console became the hub of a showcase demonstration area designed to Arthur Collins' specifications. The control room was enclosed in glass, completely soundproof with restricted access, but visible to visitors. Elsewhere in the spacious and spotless area were transmitters, switching equipment, stand-by generators and the company's business computers. The area also contained displays of amateur, aviation, broadcasting and other equipment.

The station figured in numerous events, many of historic significance, after being set up in 1958.

One of the early incidents involved the blustery Nikita Khrushchev, successor to Josef Stalin as premier of the Soviet Union. Khrushchev was invited by President Eisenhower to visit the United States in an effort to ease tensions between the two world powers.

During the tour of the U.S. in September, 1959, while Khrushchev was being flown to California aboard an aircraft identical to Air Force 1, his American State Department hosts were telling him about "our fancy communications system." They boasted that the system would even allow him to talk with his office in Moscow.

The aircraft radio crewman called Cedar Rapids and said, "Get me Moscow." Since no one in the U.S. ever tried to communicate directly with the Soviet Union in those Cold War days, the Cedar Rapids station operator asked if he meant Moscow, Idaho. But Arthur Collins, listening from his home, quickly cut in to say, "No, he means Moscow, Russia."

Unable to make a radio contact, the operator went the overseas telephone route. He had to go through England and France, but was able to establish a radio-phone patch link for the aircraft with the Kremlin. A Khrushchev aide on the airplane then had to convince a skeptical Kremlin phone operator to put through the call, only to discover that the person wanted was not there.

Any U.S. Soviet friendliness failed to last. By October, 1962, Russians were installing missiles in Cuba, just 90 miles from the U.S. That led to a tense period as then President John F. Kennedy demanded Khrushchev withdraw the missiles.

U.S. military forces including SAC were placed on an alert status just short of war. Looking at the communication requirements if an armed conflict should occur, SAC officials asked that the Collins station at Cedar Rapids be used to augment the Air Force network.

Vern Jones had remained at Offutt as the Collins service representative after being in charge of installing the Big Talk and Short Order systems and getting them on line. He was told by SAC brass to go to Cedar Rapids and set up the Collins radio station as a SAC command post.

Jones recalled he had to explain that while he took his orders from SAC officers while at Offutt, he also was a Collins employee and might not be able to exercise the authority he would need for the job in Cedar Rapids. A SAC general then assigned a captain to accompany him and serve as the go-between to convey what SAC would need.

They flew to Cedar Rapids in the afternoon and worked all night with Mike Phillips, Ray Ruggiero and others of the Collins station staff to fit the installation into the SAC network. Arthur Collins asked them if they needed anything, and Ruggiero told him they would like to increase the station's power. Early the next morning two 10,000-watt transmitters were on the loading dock ready to be installed.

Fortunately the Soviet Union backed off, dismantled the Cuban missiles and launch sites, and one of the most serious crises of the Cold War ended without shots being fired.

Just 13 months later, November 22, 1963, President John F. Kennedy was assassinated in Dallas.

Outwardly there was little sign of anything unusual at the Collins HF/SSB station during the afternoon and evening hours which followed the tragic shooting of Kennedy.

But on the inside there was a continuous and heavy demand on the radio and telephone circuits into and out of the station.

With telephone lines between Washington and Dallas jammed, the White House needed a clear communication channel and had it through the Collins station in Cedar Rapids. The main communication link was via high frequency single sideband radio between Air Force 1, on the ground at Love Field in Dallas, and Cedar Rapids, and phone lines between Cedar Rapids and Washington. The station also contacted a VIP aircraft flying Secretary of State Dean Rusk across the Pacific, to have him return to Washington.

The Collins communication station was an expensive facility to operate. While a part of the costs were funded by government contracts, much of it was financed by the company. It existed because of Arthur Collins — motivated by his intention to further technology and his patriotism. Few other corporate executives ever would have had such a facility.

But then few other executives were like Arthur Collins and few companies were like Collins Radio.

Arthur occasionally asked the radio station to request a White Express. That was a world-wide communications check, with every operator and every commander on duty responding as the roll was called. It was Arthur's way of knowing if the system was working properly.

The fact that Arthur could utilize the station's radios from his home caused some anxiety among the Cedar Rapids operators. They decided to install a red light on his phone line into the station to alert them when he dialed. By chance he discovered it one Sunday morning, and asked what it was for. When told, he just laughed, and joked that he would find a way to get even.

Arthur's intent was for the HF/SSB networks to maintain communication at 90 percent effectiveness or better.

His hope was that the U.S. forces could have two or three networks similar to the SAC system, perhaps world-wide systems for the Navy and Army as well. Arthur saw that possibility as providing a fantastic system.

As it was, the system he and his engineers conceived and implemented for SAC can be regarded as one of the key deterrents which helped preserve a status of detente between the U.S. and Soviet Union in some of the most tense years of the Cold War. The fact that the U.S. had such communications capability helped to restrain aggressive intentions by the Soviets.

The station at times became involved in some of the cold war "games" which went on between the U.S. and Soviet Union. During overseas presidential flights, the Soviets tried to create radio interference on communication frequencies being used by Air Force 1. At least once the Liberty operators beefed up the ground-to-air transmitting power to nearly 300,000 watts to drown out the interference. That brought an admonition from Arthur.

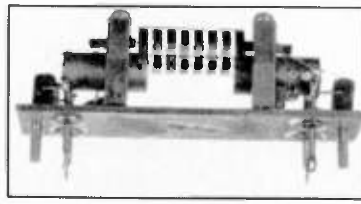
Backing up presidential flights and military operations became almost routine for the Cedar Rapids station. It also helped many military pilots who had trouble communicating through normal channels.

One such incident happened with Roger Chaffee, a Navy pilot before he became one of the three astronauts killed in a tragic Apollo launch pad fire at Cape Kennedy in January, 1967. Chaffee recalled a Navy exercise when he was flying an A3D, equipped with a Collins-built HF SSB radio.

*I remember I was leaving the Azores Islands about one in the morning, going back to Bermuda. It was a pretty bad night, a lot of thunderstorms around with severe rain and hail and lightning. It was a nasty night to be flying. About 30 minutes after takeoff from the Azores I was supposed to make a position report to New York overseas control. Well, I tried to get through on their frequency. With all that electrical interference, I heard just one big crash and bang and static. It was impossible to get through. I had been trying to call for about an hour and a half, and I was about half way between the Azores and Bermuda when out of the blue comes a real clear voice. I thought this guy must be flying wing on me to talk that clear. It really was just like somebody sitting in a chair next to you. He called my side (call) number and gave his name. First, I thought, I have never heard of this name from this operation that I am on — I don't think I will answer him. So I just sat there and wouldn't answer.*

*Arthur Collins, Frank Dyer, Jim Flynn and Walt Bigger checking out the microwave system for Continental Oil Co. at Ponca City, Oklahoma. Below, one of many Collins microwave transmission sites.*

*Arthur and Slim Dayhoff working on Mike Collins' Volvo in the Collins home garage grease pit.*



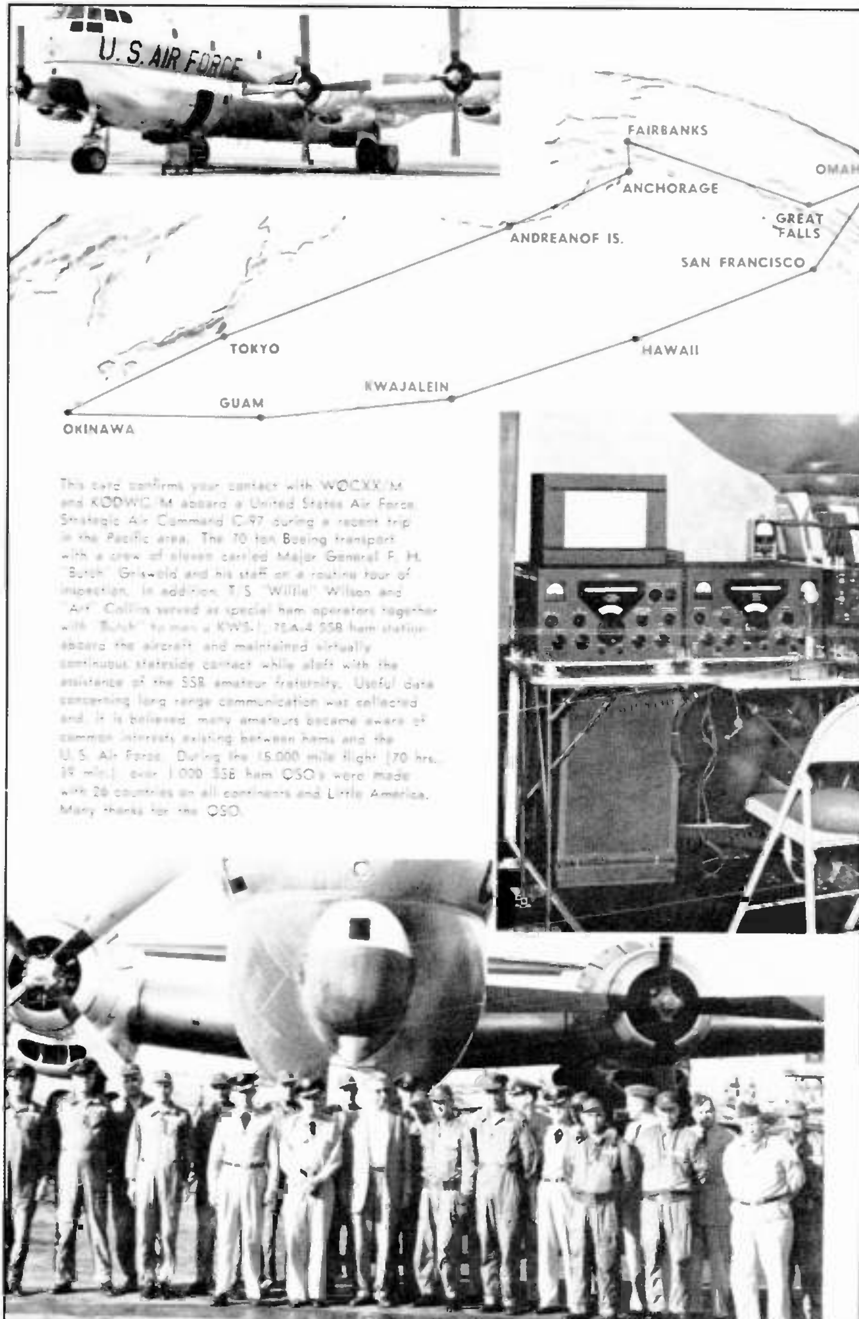
*Ted Hunter testing Permeability Tuned Oscillator. At right, Mel Doelz and the Mechanical Filter.*

*Arthur in his Cedar Rapids home ham shack, using a 32V-1 transmitter and 75A-2 receiver, about 1950.*

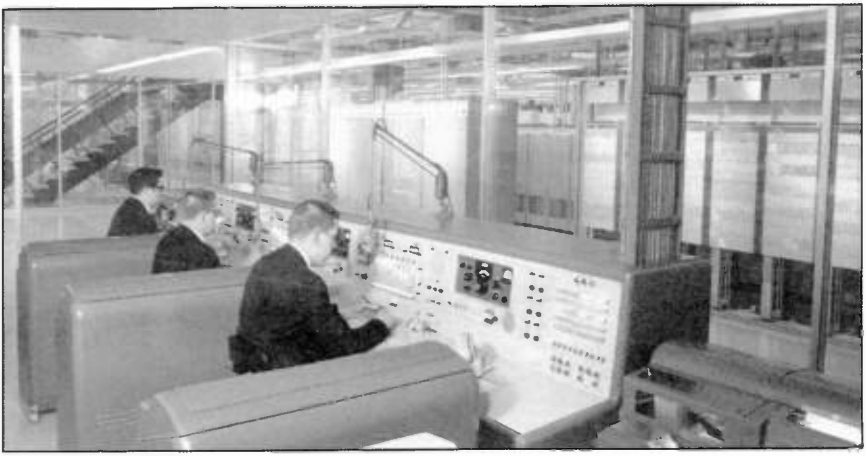
*The 45A was a highly popular Collins amateur transmitter introduced in 1935.*

*General Curtiss LeMay with Arthur Collins when the Air Force was testing the revolutionary Collins single sideband equipment.*

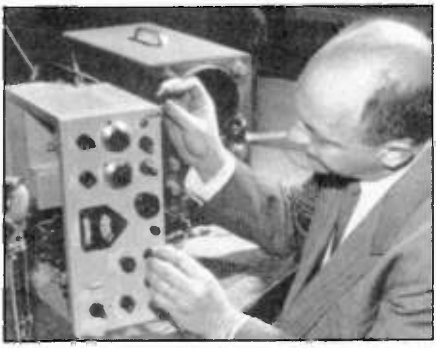
*Arthur and Maj. Gen. Francis (Butch) Griswold on one of the polar flights to prove single sideband effectiveness for SAC operations.*



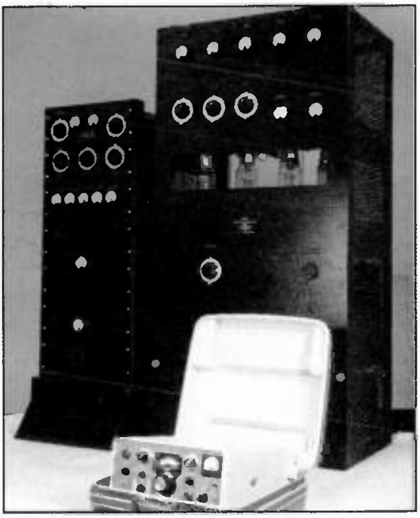

*The QSL card commemorating the first Air Force single sideband test flight in March, 1956. It showed the route flown and bases where the big C-97 Stratocruiser landed, the Collins KWS-1 and 75A-4 single sideband radios used, and the aircraft crew and radio operators including Arthur Collins.*



*The Communications Central radio station in Cedar Rapids, which played a role in many historic events from the 1950s to 1970s. Large 45KW transmitters are visible beyond the operators.*

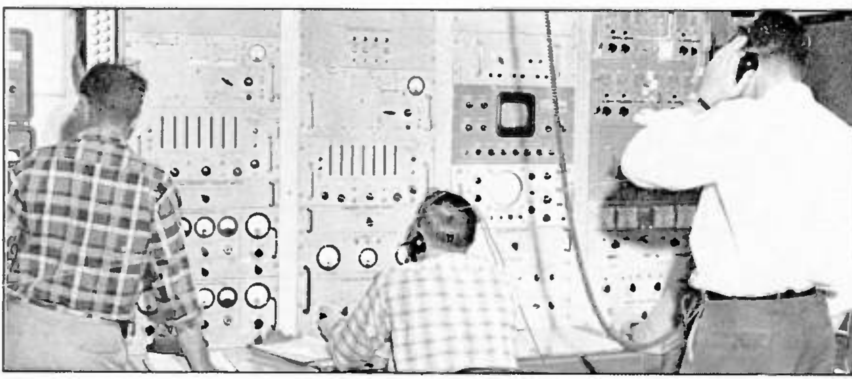


*Above, Gene Senti and the KWM-1, first amateur transceiver. At right is a blue suitcase KWM-2, shown with the 1933 Byrd transmitter. The KWM-2 was widely used by the military as well as by amateurs.*

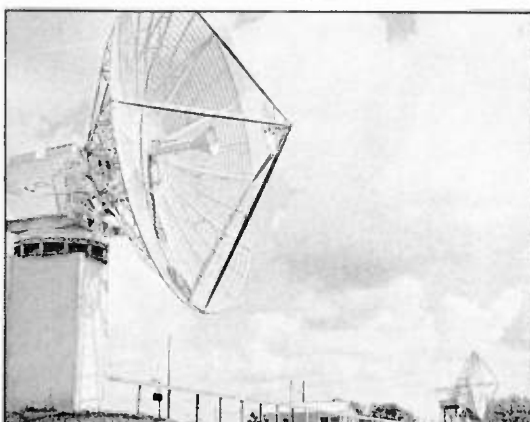


*The KWS-1 transmitter, left, and 75A-4 receiver, the first Collins amateur single side-band radios.*

*Navy officials inspect a shipboard installation of the Collins Radio Sextant, a major development in navigation capability in the 1950s.*

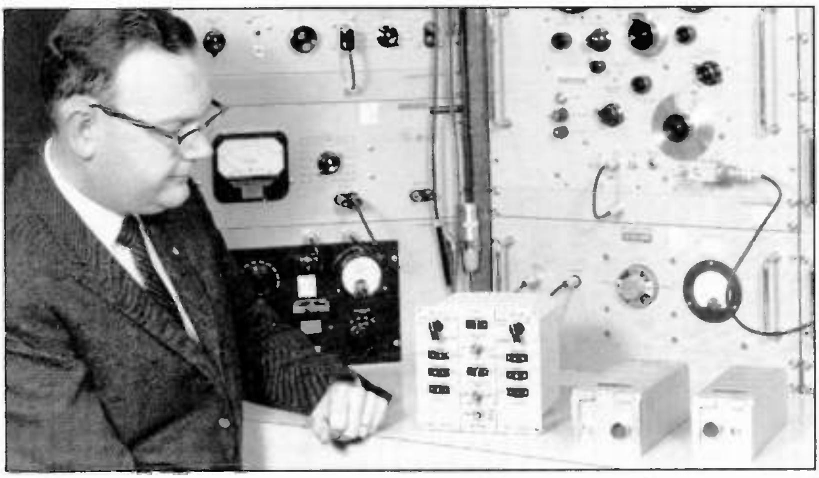


*Echo I satellite tracking equipment being operated by engineers and technicians at the tracking station north of Cedar Rapids.*

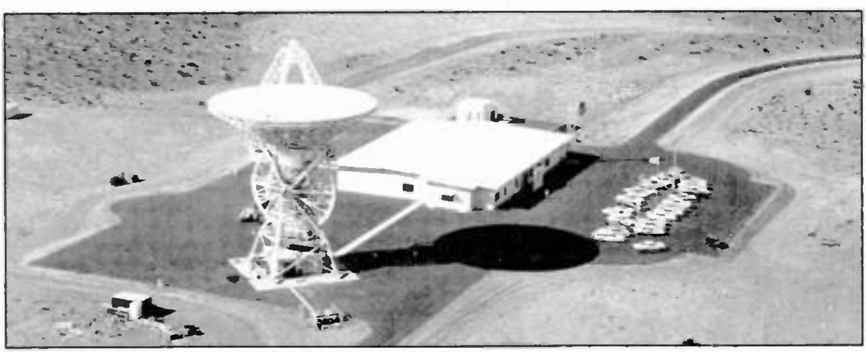


*Tracking antennas at the Cedar Rapids station, used in transmitting the first picture ever sent through space, that of President Dwight Eisenhower.*

*Collins Engineers Gene Habeger, left, and Arthur Wulfsberg, right, with Astronaut Scott Carpenter and Mercury spacecraft communication equipment.*

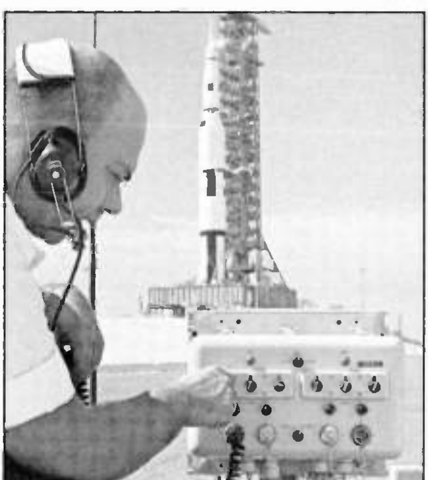


*The Collins-built voice communication equipment for the two-man Gemini spacecraft.*



*The giant 85-foot-dish Goldstone tracking station in California, used for Apollo missions and deep space probes.*

*The Apollo Command Module communication system, being tested by Collins engineers in Cedar Rapids.*



*One of the communication stations provided by Collins for the Kennedy Space Center launch complex.*

*Astronaut Ed White observes test of spacecraft communication system during visit to Cedar Rapids.*

*In a couple of minutes he came back again. He gave his call sign again and said, 'I have a phone patch to New York Center. They are wondering where you are. I will relay for you if you read.' Well, then I knew what the story was, so I came up on my HF and talked to the station. I was probably a thousand miles east of Bermuda at the time. The station I was talking to was the HF single sideband station up at Cedar Rapids, Iowa, at Collins Radio Company. They patched me into a telephone line, and I communicated with the New York Center. I gave them my position report and let them know everything was okay, my flight plan was normal, by going clear to Cedar Rapids and back to New York. So that gave me great respect for HF and SSB.*

The station became involved in many other unique flights and activities, assisting them with what at the time was the world's most advanced communications system. The station eventually became known over the air as "Liberty."

One such event was a record-setting scientific flight in November, 1965, called the Rockwell Polar Flight. It involved a Flying Tigers Line 707 jet aircraft flying around the world over both poles. The aircraft had continuous radio contact with the Cedar Rapids station throughout the three-day flight.

In the spring of 1966 a round-the-world flight of a business jet, a Rockwell Standard Aero Commander, was in the planning stages. One of those making the flight would be the noted entertainer, Arthur Godfrey, and the Collins station was lined up for communication.

However, a rival jet aircraft manufacturer, Bill Lear, upstaged the Godfrey flight by three weeks with a hurriedly-planned world flight of a Learjet. He also depended upon the Collins station to maintain contact with the aircraft, which had a Collins 618T SSB transceiver strapped in the baggage rack.

Other world flights supported by the station included one by Aviatrix Ann Pelegrino to commemorate the exploits of Amelia Earhart, and a solo small plane flight by Max Conrad, the "Flying Grandfather."

The Liberty station also maintained contact with the Plaisted Polar Expeditions of 1967-68, in which a Canadian-American team equipped with KWM-2s reached the North Pole by snowmobile.

Another involvement was with the ice-breaking oil tanker Manhattan traversing Arctic seas in 1969 to reach newly discovered northern Alaskan oil fields. During a three-month voyage from the East Coast to Alaska and back, the ship and station operators communicated several hours every day. The Humble Oil Company of Houston, owner of the tanker, was tied in on much of the message traffic.

No corporate aircraft ever had as sophisticated radio communication systems as did the Collins company airplanes. The Liberty station maintained contact with the aircraft at all times, even on overseas flights.

And whenever Arthur was aboard one of his boats in the Texas gulf or California coastal waters, he had radio contact with his plants and offices through the station.

In the days before cellular telephones and satellite communications, the Collins SSB systems represented the most advanced techniques available. Over the first 15 years of operation, the Cedar Rapids station achieved well over 95 percent reliable communication with all parts of the world.

As with many of his achievements, Arthur Collins did not invent HF single sideband, and he certainly did not single-handedly develop it into the practical system it became.

But he provided the technical vision and the means to make that happen, and he truly revolutionized short wave radio as it had been to that time. It was his leadership which made the prediction of years earlier come true — of how single sideband would change radio communication. And, as with other technology achievements by Arthur Collins during his career, he had detractors who said he would not be able to do what he did.

After the initial single sideband developments at Collins in the early to mid-1950s, the company realized hundreds of millions of dollars in SSB equipment sales. It also was the unquestioned leader in HF/SSB for many years.

Not all sales of the new single sideband communications technique came easy, however. In the early 1960's Arthur Collins was trying to get commercial airlines to adopt SSB, primarily the U.S. and overseas carriers flying international routes. They were the ones needing long range, high frequency communications for flights over oceans and remote areas. The shorter range VHF (very high frequency) communications serving domestic air routes did not reach those areas.

SAC Generals LeMay and Griswold, thoroughly sold on SSB to communicate with aircraft around the world, also wanted the airlines to have single sideband equipment. They saw such capability as enhancing the SAC system in the event of a war.

The airlines were reluctant to adopt the new technology because some of them hoped satellite communications soon would be available, and they could avoid the expense of replacing conventional HF equipment with SSB gear.

To help convince them of what single sideband had to offer, SAC decided to arrange another airborne demonstration.

Invited to go along were the communications officers of most of the major airlines, including Pan Am, Delta and Eastern, and an official of Aeronautical Radio, Inc. (ARINC), communications organization serving the airlines. All of the communications executives also happened to be hams.

Arthur Collins planned to be on the flight, but a last minute conflict forced him to delegate a representative, C.S. (Chuck) Carney, manager of Collins' amateur product line department.

The end result was that most of the airlines bought single sideband sets which Collins had developed for commercial aircraft. It was almost 15 years later before air carriers had access to satellite communications.

For the commercial aviation side, Collins introduced its first single sideband transceiver in 1959. It was the 618T, a 28,000-channel, 400-watt radio. It also provided 100 watts of conventional AM. The radio soon replaced many Collins 618S-1 HF-AM transceivers in air transport aircraft. In a 1960 demonstration to the Military Air Transport command, a 618T was installed in an Air Force plane just a few hours before a flight from the U.S. to Europe and back. The radio performed perfectly on the flight, was removed and installed on another aircraft and produced the same results on a second trans-Atlantic flight. The 618T also found many more uses than in commercial and military aircraft. It became a part of numerous mobile and fixed base military systems. Versions of the radio remained in production for 20 years.

In the late 1950s the U.S. Navy began to equip its entire fleet with special single sideband marine radio sets designed and built by Collins. The SSB equipment met a need of the nuclear age for modernized, reliable long range communications with ships having to be dispersed over vast areas.

Another interesting project was White Fox, in which Collins-built SSB radio stations in Norway served as the main communication system of the North Atlantic Treaty Organization's Arctic defense network during the Cold War.

NATO had Collins SSB stations in Norway, Denmark and the Faroe Islands.

Through continuous advances in single sideband equipment design, the original 28,000 SSB communication channels (based on 1 kilohertz channel increments) became 280,000 channels (0.1 kilohertz separation.)

By the early 1960s Collins Radio offered a wide variety of single sideband transmitters and receivers for amateur, commercial and military applications. Transmitters ranged from 2.5 to 45 kilowatt systems.

One of the receivers was the 51J-4, a sideband version of the 51J series, considered a classic among general purpose communication receivers since 1949. The 51J was a receiver covering both the broadcast and high frequency radio bands, ruggedly built and providing accurate reception in all types of climate and the vibration of vehicle and shipboard installations. It also was widely used in non-mobile stations. Tens of thousands of 51Js were built and used in more than 30 countries. They provided communications for mining, logging, petroleum and agricultural work as well as military applications. They provided exceptional service for U.S. military forces in both the Korean and Vietnam conflicts. The U.S. State Department and intelligence services used banks of 51Js to monitor broadcasts from the Soviet Union and other Communist bloc nations. It was another of the Collins-built radios which played a role in the communication of historic events around the world.

An advanced new smaller and lighter-weight version of the 51J was the 51S introduced in 1961, resembling the ham gear S-line in appearance. Ed Andrade, who had been chief engineer on the fabulous KWM-2 amateur transceiver, also headed the 51S development. *Art saw that a 51S could utilize transistors to cut the size and weight after looking at a home-built version of a receiver I had made,* Andrade said. Thus the 51S became the first Collins receiver to have transistors in it. *While we could not make it an all-transistorized unit because many of the transistors of the time were not yet ready for that kind of duty, we did use some in the audio gain section. The fact was we had to do that — there just was not enough room for any more tubes,* Andrade recalled.

Single sideband versions of famous Collins Number 32 general purpose HF radios also were developed, designated the 32RS-1C and 1H. One application was in Brazil, providing the only multi-channel radio communication link for the nation's president and his staff between the new inland capital of Brasilia and the old capital in Rio de Janeiro.

Sideband capability led to contracts for various vehicle-mounted military SSB radios. One of the first was the AN/TRC-75 transceiver, installed in Jeeps for the Marine Corps. The Australian armed forces ordered a modified version of the TRC-75 to install in Land Rovers.

In 1961-62 Collins completed work on a SSB network linking the headquarters and all regional offices of the U.S. office of civil defense.

Eventually single sideband capability extended to compact back pack units carried by soldiers — the ultimate in a mobile long range radio technique until satellite links became available.

# Chapter 11
# Collins Radio and Space

The world was jolted into the space age on a Friday night, October 4, 1957, when news bulletins announced the Soviet Union had launched a satellite into orbit around the earth.

Later that night, or possibly early the next morning, Arthur Collins stood before a group of his top executives in a company conference room and asked, "How could we have allowed this to happen, and what are we going to do about it?"

One vice president, like the others roused from sleep and hastily summoned to the plant for the meeting, recalled what he hoped they would do was to go home and back to bed.

About all Collins could do was to monitor and record radio beeps from Sputnik. Collins engineers, both in Burbank, California and Cedar Rapids, succeeded in doing that in the next few days. Sputnik's signals were heard over the 20 and 40-megacycle bands.

The initial success of the Soviet Union in space achievements triggered Arthur's competitive nerves. He did not like to see his company or the United States running second in any technology race.

Well before Sputnik, Collins Radio Company was into space programs, much of the work related to the vital functions of tracking and communications.

But despite Arthur Collins' concern about space, it was ironic that the achievements for which his company became best known to the public, the communication systems aboard the Mercury, Gemini and Apollo manned spacecraft, were programs which he left up to other trusted executives and engineers to carry out. He did not get involved in developing the hardware for those programs.

The first U.S. satellite to go into orbit was the grapefruit-size Explorer I launched January 31, 1958. Preparations for launching United States artificial satellites and following them in orbit required an extensive ground tracking system. Particularly important were stations in the Caribbean and Atlantic, down range from the Cape Canaveral, FL launching base. Collins helped build or equip 11 tracking stations for NASA and the Air Force between 1958 and 1963, used for unmanned satellites and the Mercury and Gemini manned spacecraft programs.

Communications equipment supplied by Collins at those stations also played a vital role in keeping the technicians tracking the missiles in touch with mission control and the other stations. Collins VHF systems were used to interrogate and receive data from satellite telemetry transmitters.

Collins first became involved in research associated with upper reaches of the atmosphere and outer space shortly after World War II, working in the relatively new field of radio astronomy. Soon after the discovery of solar radio waves, Collins engineer-scientists sought to apply that finding to the creation of a practical navigation technique.

That led to the company's development of a precision tracking device called the radio sextant, termed *one of the most significant advances in the history of navigation*. It was an answer to the age-old problem of mariners when skies were overcast and they were unable to view the sun with a hand-held optical sextant to know a ship's position.

The radio sextant detected microwave energy emitted by the sun to give ocean vessels an accurate navigation system in all types of weather. Much of the work on the sextant, which was under contract with and tested by the U.S. Navy Bureau of Ships, was done at the Feather Ridge Laboratory near Cedar Rapids. Two of the main experimenters for Collins were Dr. Gene R. Marner and Dr. Dale O. McCoy. Continuing development resulted in a more advanced radio sextant which could detect radio energy from both the sun and the moon, permitting day and night navigation for ships with the method.

Another contemplated application was to couple the sextant with an inertial navigation system for nuclear submarines. The intent was to allow submarine crews to know their precise location at all times, and not have to surface to establish a position before firing a missile.

In 1950 the company constructed the *Big Ear* for the Naval Research Laboratory, located on the Potomac River just south of Washington, D.C. The purpose of the antenna, the largest parabolic reflector ever built to that time, was to detect radio waves emitted by the sun and other celestial bodies. The 50-foot aluminum dish was built in sections in Cedar Rapids, shipped east by rail, and erected on the roof of the Research Laboratory building.

That marked the beginning of extensive involvement in ensuing years for Collins Radio in space listening and tracking, furnishing equipment for some of the world's largest facilities.

One of those was the giant 85-foot dish antenna station of the California Institute of Technology Jet Propulsion Laboratory at Goldstone Lake, CA. Collins did not build the dish or its mount, but supplied highly sensitive tracking receivers, 15 racks of data display, telemetry, instrumentation, recording equipment and the control console, plus antenna feeds and the servo amplifier for the reflector mount. Collins also constructed buildings and roads at Goldstone. The Goldstone tracking equipment was used in many space programs, including reception of data that helped determine the location of the Van Allen radiation belts. The Pioneer IV probe launched in 1959 was tracked by the station to a distance of 407,000 miles in space, a record at that time.

The U.S. Army's first successful space probe launched from Cape Canaveral in December, 1958, was tracked by a down-range dish antenna station at Mayaguez, Puerto Rico, designed and constructed by Collins. The highly sensitive receiving equipment was capable of picking up signals from low power satellite transmitters out to 50,000 miles. The Goldstone site also helped track the Army space probe.

Later Collins provided construction services for another huge antenna installation at Araceibo, Puerto Rico. It was a gigantic dish which did not rotate but remained stationary as it pointed out toward space from its location in a natural depression.

In November, 1951 Collins had been part of an experiment that produced the first intelligible message transmitted through space. It was reflected off the surface of the moon.

The signals which made that possible were generated by a huge ultra high frequency radio tube called the Resnatron, used in a 20-kilowatt transmitter. When the moon was in the proper location, the signals were transmitted through a 75-foot-long funnel-shaped antenna made of chicken wire. It was located alongside the Collins hangar building at the Cedar Rapids airport. About two and one-half seconds were required for the coded 418-megacycle signal to be transmitted to the moon and reflected back to earth. The signal was received some 800 miles from Cedar Rapids, by a receiving station of the National Bureau of Standards at Sterling, Virginia. The achievement was considered an important step in what then was still an uncertain area — sending and receiving communications through space.

A follow-up program several years later based on the first moon bounce was a cooperative effort by Collins and the U.S. Army. That involved a series of tests using the moon as a passive relay for UHF radio-teletypewriter transmissions from various stations on earth.

Another space-related activity in which Collins became engaged in the early to mid-1950s was developing guidance systems and fuses for ballistic missiles. It was classified by the government as secret work, so very few people ever knew about it.

After Dr. Alexander Lippisch, who was on the fringe of German rocket work in World War II, came to Collins in 1950, he along with Walter Wirkler and Arthur Collins reportedly dreamed up an idea they hoped might get the company in the missile business. The concept was to develop a missile without a warhead, but which would be so accurate in its flight path it could ram a target flying through space. The idea was suggested to Air Force officials, who showed no interest in it.

But the Collins' quest for missile work brought some subcontracts, developing a fuse mechanism to detonate an atomic warhead for the Bomarc missile, and guidance systems for the Terrier and Trident missiles. The Bomarc was a ground-launched Air Force missile, primarily for air defense. The Terrier was a Navy shipboard missile designed to strike other ships or land targets, and the Trident a submarine-launched ballistic missile, forerunner of the Poseidon and Polaris missiles. Collins also provided equipment for Sergeant, Nike-Ajax, Atlas and Firebee missiles.

By the late 1950s Arthur decided his company should get out of those programs and pursue other space related work. That initiative led to the Project Mercury spacecraft communication system.

In the meantime Collins began to participate in the U.S. X-15 experimental rocket powered aircraft program. The Collins gear for the X-15 consisted of an ultra high frequency communication transceiver, an automatic direction finder (ADF) system, an ADF antenna and a cockpit control unit. They were basically the same types of equipment built by Collins for military aircraft, specially modified for the X-15 missions.

The X-15 program, a joint effort of the National Aeronautics and Space Administration, Air Force and Navy, began about 1954. Three X-15 aircraft were built and used in the project. They were 50 feet in length with 22-foot wingspans, carrying a single pilot, and capable of climbing to the edge of space, higher than any manned aircraft had flown.

The X-15 was carried aloft under the wing of a B-52 bomber to about 40,000 feet altitude. Separated from the B-52, the pilot ignited the rocket engine and began his climb above the earth. After fuel was expended the aircraft glided to a landing at the Edwards dry lake bed in southern California. A total of 199 test flights were made by X-15s from 1959 to 1968. The maximum altitude reached was 354,200 feet and the top speed attained was 4,520 miles per hour. The project results were particularly helpful in planning the Apollo and Space Shuttle programs.

Another interesting space-related venture by Collins engineers involved the Echo balloon satellite in 1960. Echo was a huge aluminized Mylar plastic sphere, boosted aboard a rocket into orbit, then inflated to 100 feet in diameter to form a fragile but highly visible satellite. Orbiting at 16,000 miles per hour and 1,000 miles high, Echo was seen by millions around the earth in nighttime hours as it travelled across the sky.

NASA had established Echo as a research project and invited industries to join in. Collins Radio engineers took advantage of the opportunity and conducted some noteworthy experiments.

Collins utilized two tracking facilities. One was at Richardson, Texas, then a modest sized suburb on the north edge of Dallas. The other was a site a few miles north of the Cedar Rapids plant, on the highest point of ground in Linn County, Iowa. It became known as Echo Hill. The Richardson station had a 40-foot dish-shaped antenna to receive signals, and a 28-foot antenna for transmitting. The Cedar Rapids station had two 28-foot antennas. The Echo tracking teams pointed the antennas toward the known orbital path, located and locked onto the satellite by means of radio signals. Antennas then pivoted slowly to follow Echo from horizon to horizon on its passes around the earth.

On the day after Echo went into orbit, engineers at the Richardson and Cedar Rapids stations carried on *loud and clear* voice communications, their radio signals reflected by the orbiting balloon in the first known two-way voice transmission via an artificial satellite.

About a week later another experiment was tried with wirephoto equipment of the Associated Press, modified to transmit by radio. A photograph of President Dwight D. Eisenhower, which had been taken the day before in Washington, was transmitted through space from Cedar Rapids to Dallas by way of Echo. The photo then was distributed by the Associated Press and appeared in almost every

U.S. and many foreign newspapers and news magazines. It was the first picture ever sent through space. Besides voice and wirephoto transmissions, Collins collected a vast amount of scientific data from Echo.

By the 1950s Collins Radio Company was the acknowledged leader among firms in the world in radio communications technology. If any government or industry customer had a communication need or problem, Collins Radio Company was the source to turn to for an answer.

Thus it seemed Collins was the logical choice to provide the radios for America's first manned space flight vehicle, and that is the way it turned out, even though there was intense competition.

A year after the launch of Explorer I the National Aeronautics and Space Administration was well into plans for the first U.S. manned spacecraft program, known as Project Mercury.

In January, 1959 NASA selected the design submitted by McDonnell Douglas Aircraft Corporation of St. Louis for a space capsule to carry a single astronaut into orbit and return him safely to earth. McDonnell had a team of subcontractors lined up to provide various systems for the spacecraft, and that team included Collins.

Unfortunately, as in the case of Sputnik and Explorer, the Russians also won the race to put a man in space. While NASA was pressing to achieve the first Mercury manned launch, the Soviet space ship Vostok I carried Cosmonaut Yuri Gagarin on a single orbit around the earth April 12, 1961.

With Americans embarrassed by the Russians' ability to stay one step ahead in those first years of the space age, the U.S. climate was one of trying to hurry up, catch up and get ahead. That was reflected in the Collins' proposal to design and build the Mercury communication equipment. It was only 10 pages long, unlike later programs requiring volumes of detailed descriptions, pricing and other data.

On May 5, 1961, less than a month after Gagarin's flight, U.S. Astronaut Alan Shepard made a 15-minute sub-orbital flight to become the first American in space. Astronaut Virgil Grissom made another sub-orbital flight in July, 1961, and then a Mercury capsule carrying John Glenn orbited the earth three times in a five-hour flight February 20, 1962. Other flights of three, five and 21 orbits completed the Mercury program.

The Mercury capsule was small and compact, just six feet wide at the base, and weighed 4,000 pounds, a large lifting job for rockets at the time but small compared with payloads of later years. Inside Mercury it was a snug fit for an astronaut clad in a bulky space suit.

The radio equipment had to be small and lightweight, too. It provided communication for launching, flight and recovery phases of a mission. The functions included two-way voice communication between the astronaut and mission control; telemetry transmission of scientific and aeromedical data from launch through recovery to give mission controllers information on the astronaut's physical status and various spacecraft systems; tracking of the spacecraft while in orbit, and the recovery phase communications.

Both HF and UHF radios were used. The primary orbital voice communication link was UHF. The spacecraft UHF transmitter-receiver had two watts output power. A backup UHF communication set transmitted with a half-watt of power. Orbital communication also was possible with an HF transmitter-receiver, which operated with 10 watts output power. Communication was primarily HF during recovery operations, when the spacecraft had parachuted onto the ocean. C-band, S-band and VHF equipment also was part of the system for precision tracking. Antennas were housed in a fairing at the top of the capsule, part of it blown away after re-entry to expose the rescue beacon antenna, which popped up after being stowed in a flat position.

Collins built the radios and cockpit control unit with a number of sub-contractors contributing the other equipment for the system.

About 60 Collins engineers had roles in the Mercury program. The design teams faced major challenges in the size of the radios —about three by three by seven inches — and keeping them lightweight. They also had to be built to overcome the shock and vibration levels encountered during launch and re-entry. Discrete transistors and other solid state components were used. An inert plastic substance then was poured over the entire assembly. When it dried and hardened, it held everything in place, a technique known as foam encapsulation. Another Mercury requirement was a dual system of two of each type of radio, assuring communication would continue if a radio failed.

The Mercury spacecraft communication operated reliably throughout all the flights.

When the Mercury program was barely underway, in May, 1961, President John F. Kennedy proposed the bold program that became known as Project Apollo, designed to land a man on the moon and return him safely to earth *before the decade is out.*

With less than 10 years to meet its goal, NASA moved forward rapidly on Apollo. By late 1961 North American Aviation had been selected to produce the three-man command module spacecraft which would fly men to and from the moon.

Collins Radio Company was named one of the major subcontractors, to provide the communication and data system for the Apollo spaceship.

It was announced as a $40 million dollar contract, largest single contract in Collins Radio history. By the time the project was completed about eight years later after many revisions and additions, the total amount was closer to $140 million.

For about eight months, a Collins team of engineers, technical specialists and contract personnel from Cedar Rapids, Dallas and Newport Beach worked on the proposal which won the Apollo award.

Roger Pierce, first hired at Collins in 1934, had been project engineer on the Mercury communication system and helped spearhead the Collins' proposal effort for Apollo. Pierce recalled that some persons thought Collins was betting on the wrong horse to team up with North American in hopes of winning the spacecraft program. North American already had a major part of the Saturn V rocket which would launch Apollo, and aerospace industry observers were skeptical of the firm's chances to have leading roles for both the rocket and spacecraft.

Pierce also remembered that Arthur Collins, having let others in the company be responsible for space work, was unaware of the bid work for Apollo. That had proceeded under authorization from other top executives, primarily Robert T. (Bob) Cox, then vice president and general manager of the Cedar Rapids Division.

When Collins received word of the Apollo award, Bob Cox remembered walking into Arthur's office to deliver the news. He also alerted him that a North American management team would be arriving in Cedar Rapids the next day and would expect Arthur's participation in the meeting. Members of the Collins Apollo team were quickly summoned to give a two-hour briefing to the company president and chairman. Cox recalled that Arthur did his part very well, but that the space work was not his priority interest.

Throughout the years of the Apollo program Arthur kept abreast of progress and problems through his top executives, but never took an active role. He certainly was concerned that the program succeed and that the company perform well on its contractual obligations. He also had an interest in the technical designs, and there were many design challenges faced and solved in both the spacecraft hardware and specialized test equipment in the course of the project. But he felt the Apollo program was in capable hands, and preferred to concentrate his energies on other work in the 1960s, mainly his computer and data communication projects.

Before advancing from Mercury to Apollo, NASA needed an interim program to develop additional technology for a moon landing. That program was Gemini, a two-man spacecraft, also designed and built by McDonnell Aircraft. Gemini was similar in shape but about twice as large as Mercury, with separate hatches for each astronaut.

Collins had a smaller but still one of the most vital roles in Gemini, that of voice communications between spacecraft and earth, and intercom for the two astronauts. Like Mercury, Gemini used UHF for the primary voice link and HF as backup. The system consisted of dual UHF and HF transceivers and a control unit.

The radios were slightly larger and heavier than the Mercury transceivers, and were built with the same manufacturing techniques. One difference was the Gemini radios had to meet stricter environmental standards, being installed in an equipment bay outside the pressurized pilot compartment. The control unit was mounted in the center of the instrument panel.

NASA conducted 10 Gemini flights in 1965-66. On Gemini 4 Astronaut Edward White made the first *space walk* outside the pressurized cabin. On flights 6 and 7 two spacecraft performed rendezvous maneuvers, and on flight 7 Astronauts Frank Borman and James Lovell spent 14 days in orbit. Collins equipment again had a record of successful performance on all Gemini flights.

When work began on the Apollo communication and data system, there was uncertainty whether television could be transmitted from the spacecraft and moon to earth. NASA officials were concerned that TV would take up too much of the transmitted signal bandwidth, depriving them of vital medical data on the condition of the astronauts and essential technical information on the performance of spacecraft systems. But as the program development unfolded, Collins engineers including Roger Pierce determined that downlink transmissions could handle all the necessary flight data and voice communication as well as TV. They were able to convince NASA of that and gave the space agency one of the most spectacular public relations tools of any exploratory venture in history.

Collins built a full-size mockup of the Apollo Command Module in a Cedar Rapids laboratory. One of the main purposes of the mockup was to show how the communication equipment units and wiring fit into the spacecraft. The mockup also proved valuable in demonstrating how TV could be transmitted.

The functions of the command module communication and data system were:

To transmit and receive voice communications between astronauts and earth ground stations.

To transmit and receive telemetry data between the spacecraft and ground staions. That included both data on the physical condition of the astronauts and data on how spacecraft systems were performing.

To receive and automatically retransmit signals giving mission controllers on the ground the position, course and velocity of the spacecraft.

To transmit television signals from spacecraft to earth.

Intercommunication between astronauts inside the command module.

Recording of voice and data during periods the spacecraft was not in contact with earth stations, such as when it was behind the moon, and transmitting the recorded information once communication was re-established.

Transmitting radio beacon signals and voice communication from the spacecraft for recovery and rescue operations after return to earth.

Communication between the command module and lunar excursion module (LEM), also relaying communications for the lunar module with earth.

Systems for the manned spacecraft had to meet some of the most rigid reliability standards ever established for electronic equipment. NASA's initial plan for Apollo communications equipment called for an *inflight maintenance* provision, meaning astronauts would make repairs with on-board spare modules in case of a failure.

That plan was soon abandoned, because of the weight of spare parts and other problems, and a redesign of all the equipment implemented. The second configuration, which was used in Apollo missions, specified a feature called quad-redundancy. That technique required equipment be designed to include up to four possible circuit paths for a radio signal. If one circuit was faulty, automatic switching to a back-up circuit occurred. The new design also reduced the size and weight of equipment significantly.

The main frequency band used for Apollo was S-band. The term S-band refers to a group of frequencies in the microwave area of the radio spectrum. For Apollo the frequencies ranged from approximately 2106 to 2288 MHz. They were used for all deep space communication and part of the time for near earth communication. Also used during earth orbit was VHF, similar to systems employed for Mercury and Gemini. The average power output of the VHF transmitter was five watts.

S-band was used because the signals lose relatively little strength through the earth's atmosphere, which allowed the use of low power transmitters and comparatively small spacecraft antennas.

Officially the system was called Unified S-Band, meaning that voice communication and several types of data were transmitted simultaneously. TV also was transmitted on the S-band link. Power output levels for S-band transmissions from the spacecraft were 2.5 and 11 watts.

The Apollo communication and data system was a complex, coordinated group of 10 equipment units operating with precision timing to accommodate multiple functions with the highest possible level of dependability. Total weight of all system units was about 200 pounds.

Collins Radio had been selected by North American Aviation, which later became North American Rockwell, as one of its first tier subcontractors responsible for major systems on Apollo. Collins, in turn, had a number of subcontractors supplying various communication system units.

Collins built four of the 10 units in its Cedar Rapids plant. Others were supplied by Motorola Aerospace Center, Scottsdale, AZ; Radiation, Inc., Melbourne, FL; RCA Communications System Division, Camden, NJ; Leech Corporation Controls Division, Azusa, CA, and Rantec Corporation, Calabasas, CA. Collins also supplied sophisticated test equipment designed for the communication system, used by North American and NASA.

The development, manufacture and testing of the Apollo command module communication equipment, and the management of the program required the talents of about 600 persons in all. Probably 300 to 400 Collins engineers had a part in the program, some full time over several years, others for days, weeks or months, depending on their roles.

Also many assembly operators, most of them women, laboratory, electrical test and environmental test technicians, machinists and other metal working specialists were part of the Apollo team.

Subcontractors also had sizeable teams performing their parts in the Apollo program.

The Apollo communication system was not regarded as breaking new ground in a technology sense. That was emphasized by a North American program official who used the phrase, *I want to go to the moon in a Volkswagen*, meaning that equipment designs should be based on techniques known to work reliably, rather than unproven ideas. Still there were many advanced methods applied in manufacturing and administration of the program.

Assembly operators, for example, had to be trained in welding which was used in many instances rather than the traditional soldering techniques for wiring and component connections. The aluminum cases which contained Apollo units were not castings but were milled from solid blocks of metal. Before the metal blocks were approved for use they were subjected to intense X-ray inspection to be sure they were free of flaws or cracks. There was a major effort known as traceability, documenting the history and quality of all components, as detailed as listing where silicon used in transistors had been mined.

The purpose of all such steps, of course, was part of the Apollo objective to do everything that could be done to make equipment as reliable and problem-free as possible.

NASA people who oversaw quality standards had a pet phrase, *We don't punish error; we punish the concealment of error.* Collins once followed that policy when a faulty control on a vibration table caused the equipment being tested to be shaken with far greater intensity than was specified. Although the equipment worked fine after the test, Collins engineers finally junked the unit rather than take a chance that possible damage had occurred which could have affected performance later.

The paper trail in managing a program of the magnitude of the command module communication system was massive. Much of the responsibility for Collins in that area fell upon James L. Westcot, the program administrator. Westcot recalled that a method new at that time called PERT (Program Evaluation and Review Technique) was employed to track the many planning steps and scheduling of work. Initially the NASA version of PERT, run on 1960-era computers, was slow and sometimes six weeks late in analyzing information. That led Collins to devise its own PERT program to maintain up-to-date records, which NASA people did not appreciate. Finally a new planning system was initiated which solved the problems.

The Collins program manager for the communication and data system was Arthur Wulfsberg, a veteran engineering department head who had joined the company during World War II after earning an electrical engineering degree from the University of Minnesota. Wulfsberg had been a victim of polio as a boy, which required him to wear leg braces to walk. He was known as a very dedicated, hard-working, firm but fair manager and well respected by his staff.

Among those on the Apollo engineering team were Carl Henrici, who headed subcontracts management, Warren Klehfoth, engineering management, Dick Pickering, systems engineering, Dick Rowland, highly regarded for his knowledge of the total system, and Bob Mitchell. Other key people in engineering, contract management, cost management and manufacturing included Dick Albinger, John Ball, Gordon Butler, Lou Christianson, Bob Colby, John Combellick, Joseph Dahm, Neil Dietrick, John Dutton, Dick Eidemiller, Warren Fackler, Wes Follensbee, Don Green, Lou Goetz, Ralph Hepker, Gerald Hopkins, Vern Jones, Don Krebs, Peck Lasho, Burton Loupee, Joe Maerschalk, Roy Nordstrom, Harold Oates, Richard Odell, Boyd Palmer, Rodney Peterson, Dave Printy, Joe Regan, Carl Seneca, Jim Shanklin, Ruth Spurgeon, Jack Stewart, Murray Stoddard, Joe Stoos, Dale Thran, Dick Valentine, Ed Vinzulis and John Zimmerman.

On several occasions during the Apollo project astronauts visited Collins for review meetings, to give *pep talks* and visit with people involved in the work, and to familiarize themselves with equipment.

In their remarks the astronauts nearly always stated how vital and important space communications are to the success of a mission. After one such talk on the factory floor, it became apparent the astronaut had made a strong impression. A few of the ladies working on Apollo equipment asked to be transferred and several actually quit, fearing if they ever made a mistake their work might endanger the lives of astronauts.

But many more employees wanted to work on the program. They knew what they were doing was a part of history. They felt they were special, being allowed to work on Apollo.

The low point of the Apollo project was the fire inside a test unit command module on the Cape Kennedy launch pad in January, 1967. Three astronauts died in the flash fire — Roger Chaffee, Virgil (Gus) Grissom and Edward White. Collins people felt a special sorrow about the disaster, as Chaffee and White had visited the Cedar Rapids plant a short time earlier and talked with many of them. While Collins equipment was not at fault in the fire, redesigns were called for in almost every spacecraft system to prevent any more such accidents. One change for Collins was to use a different type of wiring with insulation rated totally flame-proof.

The Apollo team, from top administrators to persons with even minimal roles, was a close-knit group, focused on meeting objectives. Many of the key people were on call 24 hours a day. Even line inspectors and foremen got phone calls in the middle of the night to answer questions. There were instances of people working 24 to 36 hours straight to check out problems. Some of the top people called it the 777 program — they often met at 7 a.m. and 7 p.m. seven days a week to discuss progress and review problems.

Apollo was a high priority project. On one hot summer afternoon in Dallas, a group of passengers including Arthur Collins boarded a company plane at Addison Airport for a flight to Cedar Rapids. As the pilot was ready to taxi out to the runway and take off, word came that a part urgently needed for an Apollo radio had just arrived by air at Love Field and was being rushed by car to Addison. Arthur had the aircraft held on the ramp, and sweltered in the heat with the other passengers until the part arrived.

Collins also built a part of the Lunar Excursion Module communication system, as a subcontractor to RCA. It was a multi-function unit called the signal processor, which operated as a focal point to switch and process all LEM voice and data communications, both S-band and VHF.

The command module and LEM communication systems operated to perform voice and ranging functions simultaneously. When the two vehicles were separated, the distance they were apart was calculated by automatic measurement of the time lapse between the transmission of tones and reception of the returned radio signals.

Collins Radio Company did much more in Apollo than the spacecraft communication equipment.

The Dallas division was responsible for the design, construction and installation of the Unified S-band ground station network. This was an all-new tracking and communication network, differing from the stations used in Mercury and Gemini.

The main elements of the network were 14 stations located at strategic places around the earth. Eleven of those stations, equipped with 30-foot diameter antennas, helped provide continuous horizon-to-horizon coverage while the spacecraft orbited the earth. Supplementing the coverage were range tracking ships and aircraft, for which Collins also supplied equipment.

The other three stations were for tracking and communicating with the command module and lunar module when they had left earth orbit and were traveling to and from and around the moon.

The three stations were at Goldstone, California; Madrid, Spain and Canberra, Australia, approximately equi-distant around the earth. The locations allowed at least one station to always have an unobstructed line of sight toward the moon, despite rotation of the earth and movement of the moon around the earth. Each of those stations had antennas 85 feet in diameter.

The 30-foot-antenna stations were at Kennedy Space Center, Florida; Grand Bahama Island; Bermuda; Antigua Island; Canary Islands; Ascension Island; Carnarvon, Australia; Guam; Kauai Island, Hawaii; Guaymas, Mexico and Corpus Christi, Texas. Stations were connected by landline, ocean cable, microwave and satellite communication links to NASA's Manned Spacecraft Center, Houston, Texas and the Goddard Space Flight Center, Greenbelt, Maryland.

*Art did take a special interest in the tracking system,* said Bill Roodhouse, Collins executive vice president *In early years of our space program, the Alpha Division (a Collins special projects organization based in Dallas) had some contracts for some of NASA's first space tracking stations and Art got involved in those. Not to the extent he got involved in programs like single sideband, but he did quite a bit of work on them.*

Still another Collins' role in the Apollo program was an elaborate and complex communication system serving the massive Cape Kennedy launch complex. That facility included the huge 52-story-high Vehicle Assembly Building (VAB), a road called the crawlerway stretching from the VAB to the two Apollo launch pads, mobile towers associated with the launch pads and the control center for checkout and launch.

The gigantic Saturn V rocket stages were assembled vertically atop a huge crawler vehicle in the VAB and spacecraft sections were mated with the rocket. The entire assembly then was moved by the vehicle over the crawlerway to the launch pad.

Tying the entire complex together ws a Collins intercommunication system called RADIC (for RADio Interior Communication.) It consisted of some 2,000 operator stations and coaxial cable links.

The real excitement for Apollo began with the first manned flight in October, 1968, the 11-day Apollo 7 earth orbital mission to check out all command and service module systems.

Then came the thrilling Apollo 8 flight over Christmas, 1968, when three astronauts traveled into deep space for the first time. They made 10 orbits around the moon, then returned safely to earth. That was followed by Apollo 9 in March, 1969 to check out the lunar module in earth orbit. Next was Apollo 10, another flight to the moon, with the lunar module and two astronauts separating from and docking with the command module in lunar orbit.

All those flights set the stage for the Apollo 11 mission, July 16-24, 1969, to fulfill the Apollo objective of landing a man on the moon and returning him safely to earth. Except it would be two men.

Astronauts Neil Armstrong, Edwin Aldrin and Michael Collins lifted off from Cape Kennedy on a Wednesday morning. By early Sunday, July 20, they were orbiting the moon, about 70 miles above the surface. People around the world watched and listened to the dramatic mission events through the Apollo communication system.

Aldrin entered the lunar module about 8:20 a.m., central standard time, that Sunday, with Armstrong following a short time later, and they began checking out the many vital systems. At 12:47 p.m., while on the back side of the moon and out of communication with earth, they separated the LEM from the command module. The LEM dropped a little closer to the moon with each orbit, and the astronauts transmitted televised scenes of the lunar surface.

The next step was the critical descent to the surface. That began with firing of the LEM descent engine at 2:09 p.m. They ignited the braking engine 12 minutes before touchdown.

On the final stage of descent the astronauts realized the targeted landing area was covered with large rocks. They overrode the autopilot and Armstrong manually maneuvered the LEM to a smoother area and a gentle landing at 3:17 p.m. with just 49 seconds of rocket fuel for hovering remaining.

After setting up an emergency take-off procedure, again checking out LEM systems and having the first meal ever eaten by men on the moon, they were ready to step outside.

Armstrong was the first to set foot on the moon, at 9:56 p.m. Aldrin soon followed.

Some 240,000 miles away, millions of people on earth viewed the historic event on television. Armstrong and Aldrin remained on the moon nearly 22 hours, firing up the LEM booster rocket to take off at 12:54 p.m. July 21. After they docked with the command module and rejoined Astronaut Collins, the LEM was jettisoned, the service module engine was ignited to pull away from the moon's gravity and the trio started the three-day trip back to earth.

Like almost everyone, Arthur Collins was glued to the TV set at his Cedar Rapids home that Sunday afternoon, watching with his wife Mary and their two small sons, Alan, 6, and David, 3, when the LEM set down.

Mary Collins recalled that Arthur was so overcome with excitement at what he saw, and marvelling at the clarity of the voices and pictures, *he just whooped.*

Soon after the LEM landed, Arthur drove to the Cedar Rapids airport to fly to Dallas via a company plane.

Keith Rathjen, a Collins assistant vice president closely involved in Arthur's main work at that time, the C-System development, remembers he and Arthur were the only passengers on that flight.

Arthur's new home in north Dallas was still under construction. He and Rathjen drove there from Addison Airport, turned on a TV set and resumed watching the Apollo activities. Rathjen was part of the small group of associates who often stayed with Arthur in his Dallas living quarters while they worked day and night on the C-System.

Arthur watched much of the night, talking by phone several times with Mary, and going outside once to see if the moon was visible. But Dallas skies were cloudy.

He granted a rare interview the next day when a Cedar Rapids Gazette reporter called him, telling of his elation at the moon landing and moon walk achievements.

*I am excited like everyone,* he said. He described watching Armstrong step onto the moon as *a very emotional moment. One of the things you think about is the feeling of accomplishment and personal participation. Everyone in Cedar Rapids should be overjoyed,* he said in reference to those who worked on the spacecraft communication system.

*It was the people who did it,* he said, not wanting to take any personal credit.

Arthur added that he was especially pleased at the quality of the transmissions from the moon. *It certainly was very impressive. It represented a remarkable accomplishment in that it was a narrow band video channel, much less bandwidth than normally required for television,* he said.

Arthur did not tell the reporter about one event of that Sunday night.

Rathjen remembered as they sat watching TV, the phone rang. *Arthur went to another room to talk, and was on the phone a long time. When he finished the call, he never said anything to me about it.*

The next day Rathjen learned more about the call.

Arthur had been talking at least a part of the time to Walter Cronkite, who wanted him to come to the CBS space broadcasting center at Houston and be interviewed about the communication system. But Arthur would not agree. If anyone was to do that, it should be people who worked on the program, he insisted. Besides, Arthur always tried to avoid personal publicity, wanting his company to get the credit for achievements.

So it was that many people who could have learned about the role of Collins Radio Company in bringing voices and pictures from the moon were not made aware of it.

For Arthur Wulfsberg and the Collins Apollo team, Apollo 11 represented a great triumph. *Everything worked as it should, even the lunar landing which was the one element in the entire program that could not be tested in advance,* he said. He noted the feelings of himself and others were elation and success at having done the job they set out to do. *We've gotten an extraordinary level of effort from good people,* Wulfsberg said in reference to the Collins team.

Collins' Dallas and Newport Beach people were equally proud of their roles in the tracking stations and ground communication equipment that contributed to the Apollo mission success.

The second moon landing by men came on Apollo 12 in November, 1969.

Apollo 13 in April, 1970, also was supposed to be a lunar landing mission. But 55 hours into the mission while enroute to the moon, a service module oxygen tank ruptured, damaging fuel cells and causing a loss of electric power to the command module. The crew had to utilize lunar module systems in order to make a swing around the moon and a tense but safe journey back to earth.

Apollo 14, 15, 16 and 17 in 1971 and 72 were all highly successful missions to explore the moon's surface, the latter three involving the lunar roving vehicle. No. 17 was the last lunar manned landing of the Apollo program.

After the Apollo 17 splashdown and recovery in the Pacific December 19, 1972, everyone at Collins Radio Company breathed a sigh of relief. They were proud that equipment supplied by Collins had no failures or problems on any of the missions.

Apollo command module equipment also was used in the Skylab space station missions of 1973-74, and again in the Apollo-Soyuz docking mission of July, 1975 when U.S. astronauts and Soviet cosmonauts met in space. One of the astronauts was Thomas Stafford, who had visited the Collins Cedar Rapids plant several times.

Collins Radio also was scheduled to provide communications gear for one other manned spacecraft program known as the Manned Orbiting Program, or MOL. It was to be a highly classified military project, but was cancelled by Congress.

The firm did extensive work on another joint military service program known as TACSATCOM, for tactical satellite communications. That involved UHF ground terminals ranging from a one-man receiver to a three-man team pack, vehicle, airborne and shipboard systems.

When the U.S. launched its first small, unmanned Explorer I satellite in 1958, it carried instruments which led to discovery of the Van Allen radiation belt around the earth. The belt was named for Dr. James A. Van Allen, head of the University of Iowa physics department, and an acquaintance of Arthur Collins. Van Allen had conceived and directed the experiment.

In years following Explorer I the university was involved in numerous projects aboard unmanned satellites. Among those were the Injun Explorer series for which Collins Radio supplied command receivers and antenna systems. U. of I. physicists also utilized Collins environmental testing facilities on some of their programs.

In the years after the Apollo program, Collins used its space communications expertise to do more work in large tracking stations. Among those was a highly classified antenna facility in a remote area of central Australia, a project of the U.S. and Australian governments known as the Joint Defense Space Research Facility. Bill Weinhardt, who headed Collins construction activities around the globe, recalled the job required building barracks and other living facilities for approximately 300 workers, mostly Australians, who built the antenna station.

# Chapter 12
# BROADCAST YEARS

Commercial radio broadcasting equipment became an early product line for Collins Radio Company.

Arthur Collins started in business building amateur radios, but that was a limited market and he needed more income than amateur sales could produce.

The logical choices for increased business were domestic broadcasting stations and government and industrial short wave communications users. Some of the Collins amateur radios were general purpose units adaptable for those applications.

Commercial broadcasting had its start in the United States in 1920, and grew rapidly. Within three years more than 600 broadcast stations were licensed. There were more than 900 operating by 1940. All of them in the early years, in fact almost all of them until after World War II, were AM stations.

Arthur moved into the broadcast field in a modest way as early as 1933. By 1941, seven years later, his firm was selling more transmitters than any other U.S. supplier.

Arthur made his niche in the commercial radio station field with innovations which enhanced the quality of broadcast transmissions. A high quality signal often was not a certainty for radio listeners in that period. The Collins transmitters also became known for their reliability, with very few failures, and required minimum maintenance. Any equipment failure always has been regarded as a catastrophe in the broadcast business, as it usually puts a station off the air.

One product he designed specially for broadcast stations was the 7B Program Amplifier, introduced in early 1933. The company's product literature, prepared by Arthur, described the 7B as a radically different type of amplifier, *setting new standards in audio transmission.*

Arthur's intense research into the many factors which played a part in radio performance led him to develop major improvements in Class B modulation, first used in his amateur radio products. Radio signals must be modulated to provide various tones and pitches which make them intelligible to listeners. Arthur virtually pioneered the application of Class B modulation to low and medium powered transmitters, and became its leading proponent. He wrote at least two articles for the radio publication QST on the subject, one in 1933 and one in 1935. He noted that, *With Class B operation you can get five to ten times the audio power output possible with Class A operation of the same tubes, and this greater output can be obtained with negligible distortion.* He also wrote that the technique had been widely accepted by amateurs due to its economy and the possibility of getting a lot of power out of small tubes.

An editor's note prefacing his May, 1933 QST article on the subject stated:

*Here we present the long awaited practical information on Class B modulators using a variety of suitable tubes. The many who have requested data on 203As, 211s and W.E. 242As will find the previously unavailable answers in this article. The no less valuable information on proper circuit conditions for distortionless operation will clear up a number of the misconceptions concerning Class B that seem to be prevalent.*

His expertise in Class B modulation, compared with low level Class A grid modulation used in most competitive broadcast transmitters, was achieved with the circuitry he designed and with special transformers.

Broadcast station engineers at first were skeptical about Class B modulation. They felt because it cost less it could not be very good. They also thought it might be all right for voice but not for music.

Arthur's demonstrations soon began to convince many of them of Class B advantages. He also offered by early 1933 a wide range of transformers, enabling broadcasters to match the right transformer to their transmitters, one of the factors in achieving optimum results with Class B modulation. The transformers were made to Collins' specifications by the Chicago Transformer Co.

Some of his early transmitters operating in the high frequency band were used for radio broadcasting in foreign countries. U.S. stations transmitted on very high frequencies (VHF).

One of Arthur's early activities was to modify some of the broadcast transmitters around the Cedar Rapids area, including one at WSUI, Iowa City, to use Class B modulation.

He and his engineers built a model in the laboratory, which worked well. However, when it was hooked up to an antenna, a problem of distortion occurred which Arthur solved by introducing a method known as envelope feedback. Arthur believed that may have been the first use of envelope feedback, utilized not only by Collins but other companies in a variety of applications after that.

Roger Pierce, who began working at Collins in 1934, recalled an early project which typified the "can do" spirit that Collins became known for in the broadcast business.

"Art came to me and said, 'We need to build a transmitter in 30 days.' It was for a friend of his at Station WTAD, Quincy, Illinois who had a construction permit for a radio station and had to get on the air before it expired," Pierce said.

"When I said I doubted we could do it in that short time, Art said, 'Yes, we can,' and explained how by taking the transformer out of the transmitter he had loaned to Admiral R.E. Byrd for his 1934 Antarctic expedition and building a new chassis and cabinet. He told me to get started right away to write letters ordering the parts we'd need. Genevieve Hunter (secretary in the executive office) gave me a quick lesson in how to dictate a letter.

"We got the job done in time and got the station on the air. It wasn't a pretty unit, but later we cleaned up the design and it became the 20C, one-kilowatt transmitter."

The 20C was one of three new broadcast products introduced in late 1935, along with the 300D 100-watt transmitter and 12E Speech Input Assembly.

Bill Stewart was another engineer in the early years of Collins Radio who worked extensively with broadcast equipment. Stewart had earned a EE degree from the University of Arkansas. Like many other graduates during the depression, he did not immediately land an engineering job but continued to send out applications. He was working for the State of Missouri Extension Service when he got a telegram from Arthur Collins in July, 1935 offering him a temporary position of six to eight weeks, to start in two days. Stewart remembers he jumped at the chance to work for Collins Radio, and was assigned at first to testing audio amplifiers. His temporary job became permanent, and he stayed with the company until 1951, both in engineering and marketing.

Stewart helped develop several of the 100-watt and 250-watt transmitters introduced by Collins in the 1930s.

Stewart's wife, Hazel, became a close friend and bridge partner of Arthur's wife, Peg. That led to the two couples being together socially on many occasions. Stewart recalled Arthur would sometimes come into his office late in the afternoon and say, *Well, let's go pick up the girls,* and they would go out to dinner. Arthur, who had a reputation of being a wicked bridge player, and Bill sometimes played bridge with the wives, but not often.

Clair Miller, who first began working with Arthur in the Sixth Avenue house in 1932, did a lot of work on broadcast equipment. Miller, Stewart and several others wore two hats — marketing along with engineering. M.H. Collins directed much of the marketing effort. William J. Barkley, hired in 1935 with the title executive vice president, also sold broadcast products, working out of Washington and New York.

As the broadcast equipment business grew, Arthur branched out from transmitters, transformers and amplifiers to studio consoles and other equipment. One unit was the 12A remote amplifier. This was a portable unit that could be carried by an announcer and engineer to a location away from the studio. It became widely used for broadcasting sporting events and for *Man in the Street* programs which were popular in the late 1930s.

Arthur Collins, while being modest about his own contributions, once noted some pioneering achievements in broadcasting in the Midwest. Station 9BY in Rock Island, IL, which later became WOC in Davenport, was one of the first stations in the nation to carry network broadcasts. Station 9YA at the University of Iowa broadcast some experimental television in 1932 on a carrier frequency of about 2 megacycles.

The Collins broadcast files of the 1930s contained many letters from customer stations expressing satisfaction with equipment performance. One from KWBG of Hutchinson, Kansas stated in the three years since the station went on the air in 1935 with a Collins 300D transmitter, it had operated 16 hours a day without a single transmitter or speech equipment failure, and that *the 12A remote equipment has given the same service and makes remote broadcasts sound like studio presentations.*

The technical director of WHO in Des Moines, Paul Loyet, wrote: *We are very happy to state that after several months' use of our new speech input consoles we have found them to be everything we desire. Considering the fact that these consoles were built specially for Station WHO and and involved a considerable number of new features adapting them to multiple studio operation, it seems to us very little time was lost in the design and manufacture of these units. The workmanship in these consoles is most creditable.*

While Collins had a standard line of broadcast equipment, the firm also accommodated special orders as the WHO letter indicated.

Collins and WHO collaborated in 1937-38 in developing a technique called the polyphase broadcasting system. Warren Bruene, longtime Collins engineer and associate of Arthur, mentioned that activity in a 1980 talk prepared for the Antique Radio Society. Special amplifiers and antennas were designed and built, and the system was tested on the air on an experimental basis, but the project finally was abandoned because it could be used only with an omnidirectional antenna, Bruene said.

Another special project was undertaken for the Republican party's 1936 convention in Cleveland, when Kansas Governor Alfred M. Landon was nominated for the unenviable task of facing the popular incumbent President Franklin D. Roosevelt. Collins built special amplifiers used for Landon's acceptance speech, which was broadcast nationwide. Roosevelt won a landslide victory over Landon that year.

Arthur's company also built a 1,000-watt television voice transmitter in 1938-39 for experiments by Farnsworth Radio & Television, headed by Philo T. Farnsworth, an inventor who held the patent on an electronic television camera tube. Arthur Collins and Philo Farnsworth had a mutual attachment, both having been targets of harassment by the big Radio Corporation of America. RCA had tried to run Collins out of business with lawsuits claiming violations of radio tube patent rights. Farnsworth had faced intense pressure from RCA trying to buy him out. RCA, after spending millions of dollars and several years trying to develop its own television tube, finally decided it needed Farnsworth's tube to implement commercial TV transmission. But Farnsworth refused to sell his company and patent rights and forced RCA to settle for a licensing agreement.

Arthur once commissioned Jack Van Dyke, brother of Peg Collins, to come up with a unique design for a broadcast transmitter cabinet. Van Dyke was a noted artist, a profession which did not always bring in a steady income in depression years of the 1930s. He reportedly did an outstanding job, but the design would have been so expensive to build it was never used.

Roger Pierce had earned an electrical engineering degree from Iowa State College in 1932, and in those depression years finally landed a job with Collins in 1934. In 1939-40 he took a leave to do graduate work at Ohio State University, where he became acquainted and worked with radio pioneer Edwin Armstrong, then doing research at OSU.

Armstrong was the well-known inventor of significant advances in the field of radio including the superheterodyne circuit. Another of his developments, which he began demonstrating about 1933, was frequency modulation (FM). In engineering terms, FM offered a greatly improved signal to noise ratio over AM. To the lay person, that translated into a much clearer, static free radio signal. The industry and public began to get interested in FM broadcasting about 1939-40. At that time the frequency band from 42 to 50 megacycles was allocated for FM.

After Pierce returned to Cedar Rapids, he got Arthur interested in developing a Collins FM transmitter. But before it was completed, work in commercial FM by the broadcast industry including Collins Radio was halted by World War II. To that time only about 40 radio stations throughout the U.S. had applied for FM licenses.

Collins did build at least one pre-war FM transmitter, a 500-watt unit operating on 44 megacycles. It was used by the Cleveland, Ohio school system for educational broadcasting.

Pierce also was a main engineer on a new 5,000-watt AM transmitter, the 21A, designed in 1939-41. Station WMT in Cedar Rapids bought the first 21A, Serial No. 1, in 1941 when the station was authorized to boost its power to 5,000 watts day and night. An issue of Communications and Broadcast Engineering magazine featured the new WMT transmitter installation as its cover photo. WMT also added a third tower at that time to its transmitter facility northeast of Marion. Until then the station broadcast at 2,500 watts during days and 1,000 watts at night.

That was the only 21A sold before production was halted by the war. Collins resumed building that model after the war and it was still available as a product until the mid-1950s.

By 1941, Collins offered AM broadcast transmitters from 100 to 5,000 watts output, and a wide range of studio equipment. There were installations in stations across the nation, with Collins Radio selling more broadcast transmitters in one year than any other firm in the business.

The war ended all broadcast equipment production, as Collins devoted all its efforts to building communications gear for the armed forces.

With the end of the war in August, 1945, all military production work at Collins was cancelled. The firm had to make a quick transition to peacetime conditions. A high priority was given to turning out broadcast products, some of the first which could generate revenue.

As soon as parts and materials could be assembled, some pre-war AM equipment designs were built including the 21A, 20H and 300G transmitters and 12H remote amplifier. Also, an urgent effort began on FM equipment development and new AM transmitters.

Another project started right after the war was called a Railroad Entertainment System. It was a special type receiver, antenna and amplifier equipment to receive and play radio programs aboard luxury passenger trains. The Rock Island line was among railroads which bought it.

Soon after the war the Federal Communications Commission changed the FM band to 88 to 108 megahertz. In the three years after the war more than 600 stations received licenses for FM broadcasting, and the number soon grew into the thousands.

From 1946-48 Collins engineers developed five new FM transmitters, 250 watts, 1, 3, 5 and 10 kilowatt units.

Getting those and a wide range of studio equipment on the market during the initial FM boom gave Collins a sizeable share of the broadcast business around the country. Much of the new FM equipment was sold to stations already using Collins AM transmitters, and then expanding to offer both AM and FM. Collins also brought out new 5 and 10-kilowatt AM transmitters.

When the Cedar Rapids Gazette's KCRG-AM and KCRK-FM stations went on the air in 1947, they had Collins equipment including the new 734A 10-kilowatt FM transmitter. The company later dropped FM to apply for a television license.

Arthur always had his company stay with radio broadcasting, and did not try to build TV transmission equipment.

With a full line of transmitters, speech equipment, studio consoles, monitoring and control units and other accessories, Arthur liked to note that Collins provided everything a station needed, from microphone to antenna.

During the 1950s and 60s, Collins introduced a number of innovations in broadcasting equipment. Those included advances in transmitter designs for improved performance, taking advantage of new type tubes and other electronics developments. Broadcast engineers at Collins were not separated from military and commercial communications equipment development, so they were well aware of the latest available technology. An example was an early use of transistors in a remote amplifier, a portable device for broadcasting from sports events, concerts, conventions, etc. Weighing just 22 pounds, much less than earlier units of 50 or more pounds sometimes lugged up stadium steps to a press box, it became a popular model. One of its first applications was in broadcasting the 1952 Republican National Convention, as predecessor Collins gear had done in 1936.

At the 1959 National Association of Broadcasters convention, Collins and other companies introduced new type magnetic tape cartridges for studio use. The Collins version and playback units attracted the most attention, with 40 stations placing orders at the show for the new equipment.

Collins transmitters, studio consoles and other equipment frequently won styling awards for outstanding exterior design and appearance.

Collins Radio was the first company to install a radar system in a television station for weather tracking and forecasting. Station WFAA-TV of Dallas inaugurated the use of radar for local weather observations April 2, 1958. Those were still days of black and white television, when a weatherman showed the locations of fronts and storms by marking them on a map with a pen. The advent of viewers being able to see weather conditions on the radar scope became the talk of the town in the Dallas area.

The system was adapted from weather radar equipment developed by Collins for aircraft. The potential it represented to the TV broadcasting industry was instantly recognized by Collins' competitors. Other firms quickly introduced their own weather radar systems and mounted aggressive marketing and pricing programs. Collins soon lost any advantage it had in being first.

In 1961 the FCC authorized high fidelity stereo FM broadcasting, and Collins developed a new line of FM transmitters with stereo capability. Warren Bruene recalled the Collins transmitters provided the best stereo separation and best overall performance of any equipment on the market. There had been skepticism in the industry about stereo broadcasting, but the first three stations on the air with the new Collins equipment — WVCG, Coral Gables, KSHE, St. Louis and WKJF, Pittsburgh, all reported outstanding results. Stereo broadcasting then grew rapidly. Stereo soon spread to Europe, as well. One of the first stations to have it was Radio Intercontinental Madrid, which put a Collins 1,000-watt 830D-1 FM stereo transmitter on the air in 1963.

A few years later Collins equipment was used in a NASA experiment, transmitting an orchestra concert from London, which proved that high quality transoceanic stereophonic broadcasting via satellite was possible.

Collins Radio had done well in commercial broadcasting in the 1950s. Sales totaled almost a half million dollars in December, 1959, the highest of any month in the firm's history. But changes were occurring in the industry with many new stations being licensed. Where equipment selection once was based on performance, station owners became more concerned with cost and price, often buying the cheapest equipment that met FCC requirements. The broadcast business became more competitive, which put pressures on Collins engineers to be more creative in holding down costs and still maintain quality, as Arthur Collins would never agree to sacrificing quality. Through the 1960s, Collins had an increasingly tougher time showing a profit with the broadcast line.

Roger Pierce said it became a situation of, *Too many competitors building Chevrolet class systems while Collins was still building Cadillac types — and the customers went for the cheaper stuff.*

W.W. (Bill) Roodhouse, who was named Collins executive vice president in 1965, said the broadcast station market was not large enough for all the suppliers competing in it, and it was no longer practical for Collins to try to play a major role.

On numerous occasions over the years Collins rushed equipment to stations needing help when fires or floods knocked them off the air.

The patent violation suit filed against Collins by the big Radio Corporation of America, even though settled in 1938, apparently never was forgotten by long-time RCA President David Sarnoff. In the 1960s a Phoenix radio station affiliated with the NBC network owned by RCA wanted to buy a Collins transmitter. When Sarnoff heard about it, he blocked the sale by threatening to drop the station from NBC, which would have cost the station a vast amount of revenue.

Collins Radio Company equipment long was identified with international broadcasting, on the short waves or high frequency radio band. It is a main communications technique in many countries of the world. Most HF broadcasting is controlled by governments.

Transmitters designed by Arthur Collins in the early 1930s were widely used in foreign lands. One was the 20B 1-KW transmitter, the same model used for live broadcasts from the Antarctic by the Byrd Expedition in 1934.

From about 1935-38 Collins worked with the land-locked South American country of Bolivia to achieve HF capability both for broadcasting and communications for government departments. Equipment shipped to Bolivia included 30FXB 100-watt voice transmitters; the 300BA, 250-watt broadcast transmitter, and the 600A, 600-watt code or 150-watt voice unit, a broadcast or general purpose transmitter. The equipment was installed in a building at 13,500 feet altitude, on a high mountain plain overlooking the capital city of La Paz.

For nearly 30 years the transmitters were in use 18 hours every day, with *a minimum of trouble*, despite never having been intended to operate above 6,000 feet altitude.

Bill Roodhouse remembered a trip in the late 1960s to Australia when he was shown a broadcasting station located on a mountain peak near Canberra. *They had a Collins transmitter there with serial number two, and I was told years later it was still operating*, he said.

In the early 1950s Collins began an association with the Voice of America, the U.S.-sponsored agency broadcasting from the free world to people behind the Iron Curtain. Most VOA broadcasting was on the HF short wave frequency band with high power transmitters which could send strong signals over long distances to reach inside the Soviet Union and other eastern European countries.

In 1951 the VOA set up stations in England, West Germany and North Africa equipped with the Collins 207B-1, a five-bay, 50,000-watt HF transmitter. They relayed programs received from the U.S. by Collins 51J HF receivers.

A 1952 Collins installation included two 35-KW transmitters for broadcasting from a VOA ocean ship, the Courier. The Soviet Union constantly tried to jam VOA broadcasts by transmitting a noisy signal on the same frequency being used by VOA. It was estimated the Soviets employed more than 1,000 transmitters for jamming purposes. The most effective Soviet jamming method was to place a transmitter of equal or greater power output at a similar distance from the targeted reception area as the VOA transmitter. The ability of the Courier to move around and transmit from various locations made jamming more difficult. Other VOA methods used to overcome the jamming included switching frequencies, causing the Soviets to spend a lot of time changing frequencies on their 1,000 jamming transmitters, and transmitting on a frequency very close to that of a Soviet broadcast.

In 1963-64 Collins developed powerful 250-KW transmitters for the VOA. Nine units were built. Three each were installed at Belleville, OH, Dixon and Delano, CA. Warren Bruene recalled doing the radio frequency work on the transmitters in Cedar Rapids, then being transferred to Dallas where the project was completed. He remembered also that after the first deliveries problems developed, and the VOA agreed to accept the units if a fix was made and the units worked for 90 days without problems. The main solution was to switch from air to water cooling of capacitors. The transmitters passed the test, and for many years were considered the best transmitters the VOA had.

Around 1968-69, when Arthur Collins was moving his company heavily into computers, the world's first computer-controlled, computer-monitored broadcast transmitter was developed. It was the Collins 821A-2, a 250-KW transmitter designed for international, high frequency broadcasting, regarded by some in the industry as the finest short wave transmitter ever built. It also was looked upon as somewhat ahead of its time, which may be why only nine were built — three installed in Australia and six in Canada. Under C-System computer control, the unit could make a change in frequencies and be broadcasting on the new frequency in 12 seconds. International broadcasting often required retuning to different frequencies as many as four times a day. Manual retuning with earlier transmitters took from 10 to 20 minutes. The 821A-2 also allowed storage of the station's entire program schedule in the computer.

The 821-A transmitters were built at the Collins Canada plant in Toronto. In order to have the electrical power necessary to test a 250,000-watt transmitter, a special electrical substation had to be built adjacent to the Collins plant.

An example of Arthur Collins' insistence on equipment reliability was demonstrated by a promotion staged in 1963 for the annual convention of the National Association of Broadcasters in Chicago. The company exhibit at the show included the winning unit in a nation-wide contest to find the Collins transmitter with the longest record of uninterrupted daily service. It was a 250-watt 300F which first went on the air May 1, 1938 at Station WGAU, Athens, GA. From then until 1957 it was in operation daily from 6 a.m. to midnight, then was used for night time broadcasting until early 1963. In the nearly 25 years of service, the transmitter operated a total of 165,710 hours with only 87 minutes of down time due to equipment failure. Collins gave WGAU a new transmitter as winner of its contest.

There were complaints, to be sure, about broadcast equipment performance. But some of the *complaints* were meant to be complimentary, as was one from Glen Barnett, owner of Station KWXY, Palm Springs, CA. He indicated he hoped the company offered a replacement part which would be an improvement over the original when he wrote, in 1975:

*Gentlemen:*

*In 33 years of working with Collins equipment, I've never had to write a letter like this.*

*However, we have a defective fan in our Collins 20H transmitter (1,000-watt AM unit). This is the 10-inch fan on the rear panel of the cabinet. It's not frozen, it's always been oiled properly. It will spin freely, but just hums when power is applied and will not run.*

*We would expect this with any other make of equipment, but not Collins. This is the original fan, factory installed in 1938 when the transmitter was built at Cedar Rapids. It has a cast iron motor case and twisted pair lamp cord to the terminal strip.*

*True, the transmitter has been around in its 37 years, including KYA, KWKW, KALI and KBIG. We've used it for the past seven years. Don't you think a simple fan should do better?*

Like in other Collins Radio Company product lines, broadcast equipment engineers had considerable freedom in using their own creativity and ingenuity, but Arthur's influence and guidance always was evident.

The Collins equipment line was a major force in the broadcast industry throughout the years Arthur Collins controlled the company. It showed dwindling profits in the final years, and some observers felt Collins stayed in it because of Arthur's sentimentality for the business which had been good to him in for many years. Rockwell maintained the broadcast line for several years after gaining control of Collins in 1971, and eventually sold it to a competitor.

# Chapter 13
# ALWAYS THE UNDISPUTED BOSS

Arthur Collins was always the undisputed boss of his company. With the firm bearing his name and he the president and chairman, he was responsible for the company's course, its products, its performance and its reputation.

Arthur also always made certain he was either the largest single shareholder or that he with his family had sufficient stock holdings to assure his control of the company.

Unlike many in this world, Arthur was not concerned about projecting a personal image. He was himself — entirely wrapped up in his work.

The image he cared about was his company's image. If his name was on it, he expected the product to be the best a customer could buy, incorporating the most advanced design features possible in a practical sense and to operate reliably in performing the role for which it was intended. He insisted the design be "clean," that is neat and orderly, not a hodge-podge of wires and components. All parts showed the high level of craftsmanship that went into them. From his first experiences in putting together radio sets his credo had been that quality had to be designed and built into a product if it was to be a quality product in the true sense of the word. That quality was reflected not only in the design and construction of the internal working parts, but also in the neat, attractive, innovative appearance of the product exterior.

He wanted customers to feel absolutely certain that when they bought Collins equipment, they were buying truly first class, the best they could buy any place. He wanted them to have confidence it would work as they expected, and to know the company would back up the product without question.

As one senior engineering executive recalled, "Whenever we got off on a wrong track and came to a decision where we had to do it right or go ahead with a questionable design, we invariably had the opportunity to do it right."

Still, there were a few sub-standard Collins products which got on the market, but sales were halted when that became known, unlike the practices of some companies to deliver equipment which was not perfected. Collins Radio either discontinued the product or redesigned it to correct the flaws and reintroduced it as a dash two or three version, which told customers they again could have confidence in what they bought.

More than once, Arthur became personally involved when he learned of a problem with a company product. An example occurred with one of the firm's airborne weather radar systems. A pilot-scientist based in the Dallas, Texas area was doing meteorological research under contract to the government, in which the weather radar played an essential role. The equipment was installed in a modified World War II twin-engine P-38 fighter plane. During his research flights the pilot experienced malfunctioning of the radar system, and several attempts by technicians to fix it did not solve the problem.

The pilot's frustration reached the point where he tried calling Arthur Collins personally, and finally got through to him. The reaction was swift by the man who was president, chairman of the board and CEO of a company with 20,000 employees. Down the hall from Arthur's Cedar Rapids office was his private engineering lab. He had a radar system and test equipment delivered to the lab immediately. Giving the matter his full-time attention, Arthur, several engineers and technicians familiar with the equipment spent the next two to three days and nights determining what made the problem occur and how they could make the system operate properly.

The result was to call in all similar models of weather radar sets then installed in airplanes, mostly in business or executive aircraft, and make factory modifications to them at company expense.

In the first years of the company Arthur was directly involved in everything that occurred. He either made all the decisions or was consulted on them. But as the business grew, even though he was aware of most activities, it was inevitable that no longer could he know all details of everything happening and be a part of every decision.

Any student of management styles trying to analyze Arthur Collins' method of running his company would have found it different than the ways of most executives. The big difference, of course, was that even when his company was ranked as one of the top 300 U.S. corporations in size and income, Arthur was still in effect the chief design engineer, personally involved and responsible for many of the firm's complex products.

*People think I run this thing,* Arthur once told a group of his top VPs. *But 80 percent of the company at any one time runs itself. I have you people in place to do that. I focus on about 20 percent of what I think I should be focusing on.*

Arthur preferred having his top tier of adminstrators do most of the managing. When the first strike ever by Cedar Rapids production workers occurred in October, 1967, he left it up to Bill Roodhouse, John Nyquist and others to get it settled. By then Arthur was spending most of his time in Dallas but made it a point to come to Cedar Rapids and drive through picket lines several times. The employees, members of Local 1362, International Brotherhood of Electrical Workers, were out about two weeks before the strike ended.

Anyone who had the opportunity to be a close observer of Arthur Collins had to be in awe of the man. An amazing fact about him was that he usually was directing the development of not just one but several related projects that had to come together as a system. And he completely understood the work and precise objective of all of them. He concentrated on them partly or fulltime for days, weeks or months, depending on how extensive each project was and how long he it required his attention.

Arthur put such an intense effort into his projects that the people who were closely involved sometimes became burned out. Few persons were blessed with his energy level. Night and day were the same to him when on a project.

One engineer, working 16 to 18-hour days with Arthur for several weeks, recalled being elated about 8 one Saturday night when Arthur said, "Let's take tomorrow off." But his Sunday morning of relaxation was interrupted by a call from Arthur, who said he thought of a new idea and wanted the engineer to join him in the lab to work on it.

"I thought we were going to take the day off," the engineer protested.

"Well, I didn't say the whole day," was Arthur's reply.

Because whatever Arthur was working on always was at the leading edge of technology, many engineers welcomed the chance to work closely with him, despite the grueling hours and disruption of their family lives. Others felt just the opposite. While they liked working for Collins Radio Company, it was an unwritten rule in many engineering departments that the best policy and best job security lay in avoiding a key role in one of Arthur's pressure cooker programs. While they normally put in long hours, they usually could count on having Sundays and most evenings off.

Arthur would digress from the project at hand only to the most urgent matters requiring his personal involvement or consultation. Thus his top people were given wide responsibility to act on their own. They knew that while Arthur set the tone and direction for the company, and they were always subject to his beck and call, they had to make the functions for which they were accountable run as smoothly and profitably as possible. Some of the top executives did not have direct contact with Arthur for weeks at a time, when he became deeply involved in a project. It was an arrangement that allowed Arthur to pursue his priority program of the moment, knowing the company should keep humming along and give him a minimum of management problems.

Most of those who had close association with Arthur felt the company ran smoothest when he was fully occupied by an engineering project, times his vice presidents had to make decisions on sales and orders which kept the laboratories and factories running at top capacity and produced profits. But as one vice president recalled, *When he came out of the lab and put on his president's hat, things got choppy. Then he'd go back to developing something and things could get back on track. It showed what a great group of people he had — men such as Bob Gates, Morgan Craft, Bob Cox, Jim Flynn, Mel Doelz, John Nyquist, Bill Roodhouse, Bob Mullaley and others.*

Arthur offered so many ideas and suggestions to his top aides they knew all of them could not be carried out. And with many of those, they were never mentioned again and nothing ever was done about them. But in some instances, he would bring up a subject later and want to see what had been done.

That happened once during the early C-System period when he sent identical notes to Bob Cox in Cedar Rapids, Bill Roodhouse in Dallas and Mel Doelz in Newport Beach, who were then vice presidents and general managers of those divisions. He thought it would be a good idea for each major division to have a special place to conduct reviews of products in development. He also indicated the facility should contain a special library of all the technical documentation in the form of engineering reports, instruction books and other materials associated with the products, to have on hand for the review sessions, and be available for anyone who might need them. Development models or completed products also should be placed in the facilities. Realizing a massive and expensive effort would be required to set up such a center, the three managers did not immediately act upon it. They knew building space, which was scarce, would have to be found and remodeled for the facility, probably disrupting a number of other functions. Also, establishing a special library would be a duplication of materials already existing at various locations. Besides, they seldom attended product reviews, although Arthur often did. As time went on and they heard nothing more about it, they hoped it was one more of the numerous ideas which Arthur mentioned once and then apparently forgot as he moved to other activities.

But about six months later, Arthur asked Cox about it and said he wanted to see the facility. Cox made an excuse about first needing some time to check it out. What quickly followed over the next several days were frantic, urgent assignments for a number of persons — pulling together thousands of documents, having 6,000 special binders printed, labeled and catalogued, bookcases and other furniture ordered on a rush basis and dozens of other details. In Cedar Rapids, it was to be located in an area occupied by a field service product support employee who spent most of his time on the phone with customers. At the very moment he was hearing from his boss that he had to move to a new area, carpenters and painters showed up to begin transforming the space into the new Technical Information Center, as the facility was called. Similar scenes took place in Dallas and Newport Beach as TICs were established there.

After the Cedar Rapids TIC was opened and staffed by a couple of librarians, little if any use was being made of it. Howard Walrath, a vice president whose duties included overseeing the new facility, recalled he finally asked a number of persons to make an effort to visit and utilize the center.

Some of Arthur's key executives in time became part of an infrastructure of confidants whom he trusted and with whom he was comfortable.

Still, Arthur allowed only a few men in his company to question his judgment. And as the years went on and he plunged the company into the C-System, he tolerated no viewpoints he did not want to hear.

Of course, once one of Arthur's projects turned into a major new product area, every part of the company affected by it became involved.

Arthur expected 100 percent devotion and loyalty from his top executive corps and anyone who was in a key position 24 hours of every day, 365 days a year. He expected such obedience without concerns on their part about salaries or personal lives. If he wanted one of them, he never hesitated to call them in the middle of the night, on a Saturday, Sunday or holiday or when they were on vacation. More than one of his top aides or engineers got word to call Arthur as they left a Sunday morning church service.

Thanksgiving often was an exasperating day for some of the top echelon. Arthur had some project or meeting planned that would keep them at work for most of the day. In the C-System period, he had a group of his top people meet in a Cedar Rapids conference room Thanksgiving morning, passing out technical journals with articles marked for them to read as they sat there during the day. They finally were allowed to leave and join their families for dinner about 5 p.m., when a Midwestern blizzard was beginning to rage.

Ed Williams, financial vice president of Collins Radio in the 1960s, said he probably spent more time with Arthur over an eight-year period than he did with any other person in the company.

*Art often called me at 5:30 or 6 in the morning and said, 'let's go talk.' We might go out to my boat, we might just sit in his car. It was a very close relationship.*

*One thing always bothered me. People said he was an engineering genius but didn't know anything about business. I'm not an engineer, but I spent a lot of time with him. We talked about the company, the direction of the company, and what he wanted to accomplish. He got very deeply into accounting — cost accounting. He was well read on every subject. I resent those comments that he didn't know about the business,* Williams said.

Arthur particularly disliked those public duties considered conventional for chief executives. He hated to give speeches, agreeing to such engagements only when he felt he had a particular message to convey. Only rarely did he make himself accessible to the media or give an interview. He did not like to talk directly with bankers or financial analysts. While in early years he attended amateur radio and broadcast trade shows and conventions, he quit such activities when it became a problem of too many people wanting to talk to him.

He wanted his top people to represent the company in important industry meetings, attending only if his presence was absolutely necessary. Bob Cox recalled a time he had to convince Arthur to go to Washington, a place he had no desire to visit. The occasion was a meeting called by Najeeb Halaby, Federal Aviation Administrator under President Dwight D. Eisenhower, to discuss implementation of DME (distance measuring equipment) on the nation's airways. Halaby had insisted Arthur Collins be there in person. Collins already was working on DME, which soon became a valuable navigation aid on domestic air routes and a leading aviation product for Collins.

Arthur Collins knew how to make money. It was a matter of inventing something the world needed, and customers would buy it. It was a practice which worked for most of the years of his company.

Arthur certainly did not personally invent all of his company's products. But he created the means and the environment for others also to invent. Over a period of 40 years his business generated equipment sales of nearly five billion dollars, which were dollars made before the soaring inflation rates of the 1970s.

Like almost all successful men, Arthur was highly self-disciplined and focused in his objectives.

A key shortcoming was that he failed to follow a practice of making certain the company generated what investors considered an adequate earnings level. The temptation to spend money on his pet programs carried a higher priority with him than a profit margin which impressed Wall Street.

One of the most ironic circumstances of his life and career was the matter of personal wealth. Arthur's efforts made him truly wealthy, in the multi-millionaire class. But he was more intent on what he could invent and develop than on making money. As a result, his fortune never reached the totals accumulated by many entrepreneurs and big business executives.

While Arthur did not willingly face up to it, his lack of equating special monetary reward with work achievement cost him a number of highly talented people over the years.

Arthur believed that his key people should be every bit as enthusiastic and dedicated as he was to his latest project. While Collins professional people were well paid according to a competitive scale, Arthur's attitude was that financial compensation and personal concerns should be secondary to helping him achieve his goals.

Some who came into Arthur's company and left went on to become richer than him, through ventures which amassed great wealth. Some made their money in direct competition with Collins.

One of those was Edward J. King. He was a Kansas State College electrical engineering graduate who had an idea for a new and better machine to wind coils used in electronic equipment. After several years of working for large firms, King started his own business and soon had a factory and workforce in the Kansas City area producing the coils and other components.

Collins Radio had a big need for the coils from King's plant, wanting to buy the entire output, but was limited to one quarter of the total production. That led Arthur to make an offer to buy King's firm, Communications Accessories Company. Collins purchased CAC in 1955 for about $800,000 in stock, plus a share of profits. Ed King continued to run the firm as a Collins subsidiary for several years.

The Collins Radio team which looked into buying King's company was headed by L.E. (Les) Bessemer, then vice president of manufacturing and on the board of directors. Some years later Bessemer related a chain of events that began while Ed King remained in charge of CAC.

Bessemer said, as he recalled, that King, who was a pilot, flew a group of Collins engineers to a meeting in a twin-engine aircraft. Reportedly, a storm was encountered during the flight and it became necessary for the plane to climb above the rough weather. The unpressurized aircraft lacked enough oxygen masks for everyone aboard, but still reached its destination and landed safely with none of the passengers appearing any worse for the wear.

But Arthur happened to hear about the incident and did not like it, Bessemer said. He considered it unsafe flying, and dispatched Bessemer to fire Ed King. At least one other key CAC executive, Wayne Bonebrake, also quit as a result of the firing.

Collins Radio in time merged the former Communications Accessories Company into a Collins Components Division, much of the work being transferred to Santa Ana, California.

Bessemer said King maintained he was planning to quit before the separation from Collins Radio occurred, and that King was very much interested in and working on some designs for avionics equipment, the number one product line for Collins. He apparently had tried to interest Collins in some of his ideas, without success.

King, however, saw a market opportunity in avionics gear for business aviation that would put him in direct competition with Collins, which dominated that field since corporations began to operate their own aircraft for executive transportation after World War II. After parting with Collins he established King Radio Co. of Olathe, Kansas to design and build communication-navigation equipment for high performance single and twin-engine aircraft.

In staffing the company, he hired several persons away from Collins. They included Paul Wulfsberg, a top design engineer and group head in VHF avionics systems, and Glenn Bergmann, manager of commercial aviation marketing programs.

Wulfsberg had disagreed with Arthur on several design concepts and trends. As chief engineer at King, he saw an opportunity to develop new products more in line with his thinking, ideas shared at least in part with Ed King. Bergmann, also a KSU engineering graduate, set about building a national sales and dealer operation for King.

King Radio soon was making itself known in the general aviation market. The firm became Collins' top competitor in the high performance business aircraft field and in fact dominated some categories of the business.

Within a few years, Wulfsberg and Bergmann became wealthy from their association with Ed King. A succession of other former Collins executives, who had become disillusioned or were cast aside by Arthur after making major contributions to his company, also went to King Radio over the years.

Two of them in time held the title of president-CEO of King. One was Bob Cox, who during his Collins career had been director of engineering and vice president-general manager of the Cedar Rapids operations and on the board of directors. Cox had been a valued and loyal associate of Arthur for more than 20 years, but became frustrated with the direction Arthur was taking his company in the mid-1960s. In a change resembling but not truly a promotion, he moved to Dallas to direct Collins' space programs before the opportunity came to join King Radio.

Another was Craig Christie, who became the top officer at King after King Radio merged with Bendix. A well known and highly respected avionics marketeer, Christie had left Collins to head up King marketing efforts after Arthur tried to have him combine C-System computer sales with avionics marketing. A third executive who ended up at King as manufacturing director and other top management assignments was Robert S. Dunn, who also had been vice president-general manager of the Collins Cedar Rapids operations after heading manufacturing.

Les Bessemer also recalled that some years after the King Radio Co. became a big success, he received a call from King. Bessemer, by then retired, said King told him he just wanted to say thanks for what he considered a main turning point of his life — when Arthur Collins fired him and he began planning King Radio Co.

Wayne Bonebright also prospered after joining Ed King in leaving Collins, forming a company called Hisonic, Inc.

Several other businesses had their starts with the help of men who left Collins and became prominent companies. J-TEC was a firm started in 1968 in Cedar Rapids by Theodore Johnson, who worked in government contracts and Robert Joy, a research engineer. It became successful in developing electronic equipment and obtaining government contracts.

Two founders of what became the Norand Corp. of Cedar Rapids were George Chadima and Robert Bruce, former Collins engineers. Norand became a leading firm in developing and producing electronic equipment to facilitate inventory control and ordering in supermarkets, including some early scanning equipment.

Arthur did not condone waste, but when he wanted something he did not care about the cost if he thought it was needed. A story went the rounds about the massive data storage disc file cabinets installed in the CDS building with the first automatic wireline message switching systems. The units had windows through which the big spinning magnetic discs could be seen. Some employees were fascinated by the machines as they walked by, and would stop to watch them.

Arthur did not like to see people doing that, and ordered a large plate glass enclosure erected some distance in front of the files to keep anyone but operators from getting close to them. As usual, he wanted it done immediately. The employee assigned to carry out the job first tried to obtain the type of glass needed from local suppliers, but they did not have it. When Arthur heard that, he said surely it could be found some place in the U.S.A. The glass was located in a distant city and shipped by rush order at considerable expense. His view was that if a thing was needed and available, the company should have it regardless of the source or the cost.

Arthur felt his most valuable asset was his time. He hated wasting time. He once was aboard a company airplane, flying through the deep South after visiting his son Michael, then in the Navy at Pensacola, FL. Trying to get through to the Cedar Rapids plant on single sideband high frequency radio, he encountered one of the rare times when atmospheric conditions made SSB communications temporarily unusable. That angered him, and to avoid any more such situations, he decided the company should have its own very high frequency (VHF) network on routes the company aircraft usually followed, between Cedar Rapids, Dallas and Newport Beach. Unlike HF, VHF required a number of ground stations, which could be unmanned and operated automatically. Sites had to be found on mountain tops in the Ozarks and New Mexico. Equipment including radio gear and phone lines to reach the stations had to be installed and routine maintenance performed. Collins Radio ended up paying some $12,000 a month for leases and other expenses, with very little use made of the network. Stations were broken into several times and the expensive radio equipment stolen. But if Arthur wanted it, he could have it. The executives responsible for paying company bills finally got the network closed down after about a year.

Collins Radio Company, under the direction of Arthur Collins, was a company where people were expected to work hard and perform their duties conscientiously and with integrity.

Production workers were governed by union contract rules, and hourly paid people punched time clocks. For the salaried work force, however, which included the engineering design and development staffs, middle management office, production and service function supervisors, there was less rigidity than found in many corporations.

Arthur encouraged his engineering design and product development people to be creative — to have the freedom to be imaginative and experiment.

He had a knack for stimulating his technical people into thinking. That led to many new and improved equipment designs, in some cases to entirely new, previously non-existent products.

In the company's prolific years of the 1950s and 60s, it was not unusual to have up to a dozen or more patents issued to Collins engineers every month. Patents were the property of the company, with the patent originator receiving a bonus of $100.

Patent applications were encouraged. Collins Radio had a full-time patent attorney on staff. For many years that role was filled by Marvin Moody, a former World War II pilot who earned an electrical engineering degree from Iowa State College and a law degree from the State University of Iowa.

Engineers were given wide latitude to create and experiment on their own, in fact many wanted to do that. Ed Andrade, a top high frequency equipment engineer, recalled working late one night with other Cedar Rapids engineers, seeking the answer to a design problem. About 11:30 p.m. they decided to adjourn to Shakey's Buffet for a beer and pizza. While there, Andrade said a new idea came to him and he went back to the office, worked all night and solved the problem.

It often was said that desk drawers of Collins engineers contained enough ideas to keep the company going for years with new generation equipment. Saturday morning bull sessions sometimes resulted in more productive problem solving and design advances than a week of formal progress meetings.

In the late 1930s and early 40s, when the engineering staff was still a small, closely knit group, product development advances sometimes were dreamed up over beers at the Blue Moon Tavern, a popular after hours spot in the 3100 block of First Avenue in Cedar Rapids.

Before corporate offices were moved to Dallas in the mid-1960s, Arthur often had meetings with his top staff people in Cedar Rapids on Saturday mornings. Some of the Collins executives had season tickets for University of Iowa home football games, which started in those days at 1:30 p.m. They had the feeling that Arthur, who cared nothing about athletics, intentionally kept meetings going to make them arrive late at the games in Iowa City, 40 miles away.

Some of Arthur's staff people in the Saturday meetings tried a strategy which worked occasionally, suggesting lunch at the Indian House Restaurant at Marion Boulevard and Blairs Ferry Road, a location which later became a Toyota automobile dealership. After a couple of martinis and lunch Arthur would want to go home for a nap, which allowed the others to leave the plant and have their Saturday afternoons for themselves.

While Arthur was a reserved, soft-spoken person, some of his top executives had quite different personalities. Like a cross section of the population, some were restrained in the manner of Arthur, while others were gregarious, with a few downright characters in the ranks.

One top-ranking marketing executive was a rugged individualist type, very smart, who could be both smooth and crude. He once wound up a sales presentation to a group of senior military officers by stating, "And general, if that radio doesn't do the job, I'll kiss your ass."

After Collins became successful in selling data switching systems, a small group of British Overseas Airways (BOAC) officers and technicians came to Cedar Rapids to look over the installation which Collins maintained to handle ground message transmissions for airlines.

Leader of the group was a British Lord who served on the BOAC board of directors. He also was a land owner, interested in the latest techniques in raising hogs, and asked if a visit to an Iowa hog farm could be arranged while he was in the area.

A hog farm was located which could be viewed during a drive to the Amanas, where the Collins executive planned to take the British group for dinner.

While the Iowa farmer was showing his hog operation to his distinguished British visitor, the other members of the BOAC party, who probably never had been on a farm, were looking at various livestock pens. One of the Englishmen, noting a pile of manure, asked his Collins host what animal it had come from. The Collins exec told him, and then proceeded to identify other droppings visible in the area.

Just then the British Lord, having overheard, called to the Collins executive by name and said, "I knew you were full of it, but I did not realize you were such a connoisseur."

In the late 1960s Collins moved into a new corporate headquarters building in Dallas. The facility included spacious offices for the top executives, each with a private bathroom.

The same executive often had meetings with staff people in his office about 9:30 a.m. It became a routine as they sat around a conference table for him to get up and visit his adjoining private lavatory, saying the meeting should continue and he would participate by keeping the door open. On one occasion, amid noises and smell associated with a certain bodily function, the executive was expounding on a point he wanted the group to discuss. When he heard no one talking he called out, "Can't you guys hear me?" One of his staff then answered, "No John, we can't hear you, our eyes are burning."

Arthur's main concern was to be surrounded by can-do persons, even if they were free spirits. As a result there were many "most memorable characters" among the ranks. Collins people were proud but not haughty — they made it a fun company.

Thomas A. Campobasso, himself somewhat of a character who rose to marketing vice president and during his career headed the Collins' office in Washington, DC and international sales, said: *You never had to apologize that you were from Collins Radio Company. Almost any place in the world, when you went to see a customer for a Collins product, you got instant respect because Collins equipment was so well known and respected.*

Most Collins sales persons felt pride in the products they had to sell, because of the Collins reputation, and some were extremely enthusiastic. Jim Lenehan, who held various marketing positions at Collins, recalled an incident with one such salesman.

After weeks of working on a big sale, the customer had made up his mind to buy, and they met over drinks and dinner to close the deal. But the salesman kept talking about all the features of the product, and as the evening wore on the effects of drinks and drowsiness set in and the order was left unsigned.

The next morning the salesman's boss asked him if the order had been signed, and he had to admit it had not. *Good*, said the boss, *because we've refigured the costs and we're going to have to charge more than we told him originally.*

When the salesman went back with that news, the customer was quite miffed. *Well, it just goes to show you should have signed the order yesterday,* the salesman said.

When Arthur wanted something done, he expected results as quickly as possible. One Friday night Arthur decided he would spend his weekend checking out a new radio under development. He also wanted to do the work at his house. Word went down the line to get laboratory testing equipment moved to the Collins home in Cedar Rapids. That was a job for the company maintenance department workers. In order to make the rush job as easy as possible, they located an engineering lab near an outside door of Main Plant and removed all of the test gear to fill the boss's request. It was a surprised group of technicians and engineers who arrived for work on Monday morning to find all the test equipment missing from their lab area.

John Nyquist, long a senior Collins executive, recalled that soon after Collins had built its new Engineering Building in northeast Cedar Rapids, Arthur mentioned over lunch one day that the company ought to get some more land for future expansion in the area. Nyquist went back to his office, called a local realtor-developer, drove downtown that afternoon and bought 90 acres of ground west of C Avenue.

Another time Arthur was having some work done on his boat in Florida and became alarmed when a worker using a power drill got an electric shock. He decreed the entire company be shut down if necessary to immediately replace all two-strand electric wire and receptacles with three-wire cords and properly grounded outlets. (At that time, not all facilities had to have grounded electrical systems).

Bob Cox, then in charge of the Cedar Rapids Division, said he pointed out to Arthur that the engineering and factory areas already had grounded systems, and that remaining areas including offices could be rewired gradually with minimum disruption, and at minimum expense.

But Arthur insisted the change be made as soon as possible. Purchasing, maintenance and other departments which would be involved were told to get ready to do the work over the next weekend.

They were confronted by a major logistics problem — where and how to get the thousands of feet of three-cord electric cable, outlets, plugs and other fixtures urgently needed, and the manpower to do a rapid conversion.

Electrical equipment warehouses from Chicago to St. Louis and Cincinnati literally were cleaned out of materials to fill the Collins orders. Company aircraft were sent around the country to bring cable and accessories to Cedar Rapids.

Every electrical contractor in the Cedar Rapids area who could supply workers had them report to Collins, at time-and-a-half to double-time wage rates for the week-end crash project.

When employees came to work Monday morning they found electric typewriters and calculators, pencil sharpeners, staplers and lamps — even desk clocks which were their personal property — changed to three-wire cords and three-prong plugs.

Huge piles of two-strand electric cord were left over after being pulled out and replaced with grounded cable. Much of it was sold at a cheap price in the company surplus store and a lot of it was scrapped.

Arthur, once while at the Collins hangar at the Cedar Rapids airport, casually remarked it would be nice if the apron in front of the hangar was a little wider. Within a few days a crew was observed removing dirt and laying concrete for the expansion.

On one of the building addition projects in northeast Cedar Rapids, after Arthur drove by to check construction progress, he let it be known he did not like the location of a driveway connecting the parking lot to the street. The next morning the sound of jack hammers was heard as workmen began tearing up the newly-laid concrete to relocate the driveway.

Arthur sometimes took matters into his own hands when he was displeased. During development of Kineplex, the advanced and pioneering digital data transmission system, equipment was installed on one of the company aircraft. Arthur checked out the system as he flew one day from Dallas to Cedar Rapids, and was very unhappy with how it worked. After the plane landed and everyone aboard had left, Arthur got a pair of wire clippers from the hangar and cut all the wires to the Kineplex units. Then he called Harvey Hop, chief pilot, and told him what he'd done, adding, "You better check out the airplane — I might have cut something I shouldn't have."

During the single sideband radio development activities of the 1950s, Arthur was using his amateur equipment at his home in Cedar Rapids late one Saturday night. It was a cold, drizzly night, and he was having trouble talking by radio to Maj. Gen. Francis Griswold, vice commander of the Strategic Air Command, who was on an airplane in the vicinity of the North Pole.

With his knowledge of electricity and radio transmission, Arthur knew exactly why he was getting static and interference. The cause was an arcing condition at an electric substation not far from his house. Arthur placed a call to Bill

Weinhardt, director of construction and maintenance operations for Collins, and let him know he wanted something done about the problem.

Telling about the incident years later, Weinhardt said he had developed good working relationships with a number of local utility company executives during Collins' extensive construction programs. After receiving Arthur's call he immediately called one of the power company officials and explained the situation.

Weinhardt said he learned later how the substation arcing problem was solved. In the wee hours of a Sunday morning, when most people were sleeping, there was an unexplained power outage affecting a small area of southeast Cedar Rapids. During that brief outage Arthur Collins and General Griswold were able to complete their radio contact.

An impression prevailed from early years of the company that Arthur would not tolerate being called Art — that he had to be addressed as Arthur or Mr. Collins. While he preferred the more formal terms, his close friends and associates often addressed him as Art, and when calling them on the phone, he often identified himself as Art or Art Collins.

There were a lot of interesting, busy, talented, energetic people who made Collins Radio Company go. On any given day, anyone from Collins was almost certain to run into someone else from Collins at the major air terminals around the U.S. Often several were traveling together as a team to sell a system, negotiate a contract, attend a technical briefing and other reasons.

In the 1950s, when most air travel was still on four-engine propeller-driven aircraft such as DC-7s, the majority of passengers usually were men dressed in suits and ties. At one time American Airlines had a public relations campaign going to stress how friendly the airline was to its business passengers. One part of that was for a stewardess to come down the aisle soon after take-off and ask passengers their names, writing each one down on a pad. The purpose was to be able to address each passenger by name as she served drinks and meals.

On one occasion, three men from Collins boarded an American flight after a meeting in Washington. In order to continue working on a proposal for a federal contract, they took three adjoining seats.

The stewardess greeted the Collins man occupying the aisle seat and asked his name. *Benny Ciegelski*, he replied, which caused the young lady some difficulty in getting it spelled correctly. The next man was Ernie Pappenfus, another name that had to be repeated and spelled out slowly. When the third man, Tom Campobasso, gave her his name she said, *Aw, nuts to you guys*, and walked off in disgust.

Arthur had no active interest in religion. While he had been involved in youth programs at the First Presbyterian Church of Cedar Rapids, including a teen group also attended by Margaret (Peg) Van Dyke who later became his first wife, he did not attend Sunday church services as an adult. Sunday was another work day for him.

About 18 months after Peg's tragic death in late 1955, Arthur married Mary Meis, a devout Catholic. Before their wedding in June, 1957 Arthur met with a priest to learn about marriage vows and commitments involving any children born to the reunion, but did not join the church.

About the only times he attended religious services were the baptisms of Alan and David, the sons born to Mary and him in 1963 and 66, and Christmas Eve services when the boys were still young. As they grew older Arthur quit going.

One of Mary Collins' brothers, Ben Meis, had been a Catholic priest but later left the priesthood and married. Ben remembered that he had many conversations with Arthur, but Arthur never brought up the subject of religion.

Michael Phillips remembered an incident in the 1962-64 period when he was in charge of the company data operations center in Cedar Rapids, working weekdays and most Saturdays and often Sundays.

*Typically between 4 and 6 p.m. on Saturday Art would say, 'let's get together here again tomorrow,' but one Saturday he made no mention of a Sunday meeting. I went home that evening and told my wife, 'We have a chance for a real rest tomorrow. Art doesn't want to see me.'*

*Short lived! About 6 the next morning Art called my house and suggested we meet at his home on 34th Street immediately. I said, 'Sorry, but I have to go to church with my wife.' He asked how long that would take, and I said I could be at his house by 11:30. He then suggested I come for lunch.*

Phillips at that time drove a car which was a curiosity to most who saw it. The vehicle was a BMW Izetta, a small two-seat vehicle powered by a motorcycle engine. The whole front of the car opened outward, taking the steering wheel with it. The rear wheels were set so close together it looked like a three-wheel vehicle. The car's top speed was little more than 25 mph. He remembered it had a tough time getting up the winding and hilly driveway to Arthur's house.

*Watching me open the front and climb out, Art looked amazed and said something like, 'Now I know why you go to church to pray if you drive this.'*

*Then he opened the garage and wanted to take a look at it — over the grease pit he had there. When I said the rear wheels would fall in, he fixed some planks to support it. I drove onto the ramp and he disappeared into the pit.*

*He spent the next 20 minutes looking it over, telling me how they could have improved the design, the stability, the shock absorbers, even the transmission.*

*Then it was time for lunch. Mary was not home, and the refrigerator was bare except for a few pieces of cheese, not even a beer. But that of course was not Art's priority — he wanted to get to work.*

*During the course of our session he digressed to ask me about my faith, why I was a Catholic, what I got out of it, why it was important, etc. It was not a deep philosophical discussion but I did tell him that my family came first, that work, despite the fascination and excessive devotion we both gave to it, was number two. The glue that held it all together was my faith, which made my religion and faith important. He asked me if I prayed, and did I feel close to God at any time. He then told me of some of his earlier times with a friend in the Rockies (probably his 1927 trip west with Winfield Salisbury and Paul Engle), their truck and rudimentary radio equipment — sleeping by the battery so his body heat would keep the voltage up, etc.*

*He said that there was something in God, but that he had not thought recently about higher purposes or faith, and he wondered how persons like me could ever* *achieve a balance. No solutions were proposed — it was a fleeting discussion of no more than 10 minutes. But I saw the humanity of the man in a different sense. I don't think he was troubled. I think he was just inquisitive,* Phillips said.

Despite his lack of interest in religion, Arthur considered Dr. Joseph McCabe, a Presbyterian pastor and president of Coe College, a good friend. Dr. McCabe conducted the Cedar Rapids funeral service for Arthur in 1987.

Over the years a mystique developed about Arthur Collins that he had the temper and disposition of a mean dictator in regard to anything or anyone he disagreed with. Some persons literally were afraid of him. There was a genuine feeling they would be fired if they made a comment or suggestion that Arthur might not like.

Such presumptions were simply not true, according to persons who worked closely with Arthur. There were instances where people working on his projects were fired, but that usually occurred when they lacked competence and knowledge which they claimed to have, or when they defied Arthur's orders.

There were more instances of him tolerating people who argued with him on some technical point than there were firings. To be sure, there were persons fired when they met with disfavor. If Arthur wanted someone fired, he usually delegated that unpleasant task to an underling.

One he did discharge personally, however, was D.C. (Clem) Arnold, when Arnold was director of the engineering and research division in Cedar Rapids. Arnold was a highly regarded engineer, who had joined the company in 1948 and was promoted to head engineering and research in 1954.

Arthur always had a lot of ideas and projects on his mind that he wanted the engineers to investigate. Many were valid ideas, others were of the blue sky variety. He also felt his top assistants should be as eager and enthusiastic about his ideas as he was.

More than once Arnold felt compelled to urge Arthur to go slow, reconsider or even abandon certain projects that were suggested. Arnold always had to think of how a project could be staffed, where space would be found for the work, and what problems might arise from disrupting other work, particularly government contract jobs with specific deadlines. In some cases he convinced Arthur, with others he did not. Arnold recalled that finally on one program Arthur wanted to initiate, when Arnold questioned whether the company's resources could handle it and technology was sufficiently advanced to do what he wanted, Arthur told him: *Clem, if you're not with me on this one, perhaps you should find someplace else to work.*

Arnold then transferred to Dallas to head research activities there. He later left Collins, and always considered himself the only research director ever fired by Arthur.

Absolute loyalty from persons he had placed in positions of trust was particularly important to Arthur. He had brought William J. Barkley into the company March 1, 1935, on the recommendation of Dr. A. Hoyt Taylor, head of the Naval Research Laboratory. Barkley was considerably older than Arthur with vast experience in the radio business. He had his own company during the first

World War, contracting with the government to build radio equipment, and later held key posts with de Forest and Sylvania companies. He knew many influential people in government and business, including radio broadcasting. Because of his sales abilities, his contacts, his vast experience and his high regard for Arthur's talents and products, Arthur made him his executive vice president. Barkley was described as a very distinguished person. He was the company's one-man East Coast sales force up through World War II. He had his main office in New York and another in Washington, doing much overnight traveling on trains to keep sales appointments the next day. Bob Cox remembered that Barkley always could get tickets to Broadway shows for Collins people or their customers. He was responsible for landing a vast amount of business including many major contracts during his 20 years with Collins. Before the practice of doing a favor or offering a small token of appreciation became a forbidden procedure when working with government employees, Barkley had boxes of apples delivered as Christmas gifts to some of his key contacts in the Navy department. The fruit came from the orchard of a farm he owned in New England.

Military contract procedures were simple in the 1930s. Barkley once said in an interview. *You just got the order, they advanced the money, and you went out and built the euipment.*

Around 1955, Barkley reportedly mentioned to Arthur there was talk in some high Navy circles that Arthur should step down and turn over management of his company to others. Whether Barkley agreed with them is not known, but just hearing about it miffed Arthur. Barkley, at an age he could retire, did retire after a strong suggestion by Arthur to do so as soon as possible.

Another time a group of Navy officials came to Collins for a review of programs. In a meeting with Arthur, one Navy officer was highly critical about the deliveries of radios. He suggested it might be time for a top management change at Collins to be sure production schedules could be met. Arthur reportedly gave a very abrupt answer: *If that's all you want to discuss the meeting is over. We all have better things to do including getting to work to see that production schedules are met.*

Of all the many letters from the general public received by Arthur Collins' office, those which dealt with a sincere inquiry from a student or teacher often got his personal attention. He had a soft spot when it came to trying to encourage young people to make the most of their educational opportunities.

He responded with well thought out letters when asked about the personal qualities which his company looked for in new employees, or the importance of various types of education. He liked to stress the need for intellectual curiosity and individual effort.

In one letter to a teacher, he wrote: *I would like to offer a word of encouragement for the student who finds it a little hard to get high grades and who, as a result, may find school work uninteresting. I have the opinion that being a good student is as much a matter of curiosity, effort and encouragement to set a high standard as it is a matter of native brain power. A student may be potentially* *more competent than he or she realizes or likes to admit for fear of being 'different'.*

Another time, asked about the importance of business education, he said: *I think there is a future in business for any individual who is willing to accept the challenge and not sit back and be comfortable with achieving only a portion of what he or she is capable. The business student who will be successful and will contribute the most to his community will be the one who has freed himself from conventional complacency and is anxious for the next change to challenge his initiative. He also will be the one who finds the job he wants and gets the most out of life after he completes his formal education.* Arthur also noted that, *I believe many students are potentially more capable than they realize, and that most people only develop about fifty percent of their native abilities.*

In line with the intellectual curiosity which was a strong point of his personality, Arthur was intrigued with everything mechanical and electrical.

Besides airplanes, he was especially fond of cars and boats.

In the matter of automobiles, his preferences were those which reflected quality engineering and manufacturing, as close as cars could come to matching his standards. His son Michael said his dad bought cars for the engineering experience they gave him.

When European cars became available after World War II, Arthur acquired a French Citroen, a luxury auto which had a strikingly different look than American vehicles. It had two major characteristics — a long streamlined profile and a front wheel base wider than that in the rear. Arthur got rid of it because of servicing problems, with all the U.S. dealers in distant cities.

Perhaps his favorite car was the 300SL Mercedes Benz sports coupe with red leather seats which he acquired in the mid-50s. It was, unfortunately, badly damaged in an accident. He also had a Chevrolet Corvette for a short time, purchased at the urging of his friend, Maj. Gen Francis Griswold of the Strategic Air Command.

Eventually he decided on a Mercedes Benz sedan for his personal car, and stayed with that brand the rest of his life.

When his son Michael was ready for his first car his choice was a Volvo, and the family soon had two of them. Arthur often drove the Volvos, but they were considered Mike's cars.

Mike recalled a trip to Europe with his father. *We had the idea of touring the great car factories with a little culture thrown in — visits to Jaguar, Volvo, Mercedes, VW, Porsche and Mazerati. We didn't have time for Ferari. I remember the beautiful grease pits at Mazerati — they gave me a demo. It was a wild ride through the streets.*

Boats were a passion with Arthur. Les Bessemer told about a boat he had built, a 16-foot craft with a Model-A Ford engine. *Art took a big interest in it. When I went to test it on the Cedar River by Ellis Park, Art came out and had me run it down the river while he drove along the road in his car to see how fast it would go.*

Glenn Johnson, for many years the industrial relations director for Collins in

Cedar Rapids, remembered Arthur coming into his office one afternoon and asking him to go with him to Dubuque to try out a boat. *We ran it up and down the Mississippi way into the night, and didn't get back until the next morning,* Johnson recalled.

Arthur had a number of boats during his life, culminating with a project of building from scratch the largest fiberglass hull boat ever attempted.

He once said boating was a way for him to get away and relax, but what Arthur called relaxing was still related to his work. He often was trying out radio gear on one of his boats, and maintained radio contact with the company while on his boat.

Bessemer, who was both a close friend and a top company executive for a number of years, recalled one of the first large boats Arthur bought, about the time Collins set up its Dallas plant in 1951.

*Art called me from Dallas and said to drop whatever I was doing and come on down to Dallas (from Cedar Rapids.) He had bought a boat — a 32-foot craft with a twin engine. He called it the Osprey. It was at Freeport, Texas, down the gulf coast below Galveston. When I got down there, he had Frank Dyer helping him (Dyer was a former Braniff Airlines communications officer who later became a Collins vice president). They had put a large, pretty heavy marine transmitter in the bow. We had to put lead shot in the stern to balance the boat. We first did some fishing for a couple of days, and then Art wanted to take a cruise down to Corpus Christi. After a couple of hours we checked the gas consumption, and found because the boat was so loaded we weren't going to get very far. We changed course and put into the little port town of Palacios, then went back to Freeport the next day. He later took the boat to Sarasota, about the time his wife died (in late 1955.)*

Ted Welch, president of Peoples Bank & Trust Co., the Collins bank in Cedar Rapids, also remembered being on the boat.

*Art and Jim Flynn (Collins vice president) and I drove down to Freeport after a meeting of company bankers in Dallas. Art wanted to sail up to Galveston, and Flynn said, 'Admiral, why don't you pilot the boat.' He always called me admiral because I had commanded a Navy destroyer in World War II. It was fairly easy to do, following charts and watching the buoys. After about three hours on the bridge by myself, I wondered what Art and Jim were doing. I put the boat on autopilot and went below. They had a radio all torn apart, with the pieces spread all over the bunk. By the time we got to Galveston they had it back together and Art steered the boat into the harbor. We were in our old grubbies from being on the boat, and went into a quite plush hotel. The desk clerk wasn't very anxious to let us in, but Art talked him into it. After we cleaned up they could see we weren't bums. We had a lot of fun for several days on that trip,* Welch said.

Les Bessemer was with Arthur a number of times on his early boats. *After Art got rid of the first boat he called from Fort Lauderdale one day and said to come on down — he'd bought a used Huckins boat made in Jacksonville, and wanted to take it up to Jacksonville. We went up the inland waterway to about Daytona Beach. It was slow going and Art got impatient and said we're going outside. The* *ocean was rough and we took quite a pounding. By the time we got to the St. John's River we were taking on a lot of water. We made it into a boat yard and found the pounding caused a lot of screws to come out of the wooden bottom. He had to have the whole bottom of the boat replaced,* Bessemer said.

Arthur Kemper was an avionics engineer who was drafted to work on Arthur Collins' boat projects, along with two other engineers, Paul McKinley and Mike Pals.

After Kemper earned his EE degree from the University of Missouri, he worked on Civil Aeronautics Administration ground radio installations. He then moved to an air conditioning firm, and went to Collins in 1955. *I was working under Paul McKinley at Collins when Art asked him if he knew of someone who could install air conditioning on his boat. Paul told him he had such a man on his staff and that's how I got involved,* Kemper said.

His first boat job was another Huckins boat purchased by Arthur in 1957. *It was a 52-foot yacht named Osprey II with a wooden hull patterned after the PT Boats of World War II. It had dual 200-horsepower GE diesels with super-chargers — you can imagine how it could get up and go.*

*He rented a slip there at the Huckins Yacht Corporation in Jacksonville. Several of us, engineers and lab techs, were to go down there to install equipment. But first we came up with a complete wiring plan to handle everything imaginable that could go in a boat and built two six-foot-high radio racks which were shipped to Florida.*

*We spent about three months down there, putting in air conditioning, an HF transmitter, ADF system, compass, ship-to-shore radios, gyro stablizer, antennas and other gear,* Kemper said.

Arthur soon moved the boat to a yacht club at Dania, near Fort Lauderdale, where the Cedar Rapids group did additional work on the Osprey. *Art bought a big semi-trailer and rigged it up to be our work shop,* Kemper recalled.

Later the Osprey II was taken to Marathon on the Florida Keys, where an unfortunate incident occurred in which the boat almost sank. It had to be hauled back north to Jacksonville for major repairs by the Huckins company.

During the repair period and test runs to check out the boat, Arthur received a notice from the U.S. Coast Guard that the craft had *failed to stop* when ordered to do so by a Coast Guard unit.

Arthur then wrote a seven-page letter to the Coast Guard, a missive which would have had smoke coming out of it if letters could do that. He began by explaining that at the time of the alleged infraction, the boat was being tested in the Ortega River at Jacksonville by a well-known Huckins official, Capt. J.O.T. Markussen. He indicated he suspected a connection between the near sinking in the Keys and the Ortega River citation.

*It is a widely held belief among boatmen that any request for Coast Guard assistance during an emergency at sea will automatically be followed by a searching review of files and conditions of operating the boat in an effort to 'throw the book' at the boatman involved,* he wrote.

His letter then gave a detailed account of the accident in the Keys.

It occurred March 25, 1959, with Arthur operating the boat on a test run to check out some of the $100,000 in electronic equipment which it carried. His crew consisted of three Collins *technical specialists* and a Huckins technician.

*When I was proceeding approximately three miles from the Sombrero Key Light House (near Marathon) at a speed of 20 knots in about 35 feet of water near the edge of the Gulf Stream, the forward part of the hull was ruptured from some cause which remains unknown, and the No. 1 (forward) compartment immediately flooded.* Arthur explained that the boat had three compartments, and was designed to remain afloat if one were flooded. But a second compartment also began to fill rapidly and the rudder became inoperable.

He then ordered the crew to: 1. Don life jackets and inflate the 10-man life raft; 2. Fire distress flares to attract the attention of the nearby light house; 3. Radio the light house on 2182 kc, and 4. Do everything possible to keep the boat from sinking.

He related that he knew from previous investigation the Sombrero Key Light was supposed to be continuously manned, but there was no recognition from there that the Osprey's flares were being seen or that its radio signals were being heard.

*I then called the Miami Coast Guard stating that I required assistance. The station did not acknowledge my signals, but another boat nearer Miami relayed my call and communication was established. Approximately 15 minutes were then consumed answering routine questions.*

Arthur stated he called the Miami station on a 1-kw military type high frequency transmitter with a range of several hundred miles over water. *All other boats in the area heard my signals loud and clear, therefore I conclude the Coast Guard equipment at Miami was not operating effectively.*

He was told by the Coast Guard that an airplane was being dispatched to bring a pump to the Osprey. Arthur said at that point, due to efforts of the crew, the situation on board the Osprey improved somewhat. Hoses were run from bilge pumps in the rear which with other pumps slowed the water rise considerably. Also, rudder control was restored, allowing the boat to proceeed toward the light house at very low speed. With the plane expected in 30 minutes, he estimated the boat could remain afloat about an hour. More flares were being fired toward the light house, apparently still not seen by Coast Guard personnel.

When the plane arrived in the area, its crew dropped a pump by parachute, but the chute failed to collapse on landing and carried the pump away from the Osprey. However, a nearby sport fishing boat retrieved and towed the pump to the Osprey. It took four men to lift it aboard, Arthur said.

The next problem, he said, was that the pump's water tight container was flooded, and the pump was totally immersed in water, which made it unusable for the Osprey's emergency. Arthur noted the gasket under the container lid was badly corroded, with part of it missing.

Luckily, the Osprey reached a harbor and was quickly lifted out of the water by a boat works. It then was discovered to have a hole approximately 18 inches in diameter in the hull, apparently from striking some underwater object. The hole had not been visible from within the boat, being concealed by the metal bottom of a shower stall.

Arthur concluded his letter by stating he recognized the propriety of heeding signals from Coast Guard units, but also would appreciate assurance that the Coast Guard would act upon signals from vessels in distress and keep its equipment in safe and operable condition.

As for the Ortega River citation, Captain Markussen later wrote to Arthur he had talked to a Coast Guard official and felt the matter would be dropped.

In 1961 the same Osprey II was badly damaged again, this time by Hurricane Donna which swept through the Florida Keys.

The Collins Convair flew to Florida the next day with Arthur, his engineers and a technician aboard, to assess the damage. Kemper recalled the antennas were ripped off and parts of the super structure were damaged, requiring weeks of repairs. Later Arthur decided to have the Osprey II shipped to Newport Beach on the West Coast.

Few people at Collins Radio ever knew that Arthur's boating activities were more than just a recreational pastime.

He seriously considered having the company get into the business of building and selling boats. That was the primary purpose for what was called the marine laboratory, housed in one of the Butler buildings adjoining the Main Plant in Cedar Rapids.

The facility had a water-filled flow tank which ran the full length of the building. It was equipped to build boats and test different types of materials, various hull designs, engines and other components. One of Arthur's objectives was to build the most efficient type of hull possible.

Several boat models were built and tested on the Cedar River. Early versions included aluminum hulls. About 1959 an experimental boat designed by Paul McKinley was constructed with a hull of polyester resin and glass. It was a 26-foot model powered by two four-cylinder, 80-horsepower Volvo gasoline engines, and was first tried out in the Coralville Reservoir. Called the Peregrine, it was shipped to Marathon, Florida, docked beside the Osprey II. The Peregrine was operated and tested extensively. It survived the hurricane in better shape than Osprey II, and also was moved to the west coast.

Eventually Dr. Alexander Lippisch, the noted German aircraft designer who found a home at Collins after World War II, put his engineering talents to work in the marine laboratory. Lippisch sought to apply aeronautical design theories to water craft. It was said some of his efforts produced impressive results while others did not work very well. One of his projects was the aerofoil boat, a small single-place aircraft designed to take off and land on water. It was flown experimentally on nearby Lake Macbride.

Arthur saw merit in some of the Lippisch hull designs and wanted those adapted for his next great boat project, the 70-foot craft built at Newport Beach in the late 1960s.

That boat also was called the Peregrine. Michael Collins said the Peregrine was a direct result of the work of Lippisch and others in the Collins marine laboratory.

*The way it came about was typical of Dad — to go back to the absolute basics, the first principles of physics. They went deeply into hydrodynamics, hull designs and power plants. And he wanted everyone to understand it,* Michael said.

Bill Weinhardt, head of Collins construction projects, recalled a large Butler-type building near the Newport Beach Yacht Club was leased to build the boat. *A lot of people had to become experts at something they never had done before. No one had ever built a fiberglass boat that size. There was a lot of hectic scrambling around and a lot of long hours trying out and learning what would work and what would not. The first problem was building forms for the hull upside down, and after molding the hull over those, getting it off,* Weinhardt said.

After the hull was completed and righted, the superstructure, which had been built separately, was placed on the hull with huge cranes. Then the detailed work began of completing the other parts of the project — including all the electronic systems Arthur wanted. He wanted to eliminate the traditional pilot's wheel connected to the rudder, as he planned to have the boat operated entirely from a control panel. But that idea was squelched by Coast Guard regulations, which required a wheel to hold onto in rough weather, even if the craft had electronic controls. The boat was, of course, extensively equipped with radios, direction finders, automatic pilot, navigation gear, antennas and other systems. With all the equipment it contained, the Peregrine was said to be the only 70-foot boat ever built which could sleep just two persons. It ran like a speed boat.

Arthur reportedly paid for the boat personally, the cost slightly over two million dollars.

*A lot of people in the boat business said a boat like the Peregrine couldn't be built, but it was something Art wanted to do and he did it,* Weinhardt said.

The climax to the construction project came after the boat was finally completed and it had to be moved on a huge flatbed trailer to the yacht club. It took most of one day, requiring streets to be blocked off temporarily, utility lines and traffic signals taken down and put back in place.

Observers recalled that the first sea trial of the Peregrine, with Arthur at the controls, appeared to go quite well.

In line with his thoughts of having his company get in the boat business, Arthur had some marketing research studies done as early as 1960. Those studies included conclusions drawn from experiences with the Osprey II and the first Peregrine. But little more was done about a boat product line until the second Peregrine was completed.

Then, with all the engineering development and construction techniques that went into the project, Arthur asked Richard D. (Dick) Hanson, who headed market research and held sales management jobs in the company, to look at the feasibility of building and selling more of that type of boat. Hanson was known to many co-workers as Red Dog from his initials and his red hair.

Hanson spent about three months checking into the matter, often meeting with Arthur. He wrote a detailed report, noting that two or three such boats were sold in the U.S. in a year. He concluded that *with an intensive marketing campaign, we might be able to capture one-third of that market.* Hanson recalled after submitting his report he never heard any more about it. And he had to wonder if Arthur had completely forgotten who he was when they happened to meet several weeks later and Arthur, who always called him Dick during their boat discussions, said, *Hi, Tom.*

Arthur relished spending time with the Peregrine, as much as he could during numerous visits to Newport Beach in the last years he controlled the company. After that his visits became less frequent.

# Chapter 14
# THE PEROT SAGA

Arthur Collins, always aware of emerging technology, was quick to recognize the tremendous potential of the electronic computer for business operations, engineering programs and his company's products.

In the early 1950s Collins Radio Company obtained its first business processing computer.

A series of succeeding generation IBM computers followed. In those days IBM was so dominant in the computer field it had the lion's share of the market.

By 1961 Collins had one of the largest, most up-to-date IBM installations of any firm in the land with three 7074 computers. Each was connected to 12 tape stands, providing (for that period) substantial computer power capable of processing vast quantities of data. Other equipment included disc files for random access storage, contained in large cabinets. The computer center was in a new building adjoining the engineering building in Cedar Rapids, known as the CDS building.

Collins indeed needed large scale computer capability for its manufacturing, engineering, marketing, finance, personnel and other functions.

Data processing requirements for manufacturing and material control alone were staggering. The company had several hundred products ranging from small components to complex electronic communication and navigation systems being built at four locations for hundreds of customers. Meeting the production demands involved the purchasing of thousands of parts and materials items every week, getting them to the proper factory areas on time, the scheduling of work and workers, inventory management, shipping and delivery instructions, paying suppliers and other activities. If it was a government contract production order, a myriad of special reporting requirements were involved.

A multitude of paperwork was generated every day from offices and work stations. Those forms and reports went to a keypunch area, employing some 400 keypunch machine operators on three shifts. They transferred the pen and paper data onto punched cards. That converted the information into a format which could be entered onto magnetic tape reels and fed into the computer.

The abilities of the computer then came into play. Each day's inputs were entered into the system. Then on weekends, beginning Friday afternoon, the entire accumulation for the week was consolidated and processed. The computer could take the inputs from a variety of sources and combine them into a single comprehensive report in a time scale of minutes to an hour or two, depending upon the quantity of inputs. For a team of humans to achieve the same results would have required days or weeks of work.

The weekend computer run produced stacks of neatly printed reports, often hundreds of pages, which were distributed to Cedar Rapids work stations for use Monday morning. The reports literally gave each company operation updated work assignments and status reports on programs. Processed data for Dallas, California and Canada was entered on tape reels which were shipped by air. The data then was converted to printed report form at the destination. At that time there was only a limited capability to transmit data on telephone lines.

The method being used to compile and "crunch" the data was known as batch processing.

Such a complex data input, processing and distribution system had many possibilities for errors, and they happened even with practices designed to avoid them. For example, every input was converted twice by keypunch operators. The hope was that if one made a mistake, the second operator would catch it. Still, errors crept in and caused problems.

Probably because of numerous problems, Arthur introduced a new, young data systems manager into that scenario in 1962.

He was Michael F. Phillips, a native of England, who earned physics and mathematics degrees and emigrated to Canada at the age of 25. After other jobs he joined Collins Radio Company of Canada in Toronto in 1959, working as a contracts manager.

Phillips recalls that 1962 was a year of significant events in his life. In February he married a Canadian girl, and almost immediately he and his bride were moved by Collins from Toronto to Cedar Rapids, new and strange surroundings for them.

The reason behind the move was rooted in a decision by Arthur to identify a group of bright, young, high potential employees as future executive material. The idea was to rotate them around the company, broaden their experiences and test their capabilities to become future leaders. It became known in Collins management circles as the Astronaut Program.

Phillips' first assignment in Cedar Rapids, one which contrasted sharply with his previous responsibilities of negotiating international contracts, was that of an expediter for a foreman in a manufacturing area. An expediter was sometimes referred to as a gopher; one told to "go for this," or "go for that." Phillips, tall, good looking and well educated with a British accent, knew he was different than the average expediter, but he asked no favors. While not pleased about it, he presumed his assignment on the factory floor was intended as a learning experience.

After about 45 days, and being thoroughly bored with the factory job, Phillips' foreman told him one Thursday morning, with due reverence, he was wanted at the Cedar Rapids Country Club for lunch that day with Arthur Collins and Executive Vice President Morgan Craft.

Phillips recalls that he went home, changed from jeans and T-shirt to more appropriate dress, and went to the country club. He found Arthur, Morgan and two men associated with computer operations seated in a semi-private setting in a secluded corner.

Phillips described what happened next:

"To my surprise, Art greeted me effusively — at least as far as Art was concerned — and it was me they were honoring. He brought out a bottle of champagne and toasted me as the new manager of data processing operations for Collins Radio. At the time I didn't know a bit from a hole in the ground. When I murmured this to the group, Art reached under the table, brought out three books and said, 'Read these, by the time you start next Monday morning, you'll know all you need to know!' I was in a state of shock, didn't even know the right questions to ask, and in particular forgot to ask what happened to my predecessor and why. I had no knowledge of the scope of responsibilities, and the others were so busy celebrating I didn't seem to be able to find out. During the lunch I learned from Art that he wanted me to bring a businessman's perspective to the operation of the existing data processing organization. Also, Art said he was heavily committed to Collins' leadership and future in the world of data processing and switching computers, which he then was busily inventing.

"None of this made much sense to me, as I was still trying to figure out 'why me?' Before we separated, Art suggested that I meet him at noon Sunday at the CDS building where he would show me around."

Phillips plunged into the new challenge, and found it a seven-day-per-week job, long hours each day. "We ran a round-the-clock operation. We never closed, even for Christmas Day. In many ways it was brutal, but completely absorbing and fascinating," he said years later, reflecting upon his experiences.

During the first few months Phillips found the center still could handle the weekend batch processing workload.

But Arthur was pressuring all parts of the company to get on board the computer bandwagon. Each week the demands on the data processing center rose like a flood crest as more programs were added for the various departments and management functions.

With the computers operating 24 hours a day, software programmers who required computer time to test and debug programs often had to do their work between 1 and 5 a.m.

By the end of 1962 the weekend batch processing volume exceeded the capacity of the equipment in the Collins data center. And the demand for computer time continued to grow. Adding more computers was not a solution, as the building lacked necessary space for expansion. Nor was that an option — the center already was a costly operation. Besides, Arthur was not impressed with the IBM machines.

Collins began approaching other companies which had identical computer hardware and idle computer time on weekends which they would sell. One such source was found in Chicago, others in Dallas. Every Friday night Collins computer operators would fly to Dallas and drive to Chicago with stacks of tape reels, process the data and get back to Cedar Rapids early Sunday. Then it would be combined with other data in the Cedar Rapids center to complete the job. After that came the frantic effort of delivering tapes to the other Collins locations.

It was a logistical nightmare, with frequent mix-ups, misplaced tapes and other problems.

And still the Collins data processing center faced increasing demands for computer time.

One day in early 1963 Phillips' secretary informed him there was a salesman from Dallas in the lobby wanting to see him.

The man introduced himself as Ross Perot.

Phillips recalled what happened:

"I immediately sensed that the man had 'presence.' At the time, of course, I did not know him at all and I did not realize that he had been the top salesman for IBM. He was good, very clear, quite forceful and very believable.

"He told me he was aware of the fact that Collins needed additional processing capability over the weekend. He explained that several months earlier he had left IBM to find his own way in the world of data systems. He had contracted with Southwestern Life Insurance Co., a large firm based in Dallas, to take all of their excess computer time, especially on weekends. He needed some of the processing capability for his new business, but having recognized that a market niche existed, he expected to make a profit by reselling time to companies which needed additional capacity. He told me he had checked and believed the Southwestern Life installation was completely compatible with our needs. Further, he probably could provide experienced operators to help with the processing.

"He went on to explain that he was in a jam. He had mortgaged his home, changed his lifestyle and that of his wife and family in order to finance his contract with Southwestern Life. Unfortunately, he had very bad negative cash flow because he had not been able to sub-let a single hour of the computer time that he had contracted. He was broke, in danger of bankruptcy, and was willing to make Collins an offer for computer time that we could not refuse.

"I asked him how much he would charge. I can't remember his exact response, but it was something like, 'How about a four-month contract for a fixed substantial amount of time on the weekend at my cost? Then another eight months with a small margin of profit — say 15 percent. After a year, we then could renegotiate.'

"I compared the numbers he provided with our other experiences, and knew we had a deal, so we quickly made one. It was a good arrangement for Collins, and from what I gathered much later, an even more important deal for Perot. It provided him with cash flow, and allowed him to begin his journey to fame and fortune. There was not a lot of negotiation, as we were able to strike a deal almost immediately. Within a couple of weeks we had a contract.

"I had no idea at the time of Perot's potential. He was extremely ethical, personable and convincing. He was a bit of a hustler, but in the finest tradition of good entrepreneurs."

Perot talked about the start-up of the business he founded, Electronic Data Systems, and the Collins sale in an interview with U.S. News and World Report in June, 1992 when he was a presidential candidate:

"It took me 78 sales calls to make my first sale — though in, of all places, Cedar Rapids, Iowa. I used the $100,000 from that to hire more systems engineers," he was quoted as saying.

Phillips said he did not believe Perot met Arthur Collins during the 1963 negotiation.

The Collins contract with Perot's firm continued for about a year or two, when data processing techniques began to change. Perot went on to build up his Electronic Data Systems Corporation, based in Dallas, into an amazingly successful business venture.

The name of Ross Perot was not heard again in regard to Collins Radio Company until 1969. Then it came upon the scene like a bombshell.

Between 1962 and 1969 Arthur Collins, too, had made significant progress in the world of computers. His firm, under his personal engineering direction, had developed the C-8400 message switching computer, being used by a number of airlines, railroads and government agencies.

He then had moved into development of a next generation computer system called the C-8500, being designed to provide more than message switching. It was the heart of what Arthur called the C-System, intended to be a revolutionary computer-based technique to manage and control various operations of a corporation.

Collins had announced in 1968 that it would enter the computer field with its C-8500. Arthur's intent was not to take on IBM and others as just another business and accounting data computer, but to combine processing functions with high speed, high volume data communications.

Collins Radio Company had reported record sales of $447,026,000 and net income of $13 million, equal to per share earnings of $4.44 for the fiscal year which ended July 31, 1968. Arthur believed his company was primed for growth over the long term.

But after that a downward trend began. The company began to feel defense and space spending cuts in late 1968, soon followed by an economic slump affecting the aviation industry. The government was the company's single biggest customer, and the airlines and business aviation were Collins' main and most profitable commercial business areas.

The market value of Collins common stock dropped by about half in a little more than a year. Arthur and his family controlled about 20 percent of the stock.

Also reflected in the company's financial situation was the tremendous cost of the C-System development. In addition, Arthur embarked upon a major new facilities expansion program in the mid-to-late 1960s, partly to prepare for business he hoped the C-System would generate.

One of those buildings, housing Collins Radio corporate offices, was a modernistic new four-story glass and concrete structure on the grounds of the sprawling Collins complex in Richardson, on the north edge of Dallas. Officially the edifice carried a numerical designation, Building 407. Company people usually referred to it as Camelot.

In late January, 1969 a secretary in the top floor corporate suite answered the phone to hear the caller identify himself as Ross Perot, who asked to talk to Arthur Collins.

Perot was momentarily put on hold. Calls to Arthur were very carefully screened. They did not go through if not from persons known to be working with or familiar to Arthur. After a quick consultation among other executives present at the time, the suggestion was made to Perot that he talk with one of the company's data systems officials. It was assumed his call involved data services. One Collins officer expressed the opinion that salesmen always think they can make a big sale if they can just get to the top man of a company.

Perot insisted his business was strictly with Arthur Collins and did not involve data services. Arthur's top aides including Executive Vice President Bill Roodhouse decided, however, that if Perot wanted to talk to anyone at Collins, it would be with Howard Walrath, in charge of the company's information systems operations. Arthur was not then aware of the Perot contact.

Walrath had grown up in Cedar Rapids, earned an electrical engineering degree, took graduate work and taught briefly at the University of Iowa. He began working at Collins Radio Company in 1959. Soon after joining the company he came to the attention of Arthur because of his knowledge of computers, which he had acquired at the university. From that point he was promoted to increasingly responsible executive assignments, and eventually became a vice president.

Walrath's main office was in Cedar Rapids, but he also spent part of every week in Dallas.

Thwarted at reaching Arthur after several days of trying, Perot finally agreed to meet with Walrath, and they set up a meeting in Building 407 for 2:30 on a Friday afternoon.

Neither Arthur or Executive Vice President Roodhouse were in their Dallas offices that afternoon, and Walrath was getting ready to catch a company plane back to Cedar Rapids at 4 p.m.

Recalling the meeting, Walrath said it began with a few pleasantries, then he said, "Mr. Perot, what can I do for you?"

He was astounded by what he heard next.

"It is my intention," Perot said, "to acquire every publicly held share of common stock of Collins Radio Company that is not held by an officer or director."

Walrath said he suddenly decided this was an important meeting, and began to take notes.

He also recalled Perot saying he (Perot) wanted to acquire Collins Radio Company and merge it into Electronic Data Systems, and that he intended to make Collins the number two company in the computer business, second only to IBM. Perot said he understood technology and more importantly he understood Wall Street and marketing, and that was where Collins needed help. In effect he would combine Collins' technology expertise and his marketing savvy.

"Perot went on to say that if he could not work out an accommodation with Mr. Collins, then he would have no further interest in Collins Radio Company — that if he could not hit it off with Arthur, he had no ulterior motives — there would be no hostile takeover attempts," Walrath remembered.

Perot made a few other comments, such as believing in employee stock options.

When Perot departed Walrath called in Glenna Skyles, secretary to Arthur and Bill Roodhouse, and began to dictate: "Ross Perot came in this afternoon and his opening statement was he intends to acquire every share of Collins Radio Company common stock not held by an officer or director." Glenna's reaction was, "You're kidding," and Walrath told her, "yes, it's true, but please keep writing. I need to catch a plane."

As soon as she had typed the memo and made copies, Walrath headed for Addison Airport, about eight miles away, where the company plane for Cedar Rapids was being held until he could get there.

Glenna also put a copy in the "in" drawer of the desk of Roodhouse, the No. 2 executive in the company who was Walrath's boss. Roodhouse was on a return flight to Dallas from a overseas trip that Friday P.M., but was expected back in his office Saturday morning.

Walrath decided he should revise the memo on the flight to Cedar Rapids. He later called Glenna at home, who took down the changes and said she would go in early Saturday morning, type the new version, and replace the earlier copy in Roodhouse's desk.

Walrath was in his Cedar Rapids office at 7 a.m. Saturday to get ready for staff meetings that morning. All that day and Sunday he expected but did not receive a call from Roodhouse.

At 7 a.m. Monday Walrath was back on the company Gulfstream turboprop aircraft, heading for a previously scheduled 10 a.m. meeting in Dallas. The Cedar Rapids-Dallas flight usually took about two hours.

Shortly after 8 a.m. the pilot called Walrath to come up to the cockpit. Roodhouse was calling him on single sideband radio, having just read the memo. Agreeing they could not discuss the topic over the air, because of the possibility of others listening in, Roodhouse told Walrath to get to the Building 407 boardroom immediately upon landing. Roodhouse had gone into the office Saturday but because of several other executives waiting to talk to him about urgent problems and being dog tired from his foreign trip, he never got around to checking his "in" drawer.

The plane landed at Addison about 9:15 a.m. Told that, "Mr. Roodhouse is waiting to see you," Walrath was handed the keys to a company car and drove straight to 407. As he walked into the building the receptionist directed him not to the fourth floor board room, but to the "living room," a larger conference room on the ground floor.

Entering, he saw a number of chairs arranged in a large circle, occupied by Arthur, Roodhouse, Company Attorney and Secretary David Foster, Chief Financial Officer Ed Williams, other in-town members of the Board of Directors and outside legal counsel.

There was one chair in the middle and that was for Walrath, who then answered questions about the Perot meeting for two hours. Finally, one of the group said, "Howard, I don't think you've told us a single thing that wasn't in your memo."

After that Walrath was out of the loop. Legal, financial and other executives along with outside consultants took charge.

While Arthur had no intention of agreeing to any merger with Perot and EDS, he consented to a brief meeting of himself and Bill Roodhouse with Perot. Arthur had been president and CEO of his firm since it began and he had no plans to give up power.

In the radio/electronics terminology common among Collins people, the meeting was said to be "like AM talking to FM." That was reflected in a company statement issued later: "Discussions were of a preliminary nature and did not reveal a compatability of interest between the two firms."

Despite Perot's statement to Walrath that he had no intention of trying to acquire Collins if Arthur was not agreeable, Perot apparently changed his mind and on March 24 announced a takeover plan.

His proposal was for Electronic Data Systems, with annual sales of $8 million, to buy Collins ($440 million in sales) by swapping 1.5 shares of EDS stock for one share of Collins stock. Collins had nearly three million shares outstanding, selling at the time for about $55. EDS had 650,000 shares, owned mostly by Perot, priced at $44. A broker described his view of the situation as, "It looks like a case of Jonah trying to swallow the whale."

One story printed about the takeover attempt described Arthur as "livid," smoking up to three packs of cigarets a day compared to his usual two packs.

Perot wanted another meeting with Arthur, apparently believing he could sell Arthur on his ideas for a combined company if they could just sit down and talk.

Perot did not realize what made Arthur tick. When Arthur set his mind on an objective, he went at it with a total determination to succeed. That had been the pattern with the many company developments he had engineered.

And Arthur, always wary about anyone but himself having control of Collins Radio Company, was very determined to prevent any takeover by Perot.

He also was determined not to meet again with Perot. For the next few weeks Arthur's whereabouts and travels were known to very few persons. There was concern that Perot may have had people trying to track Arthur.

Sometimes only his wife, Bill Roodhouse, the company pilots and radio station operators knew where he was and where he was going. He did a lot of flying around in the company planes during the period, staying away from Dallas.

On one occasion Ray Ruggiero, manager of the single sideband radio station in Cedar Rapids, got a call at home from Arthur asking him to come over to his house and drive him to the airport.

Ray drove his new Volkswagen bug up the long hilly driveway to the Collins home and parked in front of the garage. Arthur came out wearing an old trench coat with the collar turned up.

Ruggiero remembered that Arthur, with his tall frame hunched down in the passenger seat, asked him why he couldn't afford a bigger car.

The top management and directors of Collins were frantically looking at every possible defensive measure to thwart the Perot takeover attempt.

They were not the only ones concerned about what could happen if the EDS initiative succeeded. The Pentagon also was worried. The U.S. military establishment liked to do business with firms it knew and trusted. EDS and Ross Perot were not well-known in Washington at that time.

Collins was still the leading American defense contractor in many areas of advanced radio communications, as well as avionics.

In addition, the company held a number of "spook" contracts — top secret programs including big dish antennas and listening equipment to track Soviet satellites.

Bill Roodhouse went to Washington to brief the Pentagon and talk to other federal agencies about the situation. *I learned a lot about the power of the government from that. Those various commissions can apply a lot of pressure when they want to, and they helped the Collins cause,* he said.

The concern by government contracting agencies about doing business with EDS was one factor which defeated Perot. The main reason, however, was the support for Collins by the eight large banks which had loaned extensive amounts of money to Collins. They made it very clear they would not back any agreement with Perot and EDS.

A particularly nettlesome aspect to Arthur and other top aides including Bill Roodhouse during the Perot episode were detailed stories about it in The Wall Street Journal. The articles irritated Arthur, who was very sensitive about personal publicity and didn't like anyone knowing any more about his business than he wanted them to know. The stories were by Norman Pearlstine, later to become managing editor of the Journal, and who had developed a close friendship with David Foster, Collins corporate attorney and a company director. Foster was a Cedar Rapids native and University of Iowa law graduate who joined the company in 1959 after working with the Cedar Rapids law firm retained by Collins. Soon after the Perot affair died down, Foster was out as a Collins officer and left the company.

A lengthy Pearlstine article relating the entire series of events of the Perot-Collins clash included reference by an EDS official that one factor in the Perot withdrawal was they did not want to pursue the effort at a time when Arthur's wife Mary was about to undergo surgery.

Talking about that later, Mary said she had been told by doctors she had to have a hysterectomy.

*Arthur came into the hospital the day before the surgery. He had a big grin on his face and when I asked him why, he told me Perot had just backed off. And then he said, 'He told the world he's backed off because of your sickness.' Then he got that silly grin on his face again.*

While Collins deflected the Perot merger attempt, it exposed a precarious financial situation. It showed that Collins Radio was vulnerable to a takeover.

Arthur's top advisors found it a touchy and difficult task to convince him of that. When he finally faced up to such a possibility, he allowed a search to begin for other potential partners.

While Perot did not succeed in gaining command of Collins Radio in the spring of 1969, Arthur was able to retain control for only two years after that.

Ross Perot, asked years later what it was he saw in Collins that made him try to join EDS with Collins, said he made his approach after being contacted by a senior Collins executive.

*I can't remember his name after so many years, but he told me he thought Collins might be interested in a merger,* Perot said.

Perot also said he had the highest regard for the people at Collins he dealt with both in 1962 and 1969.

*Arthur Collins was a great man and Collins Radio was a great company,* he said.

The unknown executive who contacted Perot may have been someone trying to get even with Arthur for some slight or he may have believed he was doing Arthur a favor by trying to help him save his company.

By 1969 there was a growing list of present and former top associates who had become disillusioned with the path which Arthur had chosen for the company — to have every activity of the company be controlled and every product designed by the C-System, and the firm's main marketing effort be to sell the C-System. A fear mentality had begun to envelop the company. People did not like what they saw happening but felt they would be fired if they voiced their opinions.

Many in top positions who worked closely with Arthur had given the best part of their careers to Collins Radio Company. They were men who contributed significantly to company growth and Collins' leadership in communications, avionics, space and data transmission fields. Some had been literally dumped by Arthur if they began to disagree with him. Others, who he felt were not as supportive as he liked them to be, had been switched to jobs with impressive titles but little influence. Others were just put on the shelf, still drawing executive pay but having little to do. Some had no idea why they fell out of favor with Arthur.

Some decided to leave Collins Radio Company for other companies or to start firms of their own.

With such a group of people no longer as pleased as they once were with Arthur Collins and Collins Radio Company, it was not surprising that one of them may have tried to bring about a change.

There also may have been another reason for Perot to have wanted control of Collins Radio.

One business writer noted that EDS was considered a *middle man* in the computer field — selling services which matched companies' needs to various computers for payroll, billing and other functions. The Collins C-System, the writer observed, if perfected could be detrimental to the middle man practice because of its ability to handle all such functions with a single system.

# Chapter 15
# THE C-SYSTEM

Arthur Collins probably was thinking how computers and communications could work together even before Atanasoff and Berry developed the first computer at Iowa State College in 1939.

Soon after World War II he had his engineers begin work in data communications. He applied increasing emphasis in that field and computers as long as he controlled Collins Radio Company through 1971.

During those years the company also produced a literal torrent of developments for aviation, military and space communications, amateur radio, microwave and troposcatter systems and radio broadcasting.

While being either involved in or abreast of all those programs, Arthur was intrigued by the thought of what computers could do.

During World War II, when company growth mushroomed, Collins Radio had the latest available IBM calculating machines, the forerunners of computers.

In the late 1940s, Collins developed analog computing devices which were part of aircraft navigation systems.

In the early 1950s the company acquired an IBM-650 for business applica tions. Most computers then were stand-alone mainframe installations, doing business computations. They had very little built-in memory capability and no modems. Inputs were mostly from punched cards. Data was stored on large magnetic tape reels. Data transmission between computers was not yet feasible. Only a few people knew much about computers. The components and technology for personal computers were still years from being developed.

A hint of how Arthur Collins could foresee future needs was recalled by Marvin Moody, who for a number of years was the Collins patent attorney. *Art got to thinking, where and how do you need to transmit the most intelligence cheaply. Long before others, he saw that need being met in a computer-data link, and that it would have to be a digital system.*

Mel Doelz, who became vice president and general manager of the Collins west coast research facilities where much computer development took place, also recalled how Arthur was thinking in the late 1940s. Doelz then was an engineer working in the Third Street Building in Cedar Rapids.

*Art came down and said the day was coming when there would be a big demand for moving large amounts of data through telephone lines, and we needed better ways to do it,* Doelz said.

*Walter Wirkler was still around in those days, and he suggested that theoretically we could do an ideal job of separating signals from noise (necessary for transmitting data over phone lines) by trying a scheme that exactly matches the* *shape of the signal to the shape of the pulse. We worked with that and eventually developed a quadrature phase shift keying system using mechanical resonators. That tied into work I was doing in mechanical filters at the time. One form we tried was a vibrating rod. Another looked like a xylophone.*

*So from that we built the first 2,400-bit-per-second modem, using a new scheme of multiple tones. It was the first high speed modem and the first one that moved data at more than 600 bits-per-second. They were not then called modems — that name came later.*

*By accident I set the standards on modem speeds— 2,400, 4,800, 9,600-BPS, etc. The 2,400-BPS modem was tied to a 100-word-per-minute teletype machine, which required a 90-bit-per-second rate. The first of the 2,400-BPS modems made many tones, each of which could deliver a 90-BPS signal. Enough of those tones added up to 2,400-BPS. Later we started running at higher speeds with fewer tones,* Doelz said.

The modem, which became a main computer system component in later years, was still a new and little known device in the early 1950s. Some have credited its origination with Sperry Univac scientists, who found that by converting data to tones and digits — which is what a modem does — data could be transmitted over telephone lines. Connecting a modem to a phone line and transmitting data was achieved despite telephone companies' assertions that it could not be done.

What Doelz, Wirkler and their Collins engineering teams did was to take modems beyond the early rudimentary versions and enhance the concept of the modem, developing higher bits-per-second rates at faster speeds.

Those early Collins Radio efforts in data transmission led to the development of modem hardware and a system called Kineplex. It was named that because it combined a type of kinematics with multiplex techniques. Kineplex was a synchronous multi-tone phase modulation method which could transmit large quanties of data. Doelz said when they began to develop Kineplex they had two objectives — one to get very high performance in sorting the signal from noise, and to utilize that high performance capability to transmit over telephone lines. Then to determine how many bits per second could be obtained for a given amount of bandwidth, and to build the modem to work with it. Kineplex also transmitted data by radio, providing the radios had the frequency stability and phase stability of such units as the Collins single sideband 51J all purpose and 75A amateur receivers. The initial Kineplex was tested on HF, VHF and UHF radio circuits as well as telephone lines.

Kineplex was the most advanced system developed by the mid-1950s for transmitting data.

Kineplex required precise timing and spacing of pulses and tones, achieved with a complement of hardware including code converters (for converting non-synchronous teletype signals), tone generators, timing equipment, tone detectors, various types of oscillators and other units for transmitting and receiving.

Doelz and the engineers he supervised at the Collins California operations, first located at Burbank and later in a spacious new complex called the Information Science Center at Newport Beach, developed several derivatives and spin-offs from the first Kineplex system. By 1955 they had a transistorized system.

While synchronous communication was not yet well understood in that era, which made its acceptance a tough sell, several U.S. military defense systems employed Kineplex or derivatives of the technique including PWRT (predicted wave radio teletype) for high speed, high volume message transmissions. One installation was the DEW line — the Distant Early Warning system — where it was used for data communication between radar stations spaced across the Arctic and distant command stations.

Additional applications came in the Naval Tactical Data System and Air Tactical Data System. Kineplex was a key component of NTDS and ATDS, complex and large scale communications systems for coordinating a naval force of hundreds of ships and aircraft spread over a vast area of ocean.

Also, in the late 1950s, Mel Doelz supervised the development of a Kineplex derivative called minimum shift keyed modulation (MSK). That modulation technique needed less bandwidth than Kineplex and was incorporated into a program named VERDIN. It was a highly secret Navy system used to communicate over very low frequency radio channels with submerged submarines. VERDIN required huge antenna systems around the country.

Collins, of course, had Kineplex installations linking its plants in California, Iowa, Texas and Canada. Punched cards were used to input data for transmission.

Systems also were used for ground stations and ships of the Pacific and Atlantic missile tracking ranges and by the Strategic Air Command.

Major U.S. industrial firms including Douglas Aircraft and Westinghouse and government agencies which bought Kineplex in the mid-1950s used it to transmit data over wirelines between widely dispersed plants and offices around the U.S.

One application was by a military supply agency which used wireline communications between its headquarters and its main depot 650 miles away to maintain daily inventory control on more than 140,000 items. Before the installation of Kineplex, it took teletype operators 10 hours each day to manually handle all transmissions. With Kineplex, a day's message volume was reduced to less than one hour.

In pioneering those early digital data transmission techniques Collins had to develop or adapt specialized terminal equipment including printers, tape decks, card readers and other devices.

The early in-depth experience with data transmission gave Collins Radio Company extensive digital circuit capability.

The technology at the time allowed data to be transmitted from one point to another, but not to be automatically *switched* to additional receiving points. Transmission is the technique of transporting information, while switching deals with ways of handling information once it is received by identifying it, routing and distributing it to appropriate destinations.

The experience with those first of their type customer applications showed that a specialized computer was needed for data transmission and switching. Arthur looked into computers then on the market but found nothing available with the capabilities he wanted. Arthur and Mel Doelz designed a small first generation computer for use with Collins modems and other equipment, but it was not an ideal solution. Collins also tried to connect its own IBM computers directly to telephone lines for real-time processing of engineering, manufacturing and financial data, but quickly found that did not work. Arthur, in fact, felt there were many shortcomings in the IBM equipment. He had his own ideas of what a computer should be able to do, and how a computer which met his objectives could be designed and built.

Also in the late 1950s, Arthur had a type of think tank seminar underway at Costa Mesa, near where the initial building of the new Information Science Center was under construction at Newport Beach. The Information Science Center (ISC) was built on a large plot of ground which in 1960 was surrounded largely by wide open spaces. Within the next few years most of the neighboring areas would be developed.

The ISC facility was a direct result of Arthur Collins' foresight about the coming computer era. One of the intended functions for the plant was silicon integrated circuit production — the chips and other components required for the future computer role he envisioned for Collins Radio.

The Costa Mesa seminar continued on and off for about three months, with Arthur and many of the company's key technical people participating on a periodic basis. The initial session, however, had about 350 attendees required to be there, with Arthur presiding and being the main speaker.

That was about the time the DEW line contract was winding down. Collins had been building and shipping hundreds of modems in refrigerator-size cabinets for the DEW line.

Among the questions posed at the meeting was: *What other uses can we find for the modem?* One suggestion was the banking industry.

And the topic of computers was discussed extensively.

Even at that time, almost 30 years before e-mail and the Internet would emerge, Arthur said he could visualize a day when everyone could communicate through a computer in their own home, with two people sending data to each other in the same way they used telephones to talk to each other.

Another prediction he made then, when AT&T and the *Baby Bells* controlled most long-distance and local telephone service in the U.S. and every residential phone had to be leased from the phone company, was this: *The day will come when you can walk into Mays drug (a drug store chain which had several outlets in Cedar Rapids) and buy your own telephone.*

Also, Arthur established a Communication and Data Processing Division for Collins, which included erection of a new building in Cedar Rapids called CDS. It housed the firm's IBM computers and data processing operations, and linked all U.S. and Canadian plants and offices with telephone, teletype and radio communications. The intent was to provide data processing both for Collins and for customers wanting to use the service.

That was the scenario which stirred him about 1960 to have Collins Radio Company enter into a computer development program.

From his usual detailed personal investigation and research, and his ability to look into the future, Arthur had much more in mind than just another computer.

Robert L. (Bob) Cattoi, who headed engineering management and development on computer programs, recalled Arthur's approach.

*He called a group together and said we had to understand more about telephony and telecommunications from the telephony side because of the need to move more and more data over telephone lines.*

He had hired Larry Hungerford from AT&T. He wanted me and my staff to work closely with Hungerford, having us learn about the phone business, then get together with people at Newport Beach — a number of newly hired persons with computer expertise, mostly from west coast aerospace and electronics firms, Cattoi recalled.

*When it came to computers and communication, Art said: 'Let's start with what we are really trying to do — that's to manage information. To manage it, we have to compute it, control it and make some decisions. We have to have more than just a computer, more than just communication — we have to look at the way information is formatted, the way we use communication and computers.'*

*He talked about the importance of the data base. He talked about what he called a data architecture, overlaid on a control architecture, overlaid on a communications architecture. He likened it to a house, where you have a basic physical structure, and on that you overlay the plumbing, heating, electrical systems architectures, etc.*

Cattoi said people have talked about what Arthur did in the data field was to marry communications and computers, but that was an over-simplification. He saw computers as a main tool in managing information for many applications.

Arthur often talked about how telephone networks were examples of a communication and switching system, in that a caller could reach another party any place in the nation, even though many different companies and systems were involved. He wanted that same capability in data transmission and switching.

Cattoi had come to Collins in 1950 with a EE degree from the University of Wisconsin. He worked on commercial and military aviation automatic direction finder systems and then helped develop the CNI (communication, navigation and identification) system for military aircraft, combining a group of individual functional units to work as a system. It was one of the first major systems applications by Collins. He then was tapped by Arthur for his computer development project.

A top priority program was established at Newport Beach in 1960-61. It came to be known as Project COMO — the acronym standing for computer mockup. It was the initial step toward developing a Collins-designed, Collins-built digital computer to be the main element in an automated data transmission and switching system, and also capable of performing scientific and business data processing. A standard practice at Collins with a new product or system was to construct a physical model — a mockup. While a mockup was not intended to be an operating system, it showed the basic design concepts, how and where all parts would fit and the size, shape and appearance of the equipment. The detailed work of developing an operating system followed the mockup effort.

Cattoi described some main objectives of COMO being to look at the logic of computational systems and memory systems, and how to determine basic building blocks. Arthur had emphasized he wanted a modular design using the basic building blocks to accommodate a small or large configuration — connecting as many units together as a customer might need without having to redesign the system. He wanted to utilize the tremendous potential provided by then new transistors and other solid state devices. As with any new Collins product, the design effort would cover not only the product design but also spell out plans of how to manufacture, test and maintain all parts of the system.

Another of Arthur's stated requirements was that it must be as reliable as the telephone system — always *up* and ready to use.

As the Project COMO momentum increased in the early months of 1961, more engineers and specialists were brought in to the assigned work area in the new Newport Beach plant. They came not only from Newport Beach but Cedar Rapids and Dallas. Eventually about 75 were involved.

The electronic design that emerged was advanced for computers in 1961, based on transistors available then, individual components slightly smaller than a pencil eraser. A dozen or so transistors and other components were mounted on a small circuit card to perform logic gate, flip-flop and other functions. Dozens of the cards were required, each about three by three inches with a pin connector on one edge and a plastic handle with a nomenclature code on the opposite edge. The cards stood vertically on shelf type structures and were plugged into horizontal rows of connectors in cabinets about 30 inches wide, six feet tall and 18 inches deep. Individual wires in the rear of the cabinet, rather than cabling common at that time, joined the cards and connector racks, both within and between cabinets. The reason for individual wires was to have the shortest length of wire possible between connections and to avoid *cross talk* that sometimes resulted from cabling. A cabinet would contain up to nine shelves of cards, about 60 per shelf, and hundreds of wires of many colors, literally miles of wiring. The supporting racks for cards and connectors were also ducts to distribute air for cooling the thousands of transistors. As one engineer said, *Those little buggers were small but they generated a lot of heat.*

The computer had a built-in *magnetic core* memory, with much smaller memory capacity than computers of later vintage, constructed of ferrite beads interwoven with fine wires, which was state-of-the-art in 1961. Collins purchased that part from a vendor firm.

Frederick W. Johnson was a mechanical engineer who had worked on a number of Cedar Rapids projects which Arthur had monitored closely. He remembered how he became the second Cedar Rapids engineer sent to the west coast to work on the COMO program.

*On Memorial Day morning, 1961, I was at the site of a new home I was having built in Cedar Rapids when my wife drove up with a message to call John McElroy (director of engineering.) He told me the company Beechcraft was ready to fly me to Chicago, where I would board a non-stop commercial flight to Los Angeles. Bob Cattoi was already at Newport Beach and would pick me up at* *the Los Angeles Airport. On the drive to Newport Bob filled me in as much as he could, saying the assignment was, 'Arthur wants to start the design of a company built computer.' My task was to get the mechanical model started.*

Johnson said solving the cooling problem involved a major effort. It was clear that the unreliability of uncooled components could have killed the program, he said. He and his associates borrowed from airflow techniques developed for aviation equipment by Dr. Alexander Lippisch, the German aircraft designer who came to Collins after World War II. Another mechanical engineer who spent considerable time in California was Johnson's immediate supervisor, Harry Passsman, who had a reputation for *full steam ahead* on any project in which he was involved. Johnson and Passman played key roles in developing the card and rack concept.

Another factor confronting the design teams was a new graphics appearance, not only for the new computer system but all Collins products from that time on.

With only a few others knowing about it, Arthur had a new trademark created for his firm by a noted Los Angeles design firm, Ken Parkhurst & Associates. Another Los Angeles firm, ZVS, after the names of the principals, Zierhut, Veder and Shimano, had been engaged to develop a comprehensive new look for all company products, signs, literature and advertising.

The new company trademark was a round shape with the word *COLLINS* in capital letters in the center, breaking up five small to large circles. It was to symbolize the firm's creativity, in the way circles ripple outward from the point where a stone is thrown into still water. Once the new logo was introduced, it quickly became known as *the meatball.*

The new design schemes retained the traditional terra cotta which Arthur long had liked as an accent color identified with Collins. Many products from then on were to have a terra cotta stripe across the top front, if possible.

The ZVS standards also impacted product shapes, colors, knob designs, surface texture and other items. Fred Johnson said it was a new experience to learn that visible screw heads were ugly. The new standards did result in highly distinctive looks for many Collins commercial products which remained recognizable through many years of service.

As the construction techniques were worked out, the mockup began to take shape. A 30-day deadline was set for completion near the end of July, a period marked by a frenzy of activity. A few days before the date scheduled for Arthur to come in and view the model, efforts began by mockup teams to track Arthur's whereabouts in case he should show up early. They learned from the company radio station in Cedar Rapids that he had gone to Indianapolis on a company plane, presumably to return to Cedar Rapids, then go on to Newport Beach. But Arthur decided to fly commercially from Indianapolis to Los Angeles, showing up at Newport Beach the afternoon before the planned viewing. The engineers completed the last touches on the model about 1 a.m.

When they came back about 7 a.m. to be sure nothing had been overlooked and to be ready for Arthur's review, they discovered he already had been there, apparently satisfied with what he found. The engineers also had prepared a set of charts to illustrate the many facets of their efforts. After word got to Arthur that the mockup team was disappointed he had not viewed their presentation, a meeting for that purpose was arranged.

Following the mockup completion, detailed work began on full-scale development of the computer system, which was given the product designation C-8400.

Bob Cattoi recalled that while the 8400 used the card and rack technique, then relatively new in the electronics industry, the vast quantity and complexity of connections led Arthur to comment that *the wiring is a bitch.* With the ongoing rapid advances in semi-conductors and integrated circuits, he soon had Harry Passman looking into new techniques for connections which would reduce or eliminate wiring.

What the C-8400 mockup did was to show how to build a computer. The next step was to use that capability to develop a store and forward message switching capability.

Arthur then added another group at Newport Beach to develop the computer language software — the operating system — to utilize the computer. That was directed by George Grondin.

He said that still did not allow the beginning of what he termed a distributive system — also needed was the software to operate multiple computers for switching over a broad geographic area. Arthur used such terms as data architecture and modular software architecture to allow all distributive elements to work together. Developing that was a major effort before COMO resulted in an operating system.

Being the first commercial computerized message switching system, the C-8400 incorporated numerous pioneering techniques developed by Collins Radio engineers and programmers which did not become widely utilized in computer technology until years later. What Arthur referred to as a distributive system later became known as networking. Another C-8400 development which can be credited to Collins was a form of packet switching although it was not called that, a technique that became essential for the internet years later.

A parallel development was a magnetic disc file memory system of gigantic proportions to store all the data and messages which the computer system would process. It was built by the Bryant Corp. Each file cabinet was about five feet high, five feet wide and 4-1/2 feet deep, and contained up to 24 discs on a six-inch diameter horizontal spindle, driven by a five-horsepower motor. The discs, 39 inches in diameter and one-quarter inch wide, rotated at 1,800 revolutions per minute. They were made of magnesium and magnetic-coated on both sides. Each disc had eight read-write head mechanisms on each side for inputting and retrieving information.

The memory capacity of each disc was 2.5 megabytes, a tremendous capacity for the time — a megabyte sometimes described as able to contain a large novel with room to spare.

The disc files were huge in size compared with data storage hardware of later years but represented the most practical rapid access memory storage capability then available. The mechanical design complexity often led to problems that could halt or disrupt a computer center's operations. One of the worst problems was found to be caused by small particles of chaff coming from drive belts connecting the motor and main spindle. When chaff got into a read-write drive head it created a *crash* of the disc file. It was finally solved with a redesign which sealed off the drive belt.

The initial installations to fully check out the computer and message switching system were in the new CDS building in Cedar Rapids and in Newport Beach facilities, and linked with terminals in the Dallas and Toronto plants.

Well before development of the C-8400 was complete, a marketing team was organized under John Boyle, recently appointed vice president of the recently created Communication and Data Systems Division. Boyle hired several persons familiar with the computer business, including some who worked for IBM. One of the salesmen, Dale Homburg, had been sent around to Collins sales offices to brief staffs on the new computer and data systems line which Collins planned to have ready soon. On a Friday afternoon in early 1962 he talked to the marketing group based in the Collins' Washington, DC office.

Among those hearing the presentation was Joseph F. McCaddon, who recently had joined Collins. McCaddon was a West Point graduate who flew Air Force fighter planes in Korea and later worked for Pan American Airways. One of his accounts with Collins was Aeronautical Radio, Inc. (ARINC), a private communications company formed in 1929 to serve the air transport industry. Among ARINC's roles were coordinating aircraft equipment specifications and providing communications services for the nation's airlines.

McCaddon was aware that ARINC was about to make a major purchase of new model teletype machines, used for airline ground message traffic. They would have offered only minimal improvements to growing airline communications needs. They still would have followed conventional methods, with operators typing messages on punched paper tape and feeding the tapes into the teletypes for transmission. If messages were for more than one destination, each had to be transmitted or retransmitted by hand.

Having just been briefed on the new Collins computerized technique to automate message sending and switching, McCaddon called a senior ARINC official to tell him about the new Collins system. On hearing what McCaddon had to say, the ARINC executive said he was planning to sign a contract the following Monday for the new teletypes, but then decided he first wanted to know more about the new Collins revelation. Over the weekend McCaddon received a call at home from an executive of Pan American Airways, his former boss. Pan Am would be a major user of any ARINC System. The Pan Am official said he wanted to talk personally with Arthur Collins about it.

McCaddon did not then know Arthur, but got the Pan Am request to him through R.P. Dutton, manager of the Washington office, and John Boyle.

ARINC officials long had seen the need for an affordable and effective type of electronic message switch. (There had been minimum use of an earlier electronic switch system in the airline industry, mostly for passenger reservations).

Arthur convinced ARINC people to hold up on updating a conventional teletype network and look at the Collins computerized message switching system.

Arthur had McCaddon bring ARINC people to Cedar Rapids for a demonstration, and the result was ARINC became the first customer for the C-8400 system. It also was the beginning for McCaddon of a move up the corporate ladder. Within three years he was vice president of marketing for the Cedar Rapids region.

The ARINC system originally was to be located in New York City, but with many bugs needing to be worked out in a new system as complex as the C-8400, it was decided to install it in the Cedar Rapids center. That was a 24 hours a day, seven days a week, stressful ordeal which went on for many months. Arthur was personally involved much of the time. The initial installation finally was declared operational after intensive hardware checkout and many changes and tests in the software. Many of the final development steps were completed in Newport Beach.

One main trend established for the computer business with the C-8400 system, was operation 24 hours a day, 365 days a year. Until then the operation of many computer installations coincided with five-day-per-week office hours.

Collins soon began handling ARINC traffic from Cedar Rapids. Eventually the Cedar Rapids center had 750 incoming and 750 outgoing teletype lines connecting it with major U.S. and foreign airline offices and terminals. It went online in early 1963, and soon handled more than 400,000 messages a day. A second ARINC center was added later in Chicago.

With the Collins system, rather than an operator typing onto punched paper tape and feeding that into a teletype machine, direct input into a computer terminal was introduced. With the receipt of a message from a point of origin, the computer took over. For example, an airline message originating in New York and addressed to managers in Chicago, Denver and Los Angeles began with a series of coded letters indicating the airline, the nature of the message and destinations. Transmission was started automatically by the computer in Cedar Rapids which on receiving it *read* the message based on the coding, automatically recorded it on disc files, then switched it onto lines to destination points. The entire procedure took only a few seconds. If a line to a destination was busy with other message traffic, the message was held in the disc file until the line was available. Even messages between LaGuardia and Kennedy airports in New York or from Hong Kong to San Francisco were routed through Cedar Rapids. A provision was included for priority messages which went before any others in line. While the system did not make reservations for passengers, it provided rapid communication between airlines regarding reservations.

Facilities housing the computers, disc files and related equipment installations had to be climate controlled to provide the right temperature and humidity levels, and draw off heat produced by electronic and electrical systems.

To assure the required reliability for continuous, non-interrupted service, the C-8400 system had to have extensive equipment back-ups, including electric power. At first that was provided in the Cedar Rapids center by a huge diesel engine driving a large generator, which would start up automatically if commercial power was lost. But Arthur saw problems with that method, such as false starts causing surges which affected the system. After one outage affecting the CDS building, Arthur ordered Howard Walrath, then responsible for the system back-up, to operate the system on batteries, which were charged by running the diesel engine and generator continuously. Because of wear and tear on the diesel, he told Walrath to get a second diesel and have one overhauled while the other was in service. The diesel-generator units were installed in sound-proof, glassed-in areas on shock-mounts to block noise and vibration that could affect the other equipment.

After the ARINC system became operational, a bulldozer operater digging in a ditch along a highway east of Cedar Rapids tore up a cable containing hundreds of long distance lines, knocking out not only telephone service but many of the circuits for teletype messages for nearly 24 hours. The accident caused havoc for many airlines. Arthur then had the phone companies install duplicate lines on widely separated routes.

The Cedar Rapids center in time became the world's largest store-and-forward electronic message handling facility. It was estimated that the center handled more message traffic in a given day than the entire Western Union network.

The computer development demonstrated an advanced capability in digital technology for Collins Radio Company.

Arthur commented about the digital revolution then beginning to sweep across the land in a 1962 talk to a Cedar Rapids IRE conference, and also how he foresaw the future.

He briefly traced the history of communication from the first days of mankind, saying the two main advances had been the developments of human speech and an alphabet which led to the ability to write, replacing picture writing.

In more recent years, he noted, two major developments occurred.

One was the concept which resulted in a digital processor using stored transfer sequence logic, the basis of operation for modern computers.

The second was the development of solid state circuit components such as the transistor and ferrite core, and the steps allowing the use of thousands of information storage cells and logic circuits in a single electronic device.

These new tools, he said, are far more powerful than was grammatical sentence structure.

*Digital systems can do things the unaided human brain cannot do, and in so doing they are making possible a new era in human communication and achievement,* Arthur said in the 1962 talk.

He concluded by quoting the 19th century British writer and dramatist Edward Bulwer-Lytton:

*Beneath the rule of men entirely great, the pen is mightier than the sword.*

Arthur then stated the aphorism could be brought up to date as follows:

*The digital system is mightier than the pen, which, in turn, is mightier than the sword.*

The Collins 1963 annual report reference to computer systems, reflecting Arthur's writing, stated:

By 1961, the company had the basis for continuing profitable operation in the military and aviation electronic fields, and was approaching a profitable point in telecommunication. The decision was made to proceed toward a fourth major segment of activity. The necessary and logical choice was digital computers for scientific, data processing, telecommunication message switching and numerous other purposes.

A careful study was made to determine the best way to proceed. IBM, in effect, dominated large portions of the market. The competitive importance of this fact was emphasized by the experience of several large firms which spent large sums in an apparent effort to parallel the position of IBM. However, our company previously had successful experience meeting established competition by making an energetic effort toward selected targets. A *rifle* rather than a *shotgun* approach was required, but it could not be a limited effort. Failure to provide a superior and complete system to the user would be inconsistent with company policy and, in any event, would not afford the scope desired for the company's growth.

In view of these and many other considerations, a detailed plan evolved. Some of its salient points are:

1. The computer is of advanced design of sufficient size to be suited for large jobs.

2. New techniques are being employed to increase greatly the versatility of a single design applicable without compromise for (a) scientific computation, (b) general data processing, (c) on line processing and message switching.

3. Initial applications are being made in the telecommunication message switching field because of the company's extensive experience. Later applications will be in large processing centers having integral data communication systems.

Appraising the success of the system, the report also stated:

The design has exceeded expectation. Performance and reliability are excellent. Production cost targets have been met. By mid-1964, there will be about 30 Collins computers in service.

The next customer after ARINC for the C-8400 was the New York Central Railroad, distributing messages and data over a 10,300-mile system. Howard Walrath recalled that the Collins system helped the railroad solve an age-old problem — knowing the location of all of its freight cars. Traditionally, many box cars spent days or weeks sitting empty on a siding, waiting to be found and reused.

Other systems soon were located in Atlanta, for Delta Airlines, in Toronto for Air Canada and in London for British Overseas Airways (BOAC). Some banks and government agencies also had installations.

The BOAC system, being an overseas installation, raised many questions about how it could be maintained and supported. Robert C. Frost, a vice president and legal counsel for Collins, recalled that BOAC had negotiated a lease for the system, with the terms being highly favorable to BOAC. Frost said that during a meeting on the subject, serious doubts about going through with the project were expressed by many of Arthur's top people.

But Arthur wanted to see the initial foreign system put in operation. Frost remembered after everyone said their piece there was a long pause, then Arthur summed up his decision to go ahead with a phrase he sometimes used: *Well, you guys just don't get the point. I'm trying to get that first olive out of the bottle.*

Bill Weinhardt, who headed the Collins construction division which performed many building and installation projects involving Collins systems, recalled an incident with the London facility.

A new building to house the switching equipment was erected on leased property near Heathrow Airport. But due to limited space, there was a problem with where to put the emergency generator system. Weinhardt said the landlord was not happy about it, but the problem was solved by digging up the parking lot and building an underground room to house the generator.

Collins built about 31 of the C-8400 systems, but the manufacturing engineers responsible for production felt they had built at least 75, based on the many changes made in the system. One count claimed there had been about 9,000 formal revisions to the scatter wiring in the back of cabinets. Part of that, of course, was required to accommodate differences wanted by various customers.

As experience was gained in their use, some of the C-8400 systems approached better than a 99 percent reliability rate. Although it was intended as a computer that could do more than just message switching, it never was applied satisfactorily for general computations.

Like many Collins products over the years, the C-8400 systems provided service far longer than many computers — up to five and 10 years or more, running 24 hours a day, 365 days a year. One installation, in fact, in a Washington, DC government agency, continued to be used well into the 1990s.

While most of the Collins workforce had little if any awareness of Project COMO at its inception, it turned out to be the most pervasive program in its effect on the entire company in the firm's 30 year history.

Arthur Collins also began to change. He developed an obsession with computers which left little room for disagreement with him on his plans for the company in that field.

Those who worked with Arthur knew he was a very demanding boss, and he had little tolerance for incompetence, whether a person's skills were in a technical or a business field. He also expected all of his top people to be as enthusiastic as he was about any of the ventures he undertook.

The biggest change for Arthur was the direction he was planning for Collins Radio Company. Many of his top executives began to have doubts as he moved further into the computer field. They wondered about the cost and how it would affect the company's traditional products and markets. They could see Arthur determined that computers would play a much expanded role in Collins Radio Company.

Because he drove himself so hard, Arthur also expected his engineering teams to work long hours with him, and produce a large volume of work. In many instances projects were understaffed in his efforts to get a lot of work out of a few people. But that was Arthur's pattern.

The C-8400 computer and message switching system became reality because of many 16 to 18-hour work days. And it was achieved by fewer persons than normally would be expected to be involved in such a comprehensive undertaking.

Mel Doelz remembered an incident during Project COMO when everyone was working all day and well into the night.

*As general manager at ISC, I had a division to run and had to do all my regular duties during the day. Then I would go over to the lab and work every evening. One night, it was after midnight, I was so tired I was of no use to anybody or anything. I went home and went to bed. I'd just gotten into bed when the phone rang and it was Art, mad as could be, saying 'Why aren't you still over here working, after all I've done for you?' Well, he had done a lot for me, but I told him I still had to get some sleep,* Doelz said.

The C-8400 was truly an innovation and major step forward in the computer world. It made possible the application of computer power to the management of communications networks. It utilized the Collins background in modems and Kineplex techniques. It was a new generation, transistorized computer, embodying a number of concepts new at that time, and later adopted in many computer designs.

It allowed, for the first time, large amounts of computer data to be *switched,* either between computers or from a computer to multiple destination points. That ability became commonplace in later years.

In effect, the Collins system created a market where none had existed, because there were no effective products filling that niche until the C-8400 came along.

Collins was readily recognized as the leader in the electronic data switching field, a unique distinction, because Collins Radio was relatively small compared with giants of the computer and communications industries such as IBM and AT&T.

But for Arthur, that was merely a start in what he envisioned computers being able to do.

He had in mind for his company a grand scheme which would be called the C-System.

The name C-System derived from the words communication, computation and control.

Arthur had carefully studied the growing complexity of the management and organization of business firms since World War II. He observed that many companies had introduced a variety of new tools and automation techniques intended to enhance management efficiency and control, but sometimes those measures resulted in more problems than they solved. For example, where different departments such as accounting, production and marketing all had digital computers to help do their work, they were hampered in exchanging information because each area used different procedures and terminology, and in some cases even different brands of computers. Nor did existing methods of direct communication between computers provide the speed, capacity and reliability needed by business and industry. In his view, the operating systems devised for computers prior to the 1960s no longer were adequate.

Bob Cattoi recalled Arthur saying that computers could process mountains of data, but if they could not extract the specific data required for a certain job and get it to the right place at the right time, their computer systems were inefficient. That was what he meant when he talked about managing information.

Arthur believed the C-System which he was planning could be the answer to such problems and needs of business, and wanted to make Collins Radio Company the model of how it should be applied and used.

He once used an analogy that when Henry Ford introduced mass production in building the Model T, it was a model for the organization of mechanization. He hoped his C-System would contribute to the organization of automation.

His C-System would need a more advanced computer than the C-8400, and development of a vast array of other new electronic equipment and programming concepts.

Anyone who followed how Arthur did things should not have been surprised when he decided to develop a new computer. Arthur never was satisfied with what had been developed — he always wanted to move ahead to the next generation of equipment.

Soon after the C-8400 went into operational service, Arthur called a meeting of about two dozen men, a diverse group representing some of the top engineering brain power in Collins Radio Company. In the typical manner that he provided notice of such a meeting, they were told to show up in Dallas the next morning but had no idea what to expect. Some were from Dallas, the others from Cedar Rapids and Newport Beach.

For most of the first day, Arthur stood at the blackboard explaining his view of future electronic equipment design and construction. In essence, he was telling them, *This is what our business will be based on in the future, beginning right now!*

He described in comprehensive detail that what they could expect was *a basic planar layer of components adjacent to several layers of planar interconnect (planar referring to a plane, or flat surface).* One attendee remembered Arthur holding both hands in front of him in flat position, one above the other, to illustrate that point.

He talked about things still quite new to many people at the time, such as computer aided design and computer aided manufacturing, and how digital computers would handle all the data required for those operations. In Arthur's vision, those capabilities would apply not only to design and production but also product testing and scheduling. He told his audience that the tools to do all that were at hand or soon would be if Collins assumed a leadership role.

In effect, what he described was a radical new design discipline. Traditionally the electrical and mechanical engineers more or less had a free hand to employ what they believed was the best use and arrangement of functional parts for maximum performance, reliability and ruggedness that met shape, size and weight requirements in electronic equipment. Now they were to learn how to differently organize and digitize their designs.

Arthur also discussed how electronic components were rapidly being integrated on silicon, reducing size, increasing performance, cutting cost and enhancing reliability. He recognized the impact that would have on the industry, and wanted Collins to lead in the revolution.

Reportedly the meeting participants appeared overwhelmed by the extent and the newness of subjects covered by Arthur. He tried but was unable to generate much audience discussion. At noon the second day, Arthur excused himself during lunch, saying he did not feel well, which was unusual for him, and that ended the meeting. Some wondered if their lack of response and enthusiasm had caused his discomfort.

A few years later, those who heard him in that Dallas meeting saw how accurate his predictions had become.

By 1965 Collins Radio already had established hybrid microelectronics facilities laboratories in Cedar Rapids, Dallas and Newport Beach. Operators using specialized equipment in those clean room environments were producing thin film circuits, small silicon surfaces the thickness of index cards less than an inch square, and containing many components about as large as pin heads. Some components were connected by wires smaller than a human hair. Other products included a metal oxide semiconductor integrated circuit, less than a quarter-inch square, and a miniature discrete component, contained in a tiny canister. Most initial production was used in various Collins products.

The Process Division soon was underway, being set up under the direction of Harry Passman. Its function was to bring into being those advanced electronic construction techniques which Arthur had outlined.

Passman was a University of Illinois mechanical engineering graduate who joined the company about 1950 after completing college. One of his early assignments was working with Dr. Alexander Lippisch. While Lippisch helped with Collins aircraft flight control projects, he also had more or less of a free hand to do what he wanted. That allowed him to continue to design airplanes and make models of them. He invited Arthur to join him in flying a model plane one Sunday afternoon and Passman went along. It was powered by a small gas engine purchased from a hobby shop. Lippisch could not get it started, but Passman had built model planes as a teen-ager and made the engine run. That impressed Arthur, who soon had Passman working on aircraft flight directors and from there he moved into other mechanical engineering assignments.

One of the basic steps in the new processes which Arthur wanted was having engineers change the way they designed and developed products. Rather than starting with a plan and build up a conventional bread board layout for a new radio, they learned how to convert a schematic drawing of a circuit to a digital format. Following an engineer's specifications, the circuit was laid out according to grid coordinates to digitally define the entire interconnect pattern, precisely locating components and lead-ins. Skilled draftsmen and specialized graphics layout machines were used to complete the circuit patterns. The method also quickly and accurately checked all measurements for errors, formerly a tedious and lengthy manual task.

Eventually the process would have circuit pattern information stored in a computer, which allowed a design to be easily changed.

The pattern was used to produce a circuit board which became the basic element in the new equipment. Circuit boards were not new (Collins had been making them since 1953), but Arthur was talking about advanced versions of circuit boards with several to many layers of circuitry and precision, high density circuit patterns. The layers were made of glass epoxy material coated with a paper thin layer of copper. A photographic and etching technique removed all copper except the circuit pattern, and layers were pressed together to form a laminate. The process also specified where holes would be drilled for connections to reach the various copper layers, and provided punched paper tape instructions to numerical control machines to perform that function. A plating process provided a solderable metal surface on the exterior layer for attaching components, and plated-through holes where connections were not intended. The latter proved to be a difficult challenge. As Collins' capabilities increased, even the mounting and soldering of components on the exterior of circuit boards was automated.

Collins Radio Company made a major investment of many millions of dollars in the equipment for the new processes. They were complex procedures and both the engineers learning how to use them and the people responsible for the numerous steps involved went through a lot of trial and error to make them work. Even before some of them were perfected, they were implemented throughout most engineering departments.

After Project COMO, most of the engineers who were called in to help with that effort had returned to their regular jobs. But Arthur also kept core computer development groups active, part of the team working under Bob Cattoi in Cedar Rapids and part under Don Martin at Newport Beach.

And since the C-8400 computer equipment was developed, Arthur was continually thinking about what he wanted in a next generation computer. It would not only be a message switching computer, as was the C-8400, but would do that and also have all the data processing capability of an IBM computer. In fact, he wanted a computer which would be more advanced than what IBM and others were offering.

In the early months of 1966 a second computer mockup and development project began, known as COMO 66. This time it did not take place in the mild climate of California, but in a rented downtown building in Cedar Rapids in a particularly cold winter. The select task force assigned to the project, representing a full range of engineering disciplines, knew more about what to expect than was the case in 1961.

The new computer would demonstrate a major step forward from the early transistors and scattered wiring of the C-8400 to integrated circuits and planar circuit boards, delivering much faster computer speeds. Significant gains made in software development, logic design, power systems, memory technology and test methods since 1961 would be incorporated in the new system.

A major challenge was developing new type connectors, connecting one or more circuit boards to other circuit boards, in order to eliminate wiring. The new connectors were not only for computer needs, but for other Collins products. The designs covered a variety of types and sizes of connectors and connections. They were unique for Collins equipment at the time, but later became industry standards.

The new computer was to establish construction concepts for all future types of Collins equipment.

C-8500 was the designation given to the new computer. Its functional elements were contained in circuit cards housed in ATR type cases. ATR refers to Air Transport Racking, a term for standard-size cases mounted in the electronics equipment racks of commercial aircraft. All communication, navigation, flight control and other gear aboard an aircraft is designed to fit in ATR cases known as black boxes. They are up to 10 inches high, and can vary from about 12 to 24 inches long and one to 16 inches wide.

Compared with one 2-3/4 by 3-1/4-inch circuit card in the C-8400 system which performed one flip-flop operation representing one electronics unit, a circuit board in the first version of the C-8500 system was 7-1/4 by 7-1/2 inches and represented 50 units of electronics. The C-8400 card contained several transistors; the later board had 50 or more integrated circuits. Several dozen circuit boards were mounted in a single 8500 ATR case. Still later designs crammed 400 electronic units on a 4-1/2 by 7-inch card. As boards became smaller, they also delivered higher levels of performance. The cost also was reduced. One of the C-8400 cards with one unit of electronics cost $12 to build, the card with 50 units of electronics cost $250, and the card with 400 units of electronics cost $800.

The ATR units housing the electronics for the various computer functions were shelf mounted boxes plugged into connectors and backplane circuit boards at the rear of a cabinet. It was a new type of floor standing cabinet meeting the latest Collins graphics guidelines. The system was based on a flexible modular concept in which as many cabinets of electronics equipment as required could be utilized for an installation, providing data transmission links with factory, office and service terminals.

Also, virtually every Collins product then could be constructed and interconnected using the process standards and asssociated manufacturing methods spelled out in the COMO 66 model.

The actual COMO 66 mockup consisted of a single cabinet with front and rear doors and two shelves of ATR cases. It was intended to demonstrate every conceivable element of interconnect capability and flexibility represented by the new Collins developed process technology.

Again, as in 1961, the engineers scheduled a time for Arthur to view their results. And once again he did his review alone in the middle of the night before they could show it off. They knew he had been there because they found one piece of instructive evidence.

Fred Johnson recalled that Arthur had been adamant about using the planar interconnect system for every possible application. To show how a temporary connection might be made, the engineers had attached two small wires between connector pins in the rear of the cabinet. *They found those jerked off and lying on the floor — a mute and firm message from Arthur of 'no wires,' only circuits embedded in circuit boards,* Johnson said.

With the shortcomings of the Bryant disc file still in mind, Arthur commissioned the design of an advanced new disc file, undertaken in Dallas. It was a proprietary Collins design achieving objectives which included high data capacity, faster access time, much reduced size and no hydraulics. The unit was about the size of a microwave oven and occupied one shelf of a computer cabinet. It contained eight permanently mounted discs, used to store 33.55 million bytes of information, which exceeded the specifications of any other disc file at the time.

The C-8500 indeed appeared to be a next generation computer, with many advanced design features not available in models then offered by the major computer manufacturers. But there was a great distance to cover from the concept and mockup stage to a final fully developed, fully tested operational system which could be delivered to customers and provide the reliable performance for which Collins products were known.

A single C-8500 processor unit was a refrigerator-size cabinet containing 12 to 20 ATR boxes and one or two of the new disc files.

With the COMO 66 mockup finished, the computer engineering teams plunged into the detailed and exhaustive work of developing the many functional subsystems of the C-8500, and meshing with the process technology still continuing to be developed and expanded to cover more company activities. Extensive new software also had to be developed.

Most people in Collins Radio Company could not quite understand what was going on in the mid-1960s, and many were totally unaware of the changes occurring around them, but Arthur Collins could clearly see the first steps of the C-System taking shape. The C-8500 computer was the key element to make it all happen.

The C-System was a highly futuristic concept, requiring a long list of hardware, software and operating systems, all of which had to be developed, coordinated and checked out to make it work. Arthur once referred to the C-System as *one large computing machine, even though it is constructed of many geographically separated, individual computers.*

Bob Cattoi described it as, *A concept of how to build a lot of things — applying a general systems approach for the management of information, using a relatively new thing called the computer. The intent was to allow you to do a lot of things better than before.*

The concept was based upon the integration of computers and communications techniques. It was to utilize the computational power of computers, a universal file system having standard identification and structure applicable to all types of data, a disciplined control system and a variety of data transmission links. In short, the Collins intent was to build a computer which basically was a message switching computer but also capable of doing other computer tasks.

Those elements were intended to have it used to interrelate all major activities of an enterprise, including accounting, payroll, product design, engineering, materials acquisition and control, manufacturing processes, personnel staffing, facilities requirements and executive management.

The hardware was the C-8500 computer and associated equipment, including storage units, control units, modems and other devices. The C-System plan envisioned a network of 100 or more C-8500 computer installations, which could be in widely separated locations.

That alone showed Arthur's computer vision, to try linking a large number of machines in a single network. Such a capability was unknown in 1966.

One of the C-System features was a communications capability just like a telephone network — all the peripheral devices in the system had immediate access to each other and to central processing and data storage facilities at all times.

Arthur's plan was both to make available to customers the use of C-System equipment and services developed and operating in Collins plants, and to provide installations in customer facilities.

In the C-8500, Arthur felt he had a computer of sufficiently advanced design with the speed, memory capacity, flexibility and operating capability to make the C-System work. He did not see any other computers then on the market offering that capability.

To fulfill C-System objectives, a number of special *systems*, actually operating processes, had to be developed. They involved dedicated software compatible with all other parts of the C-System as well as communications links to computer terminal stations in office, laboratory and factory areas.

The special systems, referred to as distributed networks, included:

Accounting Data System (ADS.) This was designed to automatically collect, process and store financial data for all parts of the company. A wide range of financial accounting functions handled by ADS involved sales, bookings, payroll, payments to vendors, product pricing based on labor and other production costs, all types of operating costs and other data. It produced a large variety of financial status reports and data for management. It was intended to provide a rapid response on any information request. E.A. (Ed) Williams, who served as vice president, control and finance for Collins from 1961-69, recalled Arthur's thinking for a system such as ADS. *In his mind, he saw no reason for Company A to write a purchase order to Company B, and then for Company B to come back and write invoices to Company A. He thought all that could be handled in an information system loop.* When it worked, the ADS produced some significant results. For example, financial reports which once took a month to compile were completed in 10 days with ADS.

Material Control System (MCS.). At any given time Collins had up to 500 types of equipment in production or on order, ranging from small components to large, complex communication systems, in varying quantities. Up to 200,000 individual material items were needed every week. The MCS was designed to keep track of the vast amounts and uses of materials and components, including purchasing, scheduling, inventories, product assembly, inspection and shipping, and the personnel needed to do the work. The computer system coordinated sales orders with production and delivery schedules, generating reports to have materials in the right place at the right time. Every Monday morning it provided the status of every production job at Collins, the steps and schedule for that week, and alerted management to any problem areas. It led to product deliveries six weeks after parts were received, compared with four to six months before MCS was initiated, and resulted in a continuing reduction in inventories.

Equipment Compiler System (ECS.). This system was intended to direct and control all steps in the digital design and fabrication process for planar circuit boards. Collins succeeded in developing a high level of capability with ECS which resulted in advanced circuit boards both for company applications and for outside customers. One of the features which Arthur foresaw with ECS was to have customers transmit their circuit designs over a data link, and have the circuit board be fabricated in a Collins facility, all under computer control. His objective was 48-hour turnaround from receipt of the design to shipment of the finished board. Company plans were to have centers around the country from where clients could input their designs.

Project Control System (PCS.). This program had as its objective the detailed organization and direction of major projects. It listed objectives and milestones, compiling all required data, covering updates and revisions in computerized reports to management.

Scientific Data Processing System (SDS). This was used by engineers and scientists whose work required extensive mathematical analyis. It was based on Fortran IV computer language and provided access to a large library of programs for analysis, synthesis and simulation.

Also required for the C-System was the development of special communication links.

One of those was the Time Division Exchange loop, called TDX for short. It was essential to give the C-System the flexibility and expansion capability which Arthur wanted, interconnecting a large number of computers, disc files, magnetic tape cabinets and printers. The TDX loop was basically a coaxial cable threaded through computers and other hardware units, circulating a high speed bit stream. The TDX enabled any unit to communicate with any other unit on the loop, by identifying a particular bit position. The TDX was a unique and advanced development for the time, when most computer installations had only limited interconnect capability.

Another interconnecting communication channel method was called TDM, for Time Division Multiplex. This was a slower speed link to control or monitor teletypes, numerical control machines such as precision drill presses, CRT displays, various test equipment and other devices which were part of the Collins digital design and fabrication processes.

One claim made for the C-8500 and C-System was far greater storage capacity than other computers of the time. Data storage was either on large disc files or magnetic tape reels and the newly developed computer disc file. The combination represented a virtually unlimited amount of storage. Much development effort went into techniques providing the classification of and rapid access to stored information.

Another major feature of the C-System was the control method. Control software resided within each computer. It consisted of three parts: (1) Operations (or Ops) control, apportioning the time of the logic unit between execution of application programs, service functions and multiplex functions; (2) Service control, managing and updating applications programs stored in disc files; and (3) Multiplex control, providing direct digital control of the numerous printers and other devices on a TDM loop.

For six years from 1965 through 1971 the C-System development went on. The greatest progress came before 1969, the year the company began to experience major financial problems, many caused by the C-System.

The Process Division grew to 1,800 people, with well over 10 million dollars of new equipment, a sizeable sum for a company like Collins. Included were automatic drafting machines, artwork generators, precision photo machines, numerical controlled drill presses, circuit board etching, laminating and plating equipment.

Another major part of the process operations were clean room facilities with highly specialized equipment to fabricate thin film and MOS circuits. All worked in digitized format. Collins engineers developed some of the key machines used in those microelectronics applications, one being a sputtering machine which laid down a tiny layer of metal on a ceramic plate. The metal was used to form minute components such as resistors and capacitors and their interconnections. Several million dollars were invested in the micro-miniature component fabrication facilities.

Besides the Process Division, there were hundreds of engineers, programmers and their support people involved in developing all the facets of the C-System, including the continuously evolving C-8500 computer.

The C-System became the top priority program for Collins Radio Company. There were many other important programs undertaken in aviation, space and telecommunications, but the C-System was Arthur's pet project. And whatever Arthur wanted, Arthur got.

There were literally no spending restraints on the C-System developments. Each of the system segments was a highly complex, difficult and challenging task, mostly because they all were breaking new ground in a technological sense.

Arthur had a top tier team of computer developers, headed by Cattoi, and numerous sub-tier teams working on the many facets of the C-System, in Cedar Rapids, Newport Beach and Dallas. Major parallel efforts were directed by Donald L. Martin at Newport Beach.

Throughout his career, Arthur Collins had been successful at almost everything he had tried. By his early 20s he had pioneered new trends in high frequency communication, amateur radio equipment and broadcasting transmission. Those achievements led to aviation, military, space, telecommunications and data transmission systems. At first he alone did the design, development and building of radios, and as his business grew he added people to help him. The products reflected Arthur's pursuit of quality in design, construction and reliable performance. By the 1960s he had a technical staff of between 3,000 and 4,000 persons. Many of his engineers were as good as could be found in any company in the world. From the Byrd Expedition project of the 1930s through the C-8400 message switching programs, he had taken on challenges that many never would have tried.

No program in the company's history, however, had been as complex or extensive as the C-System. It was intended to tie together and integrate every activity of the company.

As part of it Arthur had implemented a massive construction program, increasing total company floor space by more than one third, costing more than $40 million in 1960s money. New buildings or additions were constructed at all three major plant sites, Cedar Rapids, Dallas and Newport Beach.

Two of the buildings were costly facilities at Dallas and Newport Beach for fabricating highly advanced microelectronics circuits. Both structures required extensive concrete bases interlaced with plumbing fixtures to provide a stable platform for the sensitive and intricate manufacturing processes.

Another of the new buildings, a highly visible and somewhat controversial edifice, housed corporate headquarters. It was at the Dallas Division site, actually in the suburb of Richardson, a futuristic looking concrete and glass structure.

One other building project of note was a large addition to the major engineering-manufacturing facility in Cedar Rapids, comprised of three connected sections designated Buildings 105, 106 and 107. The new addition, Building 108, was the only part of the huge complex erected as a two-story structure. But it ended up with a second story floor, or deck, over only about a third of the building closest to outside walls. During construction the company learned that fire insurance regulations prevented extending the deck over the entire area unless an elaborate and highly expensive emergency escape system involving elevators and underground tunnels was installed.

Building 108, erected in 1967, also underwent a major revision during construction. The 600-foot-long north wall was first put up with an exterior of steel panels. But Arthur decided he wanted to change the ground floor exterior to glass. Collins and contractor construction people built a portable structure which enclosed a section of the wall even during winter months, allowing them to remove metal panels and replace them with glass. The change probably cost at least a half million dollars in 1960s money.

As the C-System inched forward at a much slower pace than anticipated and without achieving the success projected for it, frustrations mounted in almost all areas of Collins Radio Company from the top executive level on down. Some of Arthur's best people left or moved to jobs not directly involved with the C-System.

Over the years many brilliant people had cast their lots with Collins Radio Company because of Arthur Collins.

They believed in him, they had confidence that the courses of action he set for the company in areas of technical developments were the right choice. They saw how Arthur launched programs which some considered a great risk and even foolish to try, but he succeeeded and made them pay off.

Among those people were some who became Arthur's trusted top executives.

They were the ones who had the responsibility to see that the company made money. In fact, they made most of the operating decisions for Collins Radio Company, having learned what would or would not meet with Arthur's approval.

But as he steered the company into the C-System, which became a monster devourer of company resources without producing hoped for results, some of those long faithful associates began to have doubts about the course Arthur had chosen.

Robert T. (Bob) Cox was extremely capable as both an engineer and administrator. He came to Collins in 1941 with a masters degree, worked several years in engineering and became assistant to Frank Davis, who headed engineering and research. In that role, he handled many special assignments for Arthur. After Davis' untimely death in 1946, Cox took over more supervisory responsibilities, eventually becoming director of engineering and research and a member of the company board of directors. That was followed by appointment in 1959 as vice president and general manager of the Cedar Rapids Division, the company's largest operation and the division making most of the money for the company. Cox was one of Arthur's right hand men, and was highly respected by Collins employees and customers.

Recalling the early phases of the C-System, Cox remarked that: *Some of the budgets got to be a lot of wishful thinking. The company was spending money right and left on what broadly was called the C-System.*

*I don't think the C-System would have broken Collins Radio by itself, but Arthur got everything involved more broadly than usual. For instance, he insisted that all radios had to be capable of computer control long before there were any computers in airplanes to control them. That made some of the aviation radios non-competitive because they had extra stuff in them which would take up space and cause failures and certainly raised the cost.*

*Products which had been extremely profitable such as 51Rs and 17Ls (aircraft VHF communication and navigation units) had to have extra electronics and computer connector plugs added, and still had to be equipped with conventional plugs to work in an airplane.*

*The whole thing just snowballed. An enormous amount of money was being spent on things that were part of the grand plan but which were not contributing to the company's business.*

*As far as spending money on inventing computers, the company probably could have done that — the rest of the company would have made enough money to keep Art busy doing his computer thing. But when everything else became involved and we were building buildings to sell computers and set up service centers long before there were computers to sell, a lot of money was being spent that didn't make much sense,* Cox said.

In February, 1965, feeling uncomfortable about the course of events, and no longer having Arthur's complete confidence because of a lack of enthusiasm for the C-System, Cox's role ended as head of the Cedar Rapids Division. One of their differences was in Arthur's planned impact of the C-System on Collins' avionics product line, the company's most profitable business. Cox in effect was kicked upstairs to the corporate staff in Dallas. His official new title was vice president of space programs. By 1968 Cox had left Collins Radio Company to become the president of King Radio of Olathe, Kansas, the company established by former Collins associate Edward J. King as a competitor to Collins in corporate aircraft avionics.

John C. McElroy, who Arthur and Cox had selected to direct engineering in Cedar Rapids after Cox became division head, also went south to Dallas, at least in part due to concerns about the course Arthur was following.

McElroy was highly respected by his fellow engineers and by Collins' commercial and military customers as an engineer and engineering administrator. He received a BSEE degree from Purdue in 1941, did electronics work as a Navy officer during the war and joined Collins in 1946. He played a main role in developing the 51R-1, the grandfather of commercial aircraft VHF navigation receivers. He had overall responsibility for development of early TACAN equipment widely used by the armed forces, and supervised many other projects until 1965.

McElroy then moved from vice president of engineering in Cedar Rapids to the position of marketing vice president for Dallas. In Cedar Rapids, where he started his company, Arthur always had an operation of unique technical creativity and high productivity levels. Arthur hoped McElroy's transfer and his later appointment to be general manager of all Dallas operations might help create a similar pattern of capabilities in Dallas. McElroy stayed with the company into the 1970s.

Mel Doelz, responsible for key inventions at Collins since joining the company in 1941, also parted ways with Arthur in 1965. Doelz was the inventor of the mechanical filter which made possible the Collins Radio development and dominance of single sideband radio. He also had a lead role in developing several key military communication systems, including tropospheric scatter.

He was the main engineer in developing Kineplex, the system which put Collins in front in data communications. Doelz also conceived and directed much of the development of the C-8400 computerized switching system.

Doelz worked in Cedar Rapids until about 1947 when he moved to California to head up engineering for the west coast operation then being established. By 1959 he had become vice president and general manager of the Western Division, which became the Information Science Center in 1961. He was appointed to Collins' board of directors in 1961. Doelz long was regarded as one of Collins Radio's most brilliant and innovative engineers, with more than 20 patents to his credit, and like Arthur held the esteemed honor of being named a Fellow of the Institute of Radio Engineers. He was a trusted confidant of Arthur, who saw in Mel Doelz the type of engineer-manager he wanted for his major divisions. But after the C-8400 project the mutual confidence began to erode. It was said that Arthur more than once wanted to fire Doelz, but before Arthur could go through with it, Doelz came up with a new idea which intrigued Arthur and made him change his mind.

Doelz disagreed with what Arthur was attempting with the C-System. Several factors triggered his decision to leave. One reportedly was Arthur thinking about establishing a computer research center in Dallas in competition with what Doelz had built up at Newport Beach.

Another factor was Arthur's order to halt production and sales of the highly successful C-8400 switching systems after only about three years. Doelz described how he remembered that period:

*We had the first on-line digital switching system — we were way ahead of the industry with that. We had worked 24 hours a day, day in and day out, under great pressure to get it all together. We were actually selling it before we completed inventing it. We learned the computer business the hard way. I thought we had a tremendous opportunity to be a real leader with our on-line switching. That turned out to be the most important part of the whole computer business, a helluva lot more important than data processing. That was where Art and I ended up with different opinions. He came out and wanted to be kind of like IBM — into data processing as well. I was arguing we had all this investment in switching software and we should develop more powerful hardware to use that and stay in the on-line business, but he didn't want to hear that. He wanted to dump the whole bloody mess and start out with a new system which turned out to be the C-System. But you just couldn't tell him anything — he wouldn't listen to anyone,* Doelz said.

*When IBM came out with its 360 system Arthur was enamored with that. He had a whole Newport Beach crew trying to build his version of a 360 system. But then he dropped that and went into something else.*

*Art was a very hard thinking man. When he got onto something he was going to get there and do it regardless of all the obstacles. He wanted to turn the whole company into one big computer operation. He was way ahead of his time. His thinking was good but not very practical for the time,* Doelz said.

After Doelz left Collins Radio he started his own company, producing specialized high reliability computers, and built it into a highly successful venture which he operated for a number of years. The firm eventually was sold to Control Data Corporation.

Doelz recalled when he parted with Collins it was not the first time he had considered such a move. *Once before when I was thinking of leaving, Art flew me out to Burbank in his Bonanza and talked me into changing my mind,* Doelz said.

Mel Doelz voiced what was a near unanimous consensus among people who watched the performance of the highly successful C-8400 equipment — Arthur made a big mistake in halting the production, sales and enhancement of that system. Arthur's decision to end the program did not help Collins — it opened the door to competitors. He apparently was counting on the C-8500 being ready in time to keep his market edge in switching systems — but the C-8500 never reached that point.

When Arthur ordered the end of the C-8400 program, it fell upon John Boyle, vice president of data marketing, to tell those customers who had C-8400s on order that they would not get any more C-8400 systems. Instead they were told they soon would have the C-8500.

One of those customers was Delta Airlines, which liked the C-8400 switch system and wanted more of the equipment.

Boyle flew to Atlanta to deliver the news to Delta officials, who were very unhappy about what they heard.

After he got back to Dallas Boyle received a package from Delta. It contained a tube of vaseline and a piece of barbed wire, with a note telling him what he could do with the C-8500.

Once Arthur started all the wheels rolling on his C-System, it turned into an on-going development program which never quite reached a conclusion.

Bob Cattoi described how he remembered that period of working on the C-System:

*Arthur read voraciously. He gathered information like you couldn't believe. Each month he'd know you could do something different and better. He never quantized progress. He never got to the point where he'd say let's stop and build something here, and then wait until later to incorporate the new technology which is growing all the time.*

*Art could not wait to get something new in when he saw it would add leverage to whatever we were doing.*

*He was thinking 24 hours a day at a rate no one else could think. He was always thinking far out in front. Every day he'd see a new horizon ahead that he wanted us to reach. We had a helluva time understanding what he had understood a year before, let alone his latest idea. Trying to catch up with his thinking was one thing — trying to implement it was even more difficult. We had a continuous feeling of always running behind in doing what he wanted, and we always felt understaffed,* Cattoi said.

One of the most difficult problems with revisions and new features which Arthur wanted was the impact they created throughout the system. *You didn't make just a modification to the computer — it also caused a lot of changes down the line for MCS, EDS the TDX loop or other system parts, and they and programs for them all had to be implemented and checked out,* one of the engineers recalled.

The demands by Arthur often strained the energy and patience of his engineering staff.

Cattoi said he once told Arthur, when Arthur's desire to make changes was getting to everybody, *You're too impatient.*

Arthur's reply was: *I want you to understand that impatience is a virtue.*

There were times when Arthur felt progress was too slow, which Cattoi attributed to the troops getting tired and frustrated by the pace. Arthur then assigned the same task to two engineering teams. He always thought competition motivated people.

*But to his credit, despite working people hard, he appeared very concerned when he learned about someone's personal problem, and he would try to help them. We had a constant problem of guys trying to balance company time with family time,* Cattoi said.

It was common knowledge in engineering circles at Collins that after coming out of a meeting with Arthur, the C-System development team would have to hold another meeting to try to interpret and understand what he wanted.

*Arthur would say, 'You guys in engineering are always worried about doing things right. But you also need to worry about doing the right thing. First do the right thing, then do it right. And some of you like to do things as fast as you can as right as you can — I want you to do things right as fast as you can.'*

*We'd try to do it right, but it was never fast enough to please him,* Cattoi said.

A problem which engineers faced when on a project with Arthur was that he got his sleep in small snatches, day or night, felt rested and ready to go again, and expected others to be just as full of energy as he was. Most persons, of course, needed their regular sleep to do their best work.

Cattoi remembered occasions when Arthur was building his new house in Dallas. *We (his C-System development team) sometimes stayed there with him. He'd get us up at four or five in the morning, saying 'I heard you moving in there,' even though we'd all been sound asleep. Or sometimes we'd be with him on his boat, and he'd give us a wake-up call at a very early hour. 'Coffee's on and I'm sure you guys could use some',* he would say.

The building site for the new Collins house in north Dallas originally had two other houses on it which had to be torn down.

Keith Rathjen was another member of the inner circle computer and C-System engineering team, and remembered staying and working in the older houses.

*Art would talk about going into a cave on a big project, like when we were isolated at the house. He called those quarters the Boys Club. He'd often call Mary (his wife) and ask where sheets, towels, dishes, etc. were. Before he began using the houses we had an apartment where the company maintenance department provided everything. If we wanted anything, like a second TV set, all we had to do was ask and we'd soon have it.*

Rathjen also remembered weekend calls from Arthur. *Art sometimes called my house to ask about something. If I wasn't there he'd have a long conversation with one of my young sons. I sometimes wondered if he talked more with mine and the other engineers' kids than he did with his own.*

As the C-System moved forward, new techniques were devised in attempts to format information, provide communication links between computers including computers located as far apart as Cedar Rapids, Dallas and Newport Beach, and to have computers control a number of factory processes.

One of Arthur's main intentions, which he wanted to demonstrate in the C-System program, was that computers were far more than just computational machines.

In particular, as he had often stated, they were tools to manage information.

Collins Radio Company truly did achieve advances in many areas of computer technology which were years ahead of similar practices by other companies and even academic and government researchers

When Collins finally released some information about the C-System in 1968, one trade publication described the C-8500 as *a 32-bit, 1.2 usec processor that comes with up to 262K core and a host of peripherals, including a smaller* *'device control' computer, CRT terminals, modems and magnetic card files, as well as the usual printers, card units, discs, drums and mag tape. Even a small tape cartridge unit is available, for initial program load and diagnostic routines.*

*Bold and novel ideas* were among words describing the Collins approach. *Consider, for example, their concept for on-line production/process control service centers. This scheme envisions nothing less than the actual control by a customer of a part of Collins' production facilities. A customer might want, say, a certain quantity of an extremely complex circuit board. He would be able to go to a Collins service center (or be tied into it through a terminal), feed in the specifications, and initiate the actual production of the boards at a Collins plant in another city,* the article stated.

Collins had developed a high level of capability in digital data transmission when most others were still trying to learn how to do it. The capability was being applied for both wireline and radio transmission, based on Kineplex experience.

The C-System efforts included numerous applications of computers communicating with other computers, in many instances multiple computer links, a forerunner of e-mail and the Internet which came years later.

Collins planar circuit board, thin film and MOS technologies were as advanced as any American company was doing. Collins had a highly developed capability in multilayer printed circuit boards, fabricating those for outside customers as well as company applications. Boards up to 8-1/2 by 26-1/2 inches with 10 layers of circuitry were produced. The boards contained up to 4,000 holes to connect with inner layers and microcircuits mounted on the surface. Eventually boards with 22 inner layers were made.

The company claimed it was the No. 1 supplier of thin film microcircuits in the U.S., selling them to nearly a dozen other electronics firms as well as using them in Collins avionics, microwave and data products. Applications ranged from monitoring aircraft engine performance to computer circuits to missile guidance system controls. By 1971 more than a million had been produced, representing 1,250 different circuit designs. Thin films ranged in size from one-half to one inch square, and contained 250 or more tiny transistors, resistors, diodes and capacitors.

The smallest of the C-System process components were MOS/LSI (metal oxide semiconductor/large scale integration) chips, mostly logic function devices. These represented state-of-the-art microcircuitry in the 1969-70 era. Collins' MOS production was done at Newport Beach, with the process computer controlled from digitized design through fabrication. The basic MOS/LSI substrates were two-inch silicon wafers, cut up into about 100 chips one-tenth of an inch square, holding dozens of tiny semiconductor devices. Collins developed a standard MOS/LSI product line, offering 24 different chip types to electronics designers.

As in all the processes, techniques for producing circuit boards involved a great deal of trial and error effort.

Mihael F. Phillips, who had a variety of executive assignments at Collins including managing the data center, recalled a period when Arthur and Harry

Passman were trying to develop a new way to connect the circuits printed on each side of a planar circuit board.

*Initially, plated through holes were not really working out. Art had the idea of using what were called 'thrus,' tiny pieces of copper wire, very specially cut and shaped. These could be spread upon the surface of the board, and by gently shaking the board, the thrus would drop into the holes. They then could be soldered into place, provding the necessary contact between the circuits on the outsides of the board. I was no mechanical engineer, but it seemed a Rube Goldberg approach. But I gathered it was a very serious solution. My involvement, as a material system 'expert' was to decide how to code the units, the counts of thrus needed for the production process. The problem was how many — 10, 50, 100 or more? As I recall, we settled on trying to get 50 thrus in a hole for a start. Multiply that by the large number of boards going through the process and you can imagine we were quickly up to our eyeballs in thrus. Bags of them would break in the stockroom, thousands showering onto the floor. No one measured how they were applied — a scoopful was poured over a vibrating board and the little devils went everywhere.*

*One day, probably a Sunday, Art and I were looking at the process and he was quite frustrated. He referred to my Christian faith and said maybe I could recommend a solution. Paraphrasing the bible, I said it would be no easier for a thru to get into a hole on a circuit board than for a rich man to enter the gates of heaven. He was not particularly amused. He said, 'I'll fix the process, you try prayer,' and then walked off. I don't know if the process was ever successful.*

Eventually, Arthur and his engineers solved the plated-through hole problem.

Incidents such as that demonstrated how Arthur was so intense about his projects that he would get involved down to the most elemental level.

Another area where Arthur played a lead role was developing automated methods and equipment for testing MOS chips. Called DPI (digital pseudorandom inspection), it was another example of an advanced capability invented within Collins laboratories when no product existed for that purpose. DPI was a highly complex, automated procedure where production quantities of chips were tested against parameters of a known good chip. The test also covered simulated operating conditions of equipment in which chips would be used.

What Arthur attempted to do with the C-System was to combine a number of functions in a common system which previously had required separate computers and operating systems — engineering design, project management, automated manufacturing, accounting, purchasing, billing, payroll and other activities.

His goal was to see all Collins product lines — avionics, telecommunications, specialized military, space, data systems and components — as a highly organized and integrated array of equipments, software, services and techniques referred to collectively as the C-System.

But that all-important C-System objective, to have a single computer be a multi-function machine, proved such a programming nightmare it never was solved satisfactorily.

The C-System required several hundred programmers to implement the extensive project. When recruiters tried to hire experienced, professional programmers, they met with little success. On learning the Collins computer system was intended to do several functions at once, many programmers said it could not be done and wanted no part of it.

Unable to hire from the outside, Arthur tried to convert company engineers into programmers, a frustrating experience for many of them.

Arthur Collins never wanted to talk publicly about a development program until he was sure it was far enough along that competitors could not catch up, and sufficiently tested to demonstrate that the system worked. The usual pattern for Collins was to announce a new product when development was completed, then in many cases it sold itself.

But because the C-System represented such a major effort and entry into a significant new business area, he decided in mid-1968 it was time to discuss the project at least in general terms with leading business publications. That came just after Collins' record sales and earnings in the 1968 fiscal year.

In what one of the attending journalists described as *a rare press interview,* Arthur and his management team let it be known that within a few years they planned to be competing with IBM, Control Data and other giants of the computer industry. By competition, they were not thinking of offering a better accounting machine, but a computer with far greater versatility and one tied to communications capability.

They depicted the C-System approach as different, more comprehensive and more advanced, better able to handle a broad range of customer needs with a single system.

They described the C-8500 as *the first completely integrated computer system having practically unlimited expansion capability.*

While the Collins press conference produced some highly visible publicity, the resulting articles also posed questions about the firm's entry in the computer field.

A major business publication noted: *Some skeptics suggest that Collins may find the computer market a hard one to crack. They say that many current users of computers may prefer to stay with the company, if not the unit, they're now using, rather than scrap what they have to take on the Collins system.*

A respected computer industry trade magazine observed that Collins had experience in the computer field with its C-8400 switching systems, but most sales had been to companies such as airlines and railroads which already were customers of Collins for other products.

*Now, presumably, this is going to change. But the company may have a struggle ahead, not only in competing with the well-established computer makers, but even in getting the idea across that prospects should identify Collins with computers,* that article stated.

As the C-System continued to dominate company planning and strategy with almost total disregard for costs, and Arthur became more impatient with progress while ignoring how he influenced that scenario, fewer of his top people dared to voice opinions which Arthur might not like to hear.

More and more work teams and people with expertise in various areas were brought into C-System projects. Arthur at times showed a definite dislike for what someone said or did, and would say, *Get that guy out of here.*

When that happened, the person would return to his normal work post and wonder if he would be fired.

Whether Arthur wanted a person terminated or just off a project posed a major dilemma for supervisors. It often fell upon Bill Roodhouse, Collins executive vice president, to decide if he had to fire an employee or find him another job within the company.

Still, Arthur tolerated some disagreement. Once at a work session in Dallas, an engineering assistant vice president from Cedar Rapids tried to convince Arthur that a certain approach would not work. That irritated Arthur and he told him to go back to Cedar Rapids. But a day or two later, while the assistant VP sat in his office wondering if he was still employed, Arthur called him to come back, saying he'd thought about it and decided the engineer was right.

Hundreds of hours of meetings were held by Arthur with groups of engineers, programmers and others, persons both closely involved and on the fringes of the C-System. Often meetings were held at his homes in Cedar Rapids or Dallas in the evening. Attendance ranged from a few to more than 20.

At one such meeting in Dallas, an engineer who had looked into computer methods at another company said he saw practices he felt might work better than the Collins approach. Others in the meeting knew what would happen. By the next morning he was no longer employed at Collins.

At another session a West Coast engineering executive began discussing a possible solution to a technical problem. Sensing that his remarks were not being favorably received, he quickly concluded and saved himself with: *And Mr. Collins, would you believe some people actually think that might be the way to fix this problem.*

There were thousands of words written and dozens of documents prepared on the various C-System processes. At times Arthur gathered his engineering first team together for writing sessions, some lasting several days.

Arthur himself was responsible for a great deal of what was written. He often was helped by his son Michael. The pair spent many hours together with Arthur dictating his thoughts and descriptions about the C-System and Michael transcribing them.

Michael, then in his mid-twenties, recalled he still had the note-taking skills he developed during his recent years at the University of California, Berkeley, where he majored in entomology. *That allowed me to take down his thoughts, then later I would type them out,* Mike said.

*Dad had a beautifully organized mind — an analytical way of thinking. His mind was extremely fast, but he had a way of speaking very slowly and deliberately. He was thinking through those concepts such as the distributed network and how he wanted to put his thoughts into words. He would take long draws on his Chesterfield between statements,* was how Mike remembered those sessions.

One of the main documents which emerged was a 22-page brochure intended to explain the C-System to outside audiences. Like much of the material that was prepared, it was not easy to understand because the C-System itself was not easy to understand, being a broad, futuristic concept. Also, the brochure appeared to be written primarily from an engineering perspective, which made it perplexing to the non-engineering oriented reader.

Arthur preferred, even insisted, that C-System descriptions be on an engineering and technical level.

He once wanted it known there was compatibility in the Collins and other scientific computer languages, which he saw as a plus for C-System process users. He had a news release drafted, for the public relations department to distribute. Probably few persons except computer programmers would have understood it. Facing the inevitable *What does this mean?* query from Dallas newspapers, the Collins corporate PR director appended a brief explanation in laymen terms. Arthur did not like that, and it cost the PR chief his job.

After Collins Radio defeated the takeover attempt in early 1969 by Ross Perot and his Electronic Data Systems Company, Collins hired the public relations firm of Hill & Knowlton to help improve its image with Wall Street financial analysts.

Hill & Knowlton assigned Stan Sauerhaft, a senior officer of the firm, to work with Collins. Sauerhaft had worked with many large corporations and had a reputation for helping companies successfully deal with problems such as Collins was facing. After some urging, Arthur Collins agreed to talk with Sauerhaft, who flew to Dallas for the meeting.

They visited a short time in Arthur's office, with Arthur answering a number of Sauerhaft's questions. When the subject of the C-System was brought up, Arthur handed Sauerhaft a copy of the C-System brochure, suggested he go to another room and review the document, then return for further discussion. On resuming the meeting, Arthur asked Sauerhaft what he thought about the brochure. Sauerhaft replied he was highly impressed with the C-System concept, but also said as tactfully as possible he found the brochure to be heavily engineering-oriented and would be better understood by non-engineering executives if it could be explained in laymen terms. Soon after that Arthur ended the meeting, then called John Haerle, assistant vice president of advertising and public relations, and directed him to cancel the Collins contract with Hill & Knowlton.

During preparation of one of the company's annual reports, Arthur and several top aides had pored over numerous drafts of the president's letter, with the main emphasis being on the C-System. Arthur asked a lawyer who had been retained for some company business to read it, then asked him what he thought. The reply he got was: *It's kind of erudite. It probably will not go over well with your maiden aunt in Dubuque.* Arthur's comment to that was, *Well, I'm not trying to impress my maiden aunt in Dubuque. I'm trying to impress some serious investors.*

Most of the Collins workforce did not understand what was happening with the C-System, except the realization that *we're getting more into computers.*

There were no attempts to explain the new course the company was on in simple terms.

The C-System grew so big it became difficult for anyone including Arthur to keep track of all the many applications and ramifications.

As effort continued without reaching a point of completion, disillusionment grew. Key executives were leaving, money was being spent with no restraints, many engineers were being assigned to the C-System without having clear directions as to their duties, and there was none of the success that had traditionally followed Collins new product developments. Sarcastic and even obscene jokes began to make the rounds of employee groups. One depicted the bride of a Collins computer engineer, who several weeks after the wedding confided to a friend that her marriage was not as happy as she had hoped. Asked what was wrong, she told the friend her husband had yet to consummate the marriage. *What does he do?*, asked the friend. *He just sits on the side of the bed and tells me how good it's going to be*, the bride replied.

Despite never reaching a stage where development ended and full-scale production began because of continual changes being introduced, efforts were made to sell the C-System.

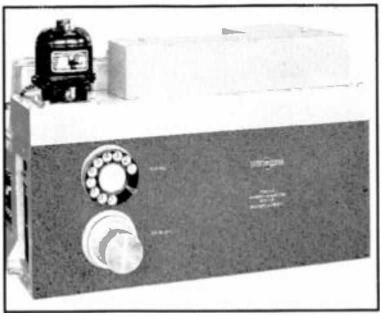
Potential customer groups were brought in to be shown various processes and applications.

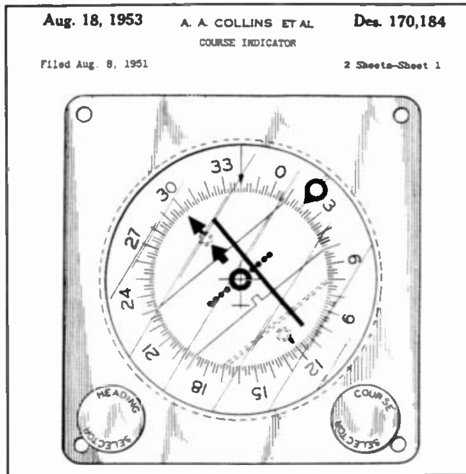
They did not always get an entirely authentic picture. Arthur wanted so badly to demonstrate an accomplishment that he appparently gave tacit consent to a practice totally uncharacteristic of him — resorting to simulation.

An automated design operation was a case in point. It was an impressive facility, with precision machines preparing circuit board and equipment designs, monitored by a few technicians. The visitors were led to believe the operation was controlled by C-System computers located some distance away. In actuality, much of it was being controlled by data inputters and programmers in another room.

Sometimes Arthur had been led to believe an internal operation was working off the computer according to plans, when that was not the case. One instance was the facility in Cedar Rapids where circuit boards as large as two by three feet were moved by an overhead conveyor system and dipped into tanks containing plating, etching and rinsing solutions. The process supposedly was under the control of a remote C-System computer, when in fact it was run by technicians operating control panels who could see into the plating room. When Arthur heard about that, he called the engineer responsible for the operation to his office for an explanation. The answer he got was that the computer programs supplied for automating the plating line did not work, fixes repeatedly requested to remedy the program problems were not forthcoming, and in order to get the work done they had to resort to manual control. The engineer had approached the meeting with trepidation, fearing the worst, but instead Arthur thanked him for giving an honest answer.

What the plating line incident showed was that some people did not always tell Arthur the truth about how the C-System was working.

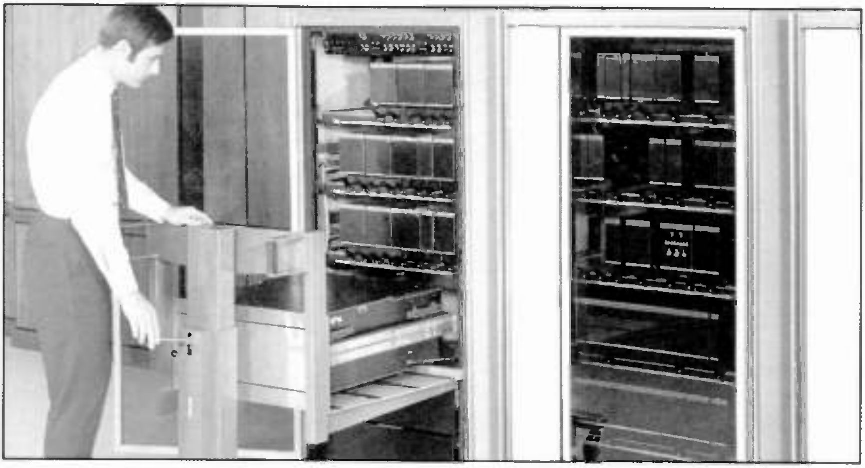





*Above, first aircraft transmitter with a Collins Autotune, built for Braniff Airways. At right, patent for the Collins Course Indicator.*

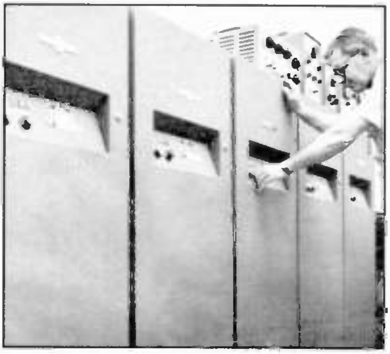
*Test pilots perform a hands off landing of an L-1011 TriStar with the Collins-Lear Siegler Automatic Flight Control System.*


*Collins equipment for the Air Force F-4 Phantom aircraft, including CNI system, high frequency radio and horizontal situation indicator.*

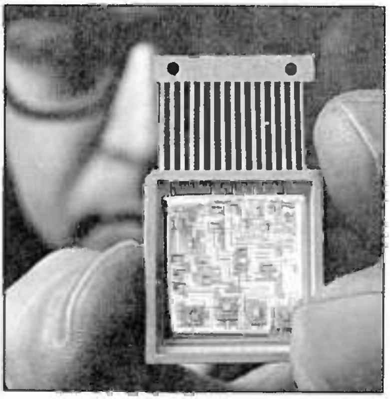


*Collins C-System hardware. The cabinet at right comprised a basic C-8500 type processor unit.*

*Arthur and his son Michael Collins stand in front of a C-8400 Switching System Processor.*



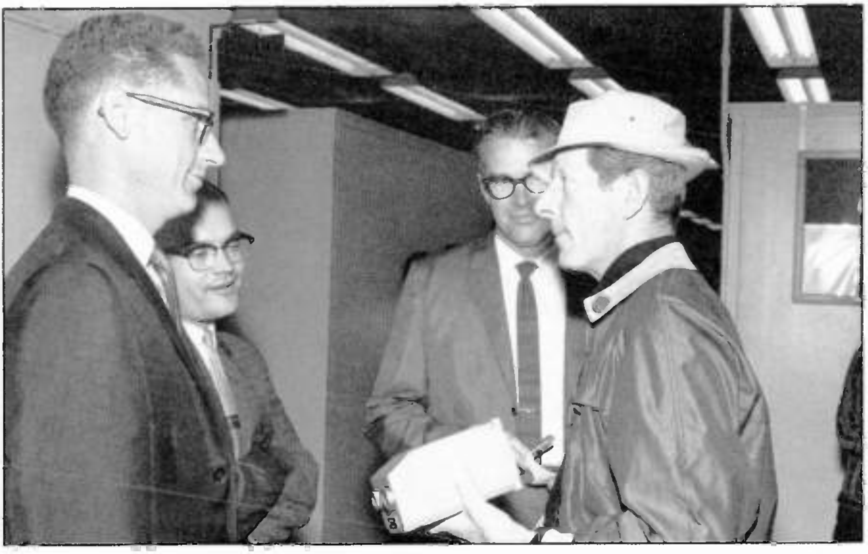
*Early generation modems, part of the Collins Kineplex system for high speed data transmission.*



*A Collins thin film component.*

*The Cedar Rapids manufacturing complex of Collins in 1969-71, located west of C Avenue NE.*

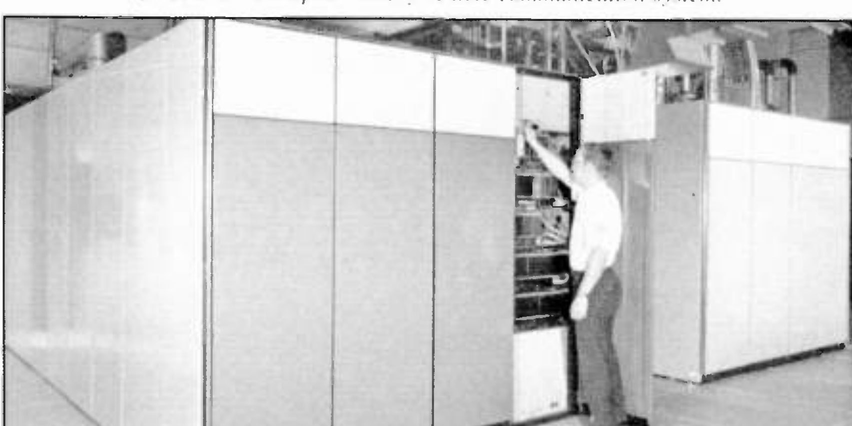
*A 1930s view of the site which became the Collins manufacturing complex. It was then an airport called the Aviation Country Club.*



*Comedian and pilot Danny Kaye on impromptu visit to Collins. With him, from left, are Glenn Bergmann, marketing director, Ed Fritze, avionics engineering head, and Bob Winston, sales manager.*

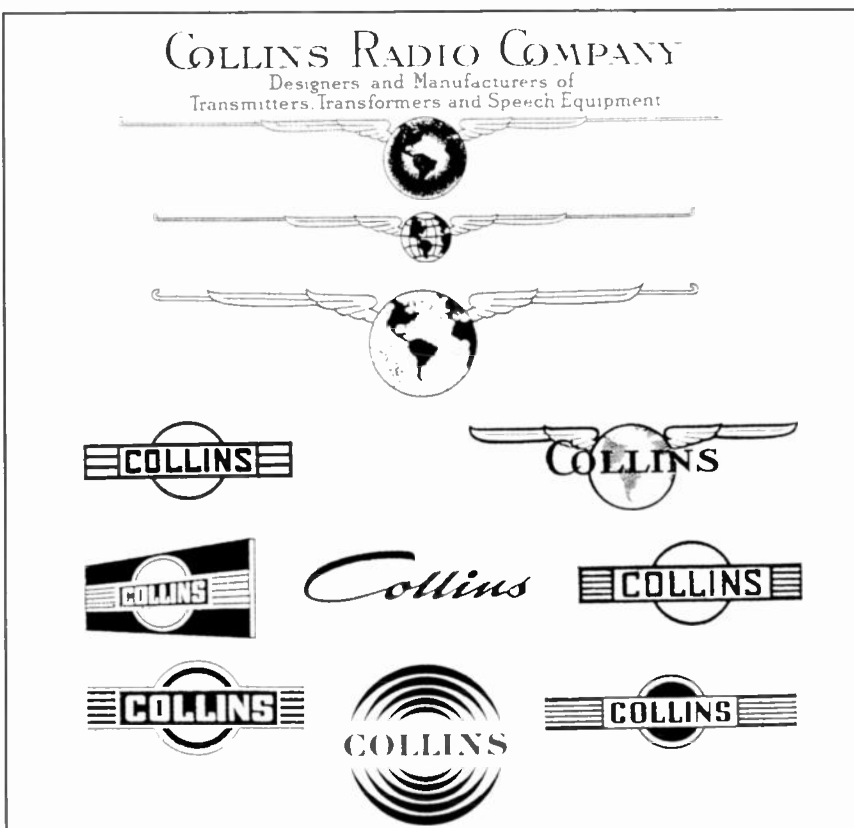
*Collins 10 kilowatt FM broadcast transmitter and disc jockey console, typical of equipment installed at KCRG-KCRK in Cedar Rapids and many other radio stations after World War II.*

*A Collins-developed military vehicle communication system.*



*A huge Collins 250-kilowatt computer controlled high frequency transmitter built at Collins Canada for the Canadian Broadcasting Corporation, used for international short wave broadcasting.*

*Arthur Collins receiving the U.S. Navy Distinguished Public Service Award, highest Navy honor for a civilian, from Vice Adm. R.B. Pirie.*




*Various logos used by Collins Radio Company through the years.*

*The flying boat designed and built by Dr. Alexander Lippisch, here being flown at Lake Macbride by Collins Pilot Clayton Lander.*

*Another Lippisch invention, the Aerodyne, a wingless aircraft. This was a model being demonstrated at Collins' Cedar Rapids hangar.*

*Arthur's 70-foot boat, the Peregrine, largest fiberglass hull boat ever built in the late 1960s.*


Don Beall


Les Bessemer


John Boyle


Warren Bruene


Bob Cattoi


Bob Cox


Jim Flynn


Bob Frost


*Morgan Craft, Bob Gates and Bill Barkley, about 1942.*


*Arthur and Mary Collins' Dallas house under construction.*


*Bill Hubbard*


*Fred Johnson*


*Alex Lippisch*


*Joe McCaddon*


*John McElroy*


*Bob Miedke*


*Bob Mullaley*


*John Nyquist*


*Harry Passman*


*Mike Phillips*


*Bill Roodhouse*


*Howard Walrath*


*Bill Weinhardt*


*Ed Williams*


*Bob Wilson*


*Rolf Wollan*

More than once some of Arthur's most trusted executive assistants had to stick their necks out over a C-System dilemma. One instance involved the Accounting Data System (ADS), crucial to day-to-day company operations. Various department managers faced major problems in getting work done properly and on time because the C-System methods and programs they had been forced to use had flaws. Their only choice was to appeal to a vice president for permission to bypass the C-System and revert to manual methods of handling work.

Howard Walrath recalled being in Arthur's Dallas home one evening when Arthur asked a question about ADS operations. At that point another VP blurted out, *I thought that was shut down,* which was news to Arthur. Walrath said he then told Arthur it was a temporary situation. *But there was hell to pay the next day as everyone scurried to get the ADS back on line,* he recalled.

While Arthur Collins tried not to show it, his closest associates could see him becoming more and more frustrated as the C-System failed to reach a termination point. He reacted much the same as many leaders throughout history have done when their grand schemes began to fall short of expectations: He poured more money and manpower into the project.

But eventually the C-System put such a strain on the company that the money supply was squeezed off.

From the time the C-System development began rolling at full speed, the cost became much greater than could be generated from annual earnings. Arthur always had counted on profits from previously developed products to pay for R&D programs.

Much of the money for ongoing development, including hiring and paying salaries of many specialized engineers and software programmers, buying new equipment, constructing new buildings and other expenses, came from adding to the company's bank borrowings.

Up until 1969 Collins had no trouble obtaining bank loans. But after Ross Perot made an unsuccessful attempt to buy out Collins, the banks began to review the Collins debt load, and told Collins to begin paying off its loans. Further bad news followed with a business decline which soon led to major layoffs. Arthur found it personally very difficult to accept the reality of his company's financial predicament. He reluctantly faced what the bankers and some of his top aides told him — Collins had to find some other company willing to invest in it or arrange a merger. That pursuit occupied much of the time of Arthur and his key people from mid-1969 into 1971.

Then North American Rockwell agreed to an investment of $35 million in Collins, but also required changes which in effect gave it a controlling interest. Within a few months the North American Rockwell management decided Arthur was not doing enough to turn his company around, and ousted him as president, chairman and CEO of the company he had founded 40 years earlier.

There had been one opportunity, in 1968, which if it had materialized, might have saved the C-System and allowed Arthur to retain control of Collins Radio Company.

The U.S. Department of Defense, specifically the Air Force, issued RFPs

(Requests for Proposals) to a number of companies for a multi-million-dollar program to provide access to information in up to 100 disc files located around the world. The disc files were to contain a huge military data base, part of the Strategic Communications Network. It was to be a highly advanced computer system calling for 64-milibits-per-second speed in retrieving data, very fast for that time.

The C-System utilized a time allocation scheme for its different functions, a form of circuit switching, to retrieve data from disc files. The method was inadequate for retrieving as much data as rapidly as the military wanted.

One of the computer scientists assigned to a team to study the military RFP, for the purpose of deciding if Collins should bid on the contract, was Roshan Sharma. He was a native of India who came to the U.S. to study physics and mathematics and had been employed at the company since 1952. Since the Collins C-8400 development he had worked extensively in computer networking.

Sharma recently had attended a conference in Europe and heard a presentation by Donald W. Davies, the brilliant British computer scientist, on a technique to access data storage systems known as packet switching. It was different than the C-System method, and had not yet been used in the U.S.

Sharma believed packet switching would work for the proposed military system, and tried to get Arthur to understand how it could be applied. *Art would listen, but if he did not understand and did not want to dig into it, it was like a barrier — you did not go any further*, Sharma said.

Arthur decided that Collins would not bid on the big military job. Bob Cattoi said a main reason was that the contract called for .999 percent availability. Collins could not guarantee that with the C-System equipment at the time.

Roshan Sharma said that years later, in Newport Beach, he ran into Arthur, who invited him onto his boat. *Arthur began to talk about the packet switching discussion of 1968. He said he later had studied what I suggested, that he agreed it might have worked, and he should have listened to me*, Sharma said.

There were some orders of C-System equipment, but not enough to make more than a small dent toward recovering the vast investment in the project.

One sale included three C-8561 processors, disc files, magnetic tape units and operator consoles to work with a new reservations system of American Airlines, known as SABRE II.

The government of Mexico purchased C-System processors, disc files and terminal equipment to compile a record of all motor vehicles in the country, their registration, licensing, owner names and addresses and other information.

The State of Iowa also contracted for C-System equipment for its motor vehicle department. It provided rapid access to vehicle registration and motorist records. A highway patrolman checking out a suspicious car, for example, could initiate an information request by radio to the data center and quickly have an answer back.

Aeronautical Radio, Inc. (ARINC), first user of the Collins C-8400 computerized message switching system, added C-System equipment to expand and upgrade communications services for airlines.

Western Electric Company purchased two C-System computers and disc files to use in data applications.

But with the C-System, there was no big success story, no widespread acceptance by customers willing to take a chance on Arthur Collins' attempt to advance the state of the art in data processing and communications technology.

Unlike his previous great triumphs, it did not attract the envy of competitors or the curiosity and admiration of potential users.

Instead, it was such a large, complex development program that it took more out of the company than it was able to return in benefits.

It cannot be said that the C-System was entirely unsuccessful, as it led to numerous advances in computer technology and data communications.

But it did cost Arthur control of the company he had founded in 1931.

There have been many post-mortems contemplating what happened at Collins Radio Company over the several years of the C-System development — what led Arthur Collins to risk everything he had built up over 40 years, and why he did not succeed. He also put at risk the careers of many persons who had given the best years of their lives to Collins Radio Company. By very nearly driving the company into bankruptcy, many long-time employees including top ranks of management became disillusioned and bitter at how he continued to press ahead on a dubious objective.

Perhaps one reason he tried it was his vision and foresight of the coming of the computer era which became reality in the final decades of the twentieth century. He wanted his company to be there first, and play a leading role in data applications technology.

For Arthur, the motivation probably was not personal glory and recognition. It was, in his characteristic ability to foresee future trends, a keen awareness of the digital revolution then moving onto the world stage. He saw the vast potential it offered, and the impact it would have not only on technology for Collins but also on countless other areas of human activity.

William T. (Bill) Hubbard, a financial vice president who worked closely with Arthur both during and after his Collins Radio Company days, said Arthur had unbelievable insight into how the computer era would develop. *Art envisioned the coming of the Internet,* Hubbard said.

Arthur did not enter into a new venture thinking of it as a risk. He had complete confidence he would succeed.

But with the C-System he made monumental errors in judgment.

The C-System was an idea too far ahead of its time. Businesses were not yet ready in 1970 to implement major, company-wide computer control systems. After the powerful personal computers came on the scene nearly every business became heavily dependent upon computers throughout their organizations, but that did not begin until 10 or more years later.

The C-System was simply too large a program for Collins Radio Company to handle.

*We needed a little more time and a little more, well, really, a lot more money,* said W.W. (Bill) Roodhouse, the company executive vice president.

*There weren't enough resources in the world (available to Collins) to do what he wanted to accomplish in the time available,* said Ed Williams. Others close to Arthur said he hurt the rest of the company with his computer effort — requiring other products to be equipped for computer control long before that capability was needed. One top company official was critical of how Arthur transferred some of the best people from other departments to C-System projects. *That hurt us in trying to build and sell the products that made money,* he said.

And another executive with both engineering and marketing experience stated: *There was a lack of common sense and no marketing input in the C-8500 design.*

Despite Arthur's ability to envision the future of electronics, it is doubtful he or anyone could have foreseen how big the computer industry would become, separated into major hardware and software segments. The industry evolved into one too large and too diversified for any one firm to play the all-encompassing role he scripted for Collins Radio.

He probably did not intend to confront IBM head-on. But he desperately wanted to build a better computer than what IBM offered.

The point also has to be explored of how Arthur guessed wrong. He had been right so many times he probably felt sure he was right when he started the C-System, and those who doubted were wrong. It appears what he overlooked was how technology was growing so rapidly and expansive by the 1960s that it was virtually impossible, even with his superb talent to absorb knowledge, for any one person to be fully aware of everything coming on the scene. No longer could he be the only one on the right course as was the case with single side-band and flight directors of earlier years. It is true he had his company on the frontier of planar circuit boards, MOS chips and other electronics processes. But he also chose not to listen to warnings and viewpoints he did not want to hear.

In retrospect, some who watched the development have questioned whether the level of C-System technology was sufficiently advanced to assure the program's success. They speculated that if the computer chips which came along a few years later had been available, the C-8500 might have been a winner. In the late 1960s integrated circuits were beginning to dominate electronic design, and Collins was one of those developing integrated circuits. The C-System computer of 1970-71 was at least as advanced if not the most advanced of any then available for message switching, but it fell short when asked to simultaneously do switching, computations and run factory processes. While tiny microprocessors which made personal computers possible were not yet fully developed, Arthur's C-System concept was not unlike the personal computer set-up of later years — a small community of computers doing the work of a department, but able to communicate with all other computer stations in a company.

The marketing effort applied to the C-System was a more likely factor than the technology question as one of the main reasons it did not gain acceptance. In selling the C-8400 switching system to airlines the company worked with customers who were familiar, but selling a computer system which would provide a corporation's data processing, data communication and automated production control was a new ball game for Collins.

From an early point the Collins marketers ran into barriers trying to explain the C-System to data processing people in other companies. They concluded those specialists had dealt only with IBM for so long it was as if IBM had trained them how to think.

That led to a rationale within Collins of not trying to sell to the data processing people, but instead attempting to reach CEOs, to convince them the C-System could be a real bonanza for their firms, leading to all kinds of productivity and cost saving benefits.

Trying to reach the top man who could make a decision was not a new approach for Collins. There were instances over the years when the first big sale of a new Collins product came after it was shown to the chief pilot of an airline, the chief engineer of a radio station or a senior military commander.

The most notable example was when Gen. Curtiss LeMay saw the tremendous benefits of Collins single sideband radio for use by the Strategic Air Command, and pushed for its adoption by the Air Force.

But those previous products, including the C-8400 message switching system, were for a single function. A new avionics system may have made a pilot's job easier, but it did not affect how management operated the airline, and did not permeate all operations of an organization as the C-System was intended to do. With the C-System the highest levels of management would have had to study it, understand it, be sold on it and approve it.

What also apparently was not recognized was how the U.S. business management environment had changed since World War II, how most other companies were not like Collins Radio, organized around a strong leader whose decisions and authority were never questioned. Most company presidents had to answer to their boards of directors and stockholders. They depended upon the advice of financial and technical people when making decisions. Neither were most of them engineers in the mold of Arthur Collins.

As John McElroy, a Collins vice president who had worked both in engineering and marketing said: *Those executives were not risk takers who made pioneering decisions, they made comfortable decisions.*

One marketing idea Arthur felt might impress other CEOs, which he suggested to Advertising Director John Haerle, was to spend the company's total advertising budget for an entire year on an eight-page C-System spread in Time magazine.

Haerle immediately saw himself facing the wrath of every salesman and marketing manager in Collins Radio Company if he had to tell them they could not advertise any avionics, microwave, ham radio and other products for an entire year. He pointed out how it could be damaging competitively for the various product lines.

A man known for colorful phrases, Haerle then offered a carefully measured comment. *Mr. Collins, it might be kind of like having a whole meal of chicken livers. A few are good, but most people don't want that many at one time.*

Haerle remembered being taken aback by what Arthur said next: *Well John, I happen to be very fond of chicken livers.* But Arthur did not go through with the idea.

The C-System also was hurt by too little being done to enlist support by describing what it was all about. Employees were never given more than fragmentary explanations or information on C-System objectives. While Arthur commented in considerable extent in annual reports, he mostly stressed how the business world needed the C-System.

Neither did bankers and securities analysts understand it. On occasions when Arthur, who usually delegated such tasks, talked in person with those groups, he was not an effective presenter. He had a way of speaking which was strange to people not accustomed to him. His comments were interrupted with long pauses and drags on a cigaret as he carefully weighed what he would say next. He also appeared sometimes to mumble rather than speak forcefully.

But the most important reason of all for the failure of the C-System was Arthur Collins himself. He guessed wrong that the world needed and would want his C-System, then tried to push too much of a new thing too fast and too soon, and insisted on one more step after another in its development.

*The creeping elegance factor doomed it,* Bob Cattoi declared. *If we could have stopped and perfected what we had, the story might have had a happier ending.*

Arthur never revealed why he did not allow the program to reach a conclusion. One speculation is that he kept hoping Collins or some other company would come up with one or two more vital chips, and he could be the first to incorporate those into hardware.

Collins Radio Company, under the leadership of Arthur A. Collins, had developed over a period of years into one of the world's most innovative electronics firms. It was the world leader in radio communications.

It was a firm with quality standards which made its products unquestioned leaders in reliable performance and longtime useability.

It had hundreds of extremely brilliant people working for it in technical specialities, marketing and business management.

It was a business with ample resources, product lines, technical know-how and management skills to make money.

Just how then, could a business with all of those things going for it, get into so much trouble from a financial and profitability standpoint that it could not keep going on its own?

The answer lay in the decisions of the man who founded, built up and led the company.

There were key people who saw what the venture was doing to the company, who disagreed with his determined policies, and who tried to get Arthur to change his course. But they were not heeded. They either quit in frustration or were fired, among them longtime, close associates who had made many major contributions to the success of his company. Those who stayed either were saluters, never questioning anything, or they had to be very tactful in discussing any matters of a controversial or unpleasant nature.

Even before 1960, Robert Gates, long one of Arthur's most valuable associates, reportedly had cautioned him about the perils of getting too deeply into computers. Gates and Arthur were high school friends and classmates. After college Gates joined Collins Radio in 1935 and served for years as the company's top financial officer and on the Board of Directors. Gates had a reputation as a strong figure who could keep Arthur from spending more than the company could afford. He left the firm in June, 1961.

But any time Arthur was told he could not do something, even in the face of insufficient financial or technical resources, he did not like to hear it.

One vice president who worked with Arthur on numerous occasions said:

*What Art needed was someone like an aide-de-camp in the military, someone who could get him to see when he was on the wrong track, but he never had one.*

Arthur Collins was, in the opinion of another former close associate, *Just too stubborn and too lacking in humility to ever admit that he could be wrong in totally committing his company to the C-System development or that he was running the firm into the ground. He needed restraints. But with the changes in the company in the past 10 years, anyone who might have restrained him either had left or been replaced.*

"I think he knew we had gotten into a box canyon. But being able to stand up in front of a group of people, many of whom he didn't consider his intellectual peers, and admit wrong was not one of his virtues."

*Yes, he could have saved his company, if he had just slowed down. But he wouldn't hear of it, and the inevitable came to pass,* was the conclusion of another former vice president.

And a feeling held by many was summed up by another former executive: *It would have turned out better if he had just focused down a little more. But that wasn't Art's way — he thought in very broad concept terms.*

Arthur Collins lost control of Collins Radio Company December 21, 1971, voted out by the North American Rockwell majority on the Board of Directors. He was replaced as president and chief executive officer by Robert C. Wilson of NR.

After Wilson assumed control, he began a major reorganization, in effect setting up profit centers based on product groups. Much of the C-System project fell under the Communications and Switching Systems Division. A decision soon was made to shut off the data processing and production machine control functions attempted with the C-8500 computer, and concentrate on its capabilities for message switching.

The results were not long in coming over the next several years. Scandinavian Airlines (SAS) placed an order for equipment similar to the American Airlines Sabre passenger reservation computer systems. Another system was ordered to serve the New York and American Stock Exchanges. Collins introduced a system known as ACD, for automatic call distribution, to handle and manage both telephone and data communication traffic. PanAm, Continental and United Airlines were among customers. Other switching systems were sold to U.S. and foreign customers.

Collins Radio returned to profitability in 1973, led by the traditionally strong avionics product line.

But the fastest growing of all Collins sales segments was communications and data switching systems, based on Arthur Collins' C-System.

Thus, in the long run, the C-System was another example of Arthur's forward vision. It was a success for the company which he founded, although not exactly in the form which he had planned.

For North American Rockwell, a name changed later to Rockwell International, switching system sales realized from C-System technology more than equalled the $35 million investment which gave them Collins Radio Company.

But for Arthur personally, despite all his intense efforts, it brought no rewards.

# Chapter 16
# When Things Went Downhill

In 1969, a wave of troubles came to the fore which marked the beginning of the end of Arthur Collins' control of the company that had been his life.

The problems followed the record high volume year of 1968, when Collins Radio Company sales totaled $447 million.

Arthur saw the 1968 results justifying the course he had set for the company in computers, and a green light to press forward with increasing impetus on his huge and costly C-System project.

But then sales dropped to $400 million in the 1969 fiscal year, which ran from August, 1968 through July, 1969, and the price of Collins stock began to fall.

There were, on the surface, visible and explainable reasons for a business decline in 1969.

Spending was down for the types of military R&D, avionics and communication equipment which Collins provided, as the Pentagon priority was on guns and bombs for the Vietnam war.

There was a slight downturn in the U.S. economy, which affected almost every U.S. company.

A noticeable drop occurred in new business for the aviation industry. Aircraft production was cut as airlines ordered few new airplanes. That hit Collins hard, as air transport avionics was the company's most profitable business area.

The Apollo program reached its goal to land a man on the moon, ending most of the work on Apollo spacecraft and ground tracking communication systems. Those had been big contracts for Collins in the 1960s.

Circumstances such as those were not new for Collins Radio. Up and down cycles had occurred frequently over the years. The volume of business from government contracting and the aviation industry, the two main sources of Collins income, often varied. Some years brought higher returns than other years.

But never before in the company's history had Collins Radio been burdened with the level of bank loans it held in 1969 — over 100 million dollars — or a project as massive as the C-System gobbling up resources while yielding no income.

Still Arthur continued to pursue the same pattern he had followed the past several years of pressing the C-System development even further with a *damn the torpedos, full speed ahead* attitude regarding costs. His determination seemed to blind him to the negative impacts of his pet program, particularly the financial peril it was causing for his company.

Then in early months of 1969 an unexpected event happened. An upstart entrepreneur named Ross Perot made it known he wanted to gain control of

Collins Radio Company and merge it into his much smaller Electronic Data Systems Corporation.

Arthur looked upon the Perot takeover attempt as an irritant he was sure would go away with no serious impact. But others in his top echelon of executives and consultants saw it as exposing serious weaknesses caused by excessive spending while his company showed minimal profits. They realized the prevailing circumstances represented an ominous threat to Collins' ability to continue controlling its own destiny.

Arthur finally was forced by the company's financial predicament to face the reality his company might have to combine with or be taken over by some other firm.

Broaching that possibility was an unenviable task for the Collins legal and financial staff. Having control of the company was a crucial requirement for Arthur. He never had revealed any thoughts about a day when he would not be in charge. He never had considered having to share control or have someone tell him how to run his business.

One of the more influential Collins executives getting Arthur to see the light was Bob Mullaley, at that time heading up Collins procurement. He was a native of Marion, Iowa and had business and law degrees from the University of Iowa. He had worked for Collins in 1943 before service in the Navy, then rejoined the company on completing college studies after the war. Mullaley was known as a square shooter and extremely capable administrator, having handled a wide variety of assignments.

Mullaley was able to convince Arthur that, *Bankers don't think like we do, and we have to face the fact they now can call a lot of the shots.*

The Perot attempt failed, for a variety of reasons. The bankers looked upon EDS as a much smaller firm with inflated stock values, in no way qualified for what Perot wanted to do, and saw no advantages for Collins in his proposal. Also there were the bank loans, which Perot would have had to pay off or renegotiate.

While the bankers helped thwart Perot's effort to gain control of Collins, they also took an in-depth look at what was happening in Arthur's firm.

E.A. (Ed) Williams, who for nine years was Collins Radio vice president, control and finance, said until then the banks had offered to loan money to Collins. *We were borrowing from eight major banks. It didn't appear we were overdrawn, but suddenly they got worried. At first they told us we had to begin paying down the loans, and eventually they said we had to merge with somebody.*

*At first Art could not conceive of such a possibility. His response was, 'We don't want to take on the problems of other companies'*, Williams said.

Williams, as a trusted confidant of Arthur's, had been the company's main contact with the financial community.

*I was the outside man — I talked to banks and analysts and made talks to analyst groups. Art did not like to sit down with securities analysts, who he looked upon as Harvard MBAs wanting a company to show an increasing trend of earnings to make the stock price go up. My job also was to be an interpreter, both for Art and the financiers. I tried to convince them we were not trying to outdo IBM.*

*IBM made accounting machines, and Arthur's concept was to take computer technology and merge it with communications, looking to total information systems. He had done some good things with the C-8400 switching systems. But Art was not satisfied — he wanted to develop the next generation of computer.*

*The problem was in convincing everyone else he could do that. And he did make a lot of progress up until 1969.*

*The bankers and analysts accepted what we told them up to a certain point. Then they said, 'we still think you're trying to compete with IBM.' They noted how RCA had tried to get in the computer business and failed at it. Burroughs did the same thing. So they would ask, 'what is Collins Radio Company doing trying to build computers?'*, Williams said.

Arthur Collins was not a pet CEO of most analysts. In their view, Collins Radio was not a healthy organization from a financial viewpoint. They felt he spent too large a portion of the company's funds on R&D to ever show consistent profits and dividends. They were concerned about the volatile earnings record and one-man control, which, as one put it, *is not a lasting base on which to build an organization.*

Williams vividly remembered a meeting which he described as, *one of the worst sessions of my life.*

*Art and Bill Roodhouse (William W. Roodhouse, Collins executive vice president and No. 2 man in the company) and I sat in a room with representatives from the eight banks. Each bank had at least two people there. They started out asking really stupid questions like, 'Why don't you sell off the Western Division?'. That was where Art had people developing the new chips which were vital to his computer program.*

*It was all so negative. I tried again to explain what we were attempting to do in the computer business, and why it had not quite yet materialized.*

*We came out of that meeting and went into a little office next door. I have never seen Art so distraught. He kept saying, 'they don't believe us, they don't believe us'.*

*From then on, it was pretty much downhill.*

*We were forced to go to Minneapolis to talk to Honeywell. They were in old, old buildings. It appeared the only thing on their mind was the beautiful layout they could acquire — our modern buildings and spacious grounds — they showed no interest in the work we were doing. Besides that, they put us up at an athletic club — Art had a dingy little room.*

Williams remembered another indication of the problems for Collins Radio came with preparation of the 1969 annual report. *I had written much of the content of annual reports in recent years. Now Art was a terrific writer, and I had learned to write so that he would basically accept it. I was trying to properly reflect what was going on in the company, because legally we had an obligation under Securities and Exchange Commmission rules of not over-stating or mis-stating things. What Art wanted to do in 1969 was disregard all the bad things and play up all the good things. I tried to write a positive approach, but we had to say that at least temporarily things weren't going so well. We had problems getting the auditors to sign off on the report that year.*

Soon after that Williams said he noticed Arthur had stopped talking to him. Bill Roodhouse came into his office one day and told Ed that Arthur wanted him to resign. He never was given any reason, and Arthur insisted he remain a vice president and stay on the Board of Directors at least for a while. Williams said he was not surprised, as the same thing had happened to his predecessor, Les Wiles. The person who took over Williams' duties was W.C. (Bill) Hubbard, given the title vice president and controller.

As the search continued for some type of partner or relationship, a number of aerospace and electronics companies were considered for Collins to check out in addition to Honeywell. A few others were contacted, but no agreements resulted.

One firm, Schlumberger, acting on its own, began buying Collins stock and studying the possibility of a merger or acquisition.

Bill Roodhouse remembered sitting in on a meeting where a top official of Schlumberger came to see Arthur. Schlumberger was an international electronics firm headquartered in Europe.

*The man was a trim, impressive looking Frenchman, wearing a very expensive tailored suit. As we visited he explained that he was into physical fitness and a healthy lifestyle — he worked out in a gym and was careful about his diet. You could tell how aghast he was to watch Art light up one cigaret after another and sip black coffee all the time we talked,* Roodhouse recalled.

Schlumberger later dropped its initiative.

Arthur's intent, of course, after finally facing the reality he had to have outside help, was to find a suitor who would provide financing to allow him to complete the C-System and still leave him in charge.

By late 1970 some informal talks began with North American Rockwell. That company was the result of a merger in 1967 of once powerful North American Aviation with Rockwell Standard Corporation.

North American Aviation had developed some of the United States' top military air and spacecraft. They included the B-25 Mitchell bomber and P-51 Mustang fighter planes of World War II, the Korean War era F-86 Sabre jet fighter and a later version used in Vietnam, the F-100 Super Sabre. The firm also built the X-15 rocket plane and in the 1960s produced the Apollo Command Module and second stage of the Saturn V rocket which lifted Apollo into space. Another product was the Sabreliner business jet. Rockwell Standard was a respected and diversified firm, manufacturing automotive parts, various industrial products and the Aero Commander line of general aviation aircraft. The firm also recently had acquired Admiral Corporation, a major appliance manufacturer.

Arthur at first felt comfortable talking with North American Rockwell (NR) because of the company's CEO at the time, J. Leland (Lee) Atwood, a longtime North American executive and well-known aviation figure.

Arthur could relate to Atwood. Both were from the old school of engineering management. Each had respect for the other in contributions they had made to technology, Lee Atwood in aircraft design, Arthur Collins in avionics and communications. Both had years of experience in directing solutions to technical problems. Their two companies had worked together, with Collins providing equipment for aircraft and the Apollo spacecraft built by North American.

But Atwood retired at the end of 1970, and the North American Rockwell management changed, with former Rockwell people taking over key positions. After that Arthur may have had misgivings about further talks with NR, but he was facing the need to act soon with the Collins financial situation becoming more precarious.

Another opportunity appeared in March, 1971 as Collins began discussions with TRW. Those, like the Honeywell negotiations, failed to produce any solid agreement, but the door had been kept open with NR.

Collins' sales had declined further in the 1970 fiscal year, to $349 million, compared to $400 million for 1969 and nearly $450 million for 1968. The common stock price was in the $12 range, a drop of 80 percent in two years. The bankers forced the company to begin restructuring its debt load and not do any new borrowing. Collins also appeared to be facing a big loss for the 1971 fiscal year.

One of the most painful impacts of the business downturn was a continuous series of employee layoffs.

Over a two-year period from 1969 to 1971, company employment which had totaled more than 24,000 dropped 40 percent. In the Cedar Rapids Division, which produced most of Collins' sales and profits, one of every two employees lost their jobs, the total payroll declining from 12,000 to 6,000. It became a common pattern every Friday throughout Cedar Rapids and Marion for people to ask: Who in our neighborhood or on our bowling team or in our church got let go today?

One of the most disturbing impacts was that many of those laid off really cared about Collins Radio Company. Collins was a unique company in that regard, having a high percentage of employees proud to be associated with it.

The layoffs were devastating to many employees and their families. Persons who suddenly were without a job scrambled to find any type of work, from retail sales to driving cabs. Those terminated included a number of professional people, most of whom eventually found new positions in other parts of the country but who faced weeks or months of belt tightening while seeking employment. One of the busiest places in town was the state unemployment compensation office with hundreds of former Collins workers applying for benefits.

The layoffs placed a severe strain on the Cedar Rapids metro area economy, felt by almost every retail and service business. But it was to the credit of the community that its diverse industrial and commercial mix allowed it to weather the impact.

The Collins branch assembly plant at nearby Anamosa was shut down.

While the C-System was not entirely at fault for all the Collins problems, it was the main reason.

Not only was the company drained by the C-System.

Arthur's spirit also was drained, by concern about the layoffs, by having to go begging for money, by frustration that everything he had planned still had not come together and become the big hoped-for success.

One of the executives who worked closely with Arthur remembered that his frustration frequently reached a point on some matter where he would say, *I think I better issue a ukase on that* (ukase being an order proclaimed by czars who held absolute power in Russia.)

Mary Collins, Arthur's wife, said he mentioned numerous times how deeply distressed he was over the layoffs.

Throughout the company an atmosphere of low morale and low level of enthusiasm was widespread. Employees wondered if they would have jobs the next week. Managers wondered if they would have enough people on their staffs to handle work adequately, particularly anything outside of C-System projects which required new equipment or travel funds.

Resentment and anger prevailed among employees as they saw so many co-workers go out the door. An unpleasant incident occurred in the spring of 1971 when a maintenance department crew drove a truck loaded with garden equipment and bedding plants to a main entrance of a Cedar Rapids building and began an annual ritual of planting hundreds of flowers. Their work was noticed by a group of employees who had ventured outside at lunchtime on the sunny spring day. They became outraged to see the company spending money on flowers when people were losing their jobs. Word spread quickly through plant areas about the flower planting, and supervisors up to vice president levels were confronted with noisy protests. The flowers were never planted that year.

Instead of being the great program which would save the company and move it forward, the C-System drained resources and diverted too much of the top management's energy and attention which should have gone into helping the traditional money making product lines recover from the business slump.

So with North American Rockwell being the best option open, Arthur had to allow an agreement to be worked out.

It became finalized in May, 1971. The two main factors of the agreement were:

—An investment of $35 million in Collins by North American Rockwell, through purchase of a new issue of convertible stock.

—North American Rockwell received the right to elect a majority of the Collins Board of Directors, which in effect gave NR control of Collins Radio Company.

Also part of the terms were further restructuring of Collins' bank debts to provide essential working capital.

Even before the agreement was formally arranged, a rising young North American Rockwell executive, Donald R. Beall, was assigned to move into the Collins corporate suite. Beall's primary responsibility was tracking the Collins financial picture. Another part of his duties was closely monitoring what Arthur Collins did. That made him a member of the C-System inner circle, which often meant getting calls at midnight, rising before dawn and complying with other traits of Arthur's work habits. But rather than resenting Beall's presence, Arthur developed respect for Beall. Mary Collins remembered Arthur saying, *That young man someday will be president of Rockwell.*

Bill Hubbard remembered a trip to the West Coast to iron out details of the Collins-NR arrangement.

*Its was a touchy and tense flight back to Dallas.*

*Art sat staring out the window most of the time. At one point Don Beall and I started to play cards just to break the tension. That upset Art, and we put the cards away.*

As the date arrived for the final signing of the Collins-NR agreement, it was with a heavy heart that Arthur Collins boarded one of the Collins twin turboprop Grumman Gulfstreams to fly from Dallas to Pittsburgh.

Bill Roodhouse remembered the next day at the NR headquarters was an extremely traumatic time for Arthur. At the appointed time to begin signing documents Arthur said he needed a break, and excused himself.

*Art asked me to come with him, and we went outside and took a slow walk around the block. He finally said, 'Well, I guess we have to do it,' and we went back in and he signed the papers,* Roodhouse said.

But Arthur did not mope long. In that summer of 1971 he soon was again at work primarily on the C-System, concentrating on those areas he believed could show the quickest results in the way of a completed development. He agreed to some layoffs even in key C-System engineering departments, referred to as *staff reductions,* but not of programmers. New R&D work was shut off. In the conventional product lines emphasis was placed on marketing previously developed equipment and seeking outside sponsorship for new programs.

The NR-Collins agreement called for approval by directors of both companies, and by Collins shareholders.

In the letter to stockholders informing them of the NR arrangement, Arthur said it was necessary to keep the company in business.

The extent of how bad the Collins financial problems were came at the close of the 1971 fiscal year, July 30. The company reported a loss of $46 million on sales of $287 million for the year.

On August 31, a special meeting of shareholders was held. Revised articles of incorporation were approved which allowed the agreement with NR to be ratified. The Collins Board of Directors was increased from 12 to 13 members, and the new convertible stock issued.

Three days later, September 2, North American Rockwell had made its investment of $35 million in Collins in return for the stock, and elected seven members to the Board. Arthur remained president and chief executive officer of Collins, but Willard F. Rockwell, Jr. was now chairman of the board. He also was chairman and CEO of NR. The NR funds gave Collins breathing room in meeting payrolls and paying bills from suppliers which had been mounting.

With the 1972 fiscal year then underway, the board was told Collins probably faced further losses for the year.

Another round of layoffs soon followed.

And the NR people began an in-depth look at Collins' operations and what assistance they could offer to help reverse declining sales and begin recovery.

They found what they considered inadequate planning and remedial measures to increase business volume and profit margins. Some of the areas reviewed were discussed in a letter to Arthur Collins from Dupuy Bateman, Jr., senior vice president and assistant to the chairman of NR. Bateman had been one of the main investigators of NR's decision to invest in Collins, and was one of the NR representatives on the Collins board.

Referring to a microwave product line presentation, Bateman wrote: *Not only are we missing our projections as to sales and profits substantially, but the gross margins appear to be so unremunerative that increased volume may not improve our profit picture.*

*Another concern results from our discussions about computers and switching systems in which you stressed that all of your major business areas are tied together; you left the impression that major economies are not possible through elimination of certain product lines or substantially curtailing development expenses in such lines, and that it is going to take a lot of money to realize full potential.*

Bateman then expressed his opinion that pouring more money into computer development *should not be considered as one of our options for running the business in a normal manner.* He said a more acceptable option for Arthur to consider would be what development expense and product lines might be discontinued or deferred, what facilities might be eliminated or shut down, and the effect of such actions on future business. *For instance, my tour through the Newport Beach facility leaves me with the impression that this plant is so under-utilized that closing it could hardly have anything but a positive effect upon earnings,* Bateman wrote.

But Arthur did not respond with any plans to close plants or curtail programs, including spending on computer development. Nor, because he wanted no advice from outsiders, did he like an NR suggestion to bring in management consultant firms. Rather, there was a widening gulf between him and the NR management regarding business philosophies.

The annual meeting of Collins Radio shareholders was always scheduled for the third Tuesday of November in the cafeteria of the Engineering Building in Cedar Rapids. In 1971 that date was November 23.

On the Friday preceding the 1971 meeting Arthur was confronted with an ultimatum by North American Rockwell executives — they did not approve of his direction of the company and asked him to relinquish his position as president and CEO.

The NR people felt Arthur was not taking strong measures to turn the company around, and was continuing to spend at an unacceptable rate. They saw Collins facing a loss of $30 million for the first quarter, and even with improvement in the next nine months could end up with a $20 million loss for the year.

Arthur was offered a position such as scientific adviser or technical consultant, neither of which was to his liking, and the title of Honorary Chairman of the Board.

Arthur, who never had seen fit to groom anyone from Collins as his successor, also disagreed that any NR executive could replace him and successfully manage Collins.

The weekend that followed was obviously one of the darkest periods of his life. Only a few associates and his family were aware of what happened.

Bill Roodhouse said Arthur had told him he felt after the August 31 meeting that he probably would be forced out, but the reality of it still was a shock.

Arthur's only choice was to resign or be fired. He did not immediately resign. Early in dark hours of Monday morning, before any office staff came in to work, his personal files and effects including some antique furniture and paintings were quietly removed from his offices in Cedar Rapids and Dallas.

Later that day and Tuesday morning, corporate officers and staff people from Dallas flew to Cedar Rapids for the Collins annual meeting scheduled early Tuesday afternoon. NR board members and support personnel also arrived. Only a very few NR and Collins people apparently knew what was going to happen.

Board Chairman Willard Rockwell, Jr. opened the meeting and presided over a few preliminary items. Rockwell then announced it would be necessary to postpone the election of the six Collins members of the board until December 21. The main reason was that none of the three Collins directors authorized to vote proxies, Arthur, Bill Roodhouse and John Nyquist, were present. Arthur and Roodhouse intentionally stayed away from the meeting, and Nyquist was recovering at home after being hospitalized.

Rockwell noted that the Collins slate now totaled only five nominees for the six director posts as Bill Roodhouse had resigned from the company. Roodhouse's step was in support of Arthur, who he knew was being forced out. On the weekend before the meeting Roodhouse was flying back to the U.S. from Australia, through Europe, when he got a call in a Rome hotel room from Arthur telling him what had happened. Roodhouse said that after much soul searching, and calls to the top Rockwell people, he wrote out a letter of resignation.

Rockwell declared the meeting adjourned. The directors who were present left the cafeteria and went to an upstairs board room. A few minutes later Rockwell had his public relations people call a news conference. Several local news reporters were still in the building, having come for the shareholder meeting, others were quickly summoned.

It was then Rockwell announced Arthur had been replaced. He introduced Robert C. Wilson, 51, as the the new president and CEO of Collins. Rockwell said only that Arthur's departure *was a decision of the Board of Directors.*

Thus ended with a sudden and dramatic finality the 40 years of Arthur Collins' role as head of the company he founded and which bore his name.

Howard Walrath, then vice president of Information Systems and part of the inner circle of executives who worked closely with Arthur, had placed a tape recorder on the table where Willard Rockwell sat to conduct the news conference.

*About an hour or so later I got a call from Bob Cattoi, who was at Arthur's house (in Cedar Rapids). He and Art had heard I taped the press conference and wanted to know what was said. I told him I was having it typed and would bring the transcript out to the house.*

*When I got there, I found Art, Cattoi, Larry Hungerford and Keith Rathjen* *(main players on the C-System engineering team) sitting around like they were holding a wake. There was a jug of piestengel (a potent rhubarb wine made at the Amana Colonies) and a bottle of Jack Daniels, and they appeared to alternate when they wanted another drink. After a while Susie came in with some groceries and started cooking. (Susie was Susan Collins, Arthur's grown daughter who lived in Cedar Rapids. His wife Mary was in Dallas with their two two small sons.) Art said, 'This is getting too morose. Why don't you guys go home and get your concubines (a term he sometimes used when referring to wives) and come back here for dinner'*, Walrath said.

*I think there were about six or eight of us who went back for dinner. I remember it had started snowing, which got worse as the evening wore on. We had to push cars and were skidding and sliding going down the hilly driveway from Art's house when we finally went home.*

*At one point that night I think the reality of what happened was beginning to get to Art. He said to me, 'Howard, I don't want to get you in any trouble, but is there a way to leave the company phone in my house so I can call some of my friends sometime?'*, Walrath recalled.

It was a bitter pill for Arthur to face his ouster. While he remained the largest single stock holder, no longer was he the chief executive. Gone was his absolute power to do anything he wanted in his company, to have any of the vast resources of the company available, to make the major decisions. No more did he have groups of vice presidents, secretaries and others to serve him, or control of private airplanes.

Arthur did keep the phone for a while in a consulting role which he finally accepted.

The North American Rockwell leaders knew they had made a terrific bargain in gaining control of Collins Radio with an initial investment of $35 million, perhaps one of the greatest bargains in the history of business. They also knew they had to get the company turned around and avoid a possible second consecutive year of heavy losses. *Unless the company can do better than that, it probably would wind up in the hands of a receiver and you would find a court-appointed receiver taking action similar to which we were forced to take*, Willard Rockwell told Arthur in a letter dated November 24, 1971.

Wilson, who had been executive vice president, Industrial Products and Electronics Groups of NR, was a consummate, professional corporate executive. He was a native of Idaho who grew up in Southern California and earned a mechanical engineering degree from the University of California. He was hired by General Electric in 1941 and except for World War II Navy service worked in engineering, manufacturing and marketing with GE until 1969, becoming a vice president. He left GE for NR in 1969. Wilson once was quoted by The Wall Street Journal as saying his career objective long had been to become a president and CEO of some company some day.

Arthur finally did submit a resignation from Collins Radio Company December 7, 1971. He agreed to provide advisory services until June 8, 1973 at a monthly retainer of $2,500.

But even though he no longer was in charge, he did not give up on trying to keep the C-System project alive.

Several weeks after his ouster, he made an effort on a Thursday to set up a weekend meeting starting Saturday in Newport Beach for a program review by his C-System team. As he sought to arrange a meeting facility, the contact who received the request immediately put out an S.O.S. to his superiors for direction and guidance. As word of Arthur's plan passed up the line among executives, the question of *who's now running the company?* was heard.

The matter finally landed in the lap of Bob Wilson, who met for three hours that evening with several of Arthur's former close associates. Wilson obviously was not in favor of allowing Arthur to hold his meeting, but wanted to resolve the matter as tactfully as possible. He noted that, *Arthur is still the largest shareholder and controls six seats on the Board of Directors.*

The decision was made that Arthur's meeting would not take place, and that a specific agreement should be reached with Arthur on his duties and role as a consultant.

Howard Walrath remembered a call from Arthur asking him to attend his proposed review meeting. Walrath said it tore him up inside to have to tell Arthur that he did not think the meeting should be held, and that Arthur hung up on him.

Wilson, after moving into the president's chair, began mapping out a reorganization of Collins Radio Company, establishing profit centers based on product lines, market sectors and service functions. Recognizing the immense wealth of talent in the Collins organization, Wilson appointed Collins people to head most functions. Exceptions were himself as president and CEO and Don Beall as one of two executive VPs. The other executive VP was Bill Roodhouse, who was convinced by Wilson to reconsider his resignation and return.

The immediate concern was how to stop the drain on resources that had brought down the company, build up cash flow and take the hard steps toward a turnaround and recovery. One action to bring in immediate cash was the sale of part of the land in the Richardson complex. Offered for sale along with the land was the recently built Collins headquarters building. The buyer made it known he wanted nothing to do with the modernistic new structure, reputed to be expensive to operate and maintain.

Another step affecting many salaried personnel was a five percent pay cut, which Wilson promised to restore as soon as the business level picked up. There were, of course, many cost cutting measures imposed — only essential long distance phone calls, reduced copy machine usage and the like.

Every phase of the Collins organization, activities and facilities were reviewed and analyzed with an objective of improving efficiency and profits while maintaining traditional strengths — innovative, high quality products and service.

Inevitably, that led to more layoffs. Departments such as an in-house printing plant began to solicit outside business.

The C-System program was broken up, and the parts of it which had potential to make money were separated out. The planar circuit boards, thin films and miniaturized advanced components had to become products primarily for the market place. That forced some Collins executives to adapt to new roles. Harry Passman, for example, long had been in engineering positions, known for his intensity and uncompromising loyalty in whatever assignment Arthur threw at him, spending money with abandon to carry out C-System work for which he was responsible. But when Bob Wilson put him in charge of selling and producing planar circuit boards, Passman quickly turned that activity into a profitable product line.

The part of the C-System receiving the most emphasis was the switching system technology developed by Collins. It offered the potential for extensive sales and profits.

Wilson spent a lot of his time talking to Collins employees, either small groups called together for just that purpose or informally as he walked through company areas. Those he visited with ranged from assembly operators and custodians to middle management. He, of course, met frequently with his top management officials. He also made periodic reports on progress in talks to lower and middle management.

A major thrust of the Wilson plan for reviving Collins was to beef up marketing efforts, reassuring and enhancing relationships with existing Collins customers while seeking new opportunities for sales. One area given attention was telecommunication systems in foreign countries, particularly those emerging as developed nations. Another Rockwell goal was to try to overcome the effect of down cycles in federal contracting on which Collins was heavily dependent with improved forecasting and other steps.

Wilson and the Collins board also made the decision to take a huge loss of $64 million for the fiscal year 1972, a *bite the bullet* action intended to enhance the company's financial revival and allow profitability to be restored.

The actions taken under his direction began to show results by late 1972.

By the end of the fiscal year ending August 3, 1973, Collins Radio's sales were up by $100 million over the 1972 year and the firm showed $13 million net profit, compared with the $64 million loss of a year earlier.

Wilson was hailed in the media as a miracle man.

He was the subject of numerous business publication articles. His picture appeared on the cover of Business Week Magazine, on an early morning jog in the streets of Brussels during a business trip.

Wilson clearly enjoyed the success he was having in the role he long had sought for himself, that of a company president and CEO.

But on August 10, just a week after the FY '73 results were disclosed, Rockwell International as it now was called, having dropped the name North American Rockwell, announced plans to buy all Collins Radio common stock. That would bring the merger of Collins into Rockwell.

Certainly a merger was likely ever since the 1971 investment which rescued Collins and gave Rockwell control. But few foresaw it happening less than two years after Wilson was put in charge.

At the time North American Rockwell began to seriously consider an investment in Collins, Wilson, as an NR executive VP, had been in charge of looking for potential acquisition opportunities. He made a strong pitch to NR management to buy into Collins.

Then, when NR decided to remove Arthur Collins as president and CEO, NR Chairman Willard F. Rockwell, Jr. reportedly told Wilson that since he had recommended the deal with Collins, he should be the one to step in and try to get it back in shape.

Wilson's success obviously impressed the Rockwell hierarchy as it did Collins employees and communities, the business press and the financial sector.

It also began to ruffle the egos of some who occupied the Rockwell corporate suites, men who relished favorable media coverage and recognition for themselves. They saw Wilson as the tail wagging the dog when they viewed the widespread attention being given to Wilson and Collins.

If Wilson had any intent of keeping and running Collins as a separate company a while longer, it ended with him being blind-sided by his superiors at Rockwell. While he was enjoying a few days of vacation at a home he had on Cape Cod, he received a call that there would be a special board of directors meeting in Pittsburgh the next morning to vote on the plan to buy Collins stock. With that minimal notice, he had no time to prepare a case or marshal any support for having Collins remain an independent company. He could only state publicly that, *The proposed merger represents a strong vote of confidence in the future of Collins.*

It was not long before Rockwell had enough shares at the price it offered to assure the merger would take place.

Collins Radio shareholders of common stock, including many company employees, were offered \$25 per share for their stock, then listed at about \$19 on the stock exchange. They could sell it or trade for Rockwell stock.

November 2, 1973, marked the effective end of Collins Radio Company as an independent corporation. That was the date of a special shareholder meeting in Cedar Rapids to approve the merger. The Rockwell board members and other corporate officers flew into Cedar Rapids from Pittsburgh that morning in their BAC-111, a mid-size twin-jet designed primarily as a passenger transport. The Rockwell version had been converted to a plush executive aircraft.

Cedar Rapids was just one stop on their travel agenda for that day. After tending to the business of merging Collins into Rockwell, they were off to Los Angeles for the wedding that evening of Robert Anderson, president and chief operating officer of Rockwell, and one of the seven NR directors named to the Collins board in 1971.

Bob Wilson then appeared to settle into the role of good soldier, carrying on as president and CEO of Collins, now wholly owned by Rockwell.

Wilson, however, felt his wings had been clipped. He no longer had the full authority and freedom to act as when Collins was a publicly-owned company with its own listing on the New York Stock Exchange.

He quietly began to look for another opportunity to be the big boss. He turned to some of the talent in the Collins legal staff to scout out available positions. With the Collins turnaround to his credit, Wilson was recognized as a saviour who could rescue other flagging companies.

One such company was Memorex, with a history somewhat like Collins of having invested heavily in a computer venture which failed, was deep in debt and teetering on the edge of bankruptcy. Wilson was hired in March, 1974 to head Memorex, and Don Beall succeeded him as Collins CEO.

Over the next several years the people, their expertise and facilities of what had been Collins Radio Company became an increasingly vital and growing segment of Rockwell International, particularly in contributing to revenues and earnings. A number of Collins employees moved into executive positions in Rockwell.

The impact was such that one industry observer made the comment: *It looked like Rockwell was being Collins-ized.*

# Chapter 17
# Arthur A. Collins, Inc.

Arthur Collins was 62 years old when he was booted out as president and chief executive officer of Collins Radio Company in November, 1971. He still was in good health, and still smoked up to two packs of cigarets a day. He enjoyed martinis and other drinks, but alcohol was never a problem with him.

He finally agreed to the North American Rockwell offer to be a consultant to the company, at a salary of $2,500 per month.

He remained well off, holding and controlling for his family about 20 percent of the common stock of Collins Radio Company. He was receiving a $7,800-per-month pension. His salary for the last full year he headed the company was $133,813.

He stayed in Dallas for the most part, and over the next few weeks he and his wife Mary talked about taking a cruise to Europe.

But then, according to Mary, he suddenly said he was restless, had many ideas in his mind, and wanted to get to work on them. He told her he was forming a new company, and had hired another man to work with him.

He submitted his resignation from the Collins Board of Directors January 14, 1972, and announced the formation of Arthur A. Collins, Inc. (AACI.) A stated intention was: To develop systems, concepts, design strategies, basic design plans and innovative ideas in the field of large scale systems. This includes telecommunication, navigation and control.

This time around, Arthur wanted to make sure he was in full control — the sole owner. He would finance it with his own money and not have any banks, analysts, lawyers and other outsiders try to influence how he ran the business.

Among major opportunities foreseen by Arthur were to get into design concepts for an industry he viewed as slow to implement progress — the telephone companies. One of the first activities he undertook was to co-author a book with Dr. Robert D. Pedersen. Published in 1973, it was entitled *A Time for Innovation.* The book basically examined the history, status and need for technical innovation in telephone networks. Reportedly the book attracted the attention of Bell Laboratories, which ordered a large number of copies.

Arthur gradually began to build up his company and rented space in what had to be expensive real estate — an office complex near his home. He had an entire floor with offices, a technical library and laboratory area around the outside and a large main frame computer installation in the interior. He selected Hewlett-Packard and Digital Equipment Corp. computer equipment.

Even in the 1970s and early 1980s, well before the personal computer, e-mail and the Internet were commonplace, A.A. Collins, Inc. employed versions of desktop computers with each office electronically linked to all the others in the company and to Arthur's house.

About 18 months after Arthur formed his new company, his old company, taken over by Rockwell International, had been returned to profitability under Robert C. Wilson. The Rockwell management decided in August, 1973 to merge Collins Radio Company into Rockwell.

Arthur had become increasingly bitter toward Rockwell. The plan for a merger of the company which he had built up over 40 years was said to have made him furious. He still was the leading stockholder in Collins Radio but the total was not enough to block a merger.

From the time Rockwell announced its intent to merge, August 10, 1973, until the date of the meeting it was approved, November 2, 1973, the Collins Radio share price on the New York Stock Exchange ranged from about $17 to $24.

Rockwell had offered either to buy all Collins shares at a price of $25 per share, or exchange Collins stock for Rockwell stock.

The infuriated Arthur wanted nothing to do with any Rockwell offer. He turned his back on either selling his shares to Rockwell or exchanging them.

Rather, he had all his Collins stock sold on the open market. Some of the money went into bank notes, but none of it in banks which had any involvement in Rockwell's acquisition of Collins. His return was somewhere in the $12 million range. That, with other assets he had, was what financed Arthur A. Collins, Inc. over the next dozen or so years.

Rockwell International stock did well in the 1970s and 80s, gaining in value and having stock splits. By February, 1987, when Arthur died, the price of Rockwell stock was about $66 per share.

Ted Welch, for many years president of Peoples Bank & Trust Co. of Cedar Rapids and longtime friend of Arthur, said that just out of curiosity he once did a rough calculation of what Arthur's worth could have become if he had exchanged his shares and kept them in Rockwell common. *I estimated it at about $47 million,* Welch said.

Those hired by Arthur included several former Collins Radio engineers and executives, working either full or part-time. One who worked closely with him for several years was William C. (Bill) Hubbard, who had been Cedar Rapids Division and corporate financial controller for Collins, and under NR managed a Tokyo operation. Also working with him on a part-time basis after retiring from NR was John Boyle, former Collins marketing VP.

By 1981 his company employed 33 persons, including five with Ph.D. degrees. Arthur and his technical staff did R&D in advanced digital techniques, much of the work dealing with telephone industry switching systems. Arthur once told a visitor that with microminiature technology, a conventional telephone switching center occupying an entire building could be reduced to a few black boxes.

By the mid-1980s A.A. Collins, Inc. was running out of money. The company had obtained nine patents, but had sold practically nothing. He went looking for some capital investment to keep the business going. One contact was Robert D.

Ray, former governor of Iowa, then president of Life Investors Insurance Co. based in Cedar Rapids. Arthur also tried to interest Ray in buying his Cedar Rapids house. He also met with Clark McLeod, founder of Teleconnect Co. of Cedar Rapids, about a possible business arrangement. None of the contacts brought the results he sought.

Ironically, A.A. Collins, Inc. had two opportunities to benefit from multi-million-dollar investments. Bill Hubbard recalled Honeywell, Inc. had indicated an interest in what Arthur was doing and discussions began on some type of arrangement and investment. *They even asked how much money he wanted. But Art didn't like the direction it was going and he called it off.*

*Then an opportunity developed with IBM. At that time Art's technology probably could have helped IBM. We went to New York to make a presentation — IBM brought in senior technical people from all over. But Art suddenly broke off the meeting, and we flew back to Dallas. He thought some of their people were looking through his papers and trying to get his secrets while he went to the men's room.*

*In both cases he was afraid he would lose control. That was his great concern — to never lose control, like what happened with Rockwell. He was deeply hurt by the Rockwell episode. That's probably the main reason AACI never went over. He had the opportunities, but he couldn't bring himself to agree with what had to be done,* Hubbard said.

With the money running out, and no longer able to afford the staff he once had, Arthur moved from the office building to cheaper rental space in a warehouse. For the last year or so before he became ill and died, he was down to one employee. That was his son Alan, who dropped out of Texas A&M to work with *Pop,* as Alan called his dad.

He suffered a stroke in early 1987 and was hospitalized. He fought gamely but succumbed to the grim reaper February 25, 1987.

Arthur did not leave his family well fixed financially. Alan and David, the sons of Arthur and Mary, did not benefit from a trust as did Susan and Michael, children of Arthur and his first wife, Peg. He intended to set up trusts for them but never put the money aside. Mary Collins, left with very little but the Cedar Rapids and Dallas houses, said in later years, *I knew I married Art for better or worse, but I did not know I married him for all those debts he left me.*

Through a specially formed licensing company, the Collins family filed law suits in the early 1990s claiming infringements on patents held by AACI. A judgment and substantial award was won in a suit against AT&T, but later overturned on an appeal. Settlements were won, however, in suits against three other firms.

# Chapter 18
# Unique People

Many brilliant and talented men were involved with Arthur Collins as key associates in Collins Radio Company.

With the achievements it marked up in top quality equipment and technology advancements, Collins Radio also attracted many well-known personalities as visitors.

Several of Arthur's close associates were unique persons.

One of those was Walter H. Wirkler. He provided help of immeasurable value to Arthur on technical problems and made contributions of critical and major importance to the development of a number of Collins products.

Wirkler had grown up a farm boy in the area of Garnavillo, near the Mississippi River in northeast Iowa. On arriving at Iowa State in the late 1920s to begin college, he was uncertain whether he wanted to study veterinary medicine or some form of engineering. His dormitory roommate was in electrical engineering, so Wirkler decided to go that route. He was graduated in 1932 and went to work at Collins Radio in 1934, among the first engineers hired by Arthur.

He was associated with Arthur Collins on many projects over the next 20 years, except for a period from 1936-38 when he did graduate work at Ohio State University. It was said that some of his relatives did not consider him to be a success. That viewpoint came from family members who were independent farmers. Unlike them Walt Wirkler worked for someone else — they saw him as a hired hand.

He did not consider himself to be a hands-on engineer who liked to tinker with radio equipment in the laboratory. His main talents lay in defining a problem in terms of the laws of physics, and in devising and adapting the mathematical formulas which could lead to a solution. From his first days with the company Arthur Collins came to depend upon Walt Wirkler for the thinking and answers he could apply to a problem.

Milo Soukup, a longtime Collins manufacturing supervisor who began his association with the Collins family doing gardening and handyman jobs for Arthur's parents during the depression, recalled when the company had just a couple of dozen employees. He said factory workers could see Wirkler in his office, tilted back in his chair with his feet on his desk, appearing to be asleep. Then, suddenly, he would get up and begin filling a blackboard with schematic diagrams and mathematical equations.

After Collins built the Main Plant in 1940, Wirkler occupied an office along the hallway just inside the north side of the building. When important visitors walked down that hallway toward the executive suite, they sometimes saw

Wirkler sprawled on his stomach atop his desk, either deep in thought or taking a short nap.

Wirkler, like Arthur, was a pilot, and they often flew together. They also shared other characteristics, including a dogged determination to work on a problem for hours without let-up. Like Arthur, if an idea came to him at 2 or 3 in the morning, Wirkler would get up, dress and go to the office.

Almost everyone who knew or worked with Wirkler considered him brilliant but a little eccentric. He had traits of a stereotype absent minded professor, at times so engrossed in his work that he would stay in the plant two or three days at a time, forgetting all normal patterns of daily life. He owned three vehicles — a car, a motorcycle and a bicycle, but sometimes forgot which one he had used last or where he parked it. When it got to the point he was unable to recall the location of any of the three, friends would help him find them. Co-workers recalled that if they invited Wirkler, a bachelor, to their homes for dinner, they were never sure he would remember to show up.

A number of the young men who came to Cedar Rapids to work at Collins Radio in the 1930s were single, like Wirkler, and ate most of their meals in restaurants. One popular eating establishment was The Kozy Inn, at 10th Street and First Avenue NE. Another was the Third Avenue Virginia Cafe, at 322 Third Avenue SE, a site which later became a bank parking lot. Ed Lieske, an engineer who worked with Wirkler, remembered being in a group having dinner there one evening when Wirkler came in, his clothes wet. He explained he must have been caught in a sudden downpour while riding his motorcycle. This was puzzling to the others, as there was no rain in the area. They finally concluded that Walt, his mind deep in thought on something other than operating his vehicle, was doused when he drove his motorcycle between the curb and a city sprinkler truck which was washing the street, Lieske said.

Co-workers recalled another story about Wirkler, when he asked a young lady for a date. Engrossed in his work, he suddenly realized he had only a few minutes until the time he had promised to pick her up. Having driven his motorcycle to work that day, he rushed off on that conveyance to his date's residence. Greeting him in a skirt and high heels, she was not pleased at his choice of transportation.

Wirkler was one of the key brains and in some cases the main brain behind some of the early Collins products for aircraft navigation and flight control. He was a fluent and prolific writer, the author of a number of interesting discourses on technical subjects during his career. The Collins library contained a thick bound volume, "The Papers of Walter Wirkler," which included his writings on a variety of topics.

One of his papers was entitled "The Nature of Control," written around 1952-53. He submitted it to a leading technical journal for publication, but reportedly it was rejected on the grounds of being too futuristic for readers at that time. The paper contained a number of ideas similar to the concepts which Arthur Collins later tried to bring to reality in his C-System.

Wirkler, along with Mel Doelz, was one of the originators of Kineplex, the high speed, high volume data transmission system introduced by Collins in the mid-1950s. Kineplex was the most advanced data transmission system available after being introduced in the mid-1950s. In a 1949 article, Wirkler had outlined the basic concepts of synchronous data transmission which led to Kineplex.

He and Doelz also discovered techniques of separating signals from noise and frequency spacing that led to the first 2,400 and 4,800 BPS modems. Those first high speed modems were Collins Radio's contribution to modems.

Wirkler's work in the early flight control and autopilot systems included development of a key component required for the new systems. It was the complementary filter, a necessary device to block out radio noise which could interfere with heading and bank information displayed by cockpit instruments during aircraft approaches and landings. He received a patent for his development.

Wirkler disliked paperwork and what he regarded as bothersome company procedures. He sometimes failed to show up for work for several days. Asked to explain, he would say he was entitled to the time off as part of his vacation. That was true, but he had ignored the procedure to have it approved in advance.

Wirkler's career probably was reaching a peak when he left the company in the early 1950s. He had told colleagues: *When the company buys more tons of paper than aluminum, it will be time to leave.*"

Arthur continued to stay in touch with Wirkler and seek his counsel. Mary Collins recalled a day soon after she and Arthur were married in 1957 when they drove to Dyersville, and Arthur and Walt sat in a coffee shop talking for three hours.

* * *

James G. Flynn, Jr. was responsible for guiding the start-up of the Dallas operations of Collins and for directing the growth and development of the international activities of the firm.

Flynn was born in Galveston, Texas in 1908 and was graduated from Rice Institute in Houston in 1930. He began a career in the fledgling aviation industry as a radio operator with Texas Air Transport, one of the predecessor companies of American Airlines, and also became a pilot and navigator. He was deeply interested in technical advances in communication and navigation equipment.

As superintendent of communications for American Airlines in the late 1930s he became acquainted with Arthur Collins while overseeing American's purchase of Collins transmitters equipped with the Autotune.

Arthur once said that, "Jim had the temerity to order substantial quantities of radio sets from us during the early days of our company, and in fact he placed the first order for Autotune equipment at a time when this device was scarcely a gleam in our eye."

President of American Airlines was C.R. Smith, also a Texan, who was called to active duty with the Army Air Force when the U.S. was drawn into World War II. Smith was a brigadier general and became commander of the Military Air Transport Service. Smith arranged for Flynn to follow him into the service, where he had the rank of lieutenant colonel, and commanded a military air transport wing in the European theater.

When Allied forces liberated Paris from German occupation in August, 1944, Flynn's unit supported forward troops by flying in supplies, and set up a base at a suburban Paris airport. Flynn drove a Jeep into the city and to the famous Ritz Hotel, one of the plushest hotels in the world. The Ritz had been headquarters for Reichmarshal Hermann Goering, chief of Hitler's air forces, when he visited Paris during the occupation. When Allied troops approached Paris, Hitler ordered the city burned, but the commander of the fleeing Nazi army ignored the command. However, the Germans looted places such as the Ritz, taking all their food and wine. When Flynn found the hotel unable to offer any of its traditional luxurious service, he had crews under him fly twin-engine transports to southern France. They returned with foodstuffs, wines and fuel for cooking, which enabled the Ritz to be the first Paris hotel back in business after the liberation. That was a favor never forgotten. Whenever Flynn visited Paris after the war, he was given recognition and service worthy of royalty by the staff of the Ritz.

After the war, when C.R. Smith returned to American Airlines, he set up a subsidiary, American Overseas Airlines, with Flynn as vice president of operations. A.O.A. had routes from the U.S. to England, Norway and briefly to the Soviet Union, until the Soviets shut off land access to Berlin in 1946. Berlin was jointly occupied by Allied and Russian troops, but surrounded by the eastern part of Germany under Russian control. That forced U.S. President Harry Truman to set up the Berlin airlift, with massive amounts of supplies flown in by Air Force and civil air transports to maintain people and troops in sectors of the city for which the Allies were responsible. A.O.A., under Flynn's direction, played a large role in the airlift under contract to the Air Force.

While still with A.O.A., Flynn made himself known to the people of Collins Radio and Cedar Rapids in 1949 by flying one of his airline's giant Stratocruiser aircraft into Cedar Rapids. The Stratocruiser was then a new trans-oceanic 75-passenger plane and Flynn's Cedar Rapids' stop came after taking delivery of the ship at Boeing's plant in Seattle. The aircraft had a large amount of Collins equipment aboard.

In 1950, A.O.A. was bought from American by Pan American Airways. Flynn found himself unable to work with the legendary Juan Trippe, the founder and longtime president of Pan American, and soon resigned.

Needing another job, he contacted Arthur Collins who offered him the position of manager of the new Texas operation then being set up in Dallas. Flynn accepted and went to work with Collins in 1951.

He moved from the Dallas position to vice president of sales, and with his background helped build Collins' presence in the avionics field. He remained an active pilot in the 1950s, doing both equipment evaluation and demonstration flights. In those days Collins had its own radio operation at the Cedar Rapids airport to maintain contact with company planes. Flynn, known as a colorful character, would refer to Cedar Rapids as *Sleepy Hollow* when calling in from an airplane, and called the control operator *the weasel*. Flynn also was a well-known amateur radio operator.

Flynn's next assignment, also based on his experience in the airline business, was heading the Collins International Division, setting up sales offices and service centers at many foreign locations. He also was a member of the Collins Board of Directors.

* * *

Dr. Alexander M. Lippisch had perhaps the most colorful and noteworthy background of all the technically talented persons who came to Collins Radio Company.

He was a world famous aircraft designer in Germany before and during World War II. He led a long life filled with many accomplishments, yet had many frustrations when some of his ambitious plans failed to become reality.

Technically, Lippisch was brilliant and creative. He worked long and hard to develop his innovative designs. He was a friendly, courteous person, spoke English very well with a German accent, and willingly gave of his time to those who asked questions about his work or who sought to learn from him. But he also demonstrated a defiant streak toward anyone he felt was hindering his progress. It was a characteristic that probably kept him from achieving more of his goals.

Lippisch was born in Munich, Germany in 1894, to parents and a family life steeped in culture. He studied art and music in his early years.

As a boy he also developed a deep interest in the new science of aviation. In 1914 his father took him to see flying demonstrations by Orville Wright, then touring Europe. Along with his studies of art, he began to learn all he could about aircraft design and powered flight.

His studies were interrupted by World War I. He was drafted into the German army and sent to fight in the trenches on the Russian front. He became seriously ill with pneumonia, had to walk miles back from the front lines, and was returned to Germany. After recuperation, he worked on military topographical maps, then was chosen to help design airplanes under the noted German aviation engineer (and later aircraft manufacturer) Claude Dornier. He had to learn his craft on the job and he learned well.

Under conditions of the 1918 armistice which ended World War I, a defeated Germany was forbidden to build powered aircraft. That led German aviation enthusiasts to turn to gliders which could be flown off mountains. Lippisch soon was into glider design, demonstrating outstanding talent. His models won numerous soaring contests in the 1920s.

During the glider era Lippisch began work on what would be his greatest contribution to aviation — the delta wing shape for aircraft. He contended that if an aircraft was inherently stable, there was no need for a horizontal tail section, only a vertical stabilizer. He was credited with originating the name delta for a triangular-shaped aircraft, after the Greek letter delta. In a 1953 article he wrote after coming to Collins, Lippisch related how the principle of the delta wing came from nature, specifically the seed of the zanonia plant, a large vine of the cucumber family growing in Indonesian jungles. The kidney-shaped seed glided in a graceful pattern from the top of tall trees to propagate the species.

For more than a decade in the 1920s and 30s, as he could obtain funding, Lippisch designed and built glider and motorized versions of delta wing aircraft. At least one achieved outstanding performance. But the university and industrial clique which controlled German aviation showed no interest in Lippisch or his concept. He was without an academic degree, largely self-educated, and was looked upon as an outsider.

Eventually he was awarded the title of doctor after writing a thesis on his delta wing concept. And eventually, when jet aircraft came along, modifications of the delta wing were adopted in the designs of many aircraft.

Adolph Hitler came to power in Germany in 1933 and soon began a massive build-up of military air power. Lippisch, as head of German glider research, did not become part of that effort until 1938. Then Luftwaffe officials asked him to design a high speed, tailless aircraft.

What he was not told initially was that the aircraft was to accommodate a revolutionary new liquid fuel rocket engine. It was a super secret program.

Lippisch and his design team were moved to a Messerschmitt aircraft factory at Augsburg to do their work.

While he had to join the Nazi party, Lippisch kept to himself his dislike of the Hitler regime and its methods.

The aircraft which Lippisch designed was the ME-163 Komet, with a sleek, delta wing shape supporting a round-nosed fuselage but no horizontal tail.

ME-163 flight tests were conducted at Peenemunde, the secret German base on the Baltic Sea. Also underway there, under Werner Von Braun, was development of the V-2 unmanned buzz-bomb rockets which terrorized London in latter stages of World War II.

In August, 1941, taking off under rocket power for the first time, the ME-163 exceeded a speed of 550 miles per hour, a world record. Later, towed to 13,000 feet before the rocket engine was ignited, the aircraft attained 625 miles per hour.

The Luftwaffe still did not make the ME-163 operational until mid-1944. Eventually, about 280 were built. Many accidents occurred with rocket engine explosions and a number of pilots lost their lives during flight testing. Only 25 ever saw action in combat, possibly because rocket fuel was in short supply. The Komet had limited range and flight time because its fuel was used up rapidly.

The speed of the Komets astounded U.S. B-17 crews, but they had limited effectiveness. As a result they had virtually no impact on the war.

By the time the ME-163 went into service, Lippisch had left Messerschmitt to head a German aviation research center in Vienna. The relationship between Lippisch and Willy Messerschmitt had been a stormy episode. He also had sold most of his patents to Messerschmitt.

With the war in Europe nearing an end in early 1945, Lippisch and his family fled west from Vienna to escape advancing Russian troops. He soon made contact with American forces. Both the U.S. and Russia wanted to gain the talents of the top German scientists.

Lippisch was one of several dozen prominent German scientists taken first to

London, then to the U.S. in January, 1946 in what was called Operation Paper Clip. The name came from the custom of attaching paper clips to the files of those selected for transfer to the U.S. His family followed a year later.

He was sent to Wright Field in Ohio, and worked as an advisor on some U.S. jet fighter plane developments. Later he went to a navy facility in Philadelphia, working on problems of jet planes landing on aircraft carriers. He was bored with both assignments.

His association with Collins Radio Company began in 1950. Arthur Collins said in later years that he knew of Lippisch's background as one of the world's leading aerodynamicists. In 1950 Collins was beginning to develop flight director and automatic pilot equipment. Arthur hoped Lippisch could apply his knowledge of aircraft design and methods of controlling aircraft to Collins' work on airborne electronic systems.

That also was a time when Collins Radio was still trying to find business to replace the military production contracts canceled at the end of World War II. One area the company looked at was missiles. Lippisch was reputed to have knowledge of missiles, and could help Collins. But Collins was unsuccessful in getting any contracts for missile work. Lippisch told a colleague in later years that such contracts went only to airframe companies, and a company with *radio* in its name was not seriously considered.

Arthur, as head of a leading defense contractor firm, probably was under pressure from the Pentagon to hire one of the German scientists. Many, like Lippisch, had not yet found challenging assignments in the U.S. Some in government saw the Germans as a burden on the pubic payroll and wanted them to return to an economically devastated Germany or be employed by U.S. firms. Officially, the government policy by late 1949 was to encourage the German scientists to seek employment in private industry.

Lippisch said he did not know anything about electronics but decided to accept Arthur's offer. He moved his family to Cedar Rapids and purchased an old farmhouse in a remote location not far from Arthur's home.

He spent the next 24 years with Collins Radio. Arthur gave him the title Director of Aeronautical Research, allowed him to hire a small staff and provided a work area in the Collins hangar building at the Cedar Rapids airport. Lippisch had a free hand to do pretty much what he wanted within a limited budget, but also was expected to apply his knowledge to Collins projects.

Lippisch indeed initiated some unique, futuristic developments while at Collins. One he called the Aerodyne, a wingless aircraft. He built a large model which flew very well, mostly inside the hangar. A loose hanging electric cable was attached for remote control. The Aerodyne looked like a fuselage without wings, kept aloft by the thrust of air from a jet engine blown out a hole in the bottom of the aircraft. Other vents provided horizontal thrust and control. Lippisch had some Navy funding for the Aerodyne, one of the few projects for which he received government support. The Navy lost interest in the project before it could be developed further.

Giving a talk on the Aerodyne before a meeting of a large company group of male employees, the Collins Radio Technical Association, Lippisch was asked what would happen if the engine should quit in flight. "It would drop like a rock," he replied. The Aerodyne was designed, however, to have two engines in case one should fail.

Lippisch became known to many in Cedar Rapids from a series of programs he prepared entitled, *Secrets of Flight*, broadcast by Station WMT-TV in 1955.

Another of his projects was a chamber similar to the airflow wind tunnels used in aircraft design. The Lippisch version was a 22-foot-long smoke tunnel, providing an exceptional portrayal of air currents on models of different aircraft shapes. He built several of the smoke tunnels, some used for many years in university engineering laboratories.

A third project, in his latter years with the company, was the aerofoil boat, a small one-passenger aircraft of unconventional design which took off and landed on water. He built a prototype which Clayton Lander, a Collins pilot, flew in tests at Lake Macbride near Cedar Rapids. It had only a 7-1/2-horsepower engine. Lippisch saw such a machine as being an efficient method of travel for commuters in cities such as New York, Chicago or San Francisco.

After several aerofoil boat flights over a period of time, Lander said Lippisch invited Arthur to come out to Lake Macbride to see the craft fly. Normally it was fun to fly, Lander said. But that day the small VW engine was acting up and he never could get it up to full power — just enough to get off the water but not going fast enough to gain altitude. Arthur and Lippisch were in a boat traveling alongside, moving just as fast as the airplane. *I finally had to taxi back in to the pier. After we were all back on shore, I heard Art say, 'I think it's time to terminate this project'*, Lander said.

None of those developments by Lippisch ever resulted in marketable products for Collins.

Some other work by Lippisch and his staff was of greater importance to company programs. Arthur credited him with being extremely helpful in analyzing aircraft flight response to the early Collins flight control developments.

The Lippisch team also contributed when Collins first put together a group of military airborne equipment units as a compact integrated system. The team was instrumental in designing the cooling techniques which enabled the electronic boxes to function in the tight space and jet engine heat environment of a jet fighter aircraft.

The revolutionary Collins computer designs of the early 1960s also benefitted from the electronic cooling expertise provided by Lippisch's group.

Arthur was always interested in Lippisch's projects, and they became good friends, often joking with each other, but sometimes arguing. They had much in common in that both were inventors with inquiring, open minds.

The Lippisch work which probably interested Arthur the most was related to Arthur's 70-foot boat, Peregrine, the largest boat with a fiberglass hull ever built at the time. In fact, Arthur was stimulated, at least in part, to build the boat after studying the aerofoil boat shape. Lippisch did extensive research and testing on hydrodynamics, hull designs and propulsion for boats. He worked in a marine lab area adjoining the Main Plant in Cedar Rapids equipped with a large tank where he tested models of his aerofoil boat and Arthur's boat projects.

Lippisch had a characteristic of wanting to do his development projects on his own terms which probably kept him from realizing greater achievement and recognition.

Dr. Gene Marner, director of research at Collins, recalled times when company officials hoped outside research funding could be found to support some of Lippisch's projects.

"When he came up with something which the Navy, for example, might have an interest, we would set up a meeting in Washington. If they liked what he explained, discussions would follow on the possibility of a contract. When we finally got into dollar amounts and terms of a contract, Lippisch would begin objecting to some of the conditions, saying, 'I can't agree to that,' and soon the Navy people lost all interest in the project."

After his retirement from Collins in 1964, Lippisch continued to work on his own and in Germany on versions of his Aerodyne and aerofoil boat.

He died in 1976, always to be remembered for the significant contribution he made to aviation — the delta wing.

* * *

L. Morgan Craft typified many engineers, a man with a brilliant mind and a quiet, effective achiever with a dogged determination to apply his extensive talents and knowledge to solve problems.

Morgan Craft came to Collins from Ohio State University where he was doing advanced graduate work in communications engineering. He had been born in the small community of Scotland, Illinois, and earned his electrical engineering degree from the Universty of Illinois in 1929. The following year he received his MSEE degree, then joined the technical staff of Bell Telephone Laboratories in New York City. After about two years he decided to pursue further studies, and went to Ohio State.

Almost immediately after starting work for Collins March 15, 1935, his knowledge and abilities provided assistance that was invaluable in enabling Arthur Collins and Collins Radio Company to stay in business.

At the time Collins Radio was a small firm gaining increasing recognition for its innovative, high quality communications equipment.

It also was a company under siege. The giant Radio Corporation of America was trying to run it out of business with a lawsuit accusing Collins of violating patent rights.

RCA held rights to a patent obtained by Radio Pioneer Lee de Forest for a tube widely used in many types of radios in the mid-1930s. Collins intentionally avoided de Forest tubes, instead using tubes made from a design patented by Rocket Scientist Robert Goddard. RCA told the court the Goddard design did not work, even though it worked very well in Collins equipment, and therefore Collins had to be infringing upon the de Forest patent. During the three years of the law suit, Collins filed appeals in attempts to prove the validity of the Goddard tubes, and even made further modifications to the Goddard tubes. Much of that work was done by Morgan Craft. Another part of the law suit accused Collins of violating a patent for a technique known as Rice neutralization, or capacity neutralization. Craft enabled Collins Radio to refute that claim by developing a new technique known as inductive neutralization. He and Arthur Collins wrote a technical article describing the new technique. Despite all of Collins' efforts, RCA arguments were upheld by the court, but the suit finally was dropped.

Craft's contributions were a main factor in holding off an injunction that could have shut down Collins during the three years of litigation.

Craft also was responsible for developing a revolutionary new, low cost antenna for amateur radio operators. He was highly regarded for his expertise in many areas including high frequency communication.

A few years after he joined the company, Craft was named chief engineer under Arthur and became a vice president. As the storm clouds of World War II appeared, Craft recruited a blue ribbon group of young engineers, most of them becoming company executives in years that followed. He also played a leading role in establishing retirement and insurance programs for the firm at a time those were new in industry. During the war he headed the huge build-up of manufacturing for Collins. For several years he was director of both engineering and manufacturing.

He was first elected to the company Board of Directors in 1944, and served continually until 1970, even after his retirement.

From the late 1950s, Craft worked mostly in a consulting role to engineering and to Arthur personally when called upon. He had the title of senior vice president. He also was elected to the high honor of Fellow of the IEEE. While sometimes having few assignments, he remained loyal to Arthur and kept regular office hours except long lunch periods when he played cards at the Cedar Rapids Shrine Club. He was well remembered by old-timers for many contributions in building Collins Radio from a small to a large company.

* * *

A number of noteworthy persons came to Collins over the years as visitors, either out of curiosity or in official capacities as customers or government officials.

One visitor to the Cedar Rapids plant in 1962 was Torstein Raaby. He was part of a group of Norwegian technicians and officials who spent about two weeks at Collins working on equipment specifications and contract negotiations for a program known as White Fox. It was a NATO communication system, part of defenses against Soviet Union bomber and missile attacks, installed in Arctic areas including northern Norway.

Few people at Collins were aware of Raaby's background. He had been active in the Norwegian resistance movement during World War II. He escaped to England after Germany occupied Norway in the spring of 1940, received training and parachuted back into his native land. Once over a period of 10 months he sent almost daily radio messages to the British on activities of the German battleship

Tirpitz, hiding in Norwegian waters. He sometimes hooked his radio to a Nazi soldier's antenna at night to transmit. His information finally led British bombers to sink the Tirpitz.

After the war Raaby became one of the six crew members of the famous Kon-Tiki voyage led by Thor Heyerdahl. The Kon-Tiki was a balsa wood raft which floated with ocean currents from Peru to near Tahiti for 101 days in 1947, to demonstrate how the South Pacific islands probably had been populated centuries earlier by Indians from South America.

Another 1962 visitor was Danny Kaye, the Hollywood actor, comedian, singer and dancer, and also a pilot. Flying across country with a co-pilot in his twin-engine Beechcraft Queen Air, fully equipped with Collins gear, he decided to stop in Cedar Rapids. After radio contact with the airport and Collins flight operations, he landed and taxied up to the Collins hangar. He explained he wanted to see how his avionics equipment was made.

Brought into the plant from the airport, he was introduced to marketing officials who hurried to keep up as the fast-stepping Kaye darted from one area to another during a plant tour.

A suggestion was made that Arthur Collins might like to meet Kaye. A call was placed to Arthur who was at his home, and the phone was handed to Kaye. Michael Collins recalled that when Kaye identified himself, his father said the only Danny Kaye he knew was in the movies, and Kaye said, *That's me.* Kaye then was driven to the house to meet Arthur, then back to the airport.

Kaye also was given a short flight in a Collins plane and demonstration of the company's then new V-bar flight director system. He later boasted during a guest appearance on the radio show of fellow entertainer Arthur Godfrey, also a pilot, that *even a baby could fly an airplane* with that new Collins Radio flight director.

Jimmy Doolittle, retired Army Air Force lieutenant general and military pilot who led the 1942 surprise attack on Tokyo by carrier-launched U.S. bombers, was another visitor. In October of 1946 he flew into Cedar Rapids to have some radio work done on a twin-engine Mitchell B-25, the same type of aircraft used in the Tokyo raid. After the war Doolittle headed aviation operations of Shell Oil Co.

Among other achievements in his military career, Doolittle in 1929 had made the first flight and landing of an aircraft entirely on instruments. That was a field where Arthur Collins was to make major contributions. Arthur and other company officials entertained Doolittle at lunch at the Cedar Rapids Country Club.

Another visitor on several occasions was Bert Wilson, the radio announcer for the Chicago Cubs. Wilson was an avid amateur radio operator and Collins booster, having known Arthur from early days when he lived in Cedar Rapids. Wilson liked to see the latest developments in Collins amateur gear, and always was one of the first customers to buy it.

Also a visitor to the Cedar Rapids plant at least twice was Barry Goldwater, the Arizona senator and 1964 Republican presidential nominee.

Goldwater was an active amateur radio operator, owning a full complement of Collins ham gear, also a brigadier general in the Air Force reserves and jet-rated pilot. On one of his reserve duty tours he flew a twin-jet executive plane from Washington to Cedar Rapids to review a military equipment program.

Goldwater and Arthur also knew each other from associations at the Balboa Bay Yacht Club at Newport Beach, where each kept boats moored. Mary Collins recalled that she and sons Alan and David sometimes visited with Mrs. Goldwater during trips to be on the boat. She said Arthur had the senator aboard to look over his new 70-foot fiberglass hull boat after it was completed in 1968.

Collins Radio Company also brought in many prominent personalities over the years as speakers for the Collins Radio Technical Association. CRTA, as it was known, was originally a men only group, formed in the 1940s. Originally it was intended to give Collins people information on new technology, but in later years many programs were along the lines of entertainment.

* * *

Roshan L. Sharma grew up in a village in India, the son of a railroad worker, and came to the United States in 1949 to study at the University of California, Los Angeles. He said his American studies took longer than he planned because his early physics background was inadequate. While in the UCLA library one day he noticed a lady in native Indian dress, which led to a romance and marriage. They learned they both had attended the same college in India, but had not met because men and women were not allowed to associate at the school.

In 1952, when they were expecting their first child, Sharma was working at several jobs but realized he needed to find more substantial employment. *I started looking and couldn't find anything but menial jobs like fruit picking. I was a student, I didn't even have a green card, and I looked suspicious to everybody. I went to a lot of companies, and said please look at my physics background, and that I was a very good mathematician. But they just kicked me out,* Sharma recalled.

*Finally I saw an ad by Collins, looking for a research mathematician and engineer for a newly created division of Collins Radio Company (the new Western Division plant and laboratory at Burbank.)* Through a friend who knew Ted Salyer, the personnel manager at Burbank, Sharma was able to obtain an interview at Collins. *Mr. Salyer took me to see Mel Doelz (engineering director at Burbank), who put two things in front of me. One was an idea for a modem, the other the skeleton of a mechanical filter.*

*Mr. Doelz said after years of working at it he finally had made some small discs for the mechanical filter which vibrated at exactly 455 kilohertz, but it still was mostly a trial and error process. 'We just don't have a way to do it consistently,' he told me.*

Sharma then told Doelz about an acoustics course he had just completed at UCLA. Part of it covered a study of the vibration of tin plates. He thought that background could help immediately with controlling the frequency of mechanical filter discs, but he would have to study the mathematics and other problems of the modem. To prove he was a capable physicist, he also showed Doelz a paper he had done on atomic research.

*After about 15 minutes into the interview, Mr. Doelz said, 'You're hired. Your first job will be to define the equation for the mechanical filter discs, then we can buy millions of dollars in lapping equipment to make them',* Sharma recalled.

Sharma's work was a main factor in completing the mechanical filter and making it a practical reality. The mechanical filter was one of the most significant developments in Collins Radio history, and the key to the design of single sideband communications equipment. Sharma recalled he also tapped into studies on vibration and frequency control by a Columbia University professor, who was delighted to learn his academic research led to a practical application. Sharma later obtained a master's degree based on his work on the mechanical filter.

After beginning at Collins Sharma tried to get his naturalization process started to become a U.S. citizen, but in 1955 received a letter that he must go back to India and apply under a quota system to return to the U.S., a process which would have taken many years. *By that time I had been working more than two years and we had two children,* Sharma said.

*Art Collins was visiting Burbank at that time and asked how he could help with my immigration problem. I was then working on Kineplex. Art said, 'You have done so much work for us I am not going to let you go'.*

*Art then called a Mr. Baldwin, who was the head of the Immigration Department in Canada. They had gone to high school together in Cedar Rapids, then Baldwin left the U.S. and went to Canada. I was told to drive with my family to Canada, take my work along, and go to work at Collins Radio Canada in Toronto. There I could apply for a visa and eventually get back into the U.S.*

*I was told I did not need any papers, that when we got to the Canadian border to tell the border guard that Mr. Baldwin said it's okay for us to enter Canada. As we drove up to the border crossing, I forgot Mr. Baldwin's name. I explained the situation, and the border guard let us look at the Immigration Department organization chart. What made us remember it was Mr. Baldwin was that my wife had a professor at UCLA who lived in Baldwin Hills. The guard then said go ahead.*

Sharma stayed in Canada for about a year. The company had him placed in a category called Highly Needed Technical Personnel. He maintained contact with the U.S. embassy and was allowed to return to California in 1956. He became a U.S. citizen in 1962.

Sharma helped with mathematical models and other projects for modems and Kineplex developments and applications. When Collins Radio began the C-8400 computer and message switching program, his role was to develop the networking techniques. A main challenge was how to attain the lowest possible cost of leasing transmission lines by the most efficient use of line capacity. He developed algorithms for networking, a field he continued to pursue.

In 1968, during C-System development years, Sharma attended a high level technical conference in Edinburgh, Scotland. One of the subjects was a new concept for computer processor access to data storage known as packet switching, with Dr. D.W. Davies of the National Physical Laboratories of Great Britain, a main speaker. Davies was a well-known computer scientist. Sharma later mentioned the Davies presentation to Arthur Collins.

Soon after that a large meeting of top C-System people was held at corporate headquarters in Dallas. Sharma said he always was seated in the back of the room at such meetings.

*At that meeting Art mentioned I had attended the Edinburgh conference and asked me to describe Dr. Davies. I began by saying Dr. Davies was a short, middle-aged man about 45 years old. Just then Art interrupted and said, very angry, 'How dare you describe anyone just 45 as middle-aged!' I stood up, trembling, thinking to myself this might be the last day for Roshan Sharma at Collins Radio Company. But then I said, 'Mr. Collins, you don't realize that in India where I come from people barely live to 52 years of age — don't you think I'm being pretty generous?'*

*That made the entire audience laugh, and Art, too, began to laugh. Then they quieted down and listened to my report on the conference. Art then said to have copies of all the papers from the Edinburgh meeting reproduced and distributed within Collins. That was the first most of them ever heard of packet switching.*

Computer networking became Sharma's area of expertise, both during and after his Collins career. He wrote four textbooks and numerous technical papers and became a recognized authority on the subject. After retiring he taught at Southern Methodist University in Dallas and was a professional consultant.

# Chapter 19
# ARTHUR'S LEGACY

Arthur Collins was one of those rare men who made the most of his talents and opportunities. He did not seek recognition for himself, but he deserved credit for many achievements during his life.

Collins Radio held a dominant position in numerous areas of endeavors. Two areas were the most prominent, because the role of Arthur Collins and Collins Radio in each was so well recognized. One is avionics, the other high frequency radio communications, which includes amateur radio. No other person in the world had a greater impact on those two fields than Arthur Collins. His company repeatedly set the pace for much of the technical progress in both areas.

Avionics may not rank as a core industry, but it is one of the most vital elements of the modern economy. Avionics equipment is as essential to aviation, and thus to business, commerce and transportation, as are airplanes, engines and airports.

Arthur Collins either conceived or directed his company's achievements which greatly enhanced the ability of airlines to overcome the limitations caused by weather, both to fly an airplane on a course to a destination and to land it on a runway which pilots can't see when they begin their descent.

James Holahan, for many years editor of Business/Commercial Aviation magazine and Aviation Convention News, who was a well-respected aviation writer and longtime observer of trends in the industry, wrote in 1984:

*Arthur Collins became a primary force in making all-weather flying routine for the nation's airlines and business aviation. Probably no person alive contributed more to the art and science of avionics than this diffident radio tinkerer and electronics engineer whose genius lay not only in fashioning circuits and developing complex systems, but also in attracting other agile-minded, dedicated engineers to work for him. One doesn't have to look too hard at other leading avionics companies to find Collins-trained people at the helm or in high positions. The man not only created a company, he spawned an industry. In his years as the company's chief executive (and whether he carried the title or not, most of the time its chief engineer), Arthur Collins made the Collins name synonymous with high quality and reliability and the Collins equipment the nonpareil in avionics.*

And avionics is not confined to the commercial side of aviation. Also requiring the most advanced of equipment was military flying. The contributions to Navy and Air Force avionics by Arthur Collins' company were equally significant, in some instances legendary. One was the World War II AN/ART-13 transmitter equipped with the Autotune, another the AN/ARC-27 transceiver giving postwar armed forces UHF capability, and development of HF single sideband communication capability for the Strategic Air Command. HF/SSB also became standard for the world's air transports.

High frequency and amateur radio, like avionics, were dominated by the ingenuity of Arthur Collins for five decades. The Collins products were unmatched in performance. There was a near unanimous desire of hams the world over to own Collins amateur products. Only a small percentage of the population participates in amateur radio, but in terms of historic significance it ranks as an important technical development of the 20th century. The Collins line of amateur gear served more than hams — it was widely used by industry and government, including the military, when no other radios existed to meet their needs. And in some instances, Collins amateur gear was a test bed leading to more sophisticated communications equipment.

Arthur Collins did not personally develop every one of the avionics devices and amateur radios produced by his firm. But he set the course for the types of equipment to be designed and manufactured, and he attracted the engineering and other talent to turn ideas into products. He directed and molded his engineeers and factory managers to do his bidding. His bidding was innovation, quality and reliability in products.

Innovation was expected with every new offering from Collins. Innovation was not just to offer something new. It was based on need, and reflected what technology at the time could be coaxed to do. Arthur liked to think imagination was a basic ingredient of all his company's products, and that his development projects resulted in equipment which was beneficial to mankind.

Unlike many electronic products of the latter 20th century which became obsolete within months or years, most Collins equipment lasted and still could be operated after generations of use.

What made Collins Radio Company different was quality. The company had no need to try to convince customers through boastful advertising that its products were quality, because the products spoke for themselves.

At Collins, quality was designed into and built into products from the start. Arthur Collins demanded it.

Customers knew Collins quality was genuine. Hundreds, probably thousands, of stories have been told of how Collins equipment performed under the most strenuous of circumstances — to a far greater extent than what specifications required. Along with quality came service — Collins Radio was seldom lacking in providing service when needed to back up its products.

Being associated with such quality spawned great pride among Collins employees in the work they did.

Arthur disliked any product that was not first class — anything not representing the best engineering which could be applied to it. That was true of products he bought for his own use, and of the products which carried his name.

Many dreamers pass through this world, but only a few see their dreams come true. Arthur Collins was one of the few. He founded, built up, organized and directed a company to carry out complex ideas. Arthur not only had ideas for products — like other great inventors he had the tireless energy and tenacity to delve into the unknown and overcome the obstacles in the way of creating those products.

Few others could have provided as great a contribution as he did to the gigantic Strategic Air Command single sideband communications network, based on his technical leadership which made single sideband effective for widespread use.

Or seen the beneficial effects of flight director systems on flying an airplane, and engineered their development.

Or foreseen, as he did after World War II, the coming need for high speed wireline data transmission and equipment to provide it. His vision in making data communication over telephone lines practical through early Collins modem and transmission equipment was evident with the emergence of e-mail and the Internet.

Or press as hard as he did to develop computers which linked computation and communication in broad scale systems to sort out and relay millions of teletype messages a day. That came at a time most persons looked upon computers as accounting machines.

Or stimulated the invention of devices such as the Autotune, the Permeability Tuned Oscillator and the Mechanical Filter which led to giant steps in radio communication progress.

Or spurred development of the antennas and space communication systems which maintained contact with spacecraft traveling around the earth and to the moon.

In every product category and market area in which Arthur Collins became involved, he made a major impact. Many would be satisfied with his success record in any one of those areas — he achieved success in all of them.

His company was a pace-setter in procedures such as the Collins *Green Rooms* to develop and design new, advanced technology products. Similar concepts continue to be recommended and copied by industry and government groups.

Some who worked closely with Arthur cite his ability to direct and inspire engineers as one of his greatest contributions. As one associate described it:

*He was continually promoting his viewpoint of what the engineering process should be — to take things from a technology base, match them with needs from the market place, and add value for the guy who is going to use them. He forced people to take a systemic view of problems — not a narrow set of options. He was a systems architect. That meant an interdisciplinary approach involving not only engineering but marketing, manufacturing and business management people working together. He looked at technology from the point of how to do things differently, not the same things better.*

Even the great Guglielmo Marconi, considered the Father of Radio, recognized Arthur Collins' brilliance. Robert L. Cattoi, one of Arthur's top engineering vice presidents and later a senior engineering VP for Rockwell, learned about the Marconi connection on a visit to Italy.

Cattoi said he and Val Toschi, longtime general manager of Collins' Italian subsidiary, attended a dinner meeting of a radio group devoted to the memory of Marconi, who died in 1937. While there they were introduced to the daughter and widow of Marconi. Cattoi recalled the ladies instantly recognized the name Collins Radio Company as very familiar to them, and said that Marconi had great respect for Arthur as a man who made significant contributions to the progress of radio. It is believed that Arthur once met Marconi in the early 1930s.

John McElroy, who directed Collins engineering for a number of years, once noted that while Marconi was credited with inventing radio, Arthur advanced radio by working on shortcomings which existed and in many instances he overcame them.

While Collins products were noted for longevity, Arthur was always looking at the next generation. He often wanted to discontinue a product and build a new version even when the first one remained the best on the market. More than once his management team had to convince him to keep building and supporting radios because of the demand for them by the airlines and military services.

Arthur Collins was an extremely ethical person, very sincere in the purpose and execution of his ideas. He may not have been a saint in how he treated some of his colleagues, but he did not intentionally denigrate or downgrade another person. When he made a disparaging remark, it usually was about an inferior product and the company which made it.

Arthur was different than many entrepreneurs who come up with an idea for a new product and establish a company to produce it. At first they are devoted to making that product the best on the market. But over time their objective changes from making the best product to making money, and product integrity is no longer as important.

Arthur never wavered from trying to make every one of his products the best it could be. He was never afraid of risking his own company's money to advance technology. It was a pattern which paid off for him for many years, until he tried one too big and too complex.

Despite Arthur's main fault of ignoring negative economic impacts of his ambitious ventures, few men have ever built companies such as Collins Radio Company.

As one long-term employee who knew Arthur well said: *Collins was not a numbers company, concerned only about the bottom line. It was like family, with everyone doing their part, and that's what made it a great place to work.*

# Patents Held Solely or Shared by Arthur Collins

2,150,362, March 14, 1939 — Control Circuits for Signal Transmitting and Receiving.
2,164,309, July 4, 1939 — Shaft Positioning Device.
2,165,226, July 11, 1939 — Automatic Tuning System.
2,168,326, August 8, 1939 — Automatic Tuning System.
2,174,552, October 3, 1939 — Automatic Tuning System.
2,186,958, January 16, 1940 — Distortion Reducing System for Suppressed Carrier Transmission.
RE 22,574, June 9, 1942 — Control Systems and Apparatus.
2,185,414, June 9, 1942 — Motor Control System.
2,393,856, January 29, 1946 — Calibration System for Radio Receivers.
2,409,192, November 15, 1946 — Tuning Device Clutch.
2,447,490, August 24, 1943 — Radio Transmitting and Receiving Systems.
2,509,963, May 30, 1950 — Radio Receiving and Frequency Conversion.
2,546,980, April 3, 1951 — Shaft Positioning Apparatus.
2,617,985, November 11, 1952 — Frequency Control System.
D 170,183, August 18, 1953 — Approach Horizon.
D 170,184, August 18, 1953 — Course Indicator.
2,888,524, May 26, 1959 — Parasitic Oscillation Suppressor.
2,921,271, January 12, 1960 — Transmitter Stabilizer.
3,651,315, March 21, 1972 — Digital Products Inspection System.
3,659,271, April 25, 1972 — Multichannel Communication System.
3,692,941, September 19, 1972 — Data Exchange and Coupling Apparatus.
3,925,621, December 9, 1975 — Digital Circuit Switched Time-Space-Time Switch Equipped Time Division Transmission Loop System.
3,956,593, May 11, 1976 — Time-Space-Time Switch with Combined and Distributed State Store and Control Store.
4,005,272, January 25, 1977 — Time Folded Time- Space-Time Switch.
4,038,497, July 26, 1977 — Hardwired Marker for Time Folded Time-Space-Time Switch with Distributed Control Logic and Automatic Path Finding, Set Up and Release.
4,270,203, May 26, 1981 — Timing Adjustment Circuit for Digital Switching.
4,701,907, October 20, 1987 — Dynamically Reconfigurable Time-Space-Time Digital Switch and Network.
4,797,589, January 10, 1989 — Dynamically Reconfigurable Time-Space-Time Digital Switch and Network.

In addition to U.S. patents, Arthur had 43 patents in 13 foreign countries.

# INDEX