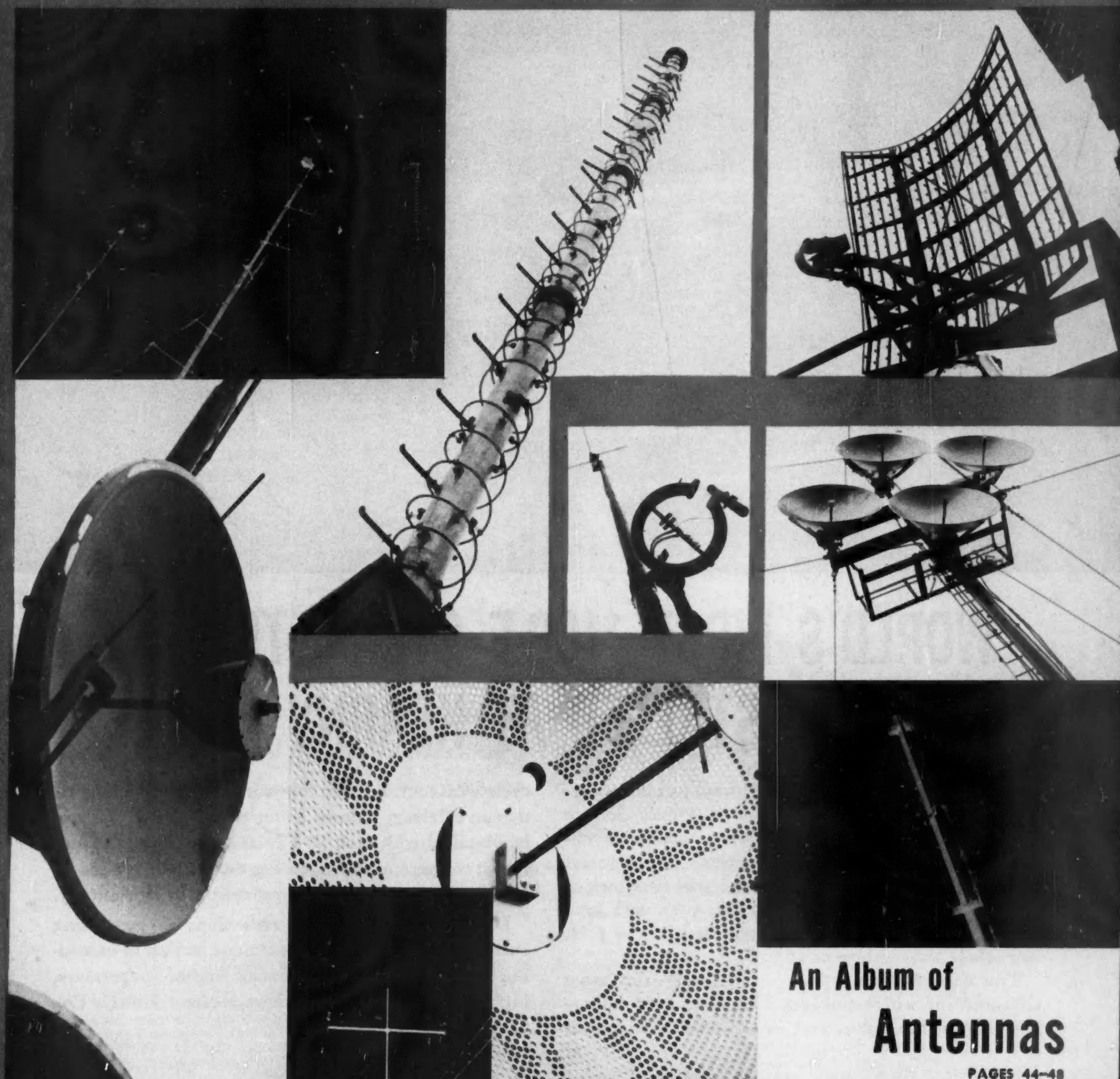
GENERAL ELECTRIC Review



An Album of Antennas

PAGES 44–48

MAY 1953

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GENERAL ELECTRIC Review

EVERETT S. LEE • EDITOR   PAUL R. HEINMILLER • MANAGING EDITOR

COVER—This array of antennas has varied applications in modern communications systems. More antennas are shown in a *REVIEW* picture story, "An Album of Antennas," beginning on page 44.

THE GENERAL ELECTRIC REVIEW IS ISSUED IN JANUARY, MARCH, MAY, JULY, SEPTEMBER, AND NOVEMBER, BY THE GENERAL ELECTRIC COMPANY, SCHENECTADY, NY, AND IS PRINTED IN THE U.S.A. BY THE MAQUA COMPANY. IT IS DISTRIBUTED TO SCIENTISTS AND ENGINEERS THROUGHOUT INDUSTRIAL, CONSULTING, EDUCATIONAL, PROFESSIONAL SOCIETY, AND GOVERNMENT GROUPS, BOTH DOMESTIC AND FOREIGN. . . . THE CONTENTS OF THE GENERAL ELECTRIC REVIEW ARE ANALYZED AND INDEXED BY THE INDUSTRIAL ARTS INDEX, THE ENGINEERING INDEX, AND SCIENCE ABSTRACTS. . . . SIX WEEKS' ADVANCE NOTICE, AND OLD ADDRESS AS WELL AS NEW, ARE NECESSARY FOR CHANGE OF ADDRESS. . . . ADDRESS ALL COMMUNICATIONS TO: EDITOR, GENERAL ELECTRIC REVIEW, SCHENECTADY 5, NEW YORK.

MY QUESTION TO THE G-E STUDENT INFORMATION PANEL:

"What opportunities are available in General Electric for a career in manufacturing?"

. . . EARLE E. WARNER, U. of Illinois, 1952

The answer to this question, presented at a student information meeting held in July, 1952 between G-E personnel and representative college students, is printed below. If you have a question you would like answered, or seek further information about General Electric, mail your request to College Editor, Dept. 123-2, General Electric Co., Schenectady, N. Y.

G. C. HOUSTON, *Manufacturing Services Division* . . . In General Electric manufacturing operations involve supervising and administering the activities of more than 100,000 men and women in more than 100 plants. This includes the operation of approximately 75 distinct product businesses, producing some 200,000 different products ranging from heavy industrial equipment to precision instruments and consumers' goods.

The cost of manufacturing our products represents 70% of the total expenditure for all operations including research, engineering, marketing and other administrative functions.

With these activities and expenditures in the field of manufacturing one can readily visualize the breadth of opportunity in the area of manufacturing. This wide scope of manufacturing activities and the importance of their integration into an effective organization provide opportunity for challenging and rewarding careers in such areas as follows:

Manufacturing Supervision: The most important part of any manufacturing organization is men—those who apply their varied skills and talents to perform the many tasks involved in the manufacturing process. To direct the activities of these men, to inspire performance, co-operation and teamwork, to provide fair and equitable treatment, to see that work is done in required quantity—on time—and at the lowest possible cost, is the responsibility of Manufacturing Supervision. It offers a challenging and satisfying career for individual growth and development.

Manufacturing Engineering: This is the creative portion of modern manufacturing. It involves interpretation of initial product designs into good manufacturing practices through planning the methods by which a product will be manufactured, specifying and designing machine tools and equipment, and planning and developing new processes. It is vitally concerned with such subjects as plant layout, materials handling, operation planning, and quality control. It requires a thorough knowledge and broad understanding of how these subjects influence the manufacture of a product.

Purchasing: General Electric is one of the most diversified purchasers in the country today, buying material from every industry. Much of this purchasing involves technical problems, and requires a knowledge of sources of supply, market trends, and new products. Many items purchased are components or finished products of other technical industries. Constant contact with price, as well as evaluation of current and long-range raw material supply situations, is another phase of this activity. It is becoming more and more important as a career opportunity for young men.

In addition to the above described areas of opportunity in manufacturing, such manufacturing services as wage-rate determination, production control, inventory management, production planning and development, and materials handling offer opportunity for highly trained specialization and for competent management supervision.

These areas of manufacturing, together with many others, offer the college graduate of today a wealth of opportunity for a challenging and rewarding career.

You can put your confidence in—

GENERAL ELECTRIC

OF ENGINEERING THERE IS NO END

It is always a happy time for us in General Electric when a new year rolls around and we have the Coffin Awards. It gives us renewed inspiration as we again think especially of our Company's founder and first president, Charles A. Coffin, who in those early days envisioned the outstanding opportunities in the electrical industry and in the power of electricity for service to mankind.

And year after year, as the Coffin Awards are presented to the employees of General Electric in honor of outstanding achievement, we see anew that opportunities are ever present for contributions to the advancement of the electrical industry. There is always a better way.

On the opposite page we carry the names of General Electric engineers who have been honored this year with the Coffin Award, together with summaries of their contributions. The stories of these achievements abound with qualities fundamental to the engineer—qualities that make him tick—engineering ability, practical ingenuity, perseverance and alertness, resourcefulness, initiative and aggressiveness, character, personality, and leadership. These are what made an Edison, a Thomson, a Steinmetz; these are what make an engineer today.

This year's Coffin achievements illustrate the scope of engineering. Prominent is the development of new materials. It is the development of new materials that makes advances possible. And many advances are made possible *only* because of them. Conversely, the lack of suitable materials is often a barrier to advances. Thus the development of new materials is a continuing challenge to the scientist and the engineer.

Not only new materials but also new products are prominent in the list of these achievements. They range from aircraft systems for our defense to television and photography for our education and enjoyment. Also noteworthy is the improvement of present products—a subject demanding the engineer's constant attention.

New machinery for greater productive output is largely the basis of our national productivity, and in this field again an important engineering contribution has been made. George Walter Hegel's outstanding engineering and co-ordinative performance in designing the world's largest continuous tin-plate annealing furnace provides equipment superseding a batch process to give a uniformity and quality of product obtainable in no other way, and at faster and greater output.

New techniques for studying engineering design requirements, for solving power application problems, for quality control of production, and for new processes are continually giving the engineer opportunities for finding ways to do a better job, to discover a more nearly perfect solution, to obtain greater certainty of result, to reduce waste and spoilage. And in actual production the manufacturing engineer can be of the greatest service.

When the product gets to the customer, the engineer can be of outstanding helpfulness. This is a service that only he, with his knowledge and understanding, can supply. To read of the contributions of Irving Kendall Clark on the front lines of Korea is to see revealed in the engineer the man of service.

In the broader aspects of planning community life the engineer has given outstanding service, though he has generally not been credited with all that he has done. The Civil Defense Communications Program of Neal Farley Harmon and Roy DeWitt Jordan represents an important civic contribution made through the engineer to the people of our country.

And this year, there is no correlation between age and contributions. The youngest engineer is 26 years old; the oldest, 56. The ability and eagerness of youth, together with the experience of age, contribute much. In terms of service, the shortest is one year and two months; the longest, 33 years. Opportunity, it seems, is always present.

Individual accomplishment and group accomplishment are both present. This is a requirement of the engineer: while he can serve with outstanding individual accomplishment, he can also team up with his associates to bring a variety of abilities into play for the attainment of the objective.

Thus we see in these contributions the continuing attributes of the engineer. His service permeates all things. His ability tackles all barriers. His perseverance brings attainment. Of engineering, there is no end.

Everett S. Lee

EDITOR

Once again, for outstanding accomplishment, a few of the nearly quarter of a million men and women in General Electric are honored with the Charles A. Coffin Award. This, the Company's highest honor, is given to those who best reflect the qualities of initiative, perseverance, courage, and vision exemplified by Charles A. Coffin, the Company's founder and first president. Engineers honored with the 1952 Coffin Award are listed below with their recognitions.

CHARLES A. COFFIN 1844–1926

PIER ANTONIO ABETTI . . . for his analytical ability, imagination, and perserverance in developing small, inexpensive electromagnetic models capable of representing characteristics of transformers with engineering accuracy.

WALTER WILLIAM AKER
HOWARD WILLIAM AVERY
ROBERT ALANSON BURT
WILLIAM THEODORE RAUCH . . . for their outstanding work, in collaboration, in the development of integrated hydraulic power systems.

H. WARD ALTER
BURTON V. COPLAN
JOHN K. DAVIDSON
EDWIN L. ZEBROSKI . . . for their imaginative conception and definitive development, in collaboration, of a liquid-liquid contactor of broad demonstrated usefulness.

NICHOLAS FRANK ARONE . . . for his success after long and untiring experimentation in producing a new and outstanding form of laminated flame-retardent insulation for use in high-voltage apparatus.

IRVING KENDALL CLARK . . . for his personal effort on the front line in Korea in training men and servicing jet engines, establishing excellent customer relations, improving the product and enhancing our ability to combat enemy aircraft.

JACKSON FRANKLIN FULLER . . . for his sound engineering and practical ingenuity in developing and constructing portable network analyzers for studying power systems. These analyzers are efficient time-savers for application engineers and power system engineers.

CYRIL HENRY HANNON . . . for his unusual vision in interpreting experimental results and for extraordinary persistence, which resulted in the discovery and commercial production of Strenicor, a copper-base alloy of high strength with excellent resistance to stress corrosion.

NEAL FARLEY HARMON
ROY DE WITT JORDAN . . . for their aggressive efforts, in collaboration, in conceiving, developing, and promoting an entirely original Civil Defense Communications Program, with benefit to all local, state, and Federal Civil Defense organizations.

GEORGE WALTER HEGEL . . . for his outstanding engineering and co-ordinative performance in designing the world's largest continuous tin-plate annealing furnace.

JOHN EDWARD JACOBS . . . for his meritorious achievement for an unusual contribution providing a growing parade of new products to open a new field.

FREDERIC BEACH JENNINGS . . . for his creative thought, in collaboration with Vincent Anthony Orlando, on a project outside of his own responsibility, and his actual conception of the basic principle of the mass flowmeter.

VINCENT ANTHONY ORLANDO . . . for his initiative, searching analysis, and unremitting effort, in collaboration with Frederic Beach Jennings, in the development of the mass flowmeter.

IRVING KALIKOW . . . for his outstanding achievement in mechanical design of aircraft generators and in particular the design of generator drives successfully isolating engine torsional vibration.

LLOYD OSCAR KRAUSE . . . for his outstanding technical skill and ability in designing a helical UHF television antenna which is an important factor in opening up the UHF-TV band.

ARNOLD ELI MINER . . . for his outstanding contributions to bearing plate material for use in Telechron clock motors with very substantial cost savings and continued high quality.

ANDREW WILLIAM RANKIN . . . for his ingenuity, perseverance and skill in applying mechanical computation methods to the solution of engineering problems, resulting in refinements in design which have been largely responsible for the outstandingly smooth-running vibration-free modern large turbine-generators.

JOHN MARTIN ROBERTS . . . for his alertness, resourcefulness, and initiative in preventing a substantial interruption of production at Hanford Works.

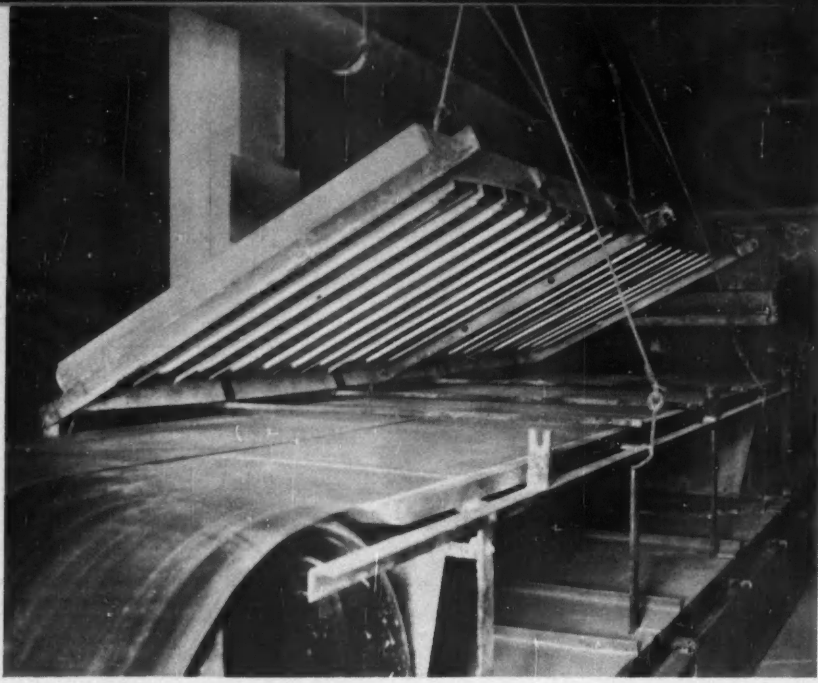
HORACE WARREN ROYER . . . for his major role in the development of ultra-vision, which has established a new standard of picture quality for the television industry.

ALLEN GWYN STIMSON . . . for his contributions made to the field of photometric and photographic measurements.

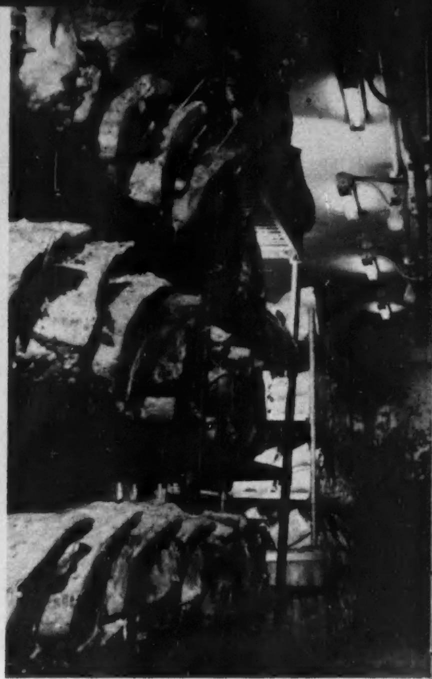
ALFRED HAROLD TINNEY . . . for his efforts in developing a method of evaluating quality of jet engines that has resulted in eliminating the necessity of a second test on 9 out of 10 jet engines, and has also contributed to the improvement of quality of all jet engines shipped.

PERRY WAYNE WEISER . . . for his ingenuity, perseverance, and initiative in developing the application of cemented carbides to percussive drilling bits.

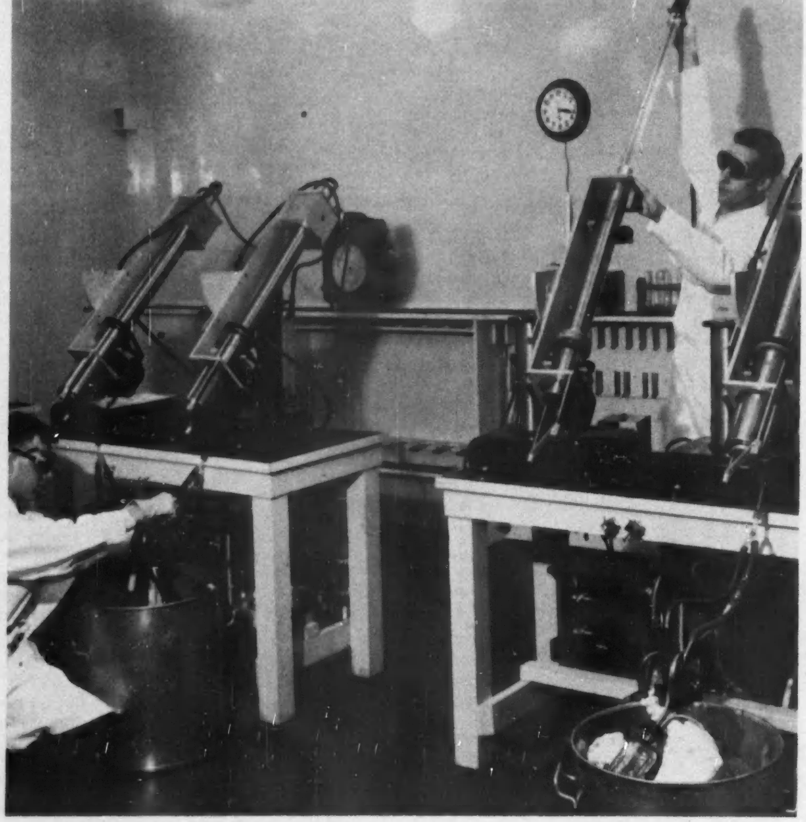
GORDON B. WILKES, Jr. . . . for his exceptional ingenuity, initiative, aggressiveness, and technical ability in the development of a blade construction for aircraft gas-turbine compressors.



SUGAR for canned vegetables is irradiated with ultraviolet from mercury lamps to destroy spoilage-causing bacteria. A happy coincidence for biophysicists, emitted wave length is 2537 Angstroms—nearly most lethal to bacteria.



MEAT is a ready target for bacteria and slime mold because the parasites need organic food materials to



BLOOD PLASMA is disinfected of jaundice virus the Army way. GI medics expose thin plasma films moving along the inner surfaces of metal cylinders to intense radiation of germicidal lamps. Concentrated blood has a low ultraviolet transmission. Milk can be pasteurized the same way.

Killing Germs

The sun emits but the earth's atmosphere absorbs germ-killing ultraviolet—remarkably generated in mercury arc

Soaking up sunshine out-of-doors isn't the same thing as soaking it up behind a window of ordinary plate glass. Nor is ultraviolet radiation reaching the earth the same as that emitted by a mercury vapor lamp. In both cases, wave length makes the difference.

Ultraviolet is that broad portion of the sun's radiant energy spectrum between the longest-wave x-rays and the shortest-wave visible violet. And as its wave length varies—more variation than over the entire visible light spectrum—so do its effects. That's why direct exposure to sunshine will tan you, but sunshine filtered through an ordinary plate-glass window will not—window glass is practically opaque to the kind of ultraviolet needed for tanning. (Wave length, incidentally, is measured in Angstrom units equal to 10^{-8} centimeters.)

survive. Cutting their growth with ultraviolet is cheaper than by low-temperature refrigeration in most storage rooms.

CHERRIES that flavor your favorite ice cream breed slime mold when processed. Although hard to kill in air, the airborne mold spore's growth on surfaces is easily prevented by steady exposure to ultraviolet radiation.

with Invisible Ultraviolet Radiation

By DR. L. J. BUTTOLPH

Ordinary glass absorbs certain wave lengths of ultraviolet from the sun just as the earth's outer atmosphere absorbs certain other wave lengths. Those absorbed by the outer atmosphere center around 2600 Angstrom units (2600 A)—most lethal germ-killing radiation—and except for this we might live in a virtually germ-free world. For air at the earth's surface carries living bacteria, yeasts, molds, and viruses to spread disease and waste. (An easy-reading book, slanted for engineers, that examines the practical aspects of ultraviolet is *Ultraviolet Radiation* by Dr. L. R. Koller of General Electric's Research Laboratory, published in 1952 by John Wiley & Sons, New York.)

Germicidal Tubes . . .

When mercury is vaporized in an electric arc, its spectrum is rich in ultraviolet. And the radiation generated by the arc when enclosed in an ultraviolet-transmitting glass envelope is essentially a function of the mercury vapor pressure. As the pressure decreases, the intensity of 2537 A ultraviolet increases rapidly.

Low-pressure mercury arcs convert 30 to 40 percent of the electric input energy into ultraviolet of 2537 A, nearly the most deadly bactericidal wave length. And this remarkable conversion is one of the unique coincidences in biophysics. (The low-pressure mercury arcs through a germicidal tube or fluorescent lamp in your home or office are identical. Difference is, the latter is coated on the inside with a phosphor that absorbs the ultraviolet and fluoresces to give off light.)

. . . and Microorganisms

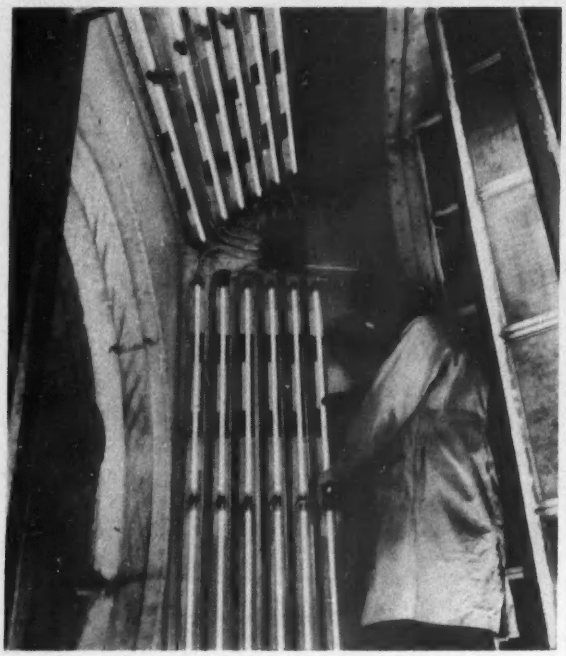
Ultraviolet in wave lengths from 2300 A to 2800 A is more lethal to bacteria, viruses, and molds than any other kind of radiant energy. The 2537 A ultraviolet is 100 times deadlier than x-rays, 1000 times deadlier than longer-wave nearly visible ultraviolet, and 30,000 times deadlier than yellow-green light.

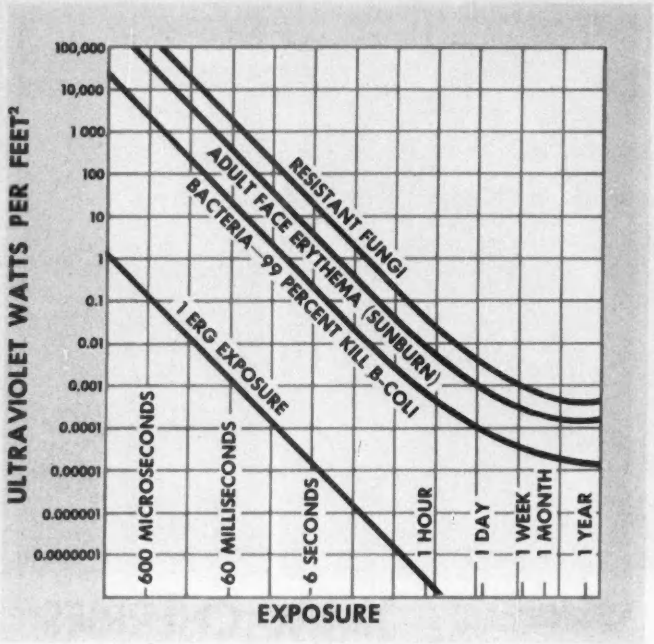
Microorganisms must absorb radiant energy before they will die. Shorter-wave x-rays and longer-wave ultraviolet pass through them with little or no absorption. But 2537 A ultraviolet is absorbed by the microorganisms' vital parts, and so changes lethal to them can be produced. (Bacteria and viruses vary in their susceptibility to ultraviolet killing; mold spores are 50 to 100 times harder to kill than bacteria.)

Camera Effects

Just as you can make a photograph in one hundredth of a second by bright light or take hours to do it by moonlight, so can you expose bacteria to a lethal dose of ultraviolet. For example, the same deadly effect is obtained in one hundredth of a minute with a certain amount of ultraviolet intensity as in 100 minutes with one ten-thousandth of that intensity. In practice, again as in photography, the exposure time is usually dictated by the job to be done. It may range from one-fifth of a second in an air-conditioning duct to five minutes for a product slowly moving along a conveyor belt.

Bactericidal ultraviolet will also give you a sunburn (erythema). Your face would have to be exposed however to 10 times the intensity needed for killing





AIR carries bacteria, yeasts, molds, and viruses. But its circulation past germicidal lamps in air-conditioning systems effectively destroys them because repeated . . .

EXPOSURE to ultraviolet radiation depends, like your camera, on intensity and time. One or the other can be varied for the same result—there's a reciprocal relationship.

bacteria—still not enough to kill mold spores. This kind of sunburn differs from that given by the sun and ultraviolet sunlamps because it's more superficial—the reddening disappears faster, your skin flakes instead of peels.

Protecting Products

Airborne bacteria are always a hazard to food, beverages, pharmaceuticals, and gelatinous photographic products. And mold spores are a menace too: hard to kill in air, their growth on surfaces is easily averted. (See photos.)

Continuous irradiation with ultraviolet will prevent mold growth on the damp walls and ceilings of bakeries, breweries, and wineries. A common use of germicidal lamps is, for example, over open-processing and storage tanks to prevent the growth of surface slime on sugar syrups, fruit products, and wine. They are also used to prevent sliming and clogging of the inner surfaces of air-conditioning ducts. Intensive irradiation of these surfaces forestalls the growth of mold and algae.

Pharmaceutical plants use germicidal lamps in many ways. One is the shielding of laboratory animals from infection by each other and by people. Besides irradiating the room air, invisible curtains of ultraviolet energy shield the occupants from infection by one another. Another use is the disinfection of blood plasma. A film of plasma a few thousandths of an inch thick is given an intense exposure of ultraviolet to rid it of the virus of infectious jaundice. (The Army specifies this method for all its blood plasma.) Milk can be disinfected by the same method but at present isn't practicable because of modified flavor.

After vacuum evaporation of sugar syrup in producing granulated sugar, bacteria remain that eventually cling to the surfaces of sugar crystals. These bacteria are harmless enough in the sugar you consume at home, but they may cause vegetables to spoil when canned. For this reason a special canner's sugar is disinfected with ultraviolet at most sugar refineries.

Spoilage-causing bacteria also grow readily on the moist surfaces of meat; refrigerating temperatures low enough to completely prevent such surface spoilage are expensive to maintain. Here ultraviolet usefully supplements refrigeration, humidity control, and air circulation. This is especially true of your retail butcher's storage rooms.

Limitations

The ideal radiation for product protection and disinfection would be one produced efficiently and with complete absorption by the microorganisms you want to kill. It would be capable of transmission to them through air and water, through all kinds of containers, and through the products they breed on. Ultraviolet of 2537 A wave length meets these requirements rather well, except for transmission through products and their containers. It is inherently limited in application to the disinfection of gases and fluids, and the surfaces of solids.

Only a few of the innumerable applications of germicidal ultraviolet have been given. Still, they illustrate the singular way in which you can use the radiant energy from low-pressure mercury arcs to destroy bacteria and fungi. This method doesn't have the objectionable heat that accompanies the longer-wave ultraviolet from high-pressure mercury arcs. Nor does it have the ionizing and destructive effects of shorter-wave x-rays and gamma rays or of electrons called beta rays. Ω

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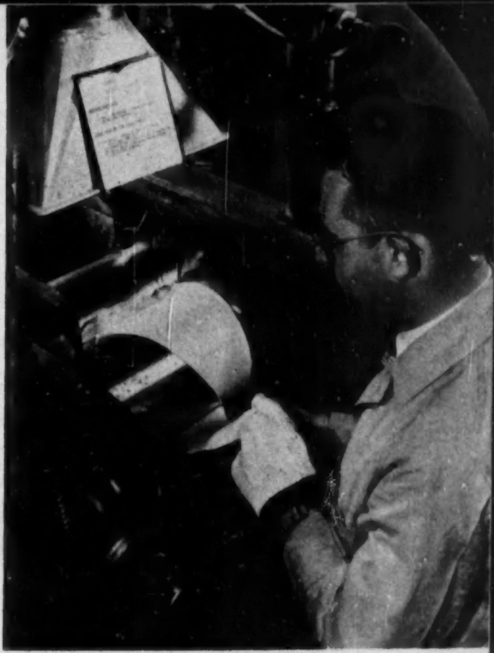
As Illuminating Engineer at General Electric's Nela Park, Cleveland, Dr. Buttolph is responsible for health application of lamps. During his 33-year association with GE he has been granted 50 patents and written 35 papers. His professional honors include the Fellow Grade of the AIEE, IES, and AAAS.



JUTE AND TAR INSULATED EARLY CABLES (ABOVE). TODAY, INSULATIONS ARE FIRST PRODUCED AND TESTED IN THE LABORATORY

Trends in Rubber Insulation

By I. C. EATON

While working in his laboratory in 1770, British chemist Joseph Priestley noticed that a mass of coagulated latex—brought from the "weeping trees" of South America—would rub out pencil marks. He promptly termed the stuff *rubber*.

Today we apply that name to a lot of finished products that are really rubber compounds. And so rubber, in its modern usage, is a material capable of a quick return to its approximate shape when stretched or otherwise distorted. A material thus classified is also called an *elastomer*.

With this in mind, then, we can rightly say that rubber—natural or synthetic—is one of the most important base insulating materials for wire and cable.

That's the way it has been since Charles Goodyear invented the vulcanizing process in 1839. In those early days, pioneers of the electrical industry made practical use of vulcanized natural rubber as insulation for telegraph cables. Gutta-percha—another of nature's elastomers—was used too. Hard and inelastic at normal temperatures, it came into use as insulation for underwater telegraph cables because of its superior water-resisting properties.

But it was Edison's invention of the electric lamp in 1879, creating a vast new demand for electric power, that made the use of natural rubber insulation increase by leaps and bounds. From there on, insulated wire and cable to transmit this power had to be built in approximate proportion to the growth of our electrical industry.

Until 1925, natural rubber had to suffice to handle the job. And it was fortunate for the industry in those days that the tree-grown elastomer is a highly versatile material. For this fact—coupled with remarkable developments in the chemistry, compounding, and processing of natural rubber—made possible its ever-expanding use in wire and cable products. These products ranged from small low-voltage building and control cables to large power cables operating at up to 15,000 volts.

First Synthetic Rubber

Since then the development of man-made rubber proved to be one of the highlights in a multitude of scientific achievements. (Because this article is confined to elastomers, no mention will be made of some important thermoplastic insulations for wire and cable.)

In 1931 the first synthetic elastomer to be made available in quantity was introduced. This was duprene—now called neoprene—and it subsequently extended the usefulness of elastomeric materials.

Neoprene, in contrast to natural rubber, is flame and oil resistant. It's also less permeable to gases and a good deal more resistant to oxygen, ozone, strong acids, and many other chemicals. It is tough and abrasion resistant. And though relatively poor electrically, and suitable as an insulation only for certain low-voltage applications, it makes a superior sheath, or jacket, for cable.

The virtues of neoprene for cable applications were early recognized, and General Electric was one of the first to take advantage of them. Developments embodying the use of neoprene streamed from our Construction Materials Division Laboratory in Bridgeport. They resulted in aircraft-ignition wire, mining-machine cable, Versatol (Reg. trademark, General Electric Company), geoprene, PreenX, and many others.

An acceleration in the material's use for cable applications, particularly as protective sheaths, has been the trend for the past 20 years. And it is likely to continue for some time to come. Production capacity for neoprene is now about 70,000 long-tons per year, more than half of it consumed by the cable industry. This should give you a good idea of neoprene's importance in cable construction.

War Baby

True, neoprene was the first synthetic rubber produced in volume. But further developments on other types originating around 1900 were climaxed by our production, also, of the German buna family of synthetic rubbers—based on the important chemical, butadiene.

Our sources of natural rubber in the Far East were cut off during World War II. And without the hundreds of thousands of tons of buna rubber produced, certainly our war effort would have been seriously impaired. It's likewise true that without these synthetic rubbers Germany's military effort would have collapsed sooner than it did.

Buna S was selected by our government as the preferred general-purpose synthetic rubber. It is a copolymer of butadiene and styrene; that is, the molecules of these materials are combined into larger, more complex molecules, or chains. The building of an enormous capacity for producing this type of rubber at record-breaking speed during the war years is a credit to America's free-enterprise system.

There are no great accomplishments without great effort. In those early war days the quality of buna S was poor. A host of problems connected with its manufacture and use had to be solved. Also it was vital that the production of rubber-tired transportation be kept going and increased demands be met in the field of electric power transmission and distribution. From necessity we quickly found how to use buna S and improve its quality.

Because of its present excellent quality, buna S is rapidly supplanting natural rubber as insulating material for a wide variety of wires and cables. In electrical properties it is superior to neoprene (July 1952 REVIEW, pages 57, 60). It has good dielectric strength, high insulation resistance, low power factor, and a low dielectric constant.

You should bear in mind that the term *buna S* is a generic one and relates to a large family of copolymers of butadiene and styrene. These materials can be tailor-made to meet a broad number of requirements. On the other hand, natural rubber, although versatile, is what the tree produces and its basic properties are definitely and inflexibly established. It's therefore likely that buna S will continue to be an important insulating material for wire and cable for some time to come. (A discussion of buna N is omitted. Although important, it is a material of somewhat limited use at present in wire and cable. It's possible, even probable, that its use will increase in special applications as time goes on. In properties it most closely resembles neoprene.)

Strictly American

In contrast to the bunas, essentially German inventions, buytl rubber is strictly an American invention. The first pilot plant for producing butyl rubber went into operation in 1939. The first commercial plant started operations in 1943 at Baton Rouge, La., with a rated capacity of 300 tons per day.

To determine their possibilities as electric insulating materials, you only have to examine the molecular structure of the various natural or synthetic elastomers. Such an examination shows that butyl rubber has excellent potentialities as high-voltage insulation. One important reason is that its molecular structure, compared to that of natural rubber or buna S, isn't vulnerable to chemical agents, such as oxygen or ozone. But like natural rubber and buna S, butyl rubber has a low power factor, low dielectric constant, and good dielectric strength. It also has high insulation resistance, is highly heat resistant, and when properly compounded has low water absorption.

All these factors add up to make butyl rubber a material of great promise, particularly for power-cable insulation. Our laboratory development of it began early in 1940, long before the material was available in commercial quantities. We recognized that in butyl rubber we might find a means of revolutionizing power cables that use rubber as an insulation. As a result, G-E Super Coronol cable is giving an excellent account of itself across the country. It is now being manufactured in ever-increasing quantity.

The trend in power-cable insulation is therefore definitely toward butyl rubber. And in view of its many excellent properties—heat resistance, low-temperature flexibility, high insulation resistance—it is likely that the usefulness of butyl rubber for cable insulation will greatly expand as time goes on.

Hybrid Rubber

During the early 1930's, General Electric's Research Laboratory in Schenectady became interested in the silicone family. Then, as developments progressed, here in Bridgeport we recognized the possibilities of silicone rubber as insulation for cable operating at relatively high temperatures. And now, through co-operative developments within the Company, silicone-rubber-insulated wire and cable are being produced at Bridgeport in increasing volume.

Silicones are chemical hybrids—part organic and part inorganic. Essentially because of the inorganic portion, they are more heat resistant than most wholly organic materials. At any rate, silicone rubber has the highest heat resistance of all known elastomers.

Besides its outstanding heat resistance silicone rubber is excellent electrically and has remarkably good low-temperature flexibility. Superior to any known elastomer, also, is its corona resistance. When burned, the material's ash is largely silicon dioxide, a nonconducting powder that lends insulating properties if kept in place around the conductor. This is an important feature because under proper conditions it allows continuance of cable service even after fire.

Although now made in considerable volume, silicone rubber is still relatively high-priced. And for many important applications in wire and cable, its extensive use must await the price decreases that ever-increasing production inevitably brings. It seems likely that both producer and consumer working together will set the stage before long for making silicone rubber a large-volume insulating material for wire and cable.

Future Trends

The success of synthetic rubber in other fields, such as automobile tires and tubes, is known to millions. You may find it interesting to note that in the United States during 1951 we consumed 748,650 long-tons of synthetic rubber of all types; this against 454,015 long-tons of natural rubber.

It is my prediction that in a short time little natural rubber will be used for wire and cable insulations—unless there is an unexpected drop in the price of natural rubber to a level below that of the synthetic product. Ω

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Manager of the Construction Materials Laboratory at Bridgeport, Mr. Eaton has a broad knowledge of the use of rubber for cable insulation. He has been with General Electric for over 20 years, was graduated from Massachusetts Institute of Technology, and is a member of the American Chemical Society.

IN THE PAST 18 YEARS, SIZE AND WEIGHT OF DISTRIBUTION TRANSFORMERS HAVE DECREASED ENORMOUSLY AS A RESULT OF . .

Orienting Grains in Transformer Steel

By MICHAEL J. BOLTON

The grain-oriented silicon steel used in today's transformer has extremely one-directional magnetic properties. Nearly 95 percent of its grains are oriented in the rolling direction. It is developed to a point where its use as a core material means a reduction of more than 60 percent in the transformer's size and weight.

So as far as grain orientation in the rolling direction is concerned, you might say that we've reached a point of diminishing returns. The next logical step is therefore to alter the present orientation: that is, make equally as good the magnetic properties across the sheet, or at right angles to the direction of rolling.

A Look Inside

Oriented silicon steel is an alloy of 3.5 percent silicon; the remainder is iron with controlled amounts of impurities. By *oriented* we mean this: a single grain is composed of either just a few or billions of cubes—the so-called body-centered cube—depending on its size. Each cube "stands" on edge relative to the grain's surface like a block rolled over 45 degrees (Fig. 1). This edge parallels the rolling direction of the steel. All the definitely constructed cubes fit together like blocks and are uniformly aligned to comprise a grain. Where one region of cubes meets another region aligned at a slightly different angle, they don't mate perfectly. This dislocation is the grain boundary.

Such an arrangement of grains allows you to take advantage of anisotropy—the variation of a cube's magnetic properties, and many other properties as well, when measured in different directions. The principal directions, or axes, are: 1) along any cube edge,

Mr. Bolton, Dr. C. G. Dunn, F. W. Daniels, and F. Lionetti, Materials and Processes Laboratory, Transformer Division, Pittsfield, Mass., received the AIME 1952 Mathewson Gold Medal for papers on grain boundary energies. With GE since 1945, Mr. Bolton is a General Metallurgy Group Leader.

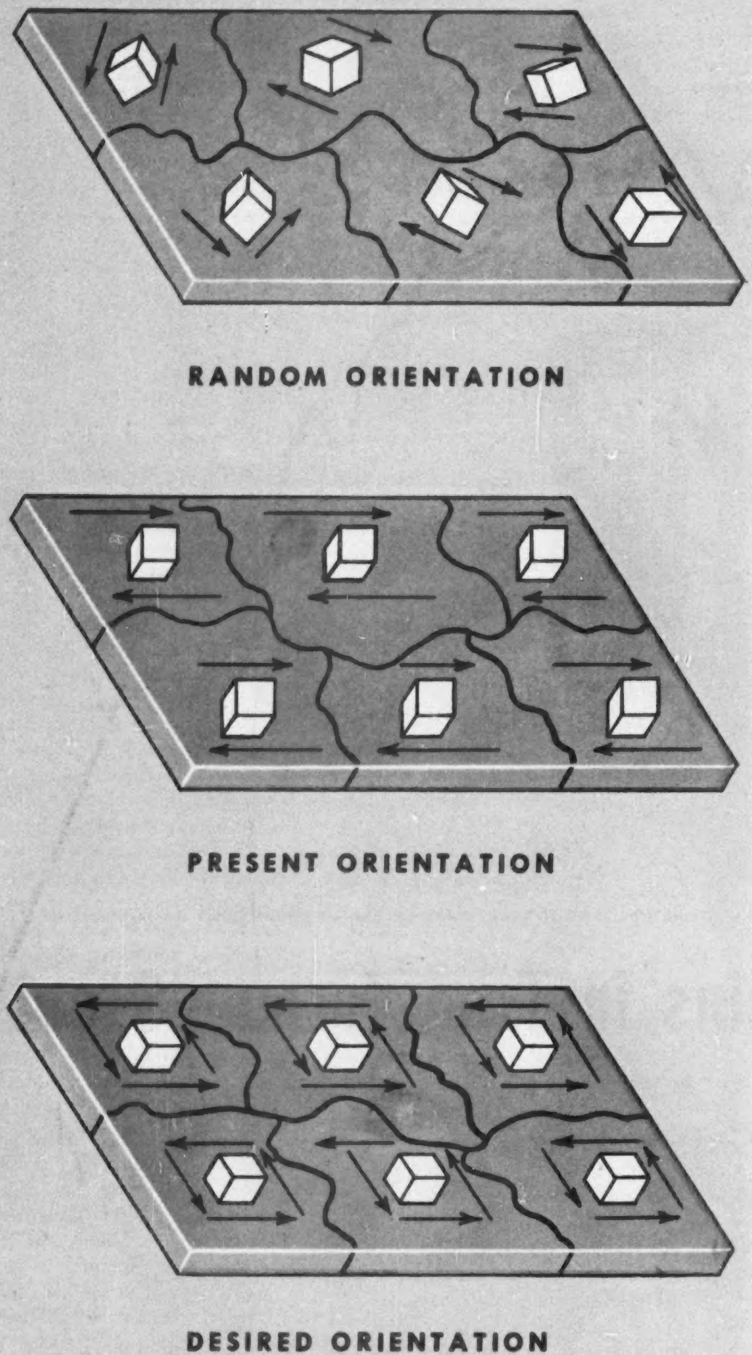

FIG. 1. CUBE ORIENTATION within grains: random; present, with cube edge in rolling direction; desired, with cube sitting on one of its faces—goal of metallurgists. Arrows indicate best magnetic directions within the steel sheet.

[100] direction; 2) diagonally across any face, [110] direction; 3) diagonally through the body from one corner to another, [111] direction. As you can quickly see from Fig. 2, the cube-edge direction has great magnetic superiority over the other two. Transformer cores are so designated that magnetic flux flows in this, the rolling, direction.

Over the Years

The graph on page 13 shows the year-by-year development of grain-oriented silicon steel and its effect on transformer size. Up to 1935, non-oriented silicon steel was used for transformer cores; after that date oriented silicon steel was generally adopted.

Oriented steel first had about 25 percent of its grains aligned in the rolling direction. And as this percentage increased through the years, the watt loss per pound of steel decreased. Today nearly 95 percent of the cubes are arranged in the desired manner.

The photograph of an etched strip of oriented transformer steel (Fig. 3) illustrates the large grain size; some of them measure a half-inch or more in length. White, black, and gray areas show up in the photo because the grains reflect light at different angles. White areas are grains in the correct plane for reflection straight into the camera, dark areas are grains tilted about five degrees out, and gray areas are grains in intermediate positions between the two. (This "flashing" method is one way to determine grain orientation.)

Engineer's Dream

Since present orientation is almost complete in degree, further improvement makes it necessary to change the type. As you've seen, the cube is oriented in the rolling direction and balanced on one edge. An obvious lead, then, would be to "roll over" the cube so that it sits on one of its faces. This way you could utilize two excellent directions—one in the rolling direction and one across the sheet.

Many new designs could be dreamed up with such a material. For example, a small transformer core is now constructed in the form of a hollow rectangle. To take advantage of present orientation, you build the core up with strips, log-cabin style. That is, you lay down two strips for legs, lap a strip across at the head and bottom, and so on until you've got the desired thickness. This way the flux is offered the best magnetic path. But in doing it, you've introduced nonmagnetic paths, or air gaps, in the lapped joints.

If, however, the material had the two good directions mentioned previously (Fig. 1), you could punch out the rectangle in one operation. Lapped joints would be eliminated and with them the tortuous path followed by the flux. Reduced core losses would allow you to reduce the transformer's size, save on all materials, and cut manufacturing costs.

A First Step

But before you roll cubes to get good magnetic properties in two directions, you first need to completely understand the mechanism of a grain nucleation and subsequent growth. In other words, given a specimen of several grains, you must know how to make one grain grow while suppressing growth of the others.

To get the present orientation, a series of closely controlled cold reductions—rolling at room temperature—followed by heat treatments are necessary. So, fundamentally, the question resolves on evaluating and utilizing the *driving force* that will make a number of grains grow. (Driving force is the repressed energy you induce in a grain by hammering or cold-rolling it. When you apply a heat treatment, this energy is released in the form of grain growth. The grain grows by absorbing its smaller neighbors, since energy is a function of mass, and depends on several other factors, also.)

The growth of oriented grains in the present strip texture is well established but not so well understood. Grains oriented in the rolling direction tend to grow faster than those in other directions. Under most circumstances well-oriented grains must therefore have a greater energy differential than poorly oriented grains before and after heat treatments. To begin to understand this phenomenon, one approach is the determination of relative energies involved in boundary movements, or grain growth.

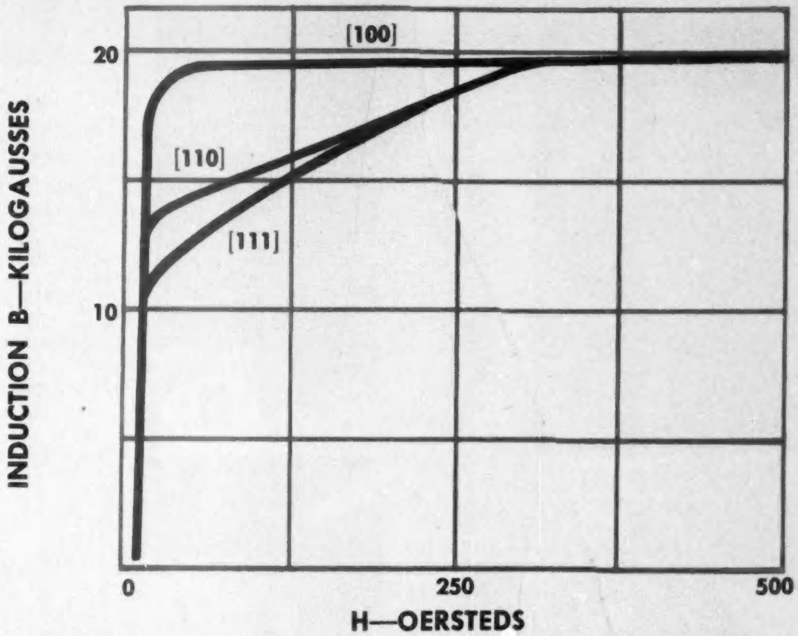

FIG. 2. MAGNETIC PROPERTIES along cube's edge are superior to other major directions. Present orientation of transformer steel has cube edge in rolling direction.

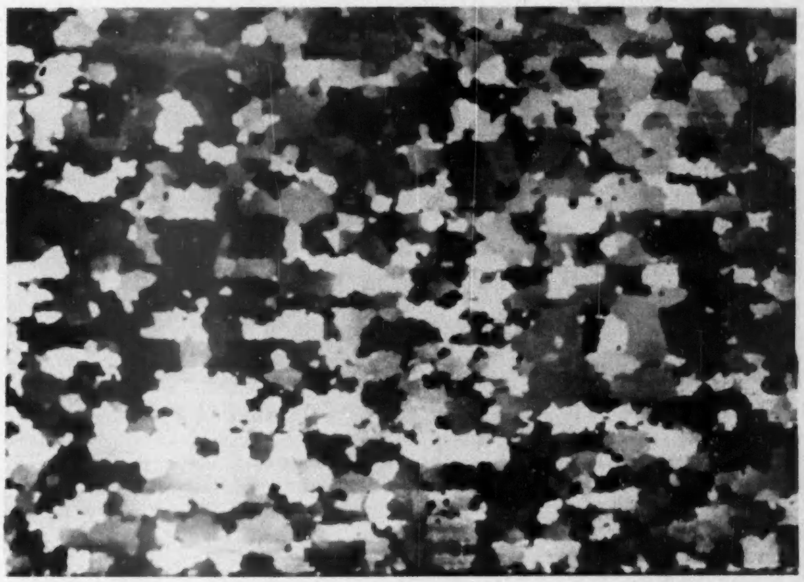

FIG. 3. LARGE GRAIN SIZE in oriented silicon steel is result of controlled growth. An understanding of this phenomena is key to further reduction in transformer size.

Shift for Position

A three-grain sample of silicon steel was prepared (Fig. 4), with all three grains having a common plane but varying in direction. Grain boundaries between each were anchored by notching the sample as shown. It was then successively heated to high temperatures and slowly cooled so that boundaries would move to an equilibrium position. In specimen T1 note how grain 3 advances and absorbs part of grains 1 and 2. That's because it has a higher energy differential than either of the others. Similarly, grain 1 absorbs part of grain 2 because its energy differential is higher than the latter's. A similar but less pronounced effect occurs in specimen T2.

Prepared like this, and annealed long enough, a sample will come to equilibrium with a configuration that depends on energy relationships. You can compare the phenomenon with a mechanical analogy—the triangle of forces (Fig. 5). If the three weights in the analogy are changed, the angles between the strings and the areas will

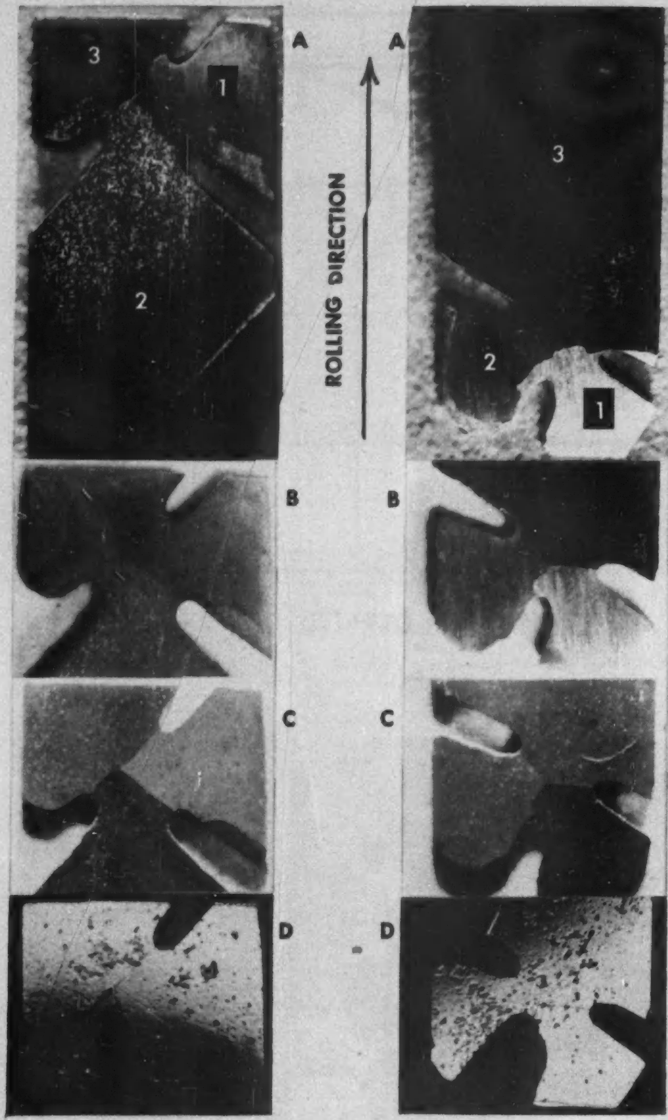

FIG. 4. GRAIN GROWTH of three-grain specimens: A, original specimens; B, after heating 12 hours at 1300 C; C, fifth anneal; D, final anneal. In specimen T1 grain three grows at expense of its neighbors. Metallurgists attribute grain growth to internal energies induced in grains by cold working of metal.

RELATIVE ENERGIES DERIVED FROM MECHANICAL ANALOGY OF THREE GRAIN SPECIMENS

Specimen	Equilibrium Angles			Relative Energies		
	θ_1	θ_2	θ_3	E_{12}	E_{13}	E_{23}
T1	82	111	167	0.11	0.50	0.50
T2	102	131	127	0.43	0.50	0.50

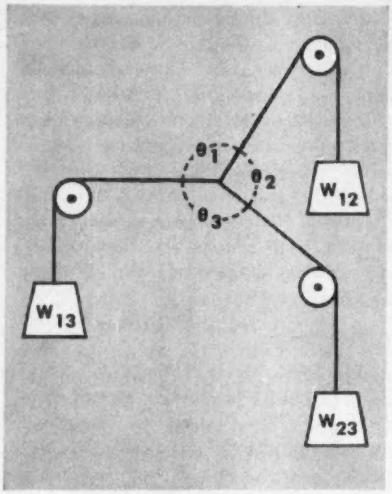

FIG. 5. FORCE TRIANGLE depicts grain growth. Weights represent grain energies.

also change until a position of equilibrium is reached. Likewise, in the three-grain group, heating the sample releases the suppressed energies—analogous to weights—and allows the grains to shift to an equilibrium position.

Measurement of the angles between grains gives you a relative comparison of energies. A formula for the three-grain group, based on the mechanical anology, is

$$\frac{E_{12}}{\sin\theta_3} = \frac{E_{13}}{\sin\theta_2} = \frac{E_{23}}{\sin\theta_1}$$

where E_{12} is the grain boundary energy between grains 1 and 2, and θ_3 is the boundary angle of grain 3. Any two energies can be calculated when a third energy and the equilibrium angles are known. Thus we can study relative energies of grains with different orientations, lying in a common plane. Results for specimens T1 and T2 are given in the table (bottom, left).

Encouraging Outlook

Although the subject has barely been scratched, we've observed some interesting features. And experimental evidence has fairly well agreed with theoretical predictions. This lends encouragement that, from a practical viewpoint, factors controlling the growth of grains in metals will one day be evaluated and understood.

The possibility exists that these energy studies will allow us to check the growth of unwanted grains and promote the growth of desired ones. When this happens, we'll be able to produce the steel that engineers need to further reduce transformer size. Ω

SOME PRODUCTS...

INDUSTRIAL

Relays
- Overload
- Time-delay
- Undervoltage
- Frequency
- Polarized
- Reverse current

Switches
- Pressure
- Vacuum
- Liquid level
- Temperature
- Position
- Speed

Brakes

Resistors

Rheostats

Push buttons

Contactors

And others

DOMESTIC

Snap switches

Thermostats

Controls for
- Refrigerator
- Freezer
- Range
- Washer
- Dishwasher
- Oil burner
- Blanket
- Toaster

MILITARY

Practically all industrial products with added design features to meet military requirements.

...AND SOME PROBLEMS

Why is silver or copper blown off in small chunks from contact faces when arcing occurs?

Why do fine silver contacts often refuse to conduct current at 110 volts?

Why does an arc that a magnetic force moves in a certain direction at sea level refuse to move at all at some altitudes, or even reverse its direction at other altitudes?

Why should a brake bring a gravity load to standstill and then later allow it to move?

Why should a five-to-one lever give only a three-to-one ratio of movement?

When metals rub on each other which pair will give maximum life or minimum wear per million operations?

When ground-magnet faces hit each other what are the conditions determining the rate at which the faces wear away?

DESIGN OF SMALL APPARATUS—HOW LARGE IS THE FIELD?

By DR. L. T. RADER

Motors, generators, transformers, and turbines are design fields known to all. But there's a field not so well-known—far more extensive, although a bit less spectacular—that covers a wide range of devices in the electrical industry. It's the field of small apparatus.

Its variety in a single product line or in kinds of products, is measured in the hundreds and its annual business runs into the hundreds of millions of dollars.

Speaking broadly, this is the field of control equipment—the control of electric power in industry, in the home, and on the fighting fronts, as shown on the partial product chart above.

Motors on a steel mill or an elevator are controlled by these products. Hand-operated push buttons or drum switches initiate action, magnet-operated switches close power circuits, time-delays accelerate and decelerate, and overload relays protect the motors. Brakes mechanically stop the motors, resistors absorb energy either on starting or stopping, and rheostats give voltage or speed control. From this you can see how all of industry depends on such devices for the control of motors.

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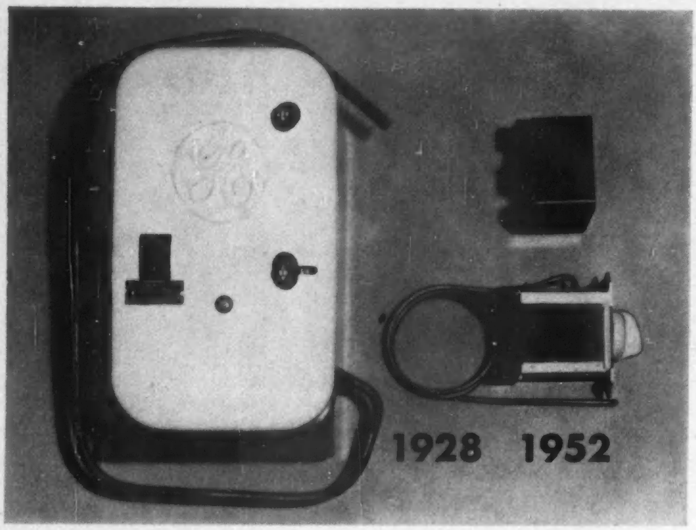
Dr. Rader joined General Electric in 1937 on the Test Course. In 1945 he went to the Illinois Institute of Technology where he was head of the Electrical Engineering Department. Returning to GE in 1947, he became Manager—Engineering, Control Department, Schenectady, in 1951. He is now Manager—Electronic and Specialty Control Planning Study in that Department.

(Small apparatus design is sometimes referred to as a field of gadgetry. Webster defines a gadget as a contrivance, object, or device for doing something. And even though there is a nontechnical connotation to the word, the definition fits quite well—largely because it is so all-inclusive.)

College Design Courses

Now that we have sketched in the boundaries of small apparatus design, let's look at an important factor.

In most college courses in electrical design, the design procedures are fairly well-established. The text books, though not up to date by industrial standards, do give an insight into certain methods of design for, let's say, transformers and rotating equipment.



HOW WOULD YOU DESIGN A CONTROL FOR A HOUSEHOLD REFRIGERATOR?

The control essentially is a temperature-sensitive device—usually a vapor-filled bellows that must energize a circuit whenever the temperature in the refrigerator rises above a preset value, and must de-energize the same circuit when the temperature falls to another point. The temperature at which the refrigerator motor is called on to start must be constant within a degree. The difference between the ON and OFF temperatures must also be held accurately.

All this is accomplished by a small control unit that the housewife sees only as a tiny knob capable of being set to various temperatures, and also capable of satisfying certain positive requirements in a defrost position. In addition, a completely hidden control that starts the single-phase refrigerator motor must insert and also remove from the circuit the starting winding in split-second accuracy, under all conditions of loading and line voltage. As a further requirement, the control must have an automatically reset overload component to protect the motor under running overload, or stalled conditions. As a further design complication, the controls must function properly in high and low temperature, must withstand impact and vibration, humidity or fungus, and be capable of at least 15 year's service—all at a cost of very few dollars per refrigerator. In the period indicated in the picture above, the size and cost have been reduced considerably and the accuracy and reliability increased to a nearly trouble-free condition.

But in the product field we're discussing, effective college training is nonexistent. Why? Largely because electrical and mechanical engineering professors have had no experience in the field, and because there is an almost complete absence of written material that can be used as a text.

Although a drawback to the college student, this is actually a long-term benefit to the young engineer in the field because it proves that the ideas move at such a fast pace that there has never been time to permit design documentation. As a result, prescribed textbook methods just don't exist.

This is a field that is dependent almost entirely upon *fundamentals* rather than on derived relationships. Every year competing companies bring out new designs to do a certain job—perhaps a refrigerator relay or a mechanical regulator—and the finished products often bear no resemblance to an earlier design, or to each other. New principles of design, new materials, or radically different manufacturing methods may be so employed that the same end-use product is unrecognizable in terms of its forerunners. The fundamentals required range the entire field of physical knowledge—current, voltage, and flux relationships, both a-c and d-c; vibration; mechanical stresses; impact; heat transfer; and in one way or another almost any physical, chemical, or metallurgical knowledge you may care to list. (Some of the problems related to this field are listed in the chart at the top of the preceding page.)

If the possibilities are so unlimited, why do some young engineers shy away from this particular design field?

One answer I have heard is that they think it involves repetitive, routine work, and a lack of contact with people. Unfortunately, many get this idea from their college design associations. True, such conditions may exist in some design fields, but most certainly not in the design of small apparatus. More than ever before a designer must be aware of all competitive products in the field; he must be able to learn from customers, commercial men, and manufacturing experts; he must know about products and their specifications; and he must be alert to the possibilities of new materials, principles, and manufacturing methods. The man in design who sits alone, apart from the moving industrial world, will not long contribute significantly.

Qualities Required

So far we have seen what the design field of small apparatus can offer the engineer. What in turn are the specifications and qualities the field demands *from* the engineer?

The qualities required for success in design are essentially those required for success in any field—a liking for the work and an ability to work toward a goal. Specifically, an inquisitive and searching mind is a definite asset.

Inventive ability is also invaluable, but only a small percentage of today's designers have that almost divine gift. Veteran designers who have received more than 100 patents are rare enough to be the exception rather than the rule.

And the kind of college course taken seems to have little bearing on success in this design field. Whether an engineer is an electrical, mechanical, chemical, or even a civil graduate makes little difference if he has learned fundamentals and possesses the ability to reason clearly. This fact is doubly confirmed by the knowledge that many of today's successful designers began their industrial careers as draftsmen or machine apprentices and did not have the advantage of college training.

Methods of Design

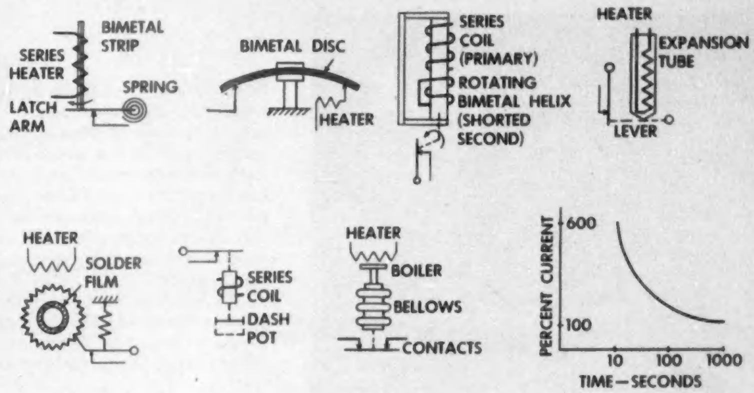
In further discussing this design field, it's interesting to note that few major contributions in the small device business had their inception in an analytical derivation. This fact is little-known but well-substantiated. You just can't sit down and write equations whose solution will produce a better overload relay than any on the market, or a better switch, brake, or regulator. First, you must determine the principle or method you will use, and the determination of the principle is usually the crux of the design.

This isn't to say that the analytical approach is useless. On the contrary, it is valuable as an *aid* to design in many instances. Dimensional analysis is particularly useful, and because data can easily be taken on small models, many of the principles of statistics find good application. Equivalent circuits, both electric and thermal, have been found useful in the analysis of overload-relay applications, resistor design, and coil heating.

But the major design method is still that of invention or ingenuity. A designer thinks a certain method may work. He sketches it out and builds a sample. He takes data on the sample and evaluates it. He often finds the idea is unworkable, but in the process of analyzing it he finds another workable scheme. Some call this cut-and-try engineering. It is, but there is no stigma attached to this method because it entails formulation of workable ideas. After all, workable ideas are the hard core of all successful designs.

Frequently, design is made more difficult by the fact that answers to physical phenomena are not always available to the engineer, because there is often a large gap that must be spanned between physical law and its useful application. The design engineer can accept little as being certain without experimental verification, because many laws hold perfectly only under certain controlled conditions. The successful designer must be certain his product will work under *all* relevant conditions.

Thus it can be said that any method achieving the desired results is a satisfactory one. C. I. Hall, one of the outstanding inventors in General Electric, has a self-made rule that there are at least eight ways to do any design job. He will not settle on any one until he has developed, if possible, eight alternatives. This may appear somewhat far-fetched, but it is a method, and it works for Hall. Some use analysis and synthesis, others depend on invention; nearly all study competitive devices in the same or related fields.



OVERLOAD RELAYS

The overload relay is an example of a line of devices in small apparatus that perform a very important function. Yet it must be of small physical size and low cost. It is perhaps the best example of a product line in which many different design principles have been used successfully. This type of relay must act to disconnect power from a motor when the motor approaches a dangerous condition of overheating. It must maintain tripping time as a function of motor current approximately as shown by the curve above.

Also shown above are some of the designs which have been built to perform this function. Besides the approaches shown, others have used curie metal, a magnetic material that changes its permeability with temperature; and temperature-sensitive resistance materials such as thermistors.

What the design of a few years from now may be is anybody's guess. It may be a principle not now known, or an adaptation of a present method. As long as the function can be performed to meet all the required specifications of performance, size, and cost, any method is permissible.

Design for Manufacture

Regardless of the principle chosen, whether it be a new approach or a modification of an old one, the skill of the designer in designing for inexpensive and easy manufacture often is the difference between success and failure.

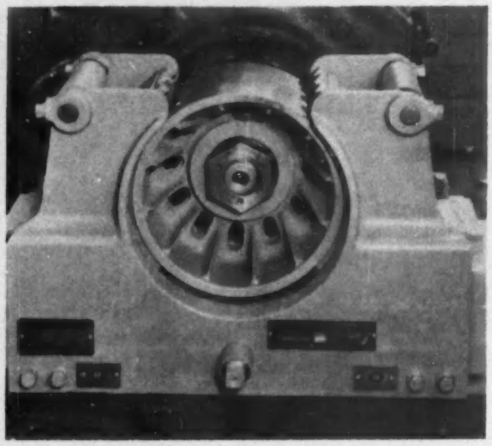
A great number of otherwise ingenious designs fail because of inherent manufacturing difficulties. In this area there are engineers who perhaps do not possess inventive ability themselves, but who do make major contributions by taking a designer's "bread-board" sample and adapting it to manufacturing.

Men with a good knowledge of manufacturing methods are invaluable in determining if punch-press stampings can be used instead of expensive screw-machine products, or if it is better to use punched phenolics instead of molded parts. They develop ingenious methods of fastening components together, break a unit down into subassemblies to give flexibility, make certain that standard parts are used where possible, and in general, make certain that over-all product costs are maintained at competitive levels.

New Materials

Because designers have so many diverse problems to solve, they are always willing to try new materials that may offer design advantages. Here again the nature of the products lend themselves to experimentation. For it is far easier—and less risky—to make ten samples of a pressure switch out of a new material and have them field tested, then it is to try the same material on a large and expensive machine.

Because of this, we find that insulating materials such as the silicones, permafil, nylon, and teflon are applied in small devices almost immediately upon discovery. Special magnetic materials like oriented silicon and alnico have also found immediate application. Plastics of every formulation and pro-



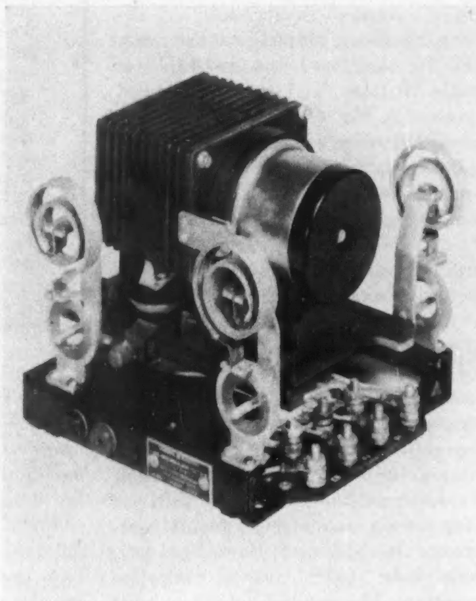
BRAKES . . . A brake in the control industry is usually set by a spring and released by an electromagnet. The latter may be a-c or d-c and may be designed in any number of ways including single-magnet or double-magnet brakes. In certain operations a motor-driven hydraulic actuator, known as a thrustor, is used, while the brake itself may have one or several shoes, or may be of the band-type. The crux of the whole brake design is, of course, the coefficient of friction between the brake lining and the wheel. Here the designer rapidly finds that he cannot go to a textbook for an answer. Instead, by analysis of his own experiments on prototypes and by utilization of information supplied by the manufacturer of the lining, he must determine the proper coefficients under all the variables with which he must cope, and design accordingly. The picture shows a two-shoe brake that has the minimum number of wearing parts, a simple means of adjustment, and ready accessibility for maintenance. All of these factors are desirable features but secondary only to performance requirements.

VOLTAGE REGULATORS . . . Few problems in design are more interesting or demanding than those related to voltage regulators. For instance, the aircraft voltage regulator is a device that must be calibrated to the precision of an instrument, must be capable of dissipating considerable power, and at the same time must control the output voltage of a generator operating over wide ranges of speeds and loads. It must maintain this control at all temperatures from tropic heat to arctic cold, in desert sand storms, ocean spray, jungle dampness, and at the highest altitude of modern flight. Weight must be held to a minimum, and the cost of each part and assembly must be carefully watched.

Three types of regulators are used in aircraft: the vibrating-contact type that is limited to low voltage and power; the finger regulator that cuts in field resistance in steps as the voltage increases; and the carbon-pile regulator that is now the most widely accepted type (picture, right).

The carbon-pile regulator makes use of an electromagnet to measure the output voltage of the generator. The magnet force is matched closely to the force of a nonlinear spring. The difference between the magnet and spring forces (the error force) is applied to the carbon pile that is in series with the generator field. The carbon pile, which consists of a stack of thin carbon and graphite discs, has a decreasing resistance under compressive force. In a current design the resistance of the pile must be capable of being varied in a range of from 1 to 35 ohms when controlling generators with field resistances of three to five ohms. This variation in resistance is accomplished by a total compressive movement of about 0.003 inch. With so small a movement causing so great a change in resistance, it becomes apparent that close attention must be given to the thermal expansion of all the parts of the device, because it must operate in ambients from −55 to +70 C while dissipating from 25 to 90 watts.

The regulated voltage must be maintained within 2½ percent under conditions of minimum generator speed at full load and maximum speed, no load; and must be held within five percent under all conditions of loading and temperature. To obtain this close control and avoid instability, negative feedback circuits are used. Because of the accuracy required, each component must be carefully designed to permit full accuracy while utilizing easily controllable manufacturing processes.



perty and special metals like stainless steel, curie metal, beryllium copper, and Z-nickel have been used immediately upon development. In the area of current conduction and interruption, special alloys made of combinations of practically all known metals are used extensively for their special properties. Because of its nature and form, small apparatus design eagerly accepts new materials almost immediately upon their release to industry and finds useful work for them to perform.

(On the preceding page and above you will find a description of some small apparatus devices, some of the problems involved in their design, and how they have been solved.)

How Large Is the Field?

Unlimited! The engineer with a desire to build something new, something better, has full scope for all his ingenuity and aggressiveness in this expanding field. No activity of present-day or future industry offers comparable promise, and no work-a-day pursuit is less cluttered with rules, signposts, and tradition. Ω

PURGES AND POLITICS OVERSHADOW TECHNICAL INFORMATION IN COMMUNIST MAGAZINES. IT'S ALL PART OF THE STORY OF . . .

Engineering Behind the Iron Curtain

By P. A. ABETTI

In a totalitarian state all human activities are dominated by a supreme political goal. Electrical engineering is no exception: the technical journals that appear from behind the Iron Curtain confirm that fact.

The articles are technical and often interesting, but they're also the means of promoting a dull and desperate brand of political propaganda. Party appeals, records of purges, portraits and fevered praises of the Communist rulers, repeated quotations from Marx, Lenin, and Stalin, raucous attacks against the countries and engineers of the free world, and sneers at their achievements —all these are found in the electrical engineering publications of Russia, Eastern Germany, and Yugoslavia.

Elektrichestvo is one of the most important and widely read Russian electrical engineering magazines, and you can get its political character from the first page of any issue. At the top of the contents page above the title are these words by Lenin: "Bolshevism is the power of the Soviets, plus electrification of the whole country." (See A, above.)

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Mr. Abetti, a native of Italy, came to General Electric five years ago. He received a 1952 Coffin Award (see page 7) for his work on large power transformers. A proficient reader in eight languages, he closely follows trends in foreign technical publications. At GE's Pittsfield plant he is an Insulation Development Engineer, Power Transformer Department.

On the next page of the November 1951 issue you'll find at the top in large type:

> For the 34th Anniversary of the Great October Socialistic Revolution! [See B, above.]
>
> Workers of the scientific institutions and institutes of higher learning! Fight for the highest prosperity of the Soviet science! Develop more daringly creative criticism and self-criticism in scientific work! Enrich science and engineering with new investigations, discoveries and inventions! Improve the training of the specialists for national economy! [See C, above.]
>
> Under the banner of Lenin, under the leadership of Stalin—forward, to the victory of communism! [See D, above.]

"Soviet science is the most progressive in the world . . ."

(From the appeal of the Central Committee of the Communist Party of the Soviet Union (Bolshevik) for the 34th Anniversary of the Great October Socialist Revolution.) [See E, top page 21]

Following this flaming appeal is an editorial titled "Let Us Conquer the Scientific and Technical Tasks to Solve the Problems of Communist Constructions." (See F, top page 21.)

First, praise and adoration:

Soviet science is the most progressive in the world, it serves faithfully the nation which is building communism. The Bolshevik party and the Soviet government continuously strive for the prosperity of science, establish all conditions for scientific creation, direct the development of science in the direction of service of the real interests of the people, and strengthen the indissoluble bond of science with practice of communist construction.

The scientists of the Soviet Nation are triumphantly solving the problem set by comrade Stalin—not only to reach, but also to overtake in the shortest time the achievements of science beyond the frontiers of our country.

(Incidentally, the slogan that Soviet science must reach and overtake the achievements of the free world is not new. It was used in 1929 with the launching of the first five-year economic plan.)

The article in *Elektrichestvo* continues with more direct references to electrical engineering:

Science and engineering are indispensable for the progress of our country, for the fulfillment of the program set by Stalin. The great hydroelectric plants and transmission lines which will distribute widely electricity cannot be realized without the self-denying and fruitful contribution of all the technical intelligentsia of the Soviet Union.

But the rhapsody fades, and a shrill wind is heard, heralding the approaching storm:

The achievements of Soviet scientists and engineers are great. But comrade Stalin teaches us not to be haughty, and not to rest on our laurels. It is evident that all failures in accomplishments must be uncovered without mercy, regardless of the kind of deficiency. Soviet scientists must correct their mistakes, to be able to mobilize their forces and wills for the solution of the new problems, presented to them by life. A tight bond with life, with practice, service for the welfare of the nation—these are the characteristics of Soviet science.

Each scientist, each member of a collective research team, each scientific research institute of the country must connect always more its activities with the demands of life. The scientific forces and the material resources of all institutes, of all laboratories, must be concentrated for the solution of the most important problems of national economy.

Denunciation of failures and mistakes in electrical engineering are pointed out so that all can see:

Not all the scientific institutes have actively inserted themselves into the work of the high-priority problems, connected to the greatest increases in production, to the construction of the giant hydroelectric plants and canals, to the construction of new machines, mechanisms, apparatus of automatic regulation, to the better organization of the work of construction and assembly, etc.

Some scientific research institutes and laboratories are detached from practice, remain aloof from life, squander forces and means by working on insignificant and secondary projects.

At the same time also the leaders of particular industrial enterprises deserve reproach. They have assessed wrongly the growing bond between scientists and industrialists. They should have submitted their problems in good time.

Some technical institutes have released young engineers, who do not know enough engineering of the past, and nothing at all about new apparatus, machinery, control systems, materials, measuring instruments. Some laboratories are not keeping up with modern science—it is no secret that there are some scientific workers, which for years have been falsely called 'co-workers' in projects which have been solved long ago in theory and in practice.

The self-denunciation of the Soviet electrical engineers begins. They bow in shame to the reproaches and dictates of the Party:

A stern and just criticism has been published in the pages of the central organ of our Party by the Division of Technical Sciences of the Academy of Sciences of the USSR. The Praesidium of the Academy in augmented session considered the statements and results of the scientific work done by the Division and by its institutions. In a resolution of September 28, 1951, were exposed (1) serious negligences of the leadership of the Division and of the institute, (2) the detachment of these institutes from active life, (3) the separation of the majority of the projects from the actual problems of national economy, (4) in a large number of theoretical investigations, the lack of any worth whatsoever for practical purposes. Furthermore, (5) the office of the Division of Technical Sciences and its leaders were not able to secure a sound organization of the projects, in relation with the effective working force, (6) the office did not establish an effective leadership for complex co-operative projects, and (7) wrongly drew industrial workers in some projects.

After this general denunciation of the organization for electrical research, there follows a lengthy and wearying list of all the institutes, the names of the leaders, and their failures, mistakes, and deficiencies. An example is the Laboratory for Electrical Systems:

The Laboratory for Electrical Systems, directed by I. S. Bruk, did not give sufficient significance in its work of development of automatic systems and of relay protection. The study of the problems for the series compensation of transmission lines was kept back and work on stability problems was promised for the future. The projects had been planned in a confused fashion, and Soviet electrical industry was badly connected with the Laboratory for Electromechanics, with the High-voltage Engineering Laboratory and other laboratories of the Institute . . . The Institute had an extremely small number of projects for applications in industry. The scientific directives in many divisions were neither clear nor legible . . . Important branches of contemporary electrical engineering remained outside the field of vision of the Institute . . . Because of deficient leadership and incorrect organization, there was no co-ordination between projects worked at in the various laboratories . . . Criticism and self-criticism were developed in an unsatisfactory manner (there were no authentic discussions) . . . Without regard to the timely directive of the Party on the significance of free discussion for the development of science, no directives were given for the development of scientific criticism and self-criticism . . .

Training of the younger scientific workers by the staff of the Institute is at the lowest level, due to the guilt of the directors of the laboratories (I. S. Bruk, S. F. Chukov, M. B. Ravic, and others). They did not allot sufficient attention to this important problem. The leaders . . . did not investigate in the due amount the essential scientific work of the laboratories, which they rarely visited.

The axe falls:

V. E. Telechevski did not have sufficient regard for the job assigned to him, and thus the job was not completed on the fixed date. The removal of V. E. Telechevski from the Institute is a serious admonishment on the responsibility of scientific workers for the successful and timely fulfillment of their obligations . . .

The lesson connected with the uncovering of the defects in the Division of Technical Sciences must be studied and assimilated by all scientific research organizations and institutes of higher learning . . .

After the bodies are kicked to one side, the banners once more are hurled aloft:

There is no doubt that the year 1952 will be a year of even greater close creative co-operation between scientists, manufacturers and designers . . . The Stalinist principle of unity of theory and practice, the Stalinist principle of popular Soviet science will sustain them with unbreakable force. Loyal to these principles, the scientific and industrial workers will use all their strength to

"... it is engineering for peace, for humanity."

strengthen the bonds between science and practice, and will plan all scientific investigations in full conformity with the fighting problems of the construction of communism!

In Russian technical articles and textbooks the foreign references are always few, and always last. In a recently published textbook on high-voltage engineering, figures and formulas are copied from the AIEE *Transactions*, and German books, without any reference to their source.

Reviews of foreign (especially American) technical papers are often incorrect, contemptuous, and politically biased. An example is the review of S.S. Rokotian (*Elektrichestvo*, May 1951) of several classic AIEE papers by S. B. Crary, manager of General Electric's Analytical Engineering Department in Schenectady. (See G, top page 21.)

The reviewer first observes that the problems of long-distance transmission of electric power are followed very attentively in Russia. He then summarizes the main points of Crary's work and discusses power limits of lines, series capacitance compensation, and connection of a long line with an intermediate power system. "But an extra-high voltage line of great length is not possible in capitalistic countries," the reviewer concludes, "and may be only realized in a socialist country." Crary is in for further heavy-handed treatment: the reviewer believes he gives too much importance to interconnection of a long line with intermediate systems, and also that Crary is guilty of several inaccuracies and neglect of many important factors.

Illustrations are sparingly used in *Elektrichestvo*. For Stalin's 70th birthday, however, there was a magnificent full-color reproduction of a portrait of the late Soviet leader.

Elektrotechnik, published in the Russian Zone of Germany, is next in importance to *Elektrichestvo*. *Elektrotechnik* was begun in 1947 because the old *ETZ* (*Elektrotechnisch Zeitschrift*), which had been published in Leipzig since 1880, was filled with "the old capitalistic tradition." The new magazine was founded ". . . to make our engineers more strongly cognizant of the political side of their work." On the supervisory committee are such well-known electrical engineers as Profs. Binder and Fruehauf, and even a *Held der Arbeit* (Hero of Work).

The satellite technical journals, of necessity, try hard to be more Leninist and Stalinist than their Russian counterparts. Thus in *Elektrotechnik* you'll find many more direct quotations, complete with biographical references, from Lenin and Stalin, than in *Elektrichestvo*.

The July 1951 issue of *Elektrotechnik* begins with an editorial by Dr. K. Zweiling titled "The Great Future of the Technical Intelligentsia." It is preceded by a quotation from a Resolution of the Political Office of the SED (East German Socialist-Communist Party) of April 23, 1951:

> With the contributions of the technical intelligentsia, on the basis of our activist and competitive movements, it will be possible to develop the productive forces of our country with a speed which can never be attained in any capitalistic country.

Dr. Zweiling's editorial commences:

> With happiness (and in part also with astonishment) those belonging to the technical intelligentsia, technicians, engineers and scientists have read the decrees issued last May by the Council of Ministers of the German Democratic Republic. These dispositions improve considerably the standard of living of all technical men, according to their productivity, and lift them from most of everyday's troubles which still oppress them . . .

Brassy praise for the Soviet and German masters follows, along with scorn of the capitalistic countries:

> This is possible because of increased productivity. The progressive workers have learned how to utilize the experience obtained by the working class of the Soviet Union. . . This new, brotherly collaboration (between working class and technical intelligentsia) is never and nowhere possible under the capitalistic system which serves the interests of a small group of lords and exploiters. This new collaboration was created by our new democratic system, which is the expression of the vital interests of the entire working population.

Several quotations from Lenin and Stalin follow, complete with bibliography. Then Walter Ulbricht, the East German Party Chief, gets the full treatment, with ample references to his speeches. The editorial concludes:

> The entire secret of our new engineering is that it is engineering for peace, for humanity. Instead, in the imperialist world, now as before, the essence of engineering is directed to the preparation of war, to destruction and murder.

Several technical articles on transformers follow: excerpts from them are depressingly familiar.

The first one is the text of a lecture by H. Stamm on "Power and Instrument Transformers for High-voltage Transmission" that was presented at the annual convention of the (East) German Electrical Engineering Association. Stamm's article begins:

> The increase of transmission line voltages, particularly to 400 kv, creates the need for special characteristics of the apparatus. Today in the German Democratic Republic there are no 400-kv transmission lines in service, because of the division of our country. But looking at the export market, and also at the unification of Germany, which is necessary and possible even against the will of the American monopolies, we should study seriously these problems in all their aspects.

From the section on "Insulation and Short-circuit Problems of Instrument Transformers," you'll learn that:

> Operating experience up to now has shown that our present practice is basically right, but deficiencies which still exist must be corrected . . . For this purpose the interchange of technical experience with the Soviet Union, with China, and the European Democracies will be very useful.

The author doesn't elaborate on just what kind of assistance he expects from Red China.

Also from *Elektrotechnik* there is the hint of a forthcoming purge in German electrical engineering:

> Also in the field of electrical engineering, considerable results were reached last year . . . However, there were mistakes and confusions, which by all means must be removed in the realization of the economic plan. For instance, not enough attention was given to the production of large electrical machines and turbo-generators . . . All these mistakes must be investigated and avoided during the realization of the 1952 economic plan. (In a later article, we will take a detailed stand on this subject.)

Even in Yugoslavia electrical engineering is warped politically. One of the best-known European authorities on transformers is Professor Milan Vidmar. In his most recent book, *Transformation and Transmission of Energy*, you read on page 16 that there are two types of transformers: *der kapitalistische Raubtransformator* (literally, "the capitalistic robber-transformer"), and the new socialistic transformer.

According to Vidmar, the losses are higher in the capitalistic transformer because the capitalistic electric utilities want the cheapest transformer so that they can pass the cost of the high losses

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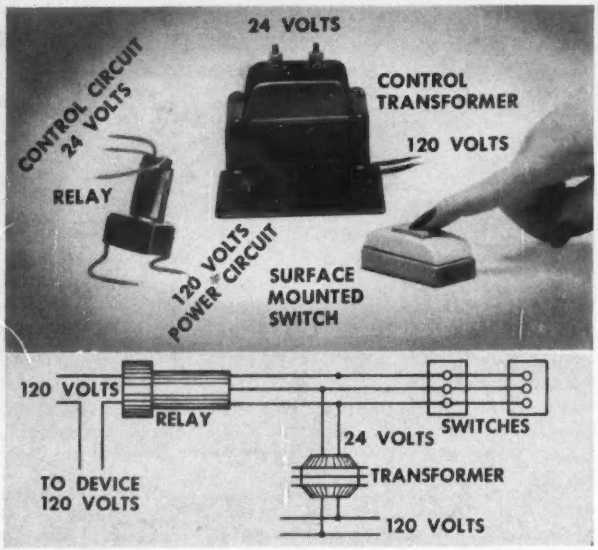

TREND IN CONTEMPORARY HOMES IS TO REMOTE-CONTROL WIRING SYSTEM BECAUSE OF VERSATILITY OF COMPONENTS (ABOVE)

Remote-Control Wiring for Your New Home

By R. E. SMITH

Where does remote-control wiring for the home stand today, seven years after its commercial introduction?

Can I design it into my small home, or is its use confined to houses in the $30,000-and-up class?

The answers to these questions are reassuring: There is no doubt that remote-control wiring has captured the imagination and interest of architects, builders, and home owners. More and more it's being used, not only in individual custom-built homes (above, pages 26–29) but also in new housing developments shown on the opposite page.

And it's economically practical for houses in all price ranges, as shown by the case histories on the next five pages.

Before designing a remote-control wiring system into your new home, it's necessary to review briefly the components (above, right). (A detailed account of the system is in the September 1951 REVIEW.)

Basically, it uses a small relay to turn on or off the 120-volt household power of each lamp, convenience outlet, or device, such as an appliance or electric motor. The versatility of the system lies in the fact that an individual relay can be controlled from any number of different locations throughout the house by means of small control switches. The relay coils and the control switches operate on a 24-volt control circuit.

Relay contacts are rated 15 amp, 1 hp, 125 volts a-c; 10 amp, 277 volts a-c. Because the contacts in the relay catch mechanically in place, the relay coils (one for opening the contacts, one for closing them) need be energized only momentarily. Relays can be mounted through a standard ½-inch knockout.

Control wiring is energized by a 24-volt 35-volt-ampere transformer of the energy-limiting type. A system uses only one transformer.

Control switches for flush or surface mounting are of the momentary contact type.

One of the most intriguing innovations of the remote-control wiring concept is the master-selector switch—a nine-point selector unit that can control up to nine circuits. Any circuit can be operated alone, or *all* circuits may be turned on or off at the same time. Most homes have a master-control switch in a bedroom so that all lights in the home—both interior and exterior—can be turned on simultaneously in case of prowlers. You can use as many master switches in your system as you desire.

Control wiring—small, light, and flexible—has two or three conductors and is easily installed in all types of building construction.

On the opposite page is a home designed by the Burton W. Duenke Building Co. of St. Louis to sell for $10,750.

In this installation all nine relays in the house are "gang-mounted" on a panel in the utility room. Green lines on the floor plan indicate the location of the switches and the devices controlled.

A master-selector switch in the master bedroom controls all nine relays. This switch is a feature not ordinarily included in a home of this size, but the builder found that it adds only about $35, or less than one-half of one percent, to the cost of the home.

Remote control installations cost about $35 to $50 more than a conventional wiring system in homes in the 1000 to 1600 square-foot floor area range.

To see how a remote-control wiring system is used on a house of 4000 square feet, and of a considerably higher price range, turn to pages 26–27.

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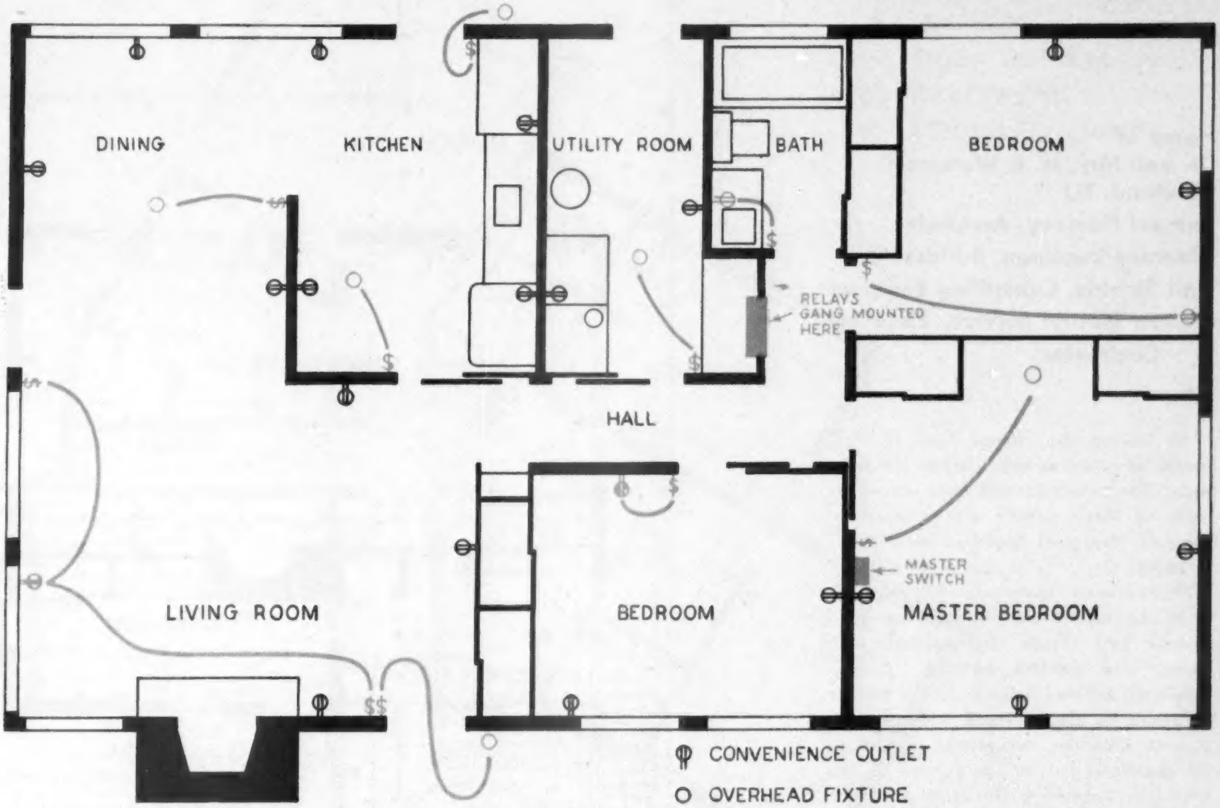
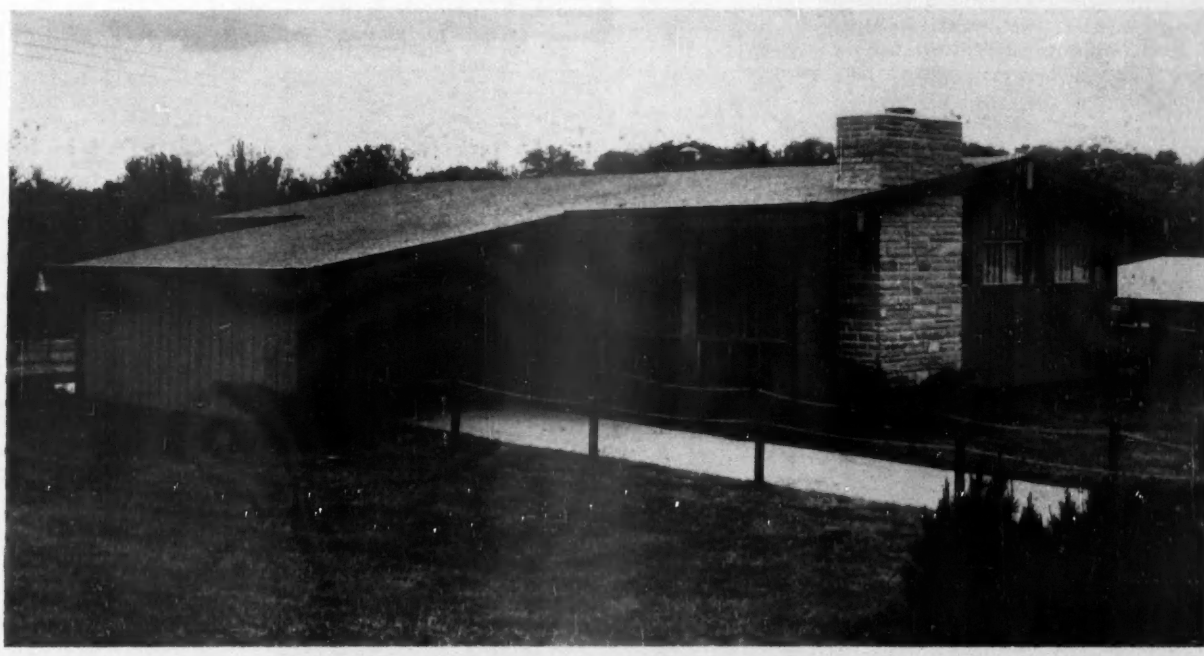
Mr. Smith had an important part in the development of the remote-control wiring system, and is helping expand its applications in homes, industry, and commercial buildings. Joining General Electric in 1942, he is now Wiring Device Commercial Engineer, Construction Materials Division, Bridgeport.

Designed and Built by the Burton W. Duenke Building Co., St. Louis, Missouri

1100 SQUARE FEET



GREEN LINES SHOW LOCATION OF SWITCHES, AND OUTLETS OR LIGHTS CONTROLLED. RELAYS ARE "GANG-MOUNTED" IN HALLWAY.



FINISHED HOME AT THE RIDGEWOOD SUBDIVISION NEAR ST. LOUIS IS A VARIATION OF THE FLOOR PLAN ABOVE.

CONTINUED ON NEXT PAGE

4000 SQUARE FEET

Home of
Dr. and Mrs. N. E. Wernicoff, Vineland, NJ
Samuel Homsey, Architect
Clarence Boorman, Builder
Carl Shields, Consulting Engineer
Norton Electric Service, Electrical Contractors

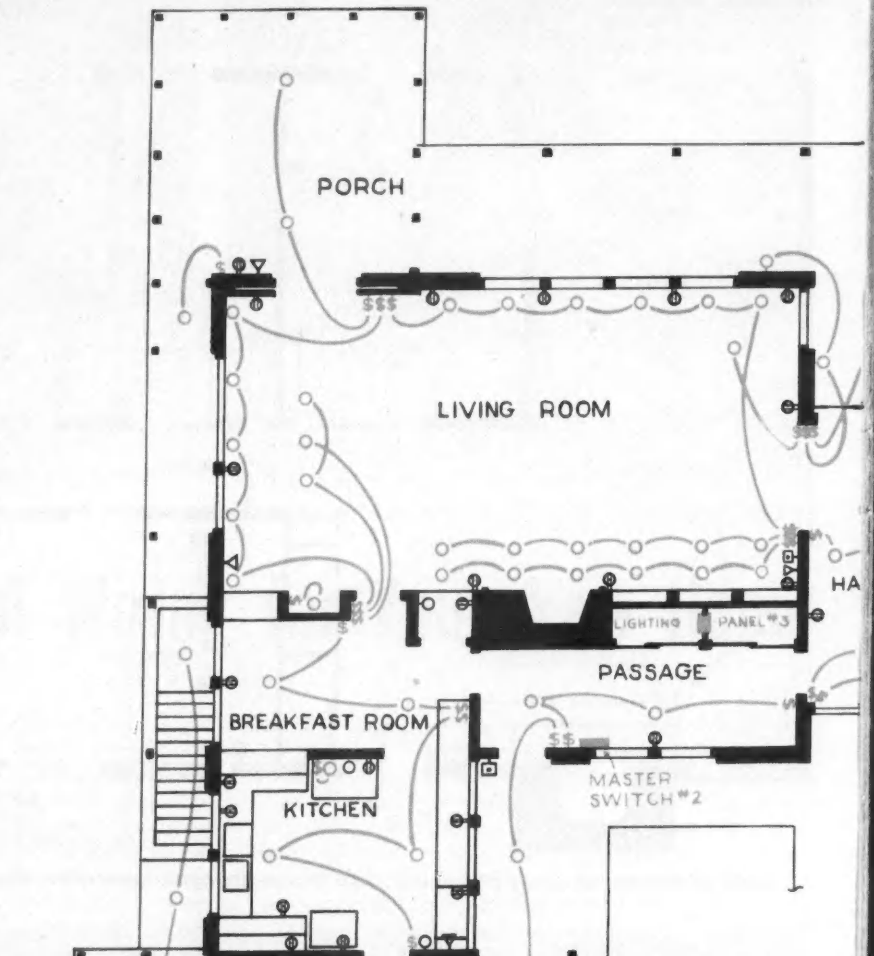
In wiring this home four lighting panels are used as indicated on the floor plan. The relays for the area served by each of these panels are grouped in specially designed boxes at each panel location.

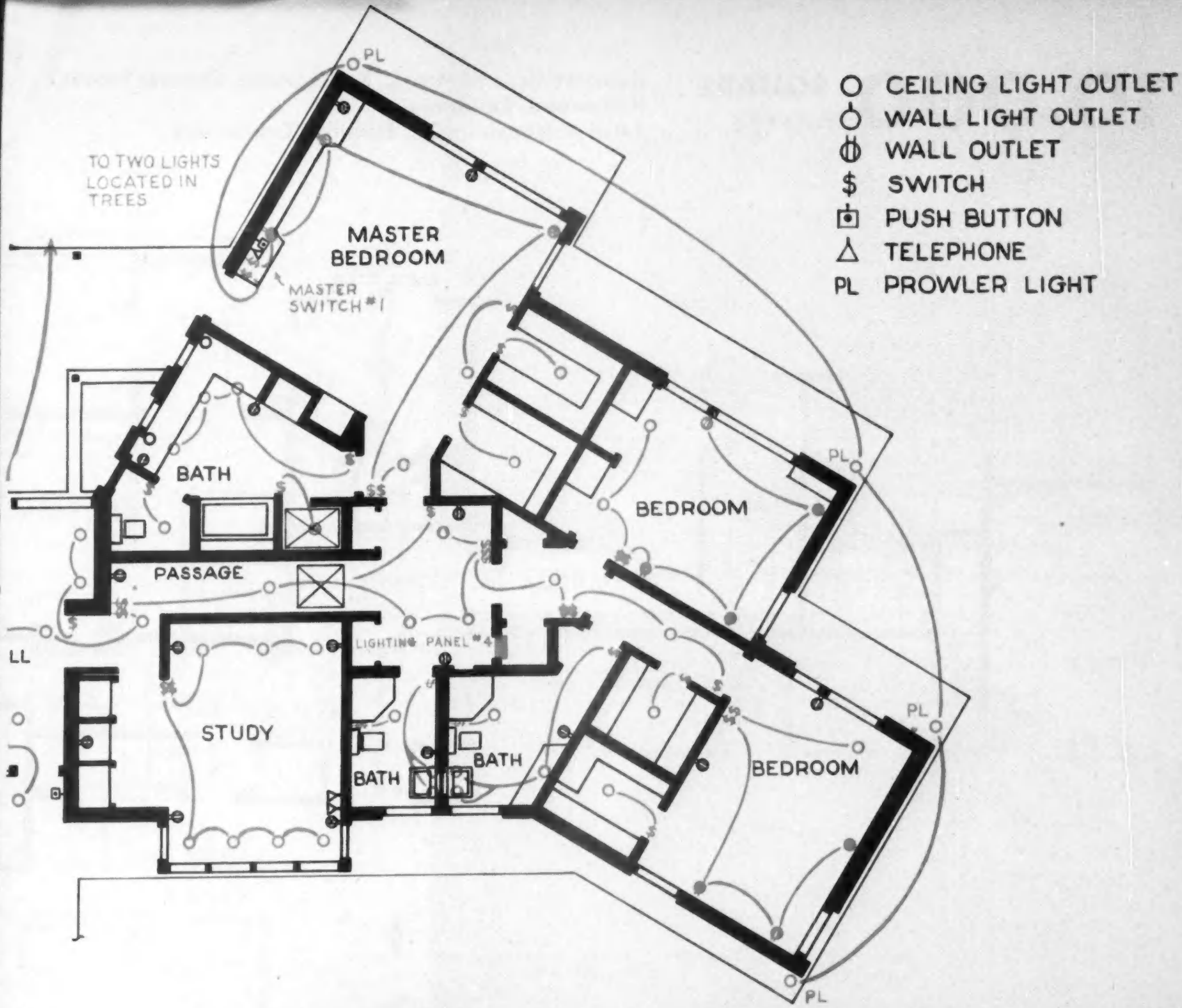
One of the two master-selector switches is in the master bedroom at the head of the bed. From this location the owner can control outside "prowl" lights, all hallway lights from the master bedroom to the covered walkway entrance, and the receptacle circuit in the master bedroom. The second master switch is located at the front entrance and controls the same lighting path.

Included in the system are four transformers, 50 relays, 60 flush-mounted switches, and two master-control switches. Approximately 4000 feet of three-conductor remote-control wire and 1000 feet of two-conductor remote-control wire are used for the control circuits. The four transformers are used for convenience in wiring only; one has enough capacity to carry the entire installation. A transformer is located in each panel location.

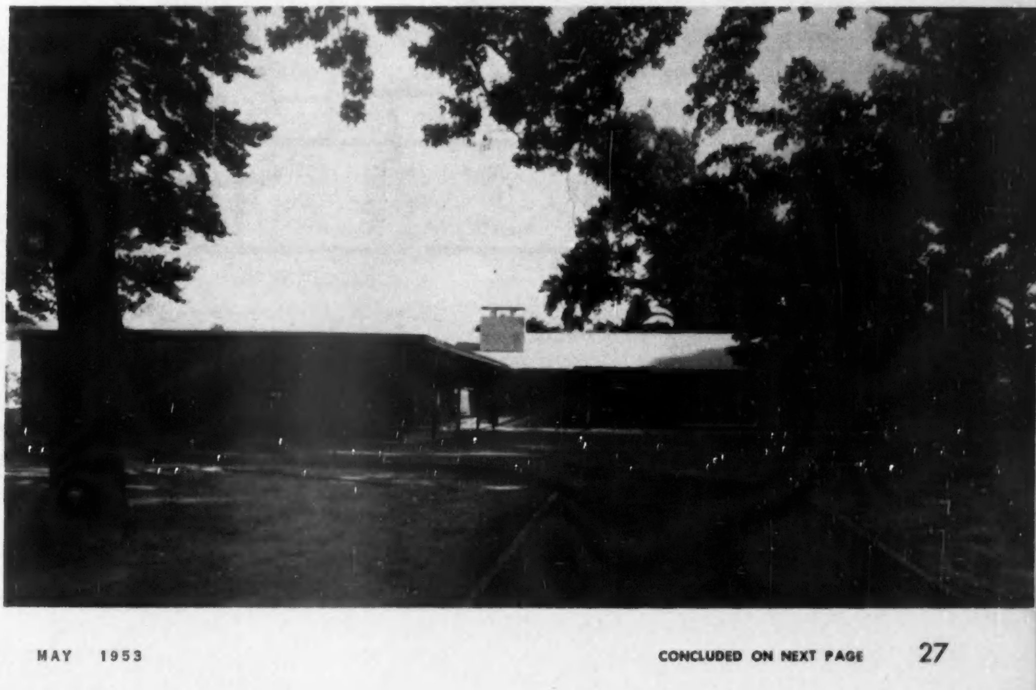
The contractor stated it would be impossible to duplicate all controls found in this home with conventional wiring and switching. He estimated that the wiring of the 219 outlets cost $1095, and that this figure would have been increased to $1900 to even approximate the control with conventional wiring.

Changes in a remote-control system such as this are simple because the control wiring can be reconnected at the various panels. With conventional switches, changes would be expensive and might require redecorating certain areas.





GREEN LINES on the floor plan show location of switches and outlet, light, or device controlled. Note location of the four lighting panels. Relays for the areas served by each panel are grouped near the panel. One master switch is in the master bedroom, the other near the main entrance. Because of space limitations, not all features of the house can be shown.



MAIN ENTRANCE is straight ahead and the service wing is at the left. This picture was taken before the house was completed.

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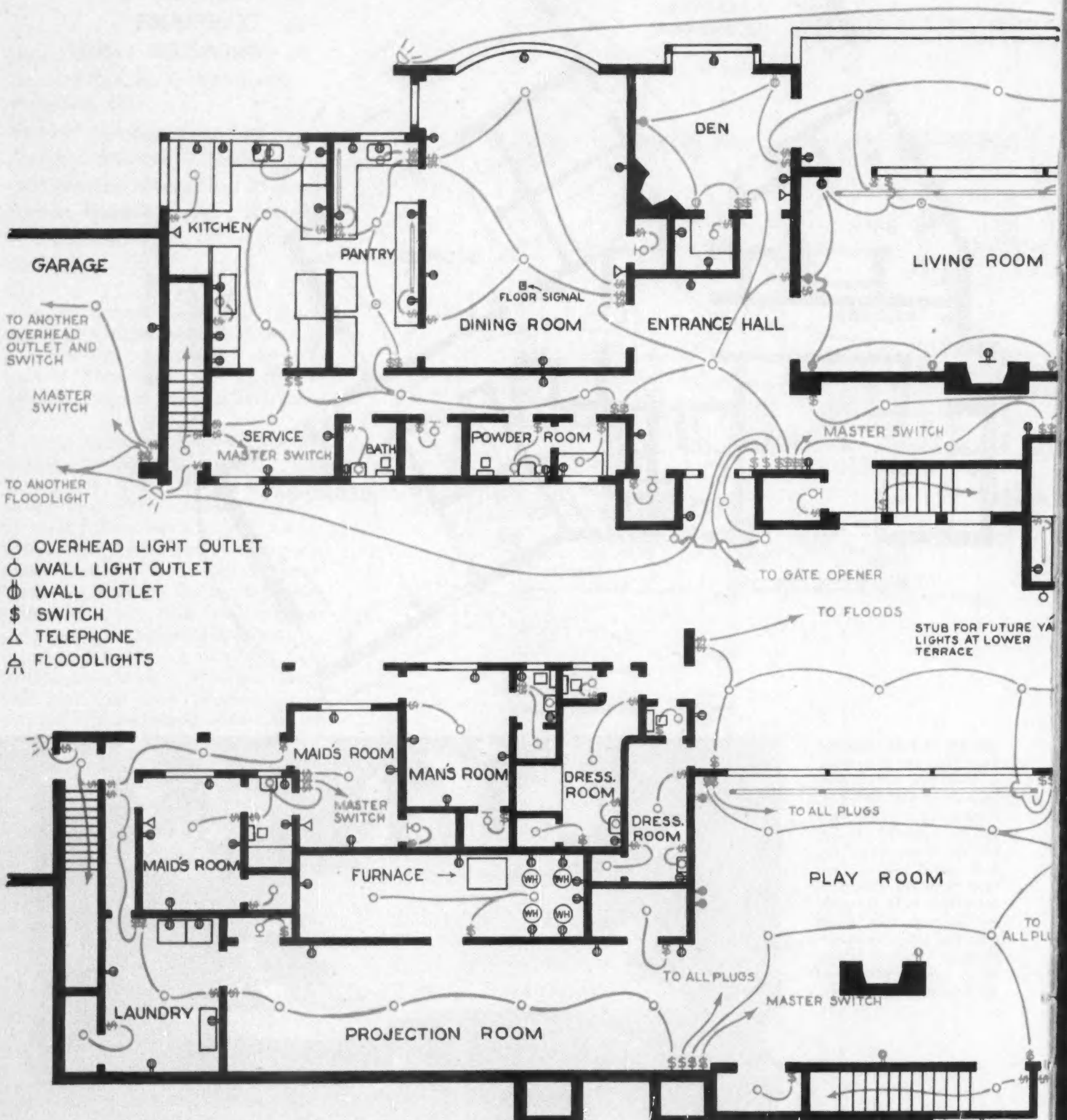
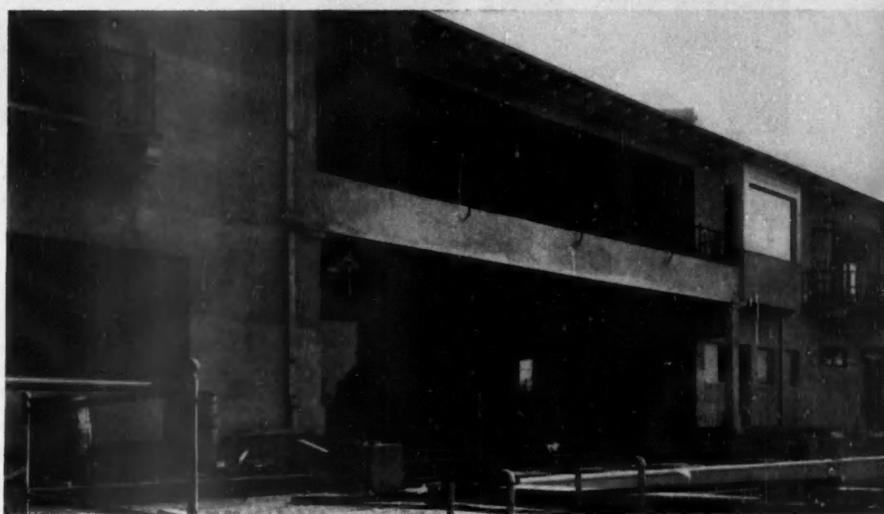
10,000 SQUARE FEET

Home of Mr. and Mrs. C. E. Toberman, Outpost Section, Hollywood, California
Allen Engineering Co., Electrical Contractors



Green lines on the floor plan show location of switches and outlet, light, or device controlled. Because of space limitations, not all features of the house can be shown.

OWNER C. E. TOBERMAN DESIGNED AND BUILT THIS HILLTOP HOUSE IN THE OUTPOST SECTION.



HEATED SWIMMING POOL AT RIGHT, PLAY ROOM ON GROUND FLOOR, LIVING ROOM ABOVE.

This home, while somewhat unusual, serves to demonstrate the adaptability of remote-control wiring to residences of all sizes, price ranges, and floor plans.

When Mr. Toberman, who is a long-time resident of Hollywood and a developer of the Outpost section, decided to build a home he approached the Department of Water & Power, the electric utility for the City of Los Angeles, with the request for assistance with the electrical design. A. K. Bennett, Supervisor of the Adequate Wiring and Architectural Service for the utility, handled the design work.

Seven master-selector switches are used and the house is completely "light-conditioned." It's equipped with a 400-amp Trumbull main entrance switch and three subpanels, one of 36 circuits and the other two of 16 circuits each.

The relays are mounted in outlet boxes at each lighting fixture. There are about 180 relays in addition to 200 switches.

Other electrical features of this home include: swimming pool with constant temperature control, circulating pumps, underwater and overhead floodlights; automatic gate opener; illuminated house numbers; automatic garage-door opener; ceiling exhaust fans in the kitchen and pantry; seven bathrooms with time-delay cutoff fans; automatic clock control of the water-sprinkler system in the yard; and a complete series of electric kitchen appliances. Ω

KONSTANTIN PALUEV, Chairman of the Workshop for World Understanding in Pittsfield, Mass., represents the United States by a ball resting on a tripod. For balance three freedoms are required. Press and radio grew rapidly, dwarfing public assembly. To the undeveloped leg of assembly Paluev adds the Workshop for a firm footing in an . . .

Adventure in Democracy

By HERBERT RAVENEL SASS

An unusual experiment in democracy is under way in Pittsfield, Mass. It's concerned solely with two fundamentals of American democracy that have suffered neglect—collective genius and freedom of assembly. And its efforts are concentrated on restoring them to their full effectiveness.

The movement is confined at present to Berkshire County, centering in Pittsfield—an industrial community of some 54,000 inhabitants in the beautiful Berkshire Hills. But the typical American citizens in this average American city believe that something has begun in their town that will grow and spread. The people's imagination has been stirred by the concepts of a quiet stranger who came to live with them 35 years ago.

To understand this dramatic story let's start with its beginning. While World War I was roaring to its climax in 1916, Konstantin Paluev of Moscow—a young man of 21—came to the United States. He was here when revolution engulfed his native land, setting up a tyranny he wouldn't submit to.

So young Paluev remained in this country. Late in 1918 he began working in General Electric's Pittsfield plant where he is now a research and development engineer. By his professional accomplishments he has achieved the grade of Fellow in the AIEE. Throughout his career he has become more and more fascinated by a simple truth whose broad significance most of us have missed completely.

Collective Genius

Paluev calls this truth the principle of collective genius, and it's one of the fundamentals of the Pittsfield movement. The astounding success of American industry results from employing this principle. Mass research utilized to produce myriad new products and keep industry humming is now basic to American industrial evolution. Paluev's article in the May 1941 REVIEW provides probably the most searching analysis of the process—an analysis that revealed to him exciting implications reaching far beyond factory walls.

All technological progress, he asserts, has been accomplished by genius. But as he computes it, relatively few complete geniuses occur in the course of a century. The traits and talents that constitute genius—those needed to conceive and implement a new idea, invention, or solution—are 15 in number, he declares. You'll note that some are predominantly mental, others temperamental, while still others are physical.

He lists them as constructive discontent, originality or vision, courage, specific knowledge, general knowledge, analytical ability, ability to synthesize, common sense, enthusiasm, perseverance, persuasiveness, initiative, sense of humor, co-operativeness, and energy.

Paluev demonstrated mathematically that in 54,000,000 then-employable American adults not more than four would possess all 15 traits to the needed degree. With such an exceedingly low percentage it's understandable that technological advancement for hundreds of years was slow and sporadic: progress depended then on the single-handed effort of the complete or nearly complete genius.

Then the factory system was transplanted to America and for many years the same condition prevailed in industry—the old European dictatorial philosophy set the pattern. Each enterprise had a single source of ideas and authority. Among the masses, individuality was sternly suppressed. And men were molded to fit specific jobs with management disregarding or completely suppressing their natural traits and talents.

But after a while a change took place within the factory gates. Along with the growing democratic spirit of the country and the ever-present urge to improve productivity came recognition and cultivation of individuality. Thus encouraged, individuality became functional, and management discovered that the complete genius was not the only source for originality, enthusiasm, analytical ability, and the other desired traits.

Somewhere in the plant one person would possess an outstanding degree of one of the 15 traits; someone else would possess another. These qualities evoked suggestions, ideas, persistence, persuasiveness, and so on. Often when they were combined in the spirit of co-operation, together with contributions from other individuals, the result would be something important.

Thus American industry gradually learned by experience to combine the outstanding abilities of otherwise ordinary individuals until all 15 traits were brought together to form a collective genius. And now, as Paluev says, "Nothing of importance to many is achieved single-handed. You do not need to depend on or search for the rare complete genius; you can synthesize him for any specific task."

By utilizing the collective genius of common men American industry has swiftly accomplished results far excelling, Paluev believes, anything attained by relying on the few—results not only outstanding in themselves but of even more import to the American people.

Here within our factory gates he has found evidence that "democracy, a society based on confidence in the individual and in the many, is not only the ideal way but the practical way, the most profitable way."

The spectacle inspired Paluev. And the more he pondered, the more convinced he became that here was a familiar yet unrecognized phenomenon full of potential meaning for America today. For outside our factory gates we are letting collective wisdom atrophy and become inoperative. Paluev finds it being superseded and replaced by a limited group genius because freedom of assembly has been crowded out by two other freedoms, speech and press. And the collective wisdom of America can operate solely through freedom of assembly—the second fundamental of our democracy.

Basis of Movement

This, then, is how an engineer came to launch a noteworthy adventure in democracy in the city of Pittsfield.

Its title, "Workshop for World Understanding," is as comprehensive as its task: to promote understanding of local, state, national, and international issues by restoring the effectiveness of this neglected freedom. About a quarter century ago, says Paluev, the marvelous mechanism of American democracy began to falter. And the main cause was that paradoxically the three freedoms upon which our democracy rests—speech, press, and assembly—were actually losing their real and original values at the very moment when the first two were gaining greatly in effectiveness.

It is true that, thanks to radio and our modern press, spoken and printed words are more influential today than ever. But actually and economically they aren't and can't be free and accessible to everyone as means of expression by the people at large. Nor do the majority of the people participate in them. And they require not only enormous outlays for equipment and other facilities but also outstanding specific skills on the part of their users. Thus a few do most of the talking and writing while the people accept more and more the passive roles of listener and reader, without a chance of "talking back or thinking together."

Meanwhile, the third freedom—freedom of assembly—has fallen completely into decay. Dwarfed today by the immense expansion of radio and press, assembly is the only mechanism that permits collective thinking. The Pittsfield movement affirms that such thinking not only is essential to the life of democracy but, as Paluev maintains, guides us more wisely than the thinking of the few outstanding individuals who are heard and read by a silent and inarticulate humanity.

Purpose

To reactivate the collective wisdom of the community—restore and promote thinking and provide free expression by the whole people—is the purpose of the Workshop for World Understanding. It operates under a carefully devised plan, assuring complete independence and requires virtually no financial outlay. At stated intervals the Workshop holds a Court of Public Opinion.

The Court is not a forum: the public is expected not merely to ask questions but to contribute facts and opinions. The expectation is full participation. Nor is it a town meeting: no stand or action is taken on any issue nor is any recommendation made. Nor is it a debate: the object is not a decision for any side, but a complete presentation of every side of every issue—not by well-known experts but by people of Berkshire County.

That there is persuasive appeal in the idea behind the Workshop movement is demonstrated by the progress made since the experiment was launched in November 1949 by a group of 35 persons. Topics discussed at the nine Courts of Public Opinion held so far include the two-party system, big business, national health insurance, the Berkshire County school budget, the McCarran Immigration and Nationality Act, and the issue between the Western World and Russia.

So much interest was aroused at the first Court that a hall with 300 seats could not hold all who came to participate in the second meeting. Subsequent meetings have been held in the high-school auditorium with attendance ranging from 400 to 900.

The town's two radio stations, WBRK and WBEC, alternately carry the entire two-hour program. And the city's daily, the Berkshire *Evening Eagle*, gives excellent front-page coverage supplemented by stimulating editorial discussion. Thus, although the great development of press and radio is considered a principal reason for the deterioration of assembly, in Pittsfield both mediums have been most cordial and helpful in this attempt to restore freedom of assembly to community and national life. Similar co-operation is expected throughout the country if the Pittsfield movement takes hold and spreads.

Expectations

That it *will* spread is the expectation of the Pittsfield group. They are confident that once the movement becomes known people in other communities will likewise be moved to restore freedom of assembly as a useful and usable mechanism of community life.

The Berkshire adventure in democracy is unique—not merely another of the thousand and one special movements in behalf of some cause or group. The Workshop movement, now in its fourth year, concerns itself with fundamentals. Its universality and simplicity; its pointing to an urgent need; its origin in the phenomenon of collective genius, a principal creator of our modern industry which has "amplified the value of the average man to himself and society"—these are the factors that give the movement broad popular appeal. Its founder is confident that it could be the beginning of a new era of expression in the development of a great thinking people. Ω

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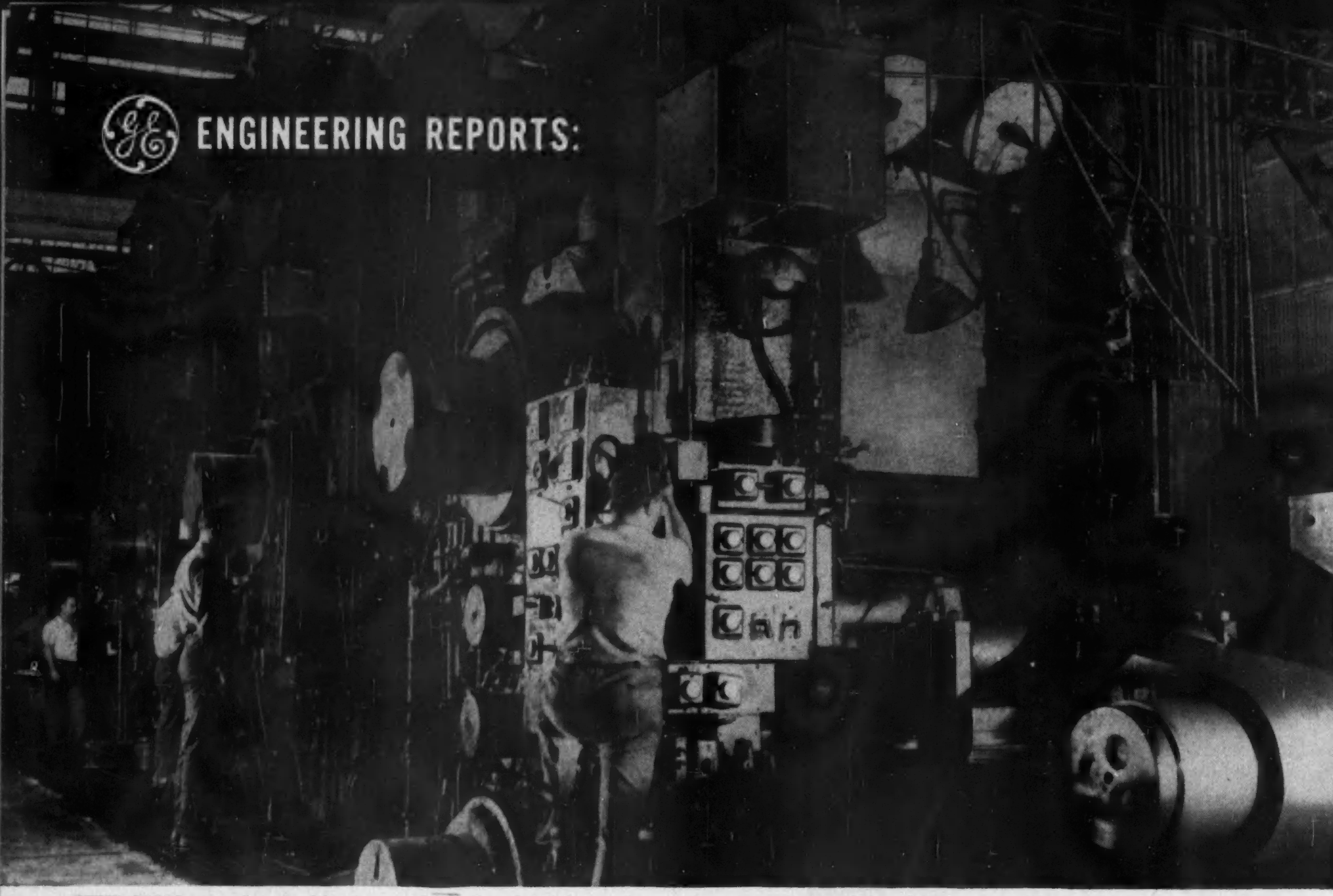
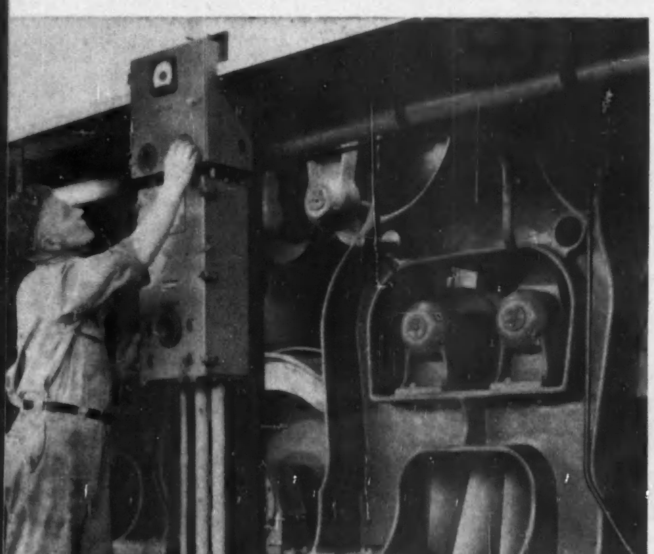
Mr. Sass, of Charleston, SC, has written a number of books on Southern history and natural history. His interest in the Workshop, which began when Mr. Paluev visited in Charleston, has led him to tell the story of the Pittsfield Movement. (Reprints of the May 1941 Review *article mentioned at the top of the opposite page may be obtained from Mr. Paluev, Power Transformer Department, General Electric Company, Pittsfield, Mass.)*

ENGINEERING REPORTS:



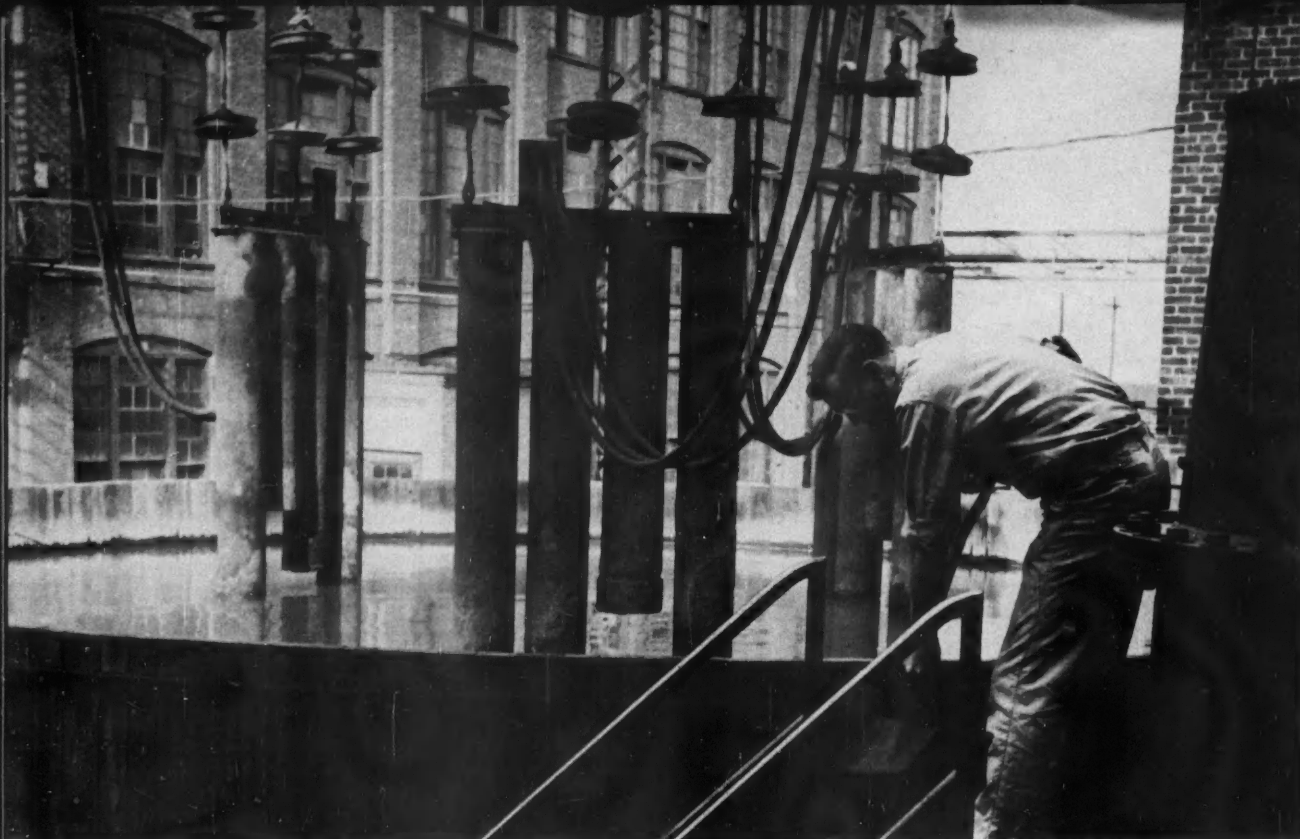
STEEL MILLS were faced with the problem of maintaining strip gage at ever-increasing rolling mill speeds. G-E engineers supplied the answer by applying G.E.'s x-ray thickness gage to steel mill drives—making possible more continuous, high-speed operation.

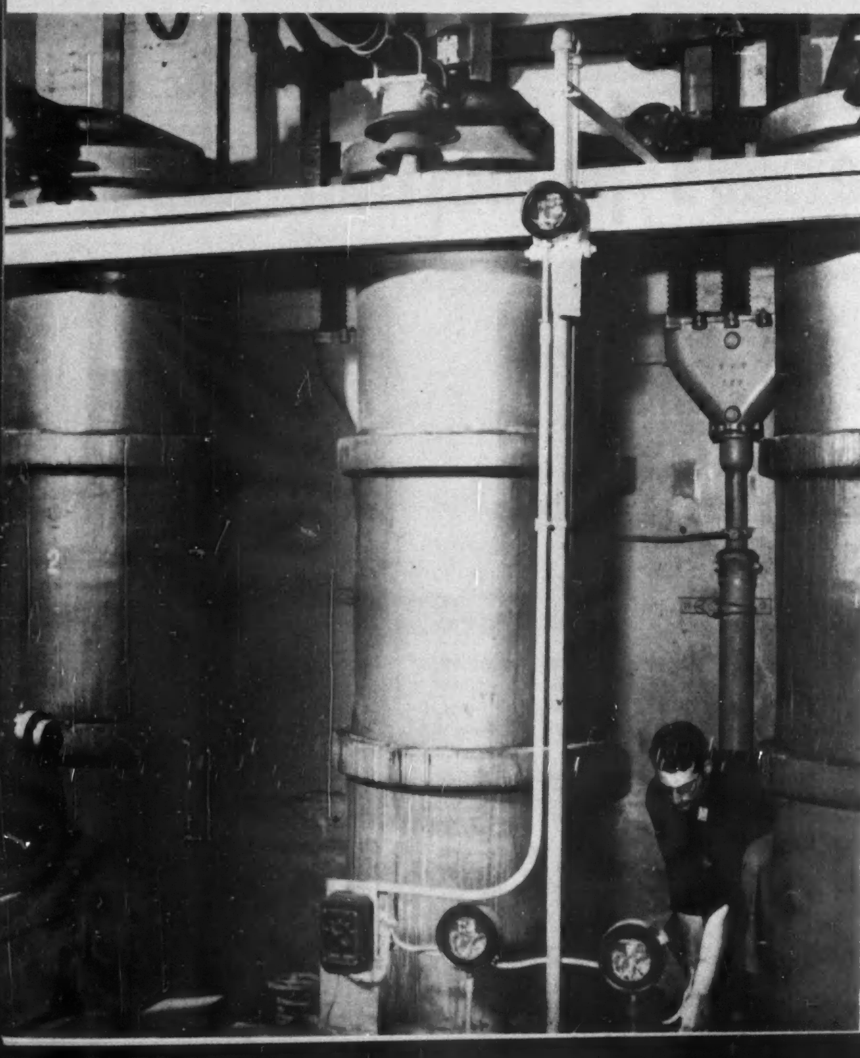
Engineers pioneer new instruments



PAPER MILLS need close control of paper tension. G-E engineers integrated a paper tensiometer with sectional drive systems—made tension-setting an exact science, helped boost production.

CHEMICAL, dye, paint and ink companies record color automatically, accurately, with the recording spectrophotometer, applied by G-E engineers to assure exact color control and matching.





OLD Conventional three-phase water-box rheostat (above) dissipates power from the test generator as the current flows between the partially submerged electrodes and boils the water. Salt is added to increase the load. Billows of steam blanket the actual operation and the surrounding areas.

NEW There's no steaming in the new indoor liquid rheostat, for the average liquid temperature is well below the boiling point. It converts electric energy to heat in three columns of circulating brine cooled by river water. Resistance of each phase is changed by varying column height. A 45 F decrease in normal cooling-water temperature almost doubles its capacity over the old rheostat.

Taking the Steam Out of a Liquid Rheostat

By K. A. PETRASKE and I. C. SAN JULE

A young Test engineer, new to GE's Schenectady Works, happened to glance out the window of a Test office. What he saw startled him: a large wooden tank belching vast quantities of steam. Alarmed and puzzled, he turned to his supervisor who assured him that everything was all right—that the steaming tank was only a conventional water-box rheostat loaded down with 6000 kilowatts of electric energy.

What this young engineer saw was one of several disadvantages of the old-style water-box rheostat shown at the top of the opposite page. Pictured below it is the completely redesigned liquid rheostat that does away with all the unfavorable features of its predecessor. Also rated at 6000 kw—a conservative rating for this design—the new rheostat completely eliminates steam. But before considering the new unit, let's briefly look at the old.

Boiling Water

The water-box rheostat operates on the principle that the resistance of water, though high in the pure state, is decreased by the addition of salt. Thus you can control resistance over a wide range by varying the percentage of salt in the solution. And into this solution power is dissipated as heat from a three-phase generator under test. For, as current flows between the rheostat's electrodes, the resultant I^2R loss makes the solution boil.

But here's where the trouble starts. Obviously, the water-box rheostat must be located out-of-doors to vent the large clouds of generated steam. This factor in itself has disadvantages: longer cable runs are needed, and the box must be protected against freezing. To make up for the steam given off, water must be continuously added. What's more, vapor bubbles gather at the electrodes and reduce their effective cross-sectional areas—this causes even greater boiling and more vapor bubbles. Then, because of the increased current density, changes in electrode resistance make it difficult to balance a delta-connected load. (A change in the water temperature from ambient to 212 F causes a four-to-one reduction in resistance.)

By the nature of its physical construction, the old water-box rheostat is inherently a low-resistance device—about 10 ohms maximum between electrodes. Although raising the electrodes decreases the conducting paths' cross-sectional areas near the electrodes, it doesn't sizably increase over-all resistance along the paths. Accordingly, large and expensive transformers must be used to reduce incoming voltage for smaller loads. Add to these difficulties the human danger of chucking in salt while the box is under load—a man stands on a platform at the rim of the tank—plus the corrosive effect of the salt itself, and you can see why it was necessary to design a new type of liquid rheostat.

Steamless Operation

Primarily the function of the new liquid rheostat is to load gas turbines under test. The turbines drive three-phase 60-cycle generators whose voltages vary from 4300 to 13,800 volts. For this reason a sufficiently flexible rheostat was built to accommodate a broad range of current, voltage, and power. It's system includes . . .

Heat exchanger to eliminate boiling
Separate tank for each phase
Noncorrosive salt
Two electrodes for each phase.

You'll note in the piping diagram on the next page there are three essentially independent systems to the liquid rheostat: loading, cooling, and salt-injection systems.

The continuously circulating brine solution enters the load tanks at a temperature of approximately 100 F and leaves at about 150 F. These conditions exist with river cooling water at 85 F. But with river water at 40 F, the Btu rating of the heat exchanger rapidly grows. Given the same maximum brine temperature (150 F), the system's possible kva rating is almost doubled.

Use of the heat exchanger to eliminate steam permits the liquid rheostat to be located indoors, in a small room, and so does away with the freezing and maintenance problems. The room is ventilated by a small fan to remove any gases formed as a result of electrolysis in the solution.

Sodium chromate used in the solution is not only noncorrosive but a rust preventative as well. A thin film formed on iron and steel surfaces of the piping, electrodes, heat exchanger, and pump keeps them from rusting. And because the load solution is continuously recirculated, the inexpensive sodium chromate is added only to increase load; that is, to lower the solution's resistance. As indicated in the piping diagram, the solution (40 percent) is held in the storage tank and injected into the system when needed.

On the Electric Side

Electric energy is converted to heat energy in three columns of circulating brine. Each column is 30 inches in diameter and has a common, variable resistivity—between 2½ and 144 ohms. Resistance in each phase, proportional to length, is varied by raising or lowering the upper electrodes. You can also vary resistance to meet your needs by injecting sodium-chromate solution or river water into the system.

The cross-sectional area of the columns determines the maximum current through them. An empirical value of one ampere per square inch of cross section is used. And because the rheostat is tentatively rated up to 15,000 volts, 6000 kw, three phase, 60 cycles, you can obtain small or large loads without the use of transformers. The kilowatt rating is limited by the heat exchanger rating.

The rheostat is wye-connected to the generator with neutral grounded. Its lower electrodes, drains, and so on are at ground potential for safety.

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Mr. San Jule, Engineer in Charge of Design and Construction Testing Equipment for the Schenectady Works, came to General Electric 26 years ago in the Test Course. He is Secretary of the Testing Safety Committee that covers all GE plants. His collaborator, Mr. Petraske, designed the liquid rheostat system and also the testing equipment for gas turbines. He joined GE in 1941 and is Assistant Section Supervisor in the Testing Section, Schenectady Works.

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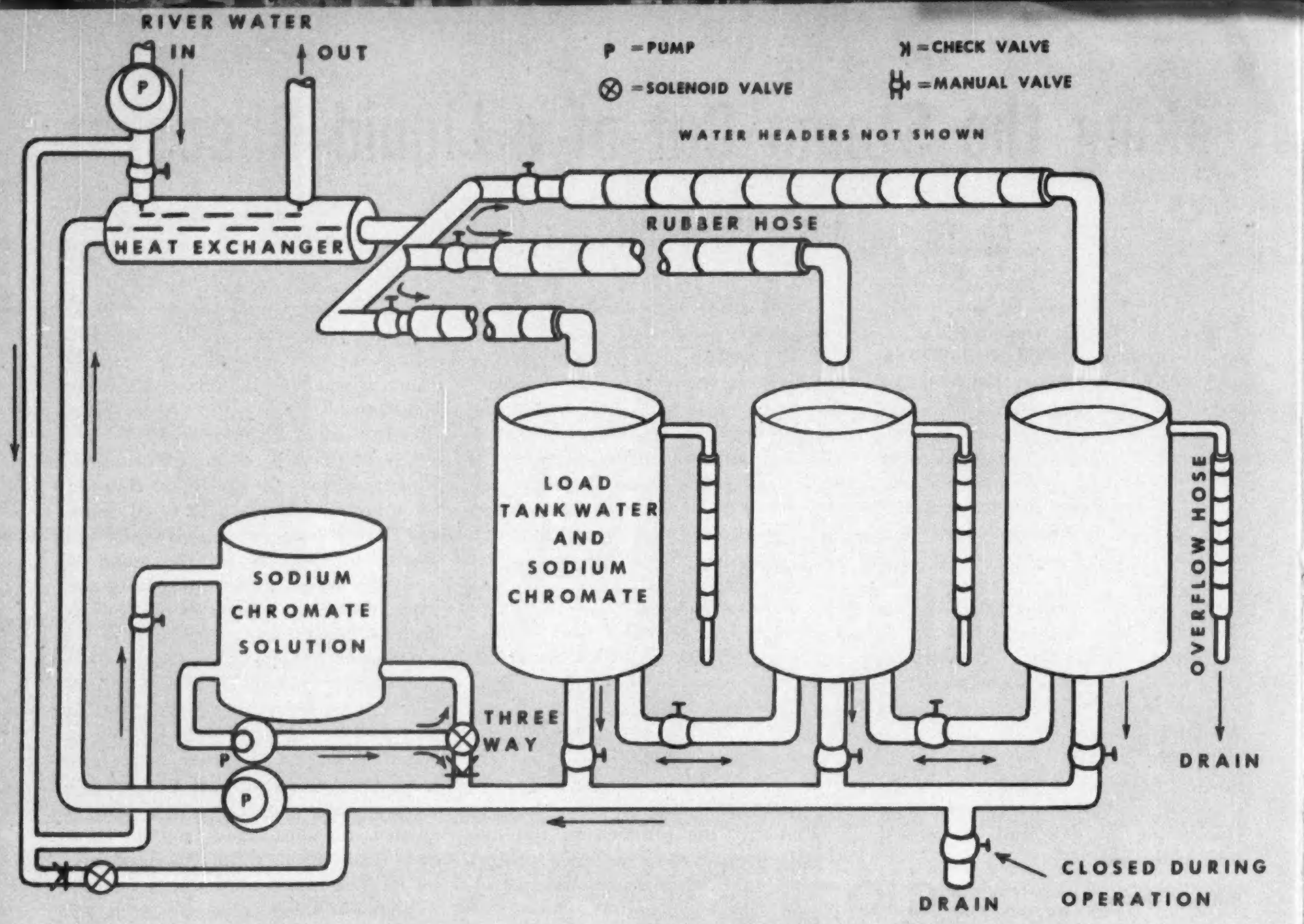


SIMPLIFIED PIPING DIAGRAM OF WATER RHEOSTAT

RIVER WATER at 85 F through heat exchanger holds circulating brine temperature to average of 125 F. Rubber hoses insulate from ground the high voltage at top of tanks. With this system of power-dissipation, there are no practical limits to design capacity.

On the Hydraulic Side

The sodium-chromate river-water solution is drawn from the bottom of the tanks and pumped to the heat exchanger. From there the now-cooler brine solution enters three rubber hoses that extend to the top of the tanks. (Purpose of the rubber hoses is to insulate from ground the high voltage at the upper electrode. The current that flows through them is negligible.) At the end of each hose, four-nozzle water headers —not shown in the piping diagram— reduce the solution's velocity to avoid splashing and evenly distribute it across the top of the tanks.

As the solution leaves a header, it passes with streamline flow through the grating of the upper electrode. Then, traveling the tank's length it absorbs heat, or I^2R loss, caused by the current between electrodes. Finally, the solution passes through the lower electrode into a common header, joins the discharge from the other two tanks and repeats the cycle.

At the top of the tanks, the liquid surfaces are open to the atmosphere. Overflow pipes, also of rubber, connect the tops of each to a drain and permit removal of excess solution from the system. A pipe and valve interconnect the bottom of each tank for flow balancing—adjusting liquid levels in each tank to the same height. To equalize flow, the two interconnecting valves are closed, and the inlet and outlet valves of the tanks are adjusted. Once the flow of the solution is balanced—liquid levels equal, the interconnecting valves are opened and they stay open to maintain balance.

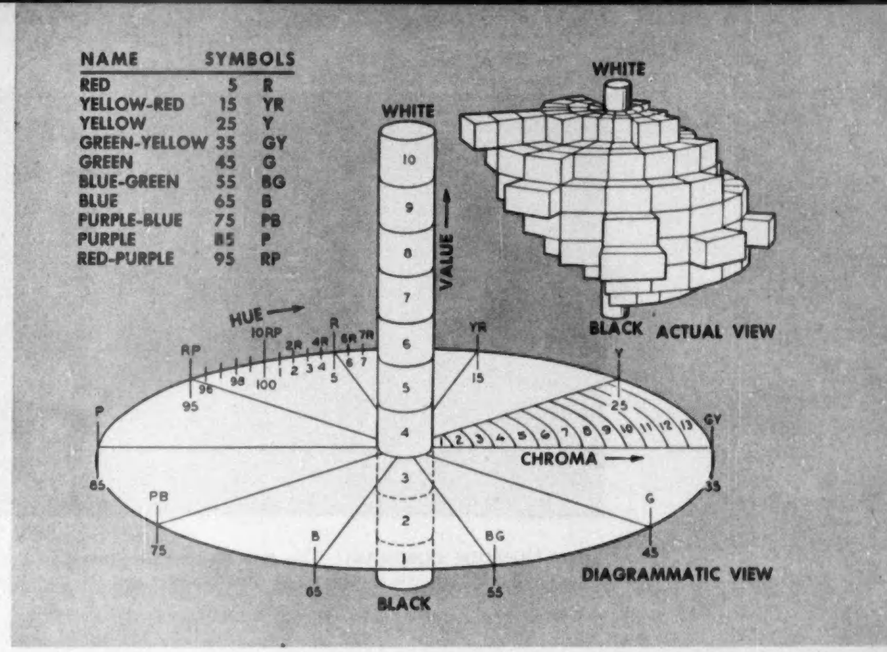
No Limits

Steam is so completely eliminated in the new liquid rheostat that the only way to tell if you have load is to consult your meters. Nor do you encounter the vexing problem of the old water-box rheostat—balancing a three-phase delta-connected load and keeping it balanced. Then too, danger to personnel is eliminated because the sodium-chromate solution is mechanically injected into the system.

The new liquid rheostat is a continuously variable stepless loading device with a great deal of flexibility. No sign of corrosion or damage shows after 442 hours of operation. And when you recall that a decrease of 45 degrees in cooling-water temperature almost doubles its capacity, you can pretty well conclude that there are no apparent limits to liquid rheostat design. This is true as far as current, volts, and power are concerned, provided the maximum values of current density and voltage gradient aren't exceeded—and provided the heat exchanger and hydraulic system can maintain a brine temperature of less than 150 F. Ω

TAMING THE RAINBOW

By JULIAN E. GARNSEY



THREE COLOR "DIMENSIONS"—hues, values, chroma—arranged by scale (*center*) according to their position in the color solid (*upper right*) of the Munsell system. Hues are arranged in spectral order upon horizontal circumferences. Value (lightness) is designated upon a gray vertical axis. Chroma (intensity or saturation) is defined radially from the gray axis. Each block in the solid represents a color differing from the others in at least one dimension.

Do you get a headache at four o'clock? Snap at your secretary? Argue with the wife? Is production down? Are employees troublesome? Perhaps color is to blame.

Color affects your every waking moment. You slide out of bed in the morning from under rose-color blankets, detecting a dark brown taste in your mouth from last night's painting the town red. In the bathroom, you reach for the green toothbrush and blue towel. After choosing a tan, blue, or gray suit with tie to match, you go down to breakfast. Your wife sends you right back to replace the tie with one more to her taste. Back at breakfast, the coffee must be golden brown, not greenish; toast red-brown, not black; and the yolk of your egg orange, not purplish-red.

At the office you open the mail in this order: 1) yellow envelope containing telegram; 2) red-white-and-blue-bordered airmail; 3) any colored envelope; 4) white envelopes. You pick a new stenographer for her peaches-and-cream complexion, passing up the more sallow candidates. In conference, discussion rages over the color of a new product: What color will sell it?

Home again: rich red roast beef, bright green peas, creamy white potatoes and golden yellow lemon pie announce their quality by characteristic colors. For the evening you choose a movie in color, and you finally turn in under the rose-color blankets after a day of decisions made on the basis of color.

Facts about Color

What is color, what produces it, how can you handle it, and how can you use it advantageously? Discussion is limited to functional color: color that will do a job based upon scientific facts of human vision, giving measurable results. Decorative considerations are omitted, though decoration might properly be called a function of color. Correct color can accomplish remarkable results in influencing people, while wrong color handicaps those who have to live with it. This is substantiated in *The Use of Color in Industry*, National Industrial Conference Board, New York, May 1947, and *The Influence of Lighting, Eyesight, and Environment upon Work Production*, Public Buildings Administration, Washington, DC, December 1947.

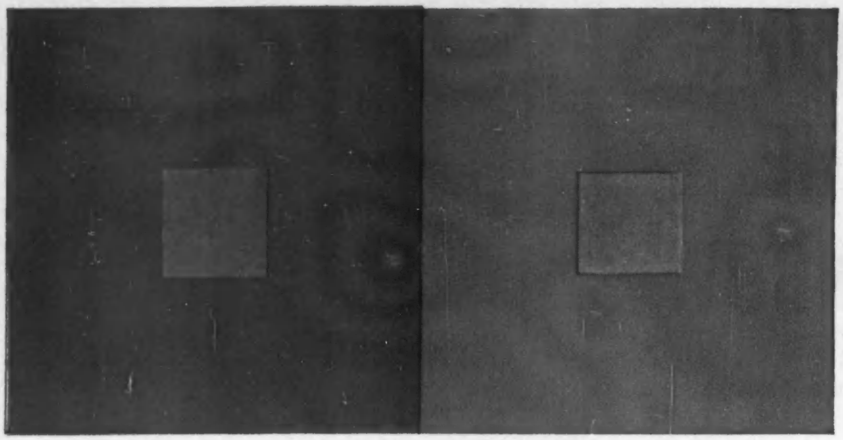
Let us note, first, that the color of any object results from its ability to absorb certain light rays (hues) and to reflect others. It follows that the object must receive from a light source the hues that it can reflect. A tomato reflects red and orange rays: under green light it looks black because no rays capable of reflection have been provided. Disregard of this principle is responsible for frequent unfortunate effects under either fluorescent or incandescent lamps.

White light contains all hues but not all colors. Passed through a prism, it reveals the component hues as a spectrum. When lightness and intensity of the hues are modified, they produce all colors. About 125 to 160 hues are discerned by the human eye, and colors by the millions can be identified under laboratory conditions. But for a practical "vocabulary" of colors, about 1500 are sufficient.

Hues of the spectrum can be conveniently arranged in a circle so that complements occur at ends of diameters (diagram, above). Useful dictionaries of color have been published by Munsell, Container Corporation, Martin-Senour and Plochère.

Since color impressions and 87 percent of all sensory impressions are received by the eye, this remarkably sensitive organ deserves attention. It has some strange habits: for example, within the eye, each color influences all others which are seen simultaneously. Also, it induces a tinge of its complement upon a neighboring color (Simultaneous Contrast, next page). Your wife's green dress or hat creates a rosy tint upon her complexion, while a red hat will bring out greenish tints, if any. Tactful use of this fact may impress her when your opinion is asked.

Another peculiarity of the eye is that it tires quickly of one hue and carries over the complement of that hue to the next color you see (After Image, page 39). At the New York World's Fair I made use of this phenomenon to enhance the Golden Circle at the Long Island Railroad entrance. Strip windows down the long train shed were glazed with violet which fatigued visitors' eyes



SIMULTANEOUS CONTRAST The gray squares are printed in the same color. But observe how the border induces a tinge of its complement upon the gray square.

to that color. Then when they walked out into the open air, they saw the complementary yellow upon the gold of the Circle. The doubled effect was terrific.

In a New York restaurant I used the reverse. A large dining room was painted in deep blue to encourage hand-holding; naturally the anteroom was warm yellow. Couples glided into a saturated blue atmosphere to their satisfaction—and the management's profit.

A third habit of the eye is to feel that one-half of the spectrum—red-violet through yellow—is warm, and tends to advance, while the other half—blue-violet through green—is cool and retreats (Advancing and Retreating Colors, next page). When I changed the walls and columns of a New York bank from faded yellow to light blue-green walls and white columns, officers and employees agreed that the interior felt much larger and definitely cooler in summer. As a by-product, women tellers were prettier against the new background, for which I received undeserved credit.

After the modifications in the eye which have been mentioned, color impressions are further transformed in the brain. It's a triple play: as color is, as it is to the eye, and to the brain. Here past associations conditioned reflexes, tradition, and fashion all have their influence. Specific colors may become associated with punishment, reward, happiness, dejection, or social position. The child who is habitually punished by being put to bed in a green-walled room may hate that color all his life Also, some associations which once were conscious and intentional may retire to the subconscious: the red of the Bible's scarlet woman and of Hawthorne's *Scarlet Letter* is now generally associated with naughtiness.

Color Preferences

Traditions and associations unite to establish a "language" of color. Yellow, color of sunlight, brings good cheer. The personnel of a Boston bank objected to working in rooms that were painted dull gray and opened upon a narrow light shaft. When the walls were repainted in warm yellow, and the lighting level stepped up, girls actually asked to be transferred to that "desirable" section.

Orange, in its pure form, is the most powerful and advancing of the hues. Its greatest usage lies in tints like peach or salmon, or in shades which are browns. Women who wish to create a sensation at a party will wear flaming orange. Blue dresses will get them nowhere. Few men, however, dare wear orange—except at Miami Beach.

The most potent hue is red. Pure, in tints, or in shades—pinks, rose, maroon—it has universal emotional appeal and is one of the two most preferred colors. Under red light, rate of pulse and blood pressure increase and time is overestimated. Red objects command attention and appear heavy—hence danger signals.

Greens pacify. Demanding no emotional response, they relax muscular and nervous tension. One who chooses a wife who is partial to green will find her to be tolerant, liberal, well-balanced, conventional. She won't be much fun, either.

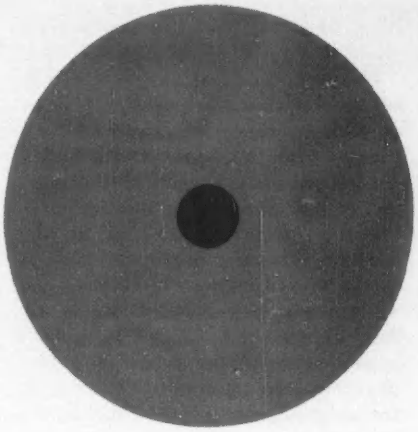
Blue-green is the best complement for human skin and probably the best all-round color for any clothing.

Blue, though not the visual complement, is the psychological complement to red. All that red is, blue isn't. Under blue light, pulse and blood pressure slacken, time is underestimated, and people calm down. It is a good color for the Complaint Department, and some authorities suggest it for treatment of hang-overs. Being the favorite color of most men, as red is of women, blue is little used in home decoration.

Limited use is made of violet except for funerals or other very serious occasions. Because of this association the purple orchid affixed to a young lady may deny by its color the sentiments entertained by its donor.

Preferences among hues enjoy a remarkable unanimity throughout the world. The order for men of all races runs: blue, red, green, violet, orange, yellow. For women, red and blue are transposed. However, choices determined by survey do not always coincide with choices for purchases. Yellow-green comes near the bottom of any list, but from time to time women's clothes break out in a rash of chartreuse, a grayed yellow-green.

In most merchandise, lower income groups buy pure colors, while people in higher tax brackets show a preference for the more refined variations. Red toothbrushes sell in low-priced lines but at more expensive levels, the pastel or



AFTER IMAGE Concentrate your gaze for 5 to 10 seconds upon the dot in the orange disc. Shift quickly to the other dot. You should see pale turquoise blue. If not, see your oculist.

translucent ones are chosen. Also, a geographical correspondence exists between proportions of sunny days in the year and color selection. At least one mail-order firm plans its distribution of colored goods upon this basis.

Using Color

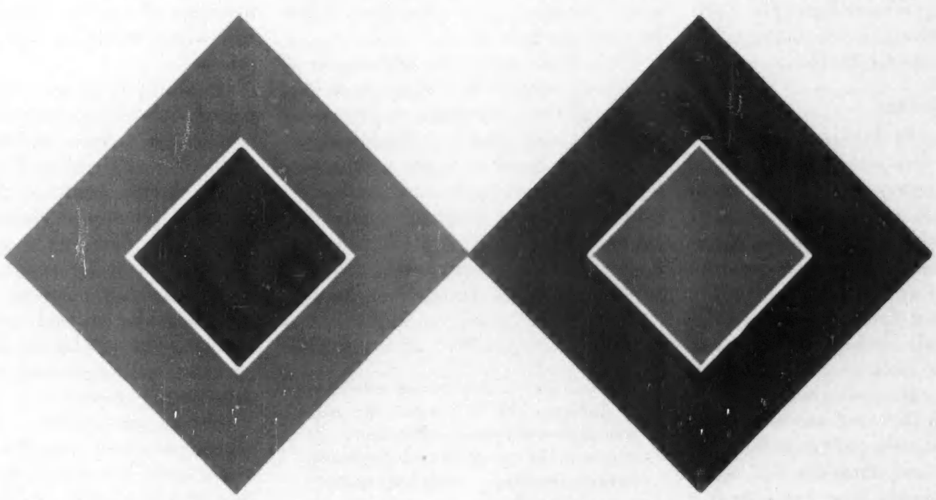
The main principles governing color physiology and psychology have now been indicated. And now application of these principles to the engineer's problems will be discussed, using a factory as an example.

At the start of any job, colorist and illuminating consultant must arrive at agreement. Both appreciate the need for footcandles but the colorist wants them to be carefully adjusted to the color scheme. Considerable electric current can be saved by correct planning of reflectances. Since both men have the same objectives as management—increased production, less spoilage, employee contentment, and reduced turnover of personnel—they usually work together harmoniously.

The colorist begins his studies with the operator at the machine and the executive at his desk. What are the visual characteristics of the work in hand? Is it large, small, heavy, light, bright, dull, colored, or gray? How does it arrive and leave the machine? Must it be revolved or manipulated? How long must the operator's gaze be concentrated upon it? Steel castings, aluminum parts, wooden objects, watch springs, all require different backgrounds for eye relief. Tan color of low reflectance furnishes a proper complement for bluish steel. Copper or brass need gray blue-green behind them. The strain of concentrated seeing can be lessened by correct colors nearby to which the eye will gladly turn. Free-standing machines in a crowded shop can be cut off from view by screens to reduce distractions.

Whatever hues are planned for machines and backgrounds, all brightness contrasts within the field of view that are the products of light and color must be skillfully handled. They should be 1) greatest within the work in hand, 2) less between work and background, and 3) no other location allowed to interfere with the first two requirements. One unshaded window in the view of an operator can measurably slow him down.

Mass color of machines need not be black, brown, or muddy green. The boredom of a repetitive job should not be increased by a boresome color. Soft green, lively gray, or warm beige is happier and also encourages better housekeeping. The bright colors of a standard accident-prevention code furnish pleasant accents as well as safety.



ADVANCING AND RETREATING COLORS WHICH DIAMOND ADVANCES? WHICH BORDER ADVANCES?

CONTINUED ON NEXT PAGE

In theory, the floor which is seen by the worker beyond his machine should be only slightly darker than the machine. In practice, this is hard to accomplish. Maintenance people object, forgetting that lightness means cleanliness, darkness encourages dirt. Skirmishes and some verbal battles ensue on this point and others in functional color schemes. The maintenance boys are often difficult to convince that good color is no harder to keep up than institutional yellow or gray. Experience in boxing or football is a useful part of a colorist's education. However, if the president can be sold at the outset, he can be effective as a blocking back in arguments.

White ceilings are most efficient for reflectance. If their design is likely to produce glare, tinting the right areas will offset it.

Walls—the largest surfaces seen—present excellent opportunities for functional color. But they don't have to be the same throughout the shop. Window walls can be very light, even white, and walls facing windows can be light to the limit of producing glare or distraction. Side walls present the best locations for attractive eye-resting color. For example, newspaper pressrooms are traditionally dark and dingy. Yet in the *Journal* plant at Portland, Ore. I had an enormous 14-unit press enamelled all in deep ultramarine blue. Surrounding it are sand-color walls, lemon-white ceiling, and vermilion columns. Light sources give 50 footcandles at eye level. Admittedly, this is not a scheme for the average factory, but it illustrates an extreme to which one may go in providing interesting environments for working people. Even the pressmen, a definitely masculine group, like it.

Influencing Factors

Temperature conditions will frequently govern the use of color. Cool tints alleviate the impression of heat, as in Southern textile mills, boiler rooms, or submarines, and they relieve the claustrophobia of army tanks. Hot colors take the chill off refrigerators.

Rest rooms, locker spaces, and cafeterias merit study. News of these travels around among workers and has been known to attract employees from elsewhere. Women like rest rooms in rose, pale salmon, or soft yellow with warm beige carpets and incandescent light. Men's rooms should have not blue but gray-green or beige walls with blue carpets. No rest room should feel cold.

Cafeterias require "appetizing" colors warm or cool according to orientation: Peach, salmon, daffodil yellow on northern exposures; lettuce green on the south side. Blues, cold reds, or violets enhance appetite, though warm reds, orange, or brown may occur as accents.

You can see excellent examples of skillful color planning in the Johnson and Johnson plants near New Brunswick, NJ, where comfort of employees has been a major consideration.

In the offices of a plant the same principles apply as in the shop, though greater ranges of color are obviously appropriate. Certainly, the one thing not to do is to carry a single scheme through a long series of offices. Such a scheme may symbolize a democracy advocated by company policy, but it also emphasizes the tedium of daily tasks. Variety promotes energy. Large suites should be broken up by contrasting colors. In the recently completed Somerset County Administration Building, Somerville, NJ, which contains many public and private offices, I used 14 paint colors to create a lively environment. The favorable reaction on the part of personnel transferred from an old building is remarkable; yet no extra cost whatever above traditional dull colors was incurred.

There is no justification, by the way, for considering one hue "easier on the eyes" than any other. Light green is not a cure-all. Any hue sufficiently grayed will be as agreeable. More important is to realize that cool colors relax; warm colors excite. Knute Rockne is said to have painted his own team's dressing room in red-orange and the visitors' room in blue for a calculated effect between the halves.

Throughout the plant, preferences of personnel should be respected so that everybody has his stake in the color scheme. Colors liked by Scandinavians would not appeal to Italians. By trying out a scheme in part and getting reactions from key employees, later uninformed criticism may be avoided. Each executive also should be consulted as to his preferences because color likes and dislikes are matters more of emotion than of reason.

However, strong arguments should be advanced against the executive's favorite dark mahogany or walnut desk top covered with plate glass. Probably few factors cause more headaches, ill temper, or obstinacy among the top brass. On the executive desk, as at the machine, strongest brightness contrast should prevail between black print and white paper, not between paper and desk. Experiment by placing a couple of large blotters in the usual gray color upon the working surface of the desk. If convinced, you will find the permanent solution in the light-colored linoleum recently made available. Plate-glass tops give irritating specular reflections from all light sources; they should go the way of roll tops and spittoons.

Some of you may design packages or comment upon designs submitted. Every package should be exactly fitted to the product, its use, and display. Fundamental differences between foods, nuts and bolts, shoes, and cosmetics should be expressed in the containers. Brown is good for coffee or shoes, not for canned fruit.

Destination is important. Will the package finally arrive at a machine, on a lady's dressing table or in the kitchen? Is it to be sold in supermarkets, appliance stores, or from catalogues? Conflicts may arise between various requirements, to be resolved by straight thinking. Coca-Cola, for instance, is a cool refreshing drink. Light green packaging would seem to be indicated, but its vending machines are bright red. The necessity of extreme visibility in public spaces has overcome the appeal of the product.

If visibility is paramount, the order of performance by hues is: red, yellow, orange, green, blue, violet, with red far in the lead. Editors of *Time* know this. When changes are to be made in an old package, elements of identification must be carried forward to new designs. Several successive steps may be necessary to ensure customer recognition. Let color be revised first. Then by degrees, change layout and form of package, testing at each step for consumer acceptance.

Indeed, the validity of any color scheme depends upon its performance under test. The probability of its success is increased by intelligent planning that concurs with the facts of human vision. Ω

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Mr. Garnsey—a professional colorist—of Princeton, NJ, is a noted color consultant for architecture and industry. As a colorist, he has done work for banks, business buildings, churches, colleges and clubs, hotels and restaurants, and housing projects. He has lectured and written extensively on color.

ENGINEERING SOCIETIES OF AMERICA

FOURTH OF A SERIES

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

By GEORGE A. STETSON

The principal areas in the field of mechanical engineering stretch back some 200 years ago to the days of James Watt and his contemporaries. For a century before the mechanical engineers became organized, the shift toward an industrialized pattern of life, with all its social, economic, and political consequences and problems was under way.

It was during the early part of the 19th century that George Stephenson—the British locomotive builder—organized the Institution of Mechanical Engineers to serve the needs of men in Great Britain who were practicing there in that new area of the engineering profession.

Progress in the industrial development of our country was stifled by the colonial policy of Great Britain. Retarding it further were the problems of a new republic, the demands that arose from settling an undeveloped continent, and the stunning effect of the war between the states.

Then, in 1876, the Centennial Exhibition was held in Philadelphia. For the first time nationwide attention was drawn to the potentialities of an industrial economy, and the opportunities of free private enterprise became apparent.

During the ferment of this enthusiastic era The American Society for Mechanical Engineers was born.

Early Founders

Organized in 1880, the ASME founders were engineers engaged in the iron and steel industry, the generation and use of power, the design of machines, the manufacture of capital and consumer goods, the administration of industrial enterprises, applied science, education, and the publication of technical works and magazines. Their aim was to aid one another, to develop the literature of mechanical engineering, and to establish a library. The economics of production was held in high regard. They recognized and deplored waste and high costs associated with nonuniform practices. Consequently they soon devised test, safety, and construction codes and organized and co-operated in standardization movements. They engaged in research and established funds to stimulate and carry forward research programs.

Their devotion to education at all levels led them to establish courses in industry for cadet engineers, foremen, and shop apprentices. As owners or managers of industrial enterprises they were concerned with costs and wage-payment plans, and under the leadership of such men as Metcalfe, Towne, Taylor, Gantt, the Gilbreths, and many others they demonstrated that one of the most fertile and important fields of engineering is that of management.

Prominent among the founders of ASME were four men whose vision, ideals, and dedication to the profession of engineering set the tone of future developments.

Alexander Lyman Holley, whose useful and brilliant career was cut short by his death in 1882, addressed the preliminary meeting and served as its chairman. He had brought the Bessemer process of steel making to this country, and made improvements in it. A monument located at the western end of Washington Square in New York City, and the Society's Holley medal are constant reminders to this generation of his devotion and achievements.

Henry R. Worthington, another founder and an Honorary Member in Perpetuity, died in 1880. He established the duplex steam-pump industry and the company that bears his name.

Another founder was John Edson Sweet—a professor at Cornell and designer and manufacturer of the straight-line steam engine—who became the second ASME president.

Robert Henry Thurston was the first president of ASME. In the opinion of some observers he was the most extraordinary and able man in the long history of the Society. Scholar, philosopher, educator, engineer, research worker, prolific writer of technical papers, he was professor of mechanical engineering at Stevens Institute of Technology and later director of Sibley College at Cornell. His vision of what an engineering society might accomplish was penetrating and farsighted.

In his inaugural address, delivered at the first ASME Annual Meeting, November 4, 1880, Dr. Thurston contended that "the management of works has become a matter of such great and far-reaching importance as to justify its classification also as one of the modern arts. It should originate from those who are also engineers, particularly mechanical engineers. Granting this," he asked, "why should it not originate from, and be promoted by, The American Society of Mechanical Engineers?" Within a few years the ASME Council had given its official blessing to these views.

Organization

The American Society of Mechanical Engineers is incorporated under the laws of the State of New York as a nonprofit membership organization. Its government rests in a Council, elected by the members, consisting of a President, five past Presidents, eight Vice Presidents, and eight Directors. The Secretary and Treasurer, also Council members are appointed annually by vote of the Council. An Assistant Treasurer is also appointed by the Council, but he is not a voting member of it.

Reporting to the Council and acting on its behalf on certain matters are the Boards on Technology, Codes and Standards, Honors, Membership, Education and Professional Status, and Public Affairs.

The Boards and a majority of Society committees generally confine themselves to policy matters. Administration and routine operations at the national level

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Mr. Stetson is Editor of MECHANICAL ENGINEERING, *the monthly publication of the ASME. He has held this position for 23 years.*

CULMINATION OF TWO CENTURIES OF MECHANICAL ENGINEERING, TYPIFIED BY GENERAL ELECTRIC'S TURBINE BUILDING—WORLD'S LARGEST.

ASME MEMBERSHIP GRADES AND MEMBERS

(September 30, 1952)

Honorary	54
Fellow	380
Member	13,429
Junior	23,230
Associate	352

(Student Members in 135 Student Branches)

1952 BANQUET SPEAKER Charles F. Kettering (*center*) talks over the Society's future with Past President E. G. Bailey and Frederic S. Blackall jr., ASME President.

are carried on by the Secretary's staff, which now numbers 140 employees.

Publications

Aside from his local activities, member's contacts with the national organization are maintained principally through publications, national meetings, division conferences, and service on national committees.

Every member receives *Mechanical Engineering*, a monthly general-interest technical magazine with a section devoted to ASME news. He may subscribe to *Transactions* (eight issues yearly), *Journal of Applied Mechanics* (four issues a year), and *Applied Mechanics Reviews*, a monthly periodical.

Preprints of papers delivered at Society meetings and division conferences are also available, as well as the ASME Mechanical Catalog and the Membership List. Obtainable too are dozens of special publications: Proceedings of conferences, codes, standards, biographies, bibliographies, and so on.

Activities

The Society holds four national meetings each year: Spring, Fall, Semiannual, in May or June, and Annual, early in December. The technical papers presented at national meetings are solicited, reviewed, accepted, and scheduled by the professional divisions. Presently there are 21: Applied mechanics, Aviation, Fuels, Gas turbine power, Heat transfer, Hydraulic, Industrial instruments and regulators, Machine design, Management, Materials handling, Metals engineering, Oil and gas power, Petroleum, Power, Process industries, Production engineering, Railroad, Rubber and plastics, Safety, Textile engineering, and Wood industries.

National meeting programs also contain papers offered by committees that are not part of the professional division structure; for example, Junior, Education, Research, and Civic Responsibility Committees, and several lectures and luncheon and dinner addresses.

The ASME Research Committee organizes special committees to supervise individual projects under contract with laboratories that are financed by funds collected from interested industries.

Under the Board on Codes and Standards are the various code and standards committees. Power test codes were proposed early in the history of the Society. Today there are 61 such codes. Under the Safety Committee there are 10 codes. The ASME Boiler Code Committee has eight additional codes. American Standards sponsored by ASME are developed under the procedures of the American Standards Association. Today there are more than 100 such standards.

ASME co-operates also with the International Standards Organization. In addition to standards under ASME sponsorship, the Society is officially represented on many standards committees sponsored by other groups under ASA. An outstanding example of international co-operation in standardization is in the field of screw threads undertaken by Great Britain, Canada, and the United States.

Fields of common interest provide many joint activities of ASME with other engineering societies at home and abroad. Among these may be mentioned the United Engineering Trustees which administers the joint properties of the Founder Societies; the Engineering Foundation; Engineers Joint Council (EJC), which is currently concerned with the manpower problem and a unity organization for engineers; Engineers' Council for Professional Development (ECPD), whose most outstanding accomplishment to date has been the accreditation of engineering curricula; the Pan-American Federation of Engineering (UPADI); and the conference of representatives from the Engineering Societies of Western Europe and the United States of America (EUSEC).

Membership

Ever since the early days, as membership grew, the need for community organization became urgent. Sections of the Society were thus established whenever a concentration of members in a given area justified local activities.

Today there are 79 Sections and 7 Subsections grouped in 8 regions. One Vice President is assigned to each region. He heads a Regional Advisory Committee which looks after the needs of the Sections and Student Branches of the Region. Sections organize as local units, appoint their own committees, and conduct their own meetings.

An organization of individual members, ASME membership constitutes recognition by his fellow mechanical engineers of the personal qualifications, achievements, and promise of the member. Advancement from Junior to Member and Fellow grades of membership is further evidence of professional recognition. Thus the Society carries out that great purpose which Alexander Lyman Holley set forth more than 70 years ago as the ". . . significance of the endorsement of a high quality of elected membership."

But ASME carries the spirit of recognition and endorsement even further. In 1880 ASME elected its first Honorary Member, Horatio Allen, pioneer railroad engineer in this country. In recognition of the outstanding mechanical engineers of the western hemisphere, in 1882 the Society elected several prominent men to Honorary Membership. Among them were: Daniel Kinnear Clark, British railway engineer; Rudolph Clausins, German physicist; Peter Cooper, founder of Cooper Union; Gustav Hirn, Alsatian physicist; Sir Edward Reed, British marine engineer and ship designer; Franz Reuleaux, German educator and mathematician; Henri Tresca, French physicist; and Henri-Adolphe-Eugene Schneider, French metallurgist and steel manufacturer.

To this list each year have been added such notable men as Sir Henry Bessemer, Andrew Carnegie, Thomas Edison, Rudolph Diesel, Rear Admiral George Melville, Auguste Rateau, Elihu Thomson, George Westinghouse, and Orville Wright, to mention but a few.

Achievements of mechanical engineers are further recognized by the annual conferring of several awards and medals . . .

- ASME Medal—for distinguished service in engineering and science.
- Holley Medal—for some great and unique act of genius of an engineering nature having great and timely public benefit.
- Worcester Reed Warner Medal—for an outstanding contribution to permanent engineering literature.
- Spirit of St. Louis Medal—for meritorious service in the advancement of aeronautics.
- Melville Prize Medal—for an original paper or thesis of exceptional merit.
- Junior Award—for the best paper submitted by a Junior Member not more than 30.
- Spirit of St. Louis Junior Award—for the best ASME paper presented by a Junior Member under 30.
- Richards Memorial Award—for outstanding achievement of a mechanical engineer not more than 45, and within 20 to 25 years after graduation.
- Pi Tau Sigma Gold Medal Award—for outstanding achievement of a young mechanical engineer within 10 years after graduation.
- Charles T. Main Award—for the best paper by a Student Member on the general subject of the influence of the engineering profession upon public life.
- Henry Hess Student Awards—two given annually for the best papers submitted by student members.

At the 1952 ASME Annual Meeting two new awards were announced . . .

- George Westinghouse Gold Medal—for eminent achievements or distinguished service in the field of mechanical engineering.
- Machine Tool Design and Economic Value Award—for the three best papers by ASME members on the subject of machine tools.

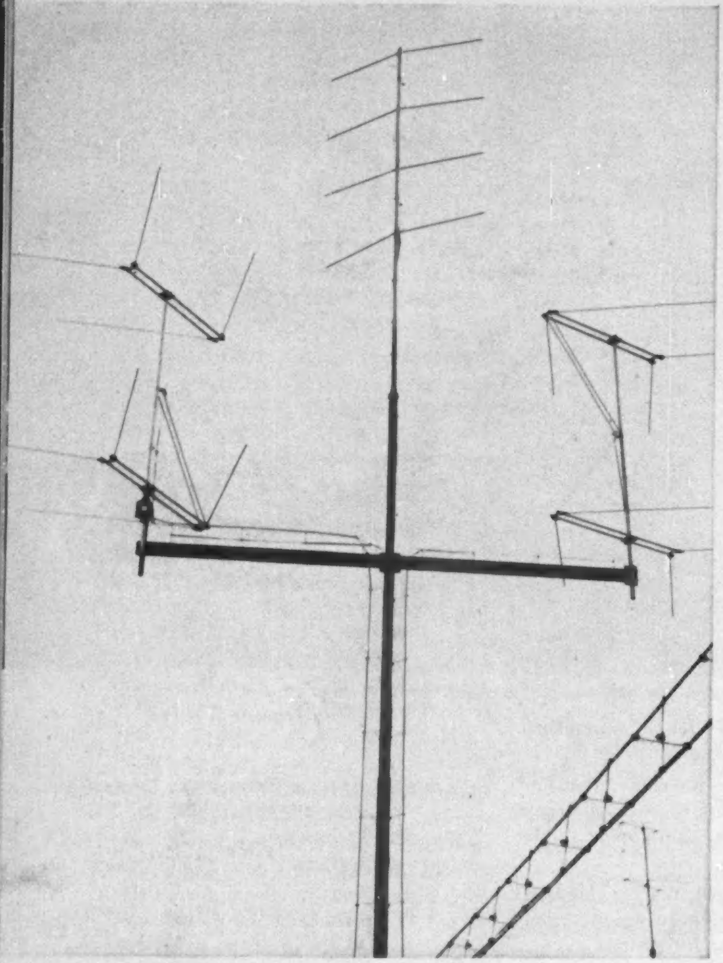
Jointly with other societies ASME participates in these awards—John Fritz Medal, Hoover Medal, Gantt Medal, Daniel Guggenheim Medal, Wallace Clarke Medal, Alfred Nobel Prize, and Washington Award.

Today's Expanding Fronts

As science and technology have advanced under the stimulating influences of free enterprise and the growth of our industrial civilization, the field in which the mechanical engineer operates has expanded and become more varied. On the technological front the development of applied science has made it necessary for many engineers to work closely with scientists and to comprehend and apply scientific discoveries. Moreover, developments in electricity, chemistry, aeronautics, and now, nuclear physics have created new groups of engineering specialists. And in these new fields, except where fundamental design is involved, most of the problems to be faced lie within the province of the mechanical engineer. Furthermore, research and design in the more strictly mechanical engineering fields—such as mechanics, power generation, heat transfer, instrumentation, lubrication, and several others—engage the activities of an ever-increasing number of mechanical engineers and demand of them a thorough grounding in mathematics and the physical sciences.

On the nontechnical front the mechanical engineer of today must work ever more closely with the social scientists. This is particularly true in the fields of economics, psychology, and employee and public relations because he so frequently finds himself saddled with the responsibilities of the management of industrial enterprises.

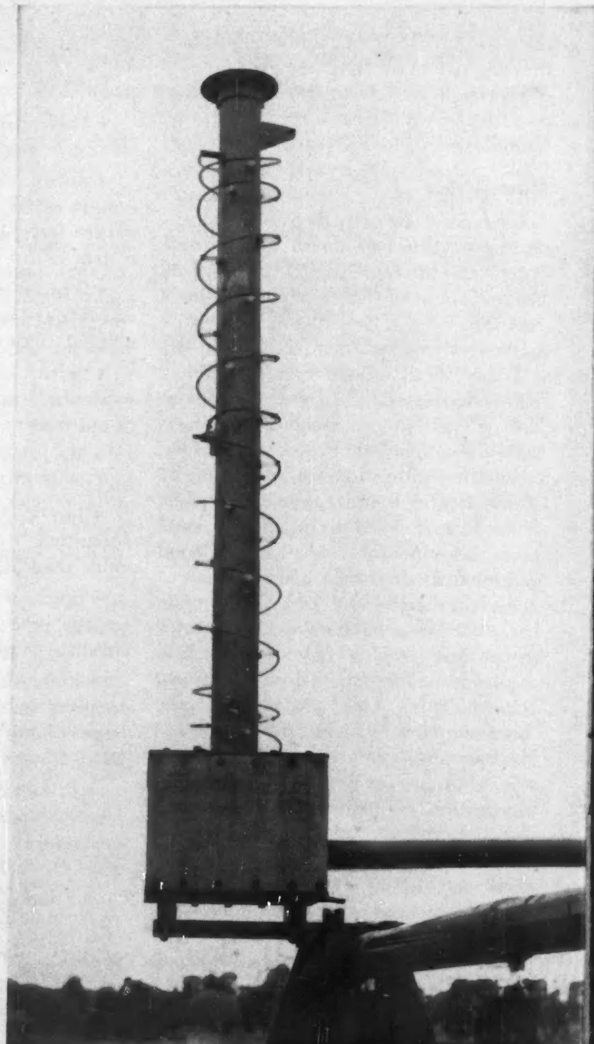
Such developments and diversities in the pursuits of mechanical engineers on both of these fronts today create the needs and opportunities which they attempt to meet collectively in the activities carried on by the ASME. Ω



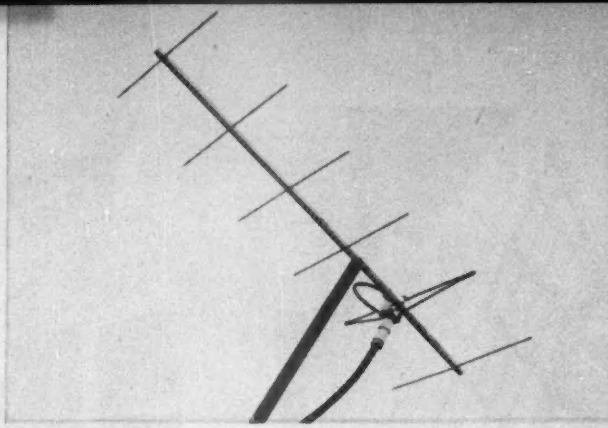
An Album of Antennas

. . . in which strange and wondrous configurations are delineated and described.

ONEIDA CHIEF, a collinear array that consists of four stacked simple dipoles, tops this set of antennas. Although it performs well in fringe TV areas, the Chief has a drawback in that it is bidirectional; it has no rejection to reflected signals from the back of the antenna. On the crossarm are two double V antennas. Two characteristics of a V-beam type are its broad band coverage and directivity. Below the left-hand double V is a rotator used to position the antenna in any direction from a remote location.

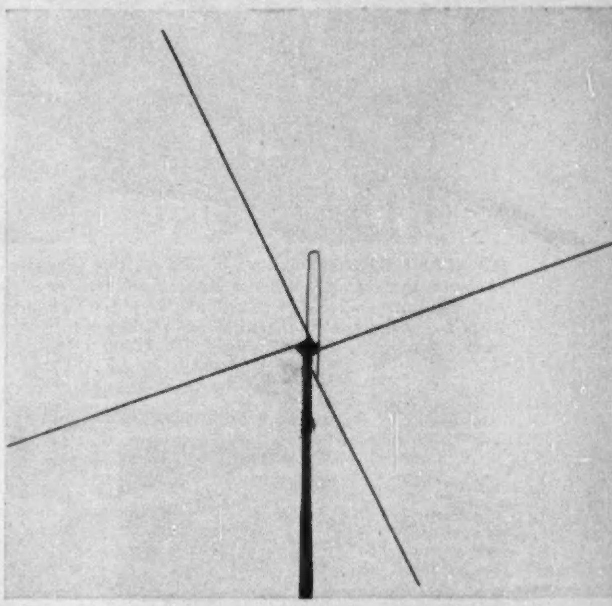


SIDEFIRE helical type of ultra high frequency (UHF) television transmitting antenna has high gain. This section is 6½ feet high and has a gain of five on 750-megacycle operation. Four or five sections can be stacked together to satisfy many requirements of commercial TV applications.

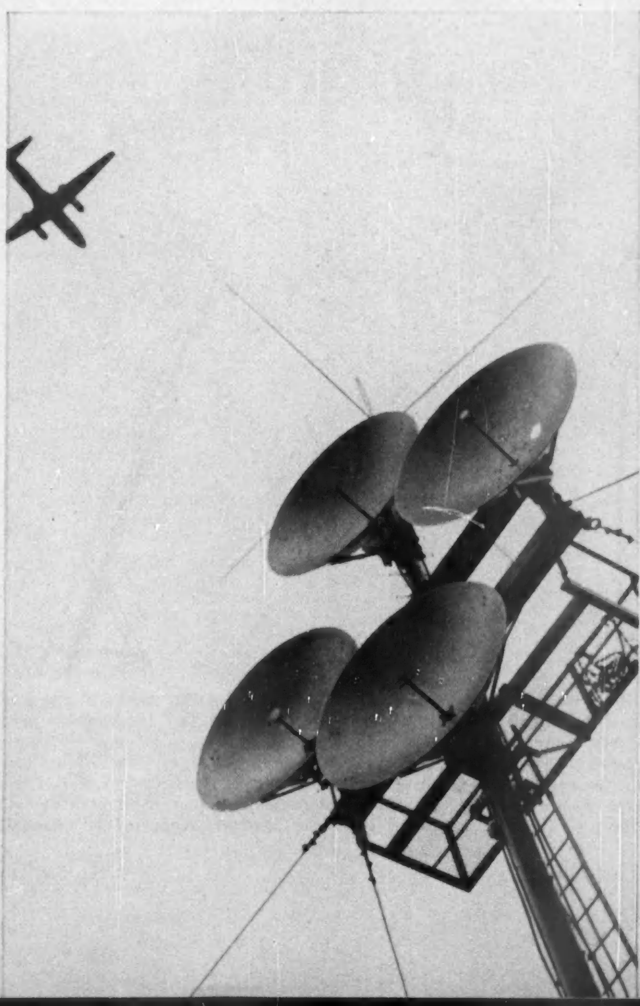


YAGI type UHF-TV receiving antenna for home sets. A directional unit like this has a power gain of about 10 to 1 over a single dipole, or 3.16 to 1 in signal gain.

All photographs, with the exception of the marine antennas, were taken by George Burns at General Electric's Electronics Park, Syracuse, NY. Not all antennas shown are products of General Electric.



UNIPOLE very-high frequency (VHF) omnidirectional antenna for operation at 40 mc. This unit is used with 50- and 250-watt base-station transmitters and receivers for two-way radio communication systems such as police, fire, and taxis.



MICROWAVE antennas with their six-foot "dishes" are used for voice communications, telemetering, teletype, facsimile, and supervisory control. At 3 o'clock is a 2000-megacycle unit with a six-degree beam. At 12 and 6 o'clock are 960-megacycle antennas with 12-degree beams. The unit at 9 o'clock has a six-degree beam and is used in the 1700–1800 megacycle band. Antennas of this type, capable of receiving and transmitting at the same time, are used from point to point over long distances by means of relay stations that pick up, amplify, and retransmit the signals.

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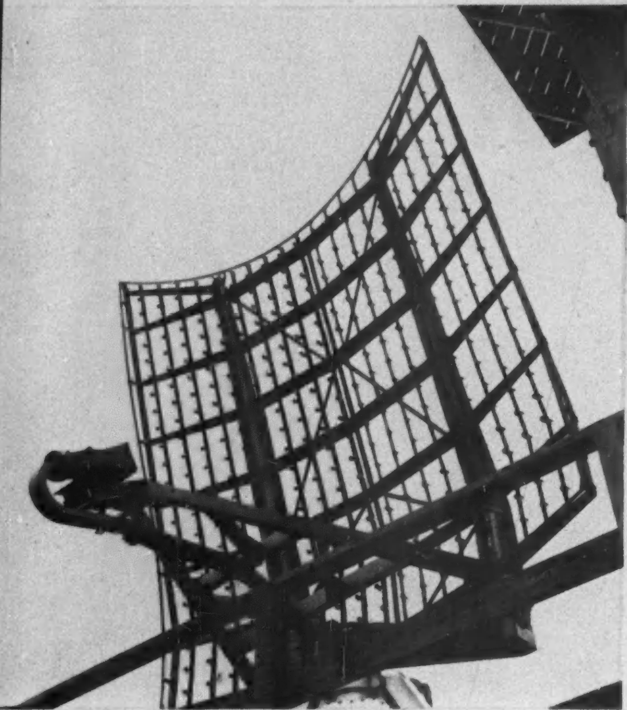

BARREL STAVE antenna on this electronic navigator is used for surface search on small ships; helps them navigate in all types of weather.

COSECANT SQUARED "dish" is used on this airport surveillance and search-type radar antenna for both receiving and transmitting. The antenna gain is 15 and it operates at 2700 to 2900 megacycles with a wave length of 10 centimeters. Output of the radar system is 500,000 watts.

An Album of Antennas

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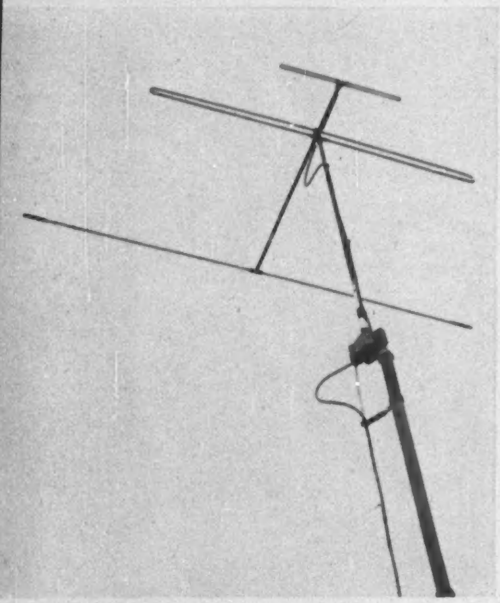
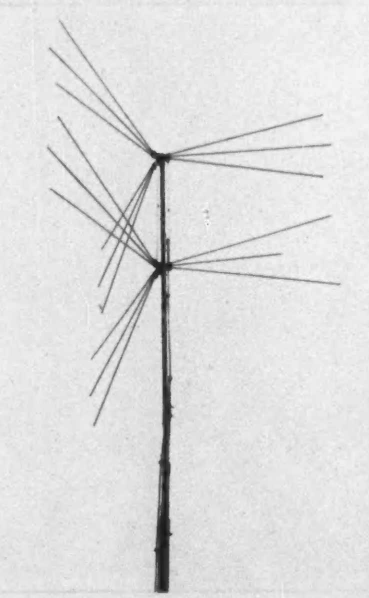
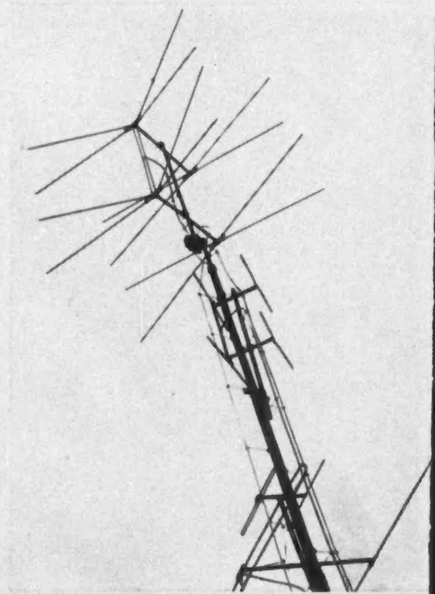




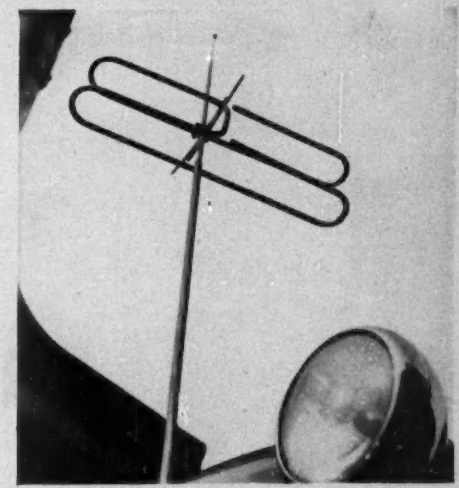


INLINE antenna consists of a Hi-band and a Lo-band folded dipole with one reflector. It is used in primary service areas where TV reception is good. One of the unusual features of this antenna that improves its performance is that the Lo-band folded dipole is used as a reflector for the Hi-band dipole.

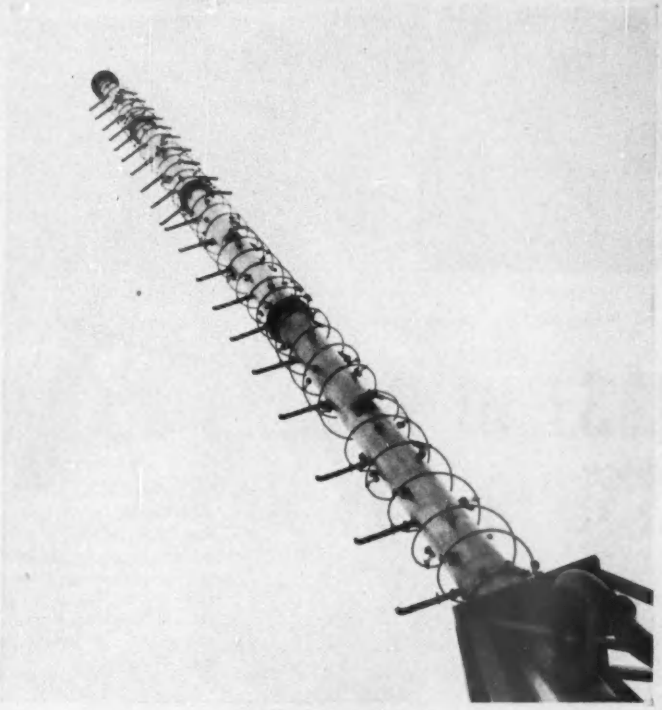
SNYDER is unique because a three-conductor transmission line is used along with a selector switch. TV signals may be received from any direction by using the switch to cut in any pair of elements. The antenna proper has three fan-type elements arranged at 120 degrees in a horizontal plane.

STACKED YAGI at the middle of the mast is a channel 8 stacked two-element beam antenna. Above it is a "Telerex" consisting of a stacked conical array. The "Hi-Lo" band antenna at the bottom consists of two two-element antennas—one covers high VHF-TV channels, the other covers low VHF channels.

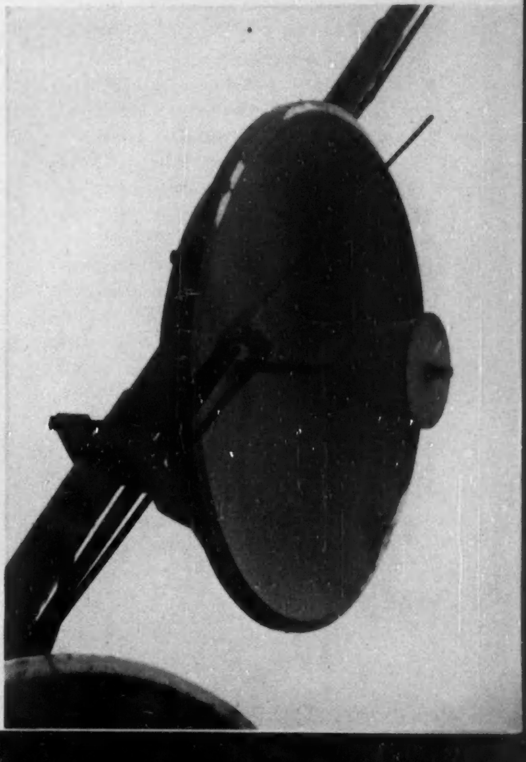
DONUT, or "loop-type folded dipole," with de-icing equipment undergoes temperature rise tests. Antennas like this are used for FM transmission.



HOT-ROD SPECIAL is of dubious value both for radio reception and appearance; may prove to be a lethal instrument in case of a bad accident.



SIDEFIRE HELICAL type of UHF-TV high-gain transmitting antenna to operate at 500 megacycles. Power gain is 20 over a dipole—each of the four 10-foot sections shown have a gain of five. Unit has a 50-kw input that equals 1000-kw ERP (effective radiated power).



PARABOLIC REFLECTOR (40-inch "dish") with dipole feed is used for 960-megacycle operation, either receiving or transmitting. Uses include studio-to-transmitter (line-of-sight) links for TV and for remote control of radio communication transmitters. Signals are transmitted in a 20-degree beam.

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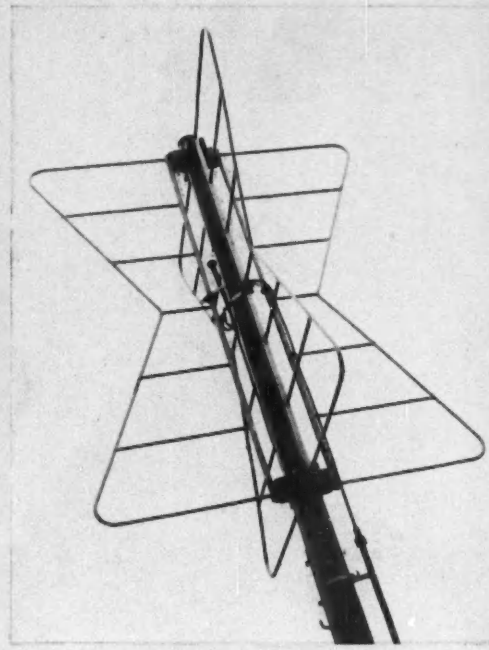
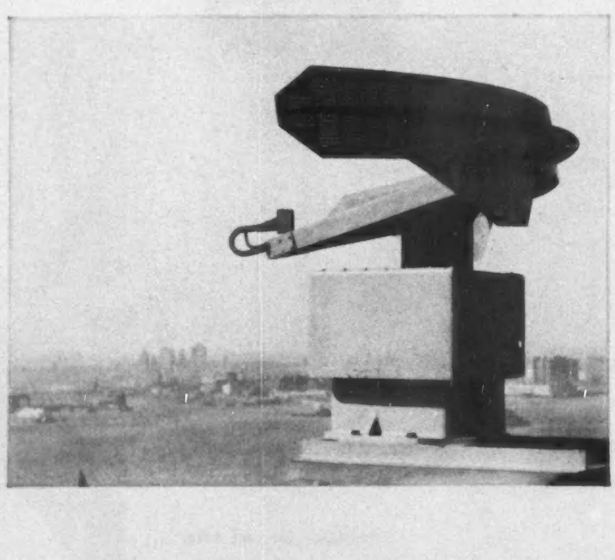
ELLIPTICAL antenna of this aircraft detection station has "sails" of lace-like steel to cut down wind resistance. Radomes of rubberized fabric often cover these antennas to protect them from weather.



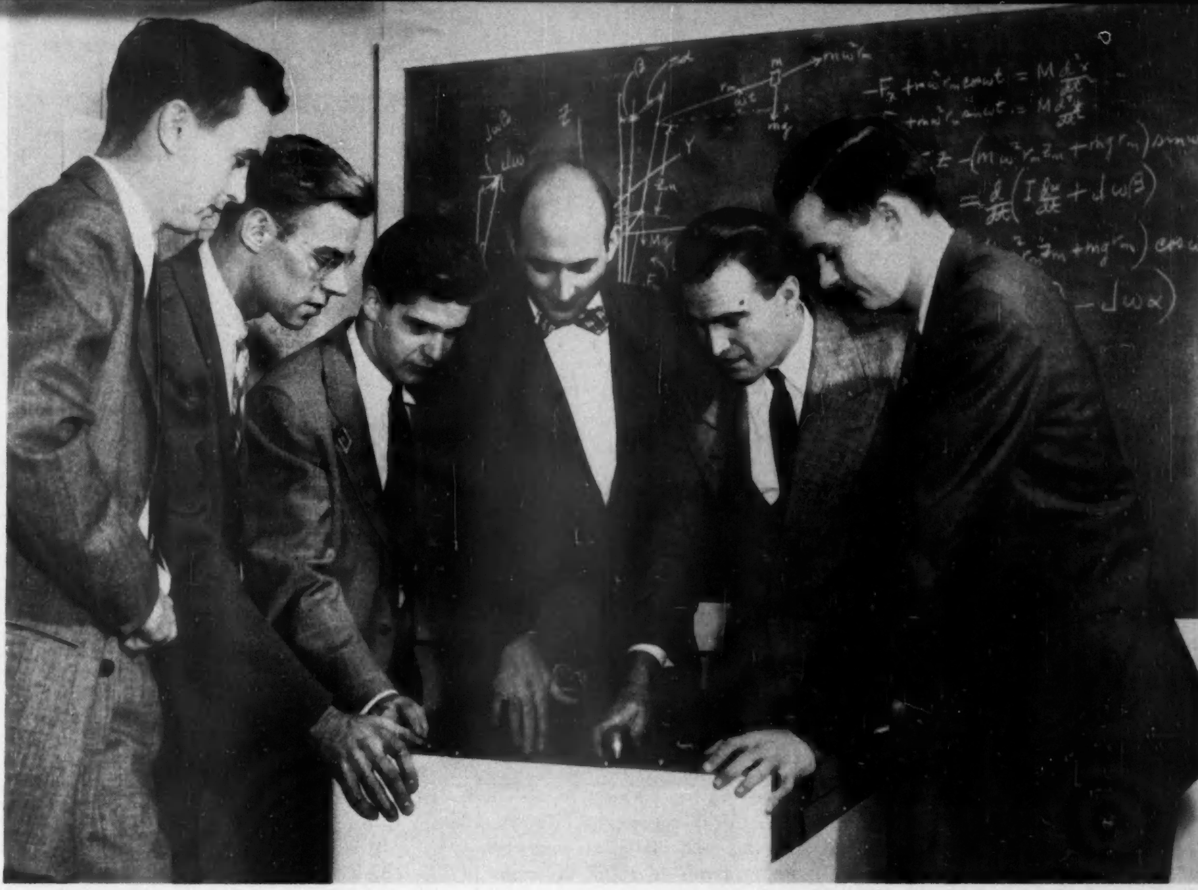
An Album of Antennas

CONCLUDED

BAT WING, also known as a "super turnstile," is a TV transmitting antenna for low-channel (2) operation. Only one bay is shown, but stacks of three to six are used on low channels; six, eight, or twelve bays on high channels.



BANANA PEEL antenna of this shore-based electronic navigator is used for navigation, can pick up squalls and other bad weather conditions. The three centimeter wave lengths give high resolution. Similar sets are used on ships.



YOUNG ENGINEERS GAIN INSIGHT INTO GROUP PARTICIPATION TO HELP BROADEN THEIR ENGINEERING CAREERS BY UNDERSTANDING THE . . .

HUMAN FACTOR IN ENGINEERING—CAN YOU SUCCEED WITHOUT IT?

By R. W. McFALL

George S. is a good engineer who knows his field and makes significant technical contributions. But George doesn't get along well with people. He upsets customers, his associates don't like him, and in a short period of time people refuse to work with him. He's too useful a technical man to lose, yet he creates so much ill-will that his value is dubious.

John T. is another capable technical man and everyone likes him. But he can't present an idea or sell a development. He has no self-confidence and no desire to press a point—even when he knows he's right. Unfortunately, his associates and supervisors can't or won't take the time and effort to extract his opinions that would prove of benefit to the company.

These cases are typical of young engineers—and some not so young—who have fizzled, either entirely or partly, in industry.

What can be done about it? Does the fault lie in the engineering college, in industry, or in the person himself?

Problems like these are hard to approach. For one thing, they are usually individual problems, and they vary widely. Also, they are difficult to define, which further complicates the matter. Facing such obstacles, supervisors haven't been able to lay out a definite course of action for the solution of such problems. And many times, unfortunately, management uses the complexity of the problem as an excuse to let things drift.

Various approaches have been tried; they usually attempt to find out what the college graduate lacks, and then determine what industry must add to make a finished product.

Perhaps a different approach is necessary—an approach whereby we take "successful" engineers (those who have made significant contributions and have the respect of their associates) and analyze their general characteristics. In that way we can set up the characteristics of the successful engineer as the yardstick, and then see how young engineers compare.

There are four general characteristics universally applicable, not only to the successful engineer but also to men in such professions as law, medicine, and teaching . . .

- Ability to get along with people
- Ability to sell themselves and their ideas
- Technical competence in their chosen area
- Initiative to exert these three traits to get things done.

The ability to get along with people, to work with them, to co-operate with them, and to be tolerant of them receives little attention in the colleges. In fact, students are encouraged to work problems and experiments on their own. Little or no effort is expended to show and convince undergraduates that group effort is the backbone of industry. True, it's a difficult thing to get across, for it's largely an individual consideration.

Industry, upon receiving the engineering graduate, can compensate somewhat for this in the training courses it offers. For instance, in GE's advanced technical programs much time and effort, both in class and individual discussions, is devoted to getting across the importance of human relations. Young engineers on the program are encouraged to feel that their temporary assignments with operating departments are just as much assignments in human relations as in technical know-how. Class seminars, led by experts from within and outside the Company, occupy a portion of formal classwork in the program. Frank, constructive discussions on the student's shortcomings are held. Group effort is often encouraged on homework.

While some progress has been made in getting across the usefulness of successful human relations, much work is ahead, both in improving the quality of the courses and increasing the number of students that take it. (The advanced technical programs involve only a small percentage of the Company's technical employees.)

The ability to sell oneself and one's ideas gets slightly better treatment in our colleges. There excellent courses in public speaking and report writing are offered. But they are apparently lacking in co-ordination for little has been done to impress the student that he must sell himself and his ideas. Again, in industrial training programs, it is necessary to stress this. For instance, students for some of our courses must sell themselves to the course-selection committee. Through courses such as one labeled "Effective Presentation," he must sell his ideas to his classmates. Through talks to public school classes, he gets an opportunity to sell engineering. Through his reports, he sells his solutions to engineering problems.

In all of these phases it is emphasized that he is trying to convince a person or a group of persons. He must consider them as individuals, and he must direct his speech, his conversation, and his reports to them, rather than the world at large. It's not the purpose of these courses to turn out supersalesmen, but it is their purpose to develop confident engineers who can present their ideas simply, effectively, and attractively. We find that this ability to sell oneself and one's ideas lies dormant, to a degree, in all young engineers. Their immediate supervisors, by patient encouragement and practice, can do much to bring it to the surface.

Technical competence is purposely low on the list; not because it's unimportant, but because it's an obvious requirement, is easy to teach, and apparently is the main objective of our college and industry educational programs. True, the colleges tend to educate in terms of technical areas—such as mechanical engineering, electrical engineering, and chemical engineering; industry tends to think in terms of job areas—such as development, design, application, and manufacturing. While the final result may be criticized from the standpoint of efficiency, it can hardly be criticized on the basis of technical caliber. Even so, a few comments are in order on the continuing debate of specialization versus generalization in regard to college courses. It must be remembered that engineers in industry become broad as managers and narrow as technical specialists. Both have need of a sound education in the basic principles of engineering, which the colleges should and do furnish. The specialist has the further need of advanced technical and practical training in his chosen area. If colleges are to effectively give courses for specialists, they must have current research and development projects on their campuses, or they must be available close by. And if such projects are not available, it is probably better for the prospective engineer to obtain his specialist's training in industry. Whether such projects should be cultivated on the campuses of universities is not a part of the discussion; it is merely pointed out that such projects are necessary if colleges and universities are to train competent technical specialists. Industry has and can continue to train a variety of high-caliber specialists, and on a somewhat more economical basis.

Initiative is the driving force; it's the engine on the train—without it no one gets anywhere. If supervisors can't motivate the young engineer to use his talents to get things done, the preceding three characteristics don't mean a thing.

In regard to motivation and initiative, both college and industry have talked too long in generalities. Philosophy may appeal to the older engineer, but the young man in college and industry is interested in himself and what he wants to accomplish. Colleges, with the help and guidance of industry, must point to specific roads of progress, to definite engineering experiences of recent graduates, to real rewards awaiting the ambitious and capable man.

Some start has been made along these lines through the attractive brochures distributed by many industrial concerns. As a further step, it may be practicable to have a young engineer from industry talk to freshman engineering students about the specific path he is traveling. Industry can and will be glad to supply these men.

Along these same lines, it should be noted that industry has been specific in pointing out the immediate challenges and goals of a job assignment. But where industry hasn't done so well is in pointing out the specific challenges and goals in the not too distant future. There are programs for new engineers and programs for older engineers, but in between things are sort of vague and uncertain.

Many of the suggestions made in this article will not be easy to accomplish. They will require hard work by competent people and the wholehearted backing and co-operation of colleges and industry.

But we must face the problems of human relations, personal salesmanship, and initiative—especially when the lack of these factors tends to slow down the progress of young engineers. The rewards to industry will be large in terms of significant contributions by the marginal and submarginal engineers who are raised to a more valuable level. For without the human factor, engineers cannot succeed. Ω

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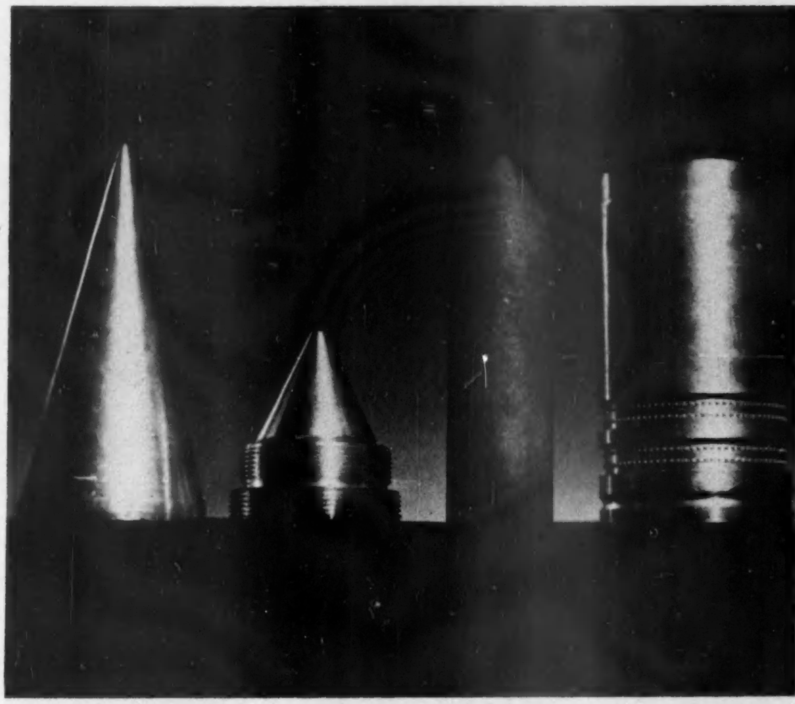
With General Electric since 1943, Mr. McFall is well-qualified to evaluate the young engineer: in his position—Manager, Technical Education Services Section, Schenectady—he is responsible for all advanced technical training for GE.



ANTITANK SHELL used in Korea once tamed German Tiger tanks at St. Lo. Left to right are windshield, nosepiece, core, and body. Hard-hitting core easily punches through . . .

TANK'S thick armor plate—soft in comparison with Carboloy tungsten-carbide core.

CARBOLOY CEMENTED CARBIDE—HARDEST MAN-MADE METAL

By KENNETH R. BEARDSLEE

Thirty days after the Allies bulled their way to the Normandy beaches, General Eisenhower wired an urgent message to the States. It said in effect: Wanted, an antitank shell that won't bounce off the new Nazi Tiger tanks. And in an incredibly short time he got the shell and thousands more like it.

The rest is history. Yet the story behind the story is something few engineers have heard, for only a few months ago the security wraps were taken off it. When the commander of the Detroit Ordnance District got Ike's message it was Friday, July 7, 1944. He contacted our nearby Carboloy Department where we were turning out cutting tools made of Carboloy—hardest man-made material—for the war industry. "Would it be possible," he asked, "to have some shell cores made immediately?" But there was a hitch in his request. The shells containing the Carboloy cores had to be suitable for immediate use in 76-mm guns at the front.

By Sunday, Carboloy engineers had 10 shells ready for test firing and were looking around for ways to mass-produce them—if the test proved successful. At nine o'clock Monday morning the first batch was flown to the Aberdeen Proving Grounds. On Wednesday a second batch was flown down. And on Thursday, five days after receipt of General Ike's message, Aberdeen wired this reply: " . . . Fired at even a 20-degree angle, the shells' Carboloy carbide cores would penetrate the thickest armor."

And so, two weeks after the original request arrived in the States, mass production started on the new antitank shell (above). Normally it would have taken months, perhaps years. But it shows what can be done in a free society. Along with engineering teamwork, the diamond-hard Carboloy cores did the trick.

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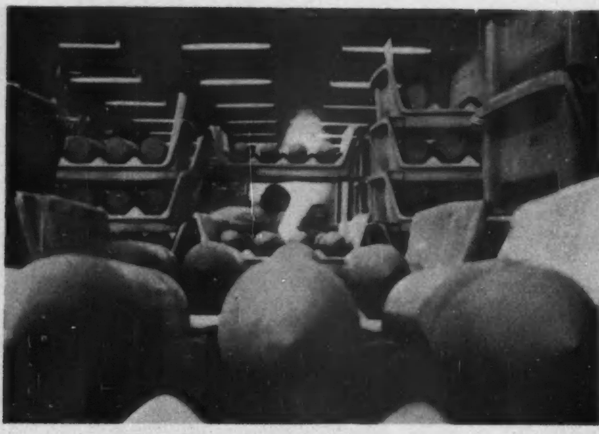
In 1930, three years after joining the Carboloy organization in Detroit, Mr. Beardslee was made Sales Manager. In 1943 he was named Vice President in charge of Sales, a post he held until becoming President in 1950. Since Carboloy's status changed from GE affiliate to department in 1951, he has been General Manager.

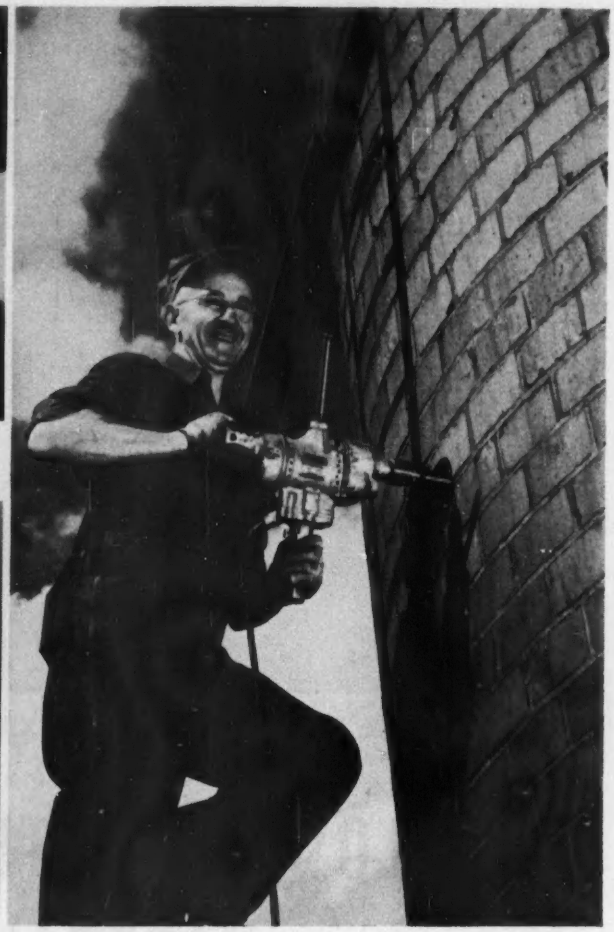
What It Is

Carboloy (registered trade-mark of General Electric Company) cemented



CARBIDE CORES for antitank shells on way to heat treatment where matrix metal is sintered to bind together hard carbide particles.

MORE HUMANE use of Carboloy carbide is handy knife sharpener for housewife that puts a keen edge on hard tempered-steel blades.



CARBIDE-TIPPED drill bores clean holes in masonry and retains its sharpness up to 50 times longer than a conventional steel bit.

carbide materials are produced by powder metallurgy. These materials are composed of hard, tiny carbide particles cemented together with a soft metal.

Carbide particles are themselves chemical marriages at high heat between finely divided carbon and a powdered metal. The metal is usually tungsten, and often titanium, tantalum, or chromium. Hard enough to put a well-defined scratch in sapphire—Nature's second-hardest mineral—carbides generally comprise more than nine-tenths of Carboloy cemented carbide's bulk.

The process by which carbides are bound in their metal matrix is called sintering. First, a mixture of carbide particles and powdered binder metal is ground together for several hours. When the carbides are thoroughly blended with binder material, the mix is molded to shape. The molded piece is then inserted in a high-temperature furnace where the metal is sintered.

Currently the most important matrix material is cobalt. Nickel is also widely used. For example, the core of the antitank shell on page 51 is made of tungsten-carbide with either cobalt or nickel as a binder material.

Diamonds in the Rough

Synthesizing diamonds for the first time, a French chemist scooped out chunks of tungsten-carbide from among the carbon crystals in his steel melt. Ironically enough, now that we look back, he threw them away as worthless. But later, during World War I, German engineers sorely needed a substitute for industrial diamonds and experimented with tungsten-carbide. They crushed the hard mass into powder, formed it into the shape of dies, and cemented it together with a matrix metal. And from these cemented carbide dies they produced fine copper, steel, and tungsten wire for their war industry.

By 1928, General Electric researchers were convinced that "Widia" metal, as it was called, had unusual possibilities as a cutting tool (November 1928 REVIEW, pages 585-91). That same year we bought the American patent rights and formed Carboloy Co., Inc. Then began 12 long years of development and financial loss.

Problems and Progress

In the early days the smallest chunks of tungsten-carbide available were two inches long—and they couldn't be cut to smaller size. When used as solid cutting tools, they cracked or broke off in the middle of a cutting operation. Hard as they were, they couldn't resist impact. So to get around this weakness, solid carbide tools were abandoned, and development concentrated on tipped tools—tips to do the cutting, but steel shanks to take the shock stresses of machining operations.

WIRE DRAWING with Carboloy carbide dies was first American application of tungsten-carbide. Wear resistance of dies (inset) considerably speeded production and reduced costs.

Thousands of carbide-tipped tools were shipped out on a trial basis in 1929. Then almost abruptly they started returning—and were junked by the thousands. "Can't be used like high-speed cutting tools," was the report from the field.

But 1930 was a better year. For one thing, manufacturing time was shortened with perfection of a machine that would saw the hard carbide tips. In addition, a new powder-molding process produced tungsten-carbide dies for working round and shaped pieces, thereby expanding its field of application. And before the year was up, a large automobile manufacturer decided to give the new material a try and ordered it in appreciable quantities. An airplane manufacturer followed suit.

In 1931 there were 25 experimental grades of carbide produced, of which 23 were later discarded. One grade for machining tough steel looked good, yet was unsuccessful in the field—and $20,000 worth of tools were scrapped. But at the year's end things picked up. A carbide-tipped tool produced one million pieces before it needed regrinding; shank breakage was eliminated with development of a new tool steel; and a wire-drawing mill using Carboloy dies reduced its scrap 98 percent.

Tungsten-carbide solved two of the automotive industry's toughest problems during 1932. The first was machining the hard cast-iron inner surfaces of brake drums that permitted better braking. Second was the machining of silicon-aluminum pistons needed to reduce piston wear in the new higher-speed automobile engines.

The only answer to the depression era of the thirties was new applications —and new business. And so, engineers stepped up development of Carboloy carbides. In 1933, 50 new developmental grades were introduced, bringing the total at that time to 200. Of these, only seven of the 50 were suitable for commercial use. Offsetting this however was the development of a new brazing process that eliminated a major source of tool spoilage and costly rejections.

In 1934, grinding wheels of diamond-impregnated Carboloy carbides were developed (February 1934 REVIEW, pages 97, 98). They enabled molded blanks of tungsten-carbide to be ground in thinner sections without chipping or breaking—and a new demand for Carboloy products quickly developed. Before the year ended, auto manufacturers were applying the superhard material to 320 machining operations.

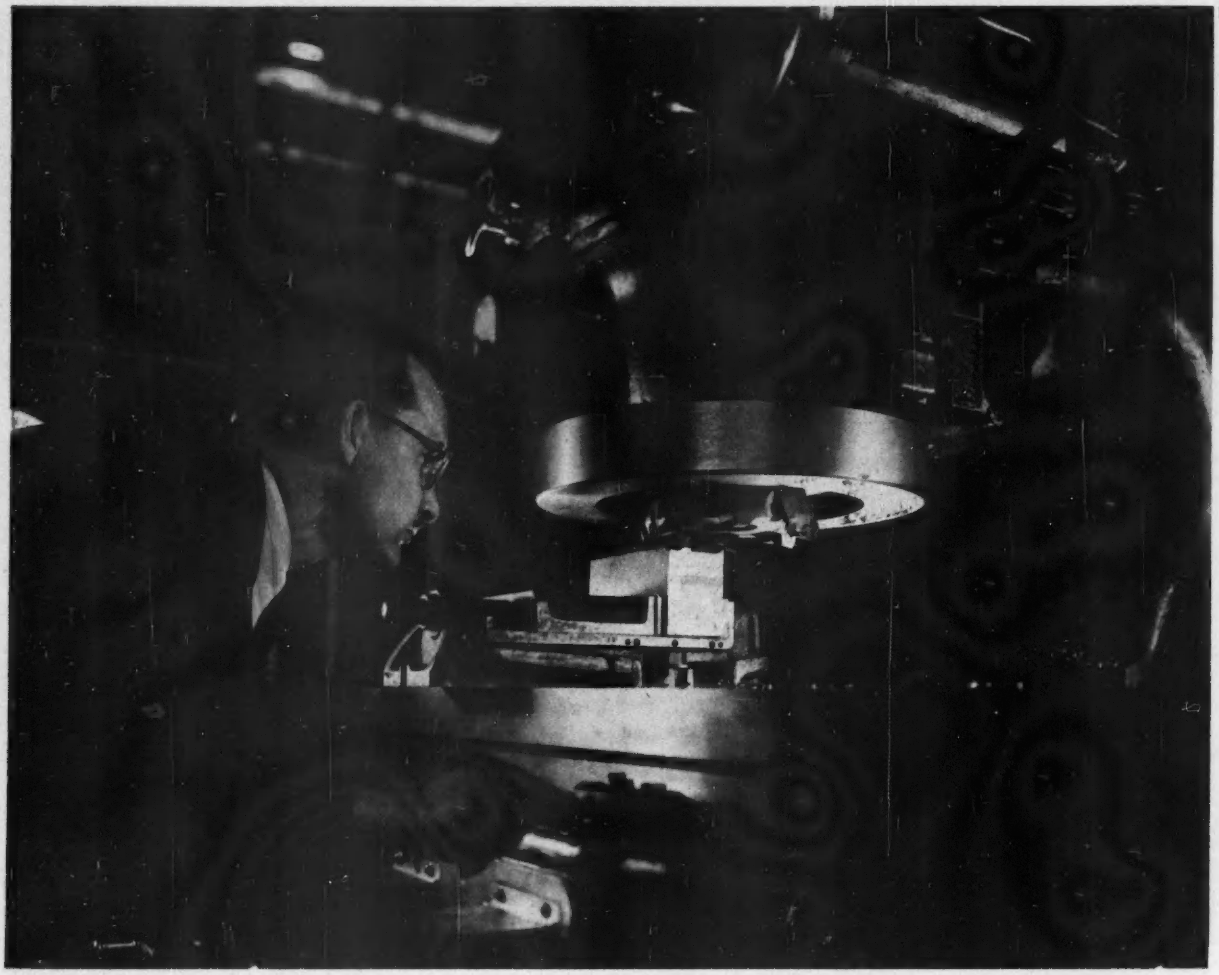
Four machines equipped with cutting tools tipped with Carboloy cemented carbides did the work of 16 in machining cast-iron refrigerator heads during 1935. Carboloy tools also eliminated another manufacturer's need for $30,000 worth of equipment to machine truck brake drums. In still other areas, tungsten-tantalum carbide replaced tungsten-carbide and did well at machining such things as artillery shells.

With this wider acceptance of carbides, changes gradually took hold of the machine-tool field. Cutting tools were built sturdier to withstand the strain of deeper cuts and operation at higher speeds. Further manufacturing developments, along with the opening of a new plant in Detroit in 1939, finally took tungsten-carbide out of the cut-and-try stage. For the first time cutting tools were mass-produced—and in 1940 the company made its first profit, after 12 years.

Today's Carboloy Cemented Carbides

Carboloy cemented carbide today is extremely versatile. Because it's basically a powdered metal product, infinite content variations can provide carbides to meet specific needs. (See photos.) Titanium, tantalum, chromium, and other metal powders can be combined to get exacting physical properties. Specialized grades are made with abilities to resist high temperature, abrasion, erosion, and corrosion. Some offer extremely high-temperature hardness combined with great mechanical strength. These characteristics, and many others, aren't obtainable with pure metals, regardless of how they're combined or manufactured.

Most carbide grades are considerably harder than high-speed tool steels. And though this is highly important in metal working tools, there's yet another im-



THE EIGHT CARBIDE CUTTING TIPS OF THIS FACE MILL ARE HARDER AT RED HEAT THAN TOOL STEEL IS AT ROOM TEMPERATURE.

portant characteristic: "high red" hardness—carbide's ability to stay hard even at red heat. When heated to 1200 F, it's still as hard as high-speed tool steel at room temperature.

You might justifiably assume that such hardness is accompanied by corresponding brittleness. But this isn't the case. Mining and stone-cutting tools, blanking and punching dies are but a few examples of the carbide's high impact resistance.

Among the materials currently machined by Carboloy cemented carbide are the entire range of steels; cast and malleable iron; copper, aluminum, and bronze, plus all other noniron metals; hard rubber, glass, and other types of nonmetallic materials. But most important from our defense-production standpoint is that carbides—and *only* carbides—can successfully machine armorplate. Most fortunate of all, projectiles made of tungsten-carbide will pierce any tank in action on the battlefront today.

Obviously, without a corresponding gain in productivity the advantages of carbide tools would be of little economic value. They are however extremely wear-resistant, and longer production runs at close tolerances are achieved with a relatively small amount of resharpening. Most important still, cemented carbide cuts at three times the speed of high-speed tool steel. No other material in use today holds such great promise of increased productivity.

Some Applications

Items varying from metal shoelace eyelets to the wire in your television set are produced with Carboloy cemented-carbide dies. Some other applications include the blanking, piercing, forming, and shaping metal products. Kitchen pots and pans, razor blades, fountain-pen barrels, and other items are all made faster and cheaper with Carboloy dies.

Coal, ore, and rock drills tipped with cemented carbides have increased production in the mining industry. (Recently, a rock drill bit equipped with carbide blades drilled through 250 feet of solid granite. At that footage, wear on the blades equalled the wear on a steel rock drill that had penetrated only two feet of the same material.) In the construction industry, also, masonry drills tipped with Carboloy cemented carbide are used. Cutting clean holes in concrete, brickwork, and tile, they stay sharp up to 50 times longer than conventional steel drills.

Mass production is speeded up wherever Carboloy carbides are applied. On many automobile assembly lines, for example, power-driven socket wrenches lined with carbides outlast by 20 times conventional steel sockets. It is used in the textile industry to reduce textile machinery wear. Eyelets, or grommets, of cemented carbide easily resist abrasive wear of thread passing through them at high speed in braiding and weaving machinery. Equally at home in the woodworking industry, Carboloy carbide tools cut, shape, and form various kinds of wood. Operations are performed faster and at a lower over-all cost.

Consumers benefit directly as well as indirectly from many unusual carbide applications. Knife sharpeners with carbide inserts sharpen cutlery faster and with a keener cutting edge. Paint scrapers with hardened carbide blades will scrape off hard, tough layers of paint from wood, metal, or cement surfaces. Advantages of carbide here: edges stay sharp long after ordinary paint-scraper blades are dulled.

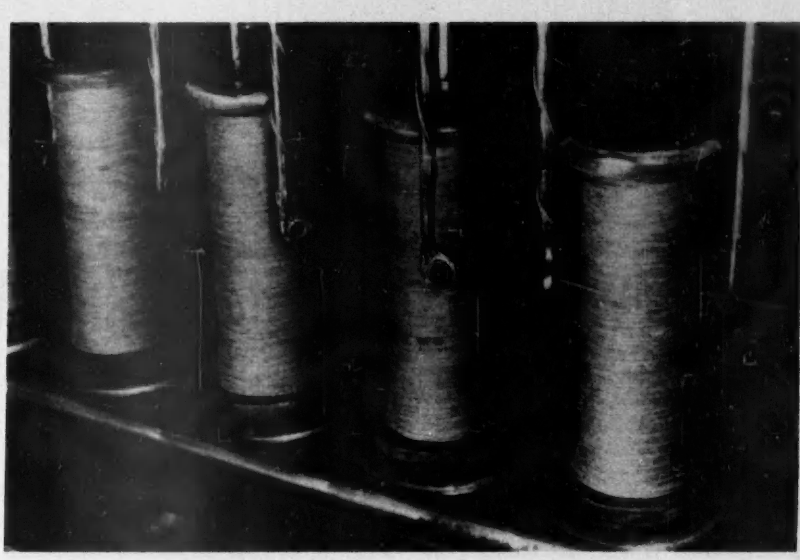
Future Unlimited

Opportunities for increased productivity through usage of Carboloy carbides were never better. Trepanning—making a hole by boring out the solid core—is one of the newest applications. With this method, holes up to 12 inches in diameter are bored in gun barrels. Today, for example, gun barrels 18 feet long are given a 2½-inch bore in 36 minutes—removing the hole in chip form would take 15 hours.

Increased efficiency in the metalworking industry depends, to a great extent, upon the rate a metal can be cut, removed, or formed with metalworking tools. Looking back to the turn of the century, you can easily see what progress we've made in this respect. For then it was common practice to machine steel at speeds of about 30 surface feet per minute with cutting tools made of high-carbon steel. Even at these slow speeds the tools dulled rapidly, because they didn't have high red hardness. As a result, a constant and unavoidable machinery stoppage seriously affected productivity. Today however the over-all average for machining steel with tungsten-carbide is about 400 surface-feet per minute—some individual jobs run in excess of 1000 surface feet per minute.

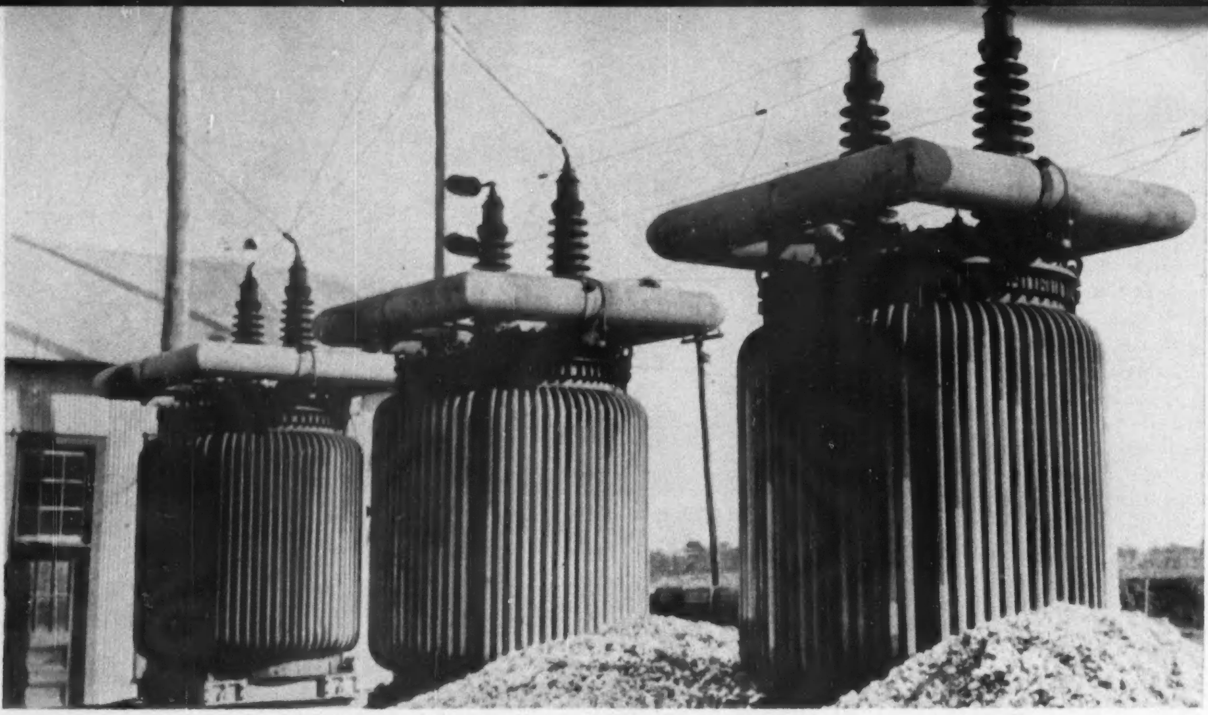
Another great stride is in the manufacture of jet engines. Operating at around 2000 F, the jet's metals and alloys must stand searing heat for hundreds of flight hours. Here, too, carbide is solving the difficult problem of how to machine these new, hard, and tough materials. And it's in this field that Carboloy cemented carbide—hardest man-made metal—holds the greatest promise for future development. Ω

SHOCK STRESSES of milling operation are absorbed by rotating steel cutter. Carboloy carbide tips do cutting. The low impact-resistance of early tungsten carbide was a problem.



REDUCED MACHINERY WEAR helps keep cost of textiles low. Here, for example, carbide eyelets, or grommets, resist the abrasive wear of high-speed thread on way to weaving operation.

MINER'S ROCK DRILL typifies rapid progress in mining industry. Carbide-tipped bits bore through coal, ore, and rock faster and with much less wear than conventional steel drills.



EARLIEST ATTEMPT AT OIL PRESERVATION IS THIS 1916 INSTALLATION OF CONSERVATORS. NEWER METHODS RAISE QUESTION OF . .

Preserving Transformer Oil—Which System?

By E. V. DE BLIEUX

Oil by the millions of gallons is used in transformers as a cooling medium and insulator. Its cost adds up to a great deal of money, prompting engineers to seek means of lengthening its operating life.

When transformers were first invented, natural air was the medium used to carry away heat generated by the core and coils. But engineers quickly found that oil did a better job of cooling and was a better insulator as well. The shift was made from air-cooled to oil-immersed transformers: as in all new methods, new problems cropped up.

The trouble starts when air comes in contact with oil. For oxygen from air combines chemically with oil—especially if the latter is hot—and makes it sludge. Sticking to cooling surfaces and ducts, the sludged oil reduces the transformer's ability to dissipate heat. What's more, moisture from the air diffuses in the oil and winding insulation, lowering their dielectric strengths.

What then are the methods engineers developed to minimize these harmful effects and prolong the life of transformer oil? At present there are two basic ones. The first minimizes or eliminates entirely the physical contact of air with oil. And the second makes use of chemical inhibitors and dehydrating agents.

Several systems employing these methods are listed in approximate chronological order . . .

- Free breathing
- Conservator
- Sealed
- Gas-oil seal
- Inert-gas pressure.

Now let's look at how these systems operate, and consider some of the good and bad features of each.

•

Mr. DeBlieux is Manager—Transformer Apparatus Engineering, Power Transformer Department, Pittsfield, Mass. With the General Electric Company for 30 years, he has a broad knowledge of transformer design, development, and manufacture. He is active on various national transformer standardization committees.

Free Breathing

The free-breathing system was the first transformer construction used. In it there's an air space above the oil, and as the oil expands or contracts with temperature, the air breathes in and out of vents. For obvious reasons this is not a good system of oil preservation and won't be discussed.

Conservator

The conservator, or expansion-tank, system (Fig. 1) was the first real oil-preservation system used on transformers. It was a big improvement over free breathing.

Expansion or contraction of the oil in the transformer tank is provided for by a pipe connected to the conservator. Thus the oil surface in contact with air is reduced—compared to its surface within the main tank—and the oil remains relatively cool. Automatic in its operation, the conservator keeps transformer oil under pressure at all times. A gage indicates whether its own oil is at the proper level. A low-level alarm can be used to signal any serious loss of oil.

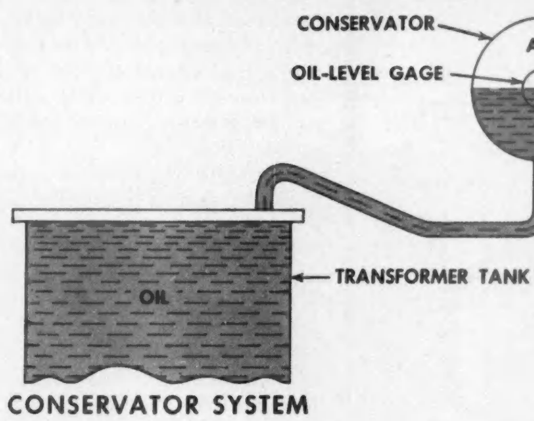


FIG. 1. CONSERVATOR keeps air, the trouble maker, from chemically reacting with oil in main transformer tank.

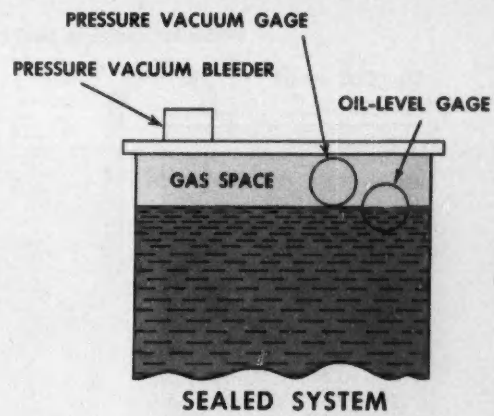


FIG. 2. SEALED SYSTEM is airtight. Gas space is big enough so expanding oil won't exceed a certain pressure.

The conservator system is a simple one. Over the years its effectiveness on thousands of transformers was proved. What is probably the conservator's first application to a power transformer in America is shown on the opposite page. The system was installed in 1916.

Good—No space for gas or oil expansion is needed. As reference to the illustration on page 59 will show, this system has the lowest-height tank—an important item because large or high-voltage transformers are usually restricted in height by shipping limitations. Removal of the top tank section for shipment and the uneconomical design of distorted core and coil heights are avoided with the conservator system.

Installation and maintenance work are simple: All that you do is fill the conservator to its proper level and check it for leaks at relatively long intervals. If leakage does occur, the location is clearly indicated by an oil stain. Because the conservator maintains a small positive pressure on the oil in the main tank and there's never a vacuum, air or moisture can't be drawn into the main tank. The absence of such vacuum minimizes tank-bracing.

Bad—Conservator and a relief pipe must be located above the transformer. This may restrict the location of bushings or connection of incoming power lines. Also, the slight pressure on the transformer oil makes the system a possible fire hazard when a nonsealed type of transformer bushing is used. For if the cavity inside the bushing isn't sealed off from the oil, breakage of its external porcelain during an arc-over or a fire might allow oil to seep through and feed the flames. (This hazard is common to all systems where oil in the main tank is under pressure.)

The exchange of moisture and oxygen between conservator oil and oil in the main tank is undesirable. However, substituting a gooseneck connection for the straight pipe between conservator and the main tank reduces this action to an extremely slow rate. With the gooseneck connection—introduced in 1917—the only significant exchange occurs when oil in the transformer expands or contracts.

Sealed

With the sealed system (Fig. 2), the transformer tank is sealed airtight. An air space of sufficient size is provided so that as the oil expands, the tank's design pressure won't be exceeded. To limit it to a reasonable value, a space equal to approximately 10 to 15 percent of the oil volume at 25 C is needed.

The transformer is usually designed so that the system's operating pressure is zero when the average oil temperature is 25 C. If the tank is opened and resealed at another temperature, then it must be resealed at the pressure corresponding to that oil temperature. To avoid this difficulty, sealed transformers are sometimes provided with a relief valve that vents the air space to the atmosphere when a preset positive or negative pressure is exceeded. But while this method prevents damage to the tank, the valve occasionally admits moisture and oxygen. And if the valve fails to close, it converts the transformer to the free-breathing type. In this respect the method is inferior to 100 percent sealed construction.

Good—Oil is completely sealed from the atmosphere when the transformer operates normally. Like the conservator system, installation is simple; there's no interference with placement of bushings or connection to incoming power lines because no part projects above the transformer's cover.

Bad—It's difficult to locate and detect leaks that occur above the oil level. Another difficulty is properly resealing the transformer once it is opened. The relief valve eliminates this problem but, as mentioned before, it has other objectionable features. Because of the high operating pressure, more elaborate tank-bracing is needed than with the conservator system. Also, a taller tank is required than with any other oil-preservation system.

Gas-oil Seal

Gas plus a variable column of oil in an auxiliary tank seals off the atmosphere and together comprises the gas-oil seal system (Fig. 3). It works this way: As oil in the transformer tank expands, pressure increases on the gas in the space above it. From there the pressure increase is transmitted to the oil in the auxiliary tank's lower compartment forcing oil from the lower to the upper compartment until the pressure finally is equalized by the height of the oil column. Conversely, a decrease of main-tank pressure will allow oil to flow from the upper to the lower compartment until pressures are again equalized.

With this system there's no interchange of oil between main and auxiliary tanks. The oil seal in the auxiliary tank prevents the escape of gas or the en-

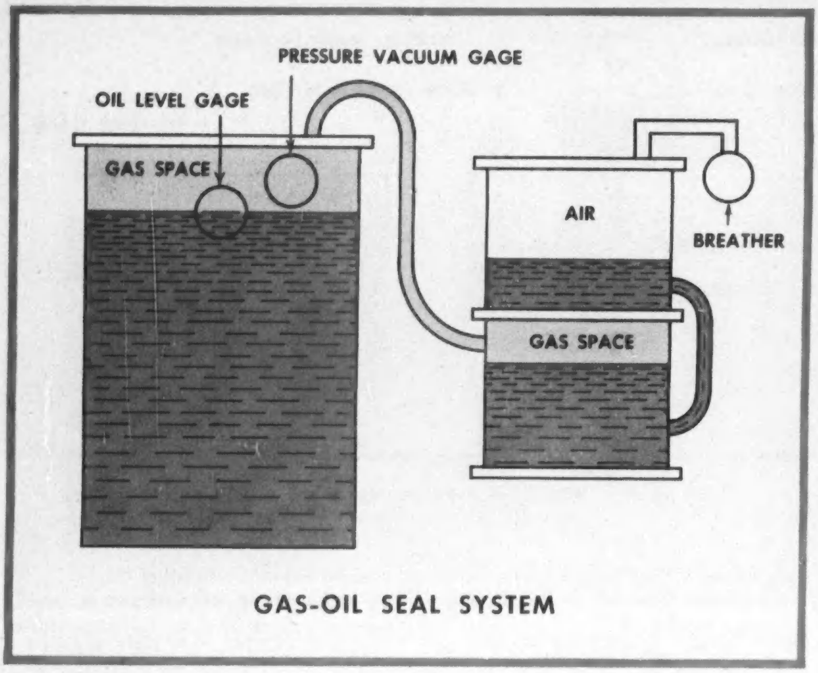


FIG. 3. GAS-OIL SEAL makes use of a gas space in the main tank and a variable column of oil in an auxiliary tank to seal out atmosphere and seal in gas.

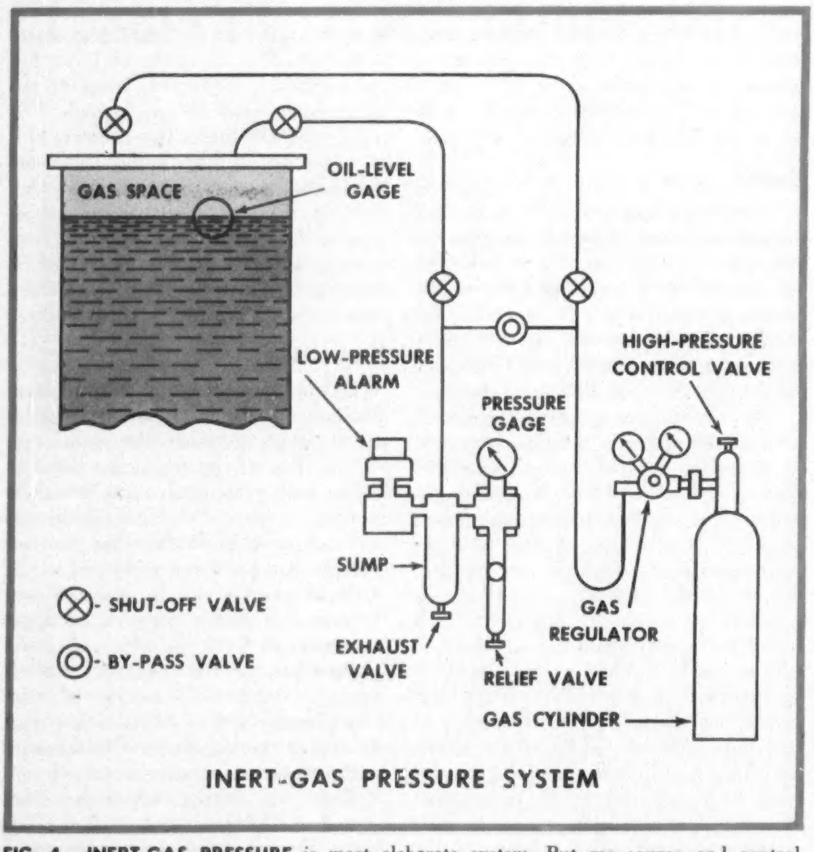


FIG. 4. INERT-GAS PRESSURE is most elaborate system. But gas source and control equipment maintain a positive pressure on the oil in several transformers.

trance of oxygen, moisture, or other impurities into the main tank. As usually designed, the seal is maintained through an operating range of 100 C. And since the oil head is low, the internal gas pressure doesn't normally exceed five psig.

The larger the gas space in the main tank, the smaller the pressure increase as the transformer oil expands—or pressure decrease as it contracts. Accordingly, the oil temperature must be proportionately higher before the pressure increase is great enough to discharge gas from the auxiliary tank; and proportionately lower before outside air is sucked into the main tank. You can see, then, that if ambient and load temperatures vary widely, a large gas space or tall oil column, or both, are desirable. The large gas space is preferable however, because a tall oil column involves high pressure and vacuum, and therefore a greater risk of leaks.

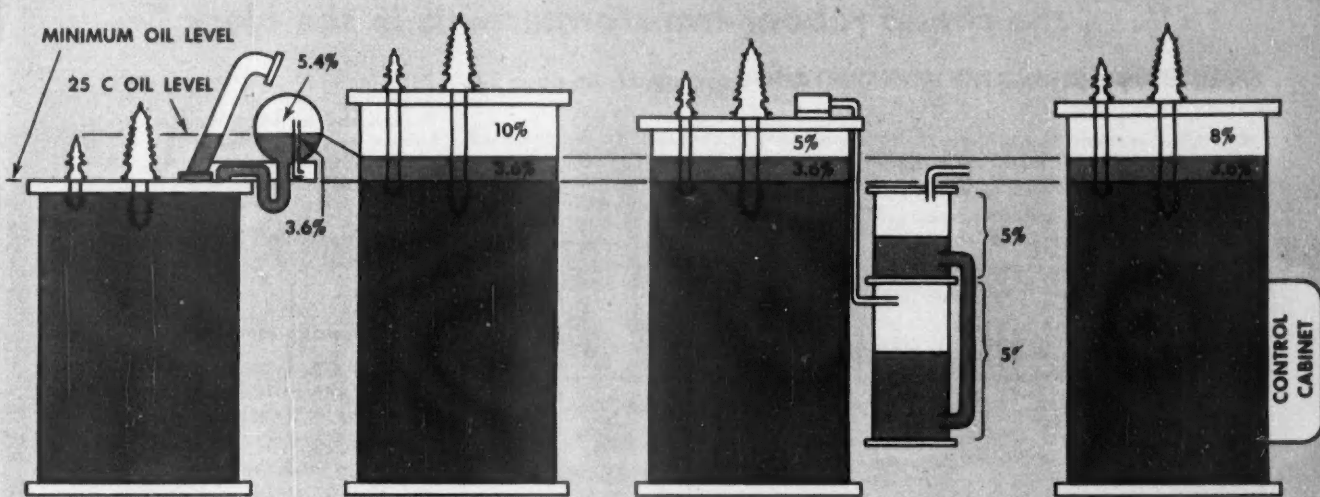
Good—Moisture and oxygen are absorbed at an extremely low rate because they must go successively through the oil and gas volumes. What's more, the positive and negative gas pressures within the transformer tank can be limited to low values. The auxiliary tank can be mounted: 1) like a conservator; 2) vertically alongside the transformer tank; 3) as two separate tanks. Regardless of its physical arrangement, the operation is identical.

Bad—It is difficult to detect leaks in the gas space above the transformer oil. Also, the transformer tank must be tall enough to have a residual gas space left over when the oil expands to its maximum volume. Height of the main tank is therefore intermediate between the conservator and sealed-tank systems. Complication, size, and cost of the auxiliary tank result from its need for the interconnected double compartment.

Inert-gas Pressure

By means of the positive pressure of an inert gas, the inert-gas pressure system (Fig. 4) seals transformer oil from the atmosphere. The gas—usually nitrogen—is supplied to the transformer by a pressure regulator. Gas is admitted when the pressure inside the tank falls below a preset minimum value. When the pressure exceeds a preset maximum, the gas is shut off; if the pressure still continues to build up, a separate relief valve vents the gas to the outside air before the safe value is exceeded. Thus, as long as there's a gas supply, a positive

COMPARISON OF OIL PRESERVATION SYSTEMS



	CONSERVATOR	SEALED	GAS-OIL SEAL	INERT-GAS PRESSURE
OIL ALWAYS UNDER POSITIVE PRESSURE?	YES	NO	NO	YES
MOISTURE CONDENSATION IN MAIN TANK?	NO	YES	YES	YES

VALUES IN PERCENT OF 25 C OIL VOLUME

pressure is exerted in the transformer at all times. One set of control equipment and one source of gas can maintain the gas pressure for a group of transformers.

The first trial application of the inert-gas oil-preservation system to a power transformer was effected in an installation at Providence, RI, in 1916.

GOOD—An atmosphere of inert gas is always in contact with the oil. And because there's never a vacuum inside the transformer tank, outside air can't be sucked in. If a leak occurs, oil streaks on the tank or rapid depletion of the gas supply gives a positive indication whether the leak is below or above the surface of the oil. There is no obstruction to bushings or power lines. Nor is there interference with radiators when the gas control equipment is mounted beside the transformer, for the cabinet containing the equipment is small.

BAD—The system is elaborate and costly, for one thing. For another, a tall transformer tank—taller than required by the conservator and gas-oil systems but not the sealed system—is needed to avoid frequently replenishing the gas supply. To provide this gas space in large transformers, it may be necessary to compromise the design to meet physical requirements.

Chemical Methods

Dehydrating breathers absorb the air's moisture as it enters into the transformer. Silica gel or activated alumina are the chemicals commonly used for this purpose. They are most effective with free-breathing transformers, but because neither removes oxygen, the sludging agent, their effectiveness is limited.

Inhibitors, on the other hand, are chemicals added directly to the oil to delay the formation of sludge. First used around 1927, various inhibitors have since been proposed and limited tests made on many. But only in recent years has interest become widespread.

Use of inhibited oil with any of these oil-preservation systems just described is too recent to determine its economic value. At present the question is this: Does an inhibitor add enough extra life to the oil to justify its use? Obviously, any added inhibitor that's compatible with oil and transformer materials serves to reinforce the natural inhibitors already in that oil. And in proportion to its effectiveness it will retard oxidation. But the increased cost of inhibited oil must be weighed against its advantages. This can only be determined by many years of life test, for the natural life of transformer oil with the different systems is relatively long. At present, inhibitors are being tried extensively in reclaimed oil for use in old transformers and similar applications.

Which System?

The transformer industry has had its longest experience with the conservator system. Many years of operation prove its worth. Still, while the three other systems of oil preservation—sealed, gas-oil seal, and inert-gas pressure—came along later, experience shows they are equally effective.

Practice indicates an increased preference towards the sealed and gas-oil seal systems for the lower-rated transformers. For this reason both are specified in the proposed American Standards (C57.12a) for transformers rated 501- to 5000-kva single-phase, and 501- to 10,000-kva three-phase with voltages 67 kv and below. It's probable that these ratings will eventually have only one standard oil-preservation system. Conservator and inert-gas pressure systems are equally acceptable for large transformers.

This, then, is the way the picture shapes up:

- Sealed system for small power transformers
- Gas-oil seal or conservator systems for medium-size power transformers
- Inert-gas pressure or conservator systems for large power transformers.

But whichever system you use, insulating materials of the transformer play a prominent part. They must be suitable, adequately dried, and immersed in good quality oil. With these precautions observed, any of the systems shown above will preserve transformer oil over a satisfactory operating life. Ω

". . . the cheap robber-transformer was in the black."

ENGINEERING BEHIND THE IRON CURTAIN (Concluded from page 23)

on to the consumer. But in the socialistic transformer the losses are lower because in a planned state economy the government-owned utilities want to minimize the total cost of the transformer to the national economy. Vidmar continues along these lines for several pages:

> What does the capitalistic manufacturer think of in building a transformer? Does he want to help, to serve, the over-all economy? No. All he wants is to sell his product, with the highest possible profit. All he is interested in is the transfer of the transformer from his hands to the hands of the customer. Therefore, he must have the lowest possible production costs. The cost of the transformer *afterwards*, that will be in another account book, that belongs to another isolated economy.

After disposing of the capitalistic manufacturers of transformers, Vidmar turns on the electric utilities of the capitalistic countries:

> . . . The ignorant majority of the buyers of transformers set the rule, and for them the cheapest transformer is the right one. Even progressive utilities often did not give much importance to the energy losses of the transformer. Because of the confusion of the capitalistic economy, in an innumerable number of cases the initial price of the transformer was paid by the consumer, and its losses were paid by the utility. In such cases, of course, the cheap robber-transformer was in the black.
>
> Only in an orderly economy, which subordinates the selfish advantages of individuals to the advantage of a large community, clear economic goals break through also in the construction of transformers . . . Thus progressive transformer manufacturing followed slowly the new direction, as capitalistic economy gradually gave way to the economy of the community.

And thus the humble transformer becomes a weapon of psychological warfare.

Two Opposing Ideologies

For years I have been searching through foreign technical literature, as practically all development engineers do to some extent. But the technical journals of Nazi Germany, Fascist Italy, and prewar Japan, wretched as they were, were still a cut above the present magazines of the Communist or Communist-dominated countries.

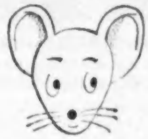
This shows clearly that the division of the world into two opposing ideological camps has never been as marked as at the present time; it also shows that engineering, often reputed to be entirely separated from politics, is being drawn more and more into the struggle by the rulers of the Red countries. Ω

CREDITS

Page	Source
Cover	George Burns and Bradley Wilson
11	Bettman Archive (left)
21	George Friday
30	Lee Phillips Pittsfield, Mass.
34	Montie Talbert
37	Munsell Corporation
42	The American Society of Mechanical Engineers (bottom)
44–48	George Burns

It is difficult to write a definition of the American way.
But it is easy to find good examples. Here is one:

"The rats and the mice,



did lead me such a life..."

Have you heard the story of Jasper, Indiana? The town the rats deserted? And the flies deserted? The garbage-less, and the garbage-man-less town?

Ingenious city fathers had an idea, now known as the "Jasper Plan," already spreading to other towns.

"Why in our beautiful town of 6,800 people," they said, "must our lovely housewives play nursemaid to decaying, messy garbage, waiting and waiting for someone to cart it elsewhere?"

Press, radio, and clubs rallied citizens to the idea. A giant purchase of G-E Disposalls® was undertaken. Jasper became the first city to outlaw garbage collection. And a recent public-health survey confirms something the citizens already knew . . . fewer flies and rats . . . with the resulting improvement in general health.

Other cities picked up the idea. Herrin, Illinois. Then Mount Dora, Florida.

Shorewood Hills, a suburb of Madison, Wisconsin, bought G-E Disposalls for its 475 homes, paid for them, keeps title. We may be witnessing a revolution in mama's kitchen, not to mention family health.

This revolution began with General Electric research, way back in 1931. First units were built in 1935. Now over a quarter million G-E Disposalls are installed across the country. Over a million dollars was invested to bring this device to its present perfection. Now it looks as if it was certainly worth the effort.

We're not telling you this story to try to sell you Disposalls. That's the job of another very capable department of General Electric. Though if any city fathers read this, and are interested, a letter to General Electric Public Relations, Room 123-2, Schenectady, N. Y., will bring further information.

We're telling you this story with another point in mind. Somebody has to pioneer things. Somebody has to dream a bit, work a lot, spend a lot, and worry a lot to get better things going. Finally things happen.

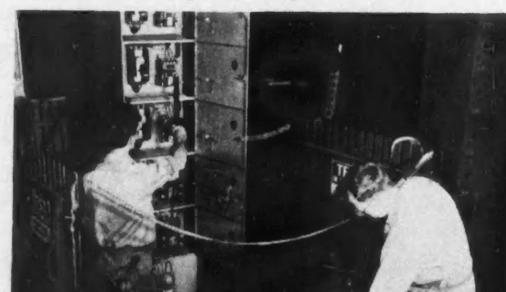
Looking ahead, five, ten, fifteen years — and doing something — is the aim of General Electric. We like the responsibility, because we like the results. We think you do too.

You can put your confidence in—

GENERAL ELECTRIC

INDIVIDUALLY PLANNED motor control centers are manufactured and delivered completely wired and ready-to-install from this new General Electric motor control center production line.

EASY TO INSTALL, inspect, and interchange starters, which are assembled as complete units, including pushbuttons and wiring terminals for easy front-connecting. Door swings more than 90°



HIGH-POTENTIAL TESTS are made of each completed General Electric control center before shipment, to assure adequate short-circuit protection, safety for plant personnel and equipment.

New G-E Motor Control Center Has Easiest-to-Interchange Units

The new General Electric motor control center is the most up-to-date equipment for the centralized control of a-c motors up to 200 horsepower. Each control center is planned for the job it is to handle, but it can rapidly be modified to meet changed requirements. Standard units can be easily interchanged or substituted, new units can be quickly added. Units may be mounted back-to-back in same standard enclosure. Master terminal boards may be located at either top or bottom of cabinet.

ACCESSIBLE. Installation is simple —just a matter of sliding the unit into its compartment. Stab-on connectors grab the vertical bus. Wiring is easy because even pushbuttons and terminals are mounted on the unit frame for simple front-connecting. Doors swing more than 90°, so unit can be lifted out of compartment for accessibility from all sides. Barriers between units can be slipped out, making a four-inch wiring trough. Master terminal boards can be swung out of place for connecting without "fishing" of wires.

FOR MORE INFORMATION, contact your nearby General Electric apparatus sales office, authorized G-E agent or distributor, or write Section 781-1 for GEA-4979A today. *General Electric Company, Schenectady 5, New York.*

You can put your confidence in—

GENERAL ELECTRIC

NEWS OF G-E HEAT PUMP PROGRESS

TOLEDO, OHIO. Model YR-30 Heat Pump System handles this ranch-type home.

Just a year ago General Electric began marketing all-electric heating and cooling. Today prospects for broad use of this development are greater than ever before!

It was in 1952 after 20 years of engineering development and field testing that General Electric began marketing its first Packaged Heat Pump. For the first time, the dream of reverse-cycle, all-electric year-round air conditioning was put to the strictest test of all—day-by-day performance under all conditions by owners who paid full prices for their Heat Pump installations.

After a full year's experience—during which these units were sold and serviced by selected G-E distributors, and operated in both hot and cold weather—prospects for this latest contribution to all-electric living are better than ever before.

Where G-E Heat Pumps are sold. Markets so far have been carefully pinpointed, principally in the South, Southwest and Pacific Coast, where folks have been trying to cool their homes by one means or another for many years. In these areas, year-round air conditioning is recognized as a necessity, and the public was ready for its most advanced form, the G-E Heat Pump. It has been installed in better homes and small commercial establishments of various kinds.

How it works. The G-E Heat Pump is a compact, self-contained unit that cools in summer without water and heats in winter without burning fuel of any kind. *In warm weather* it works much like other air conditioners, using electric refrigeration to cool and dehumidify the air. The G-E air-to-air Heat Pump has a tremendous advantage since it saves users the cost of water and needs no bulky or unsightly cooling towers—a very important feature where water is scarce or expensive. *When heating is needed* the same unit automatically reverses itself and actually heats the entire home, taking heat from the outdoor air (even if it's below freezing) and circulating warmed air throughout the building.

What owners report. Perhaps the best measure of progress in this field of G-E research is the opinion of the homeowner who has used the Heat Pump for cooling and heating. Almost every user reports satisfaction with the first-year's performance and, if he had to move, would buy another. Typical benefits cited to an independent research organization are: more refreshing sleep, relief from hay fever and asthma, cleaner homes, less moisture in muggy weather. They especially like G. E.'s air-to-air design eliminating the need for water. Operating costs have proven entirely reasonable.

How utilities benefit. Power companies are greatly interested in its effect on consumption of electricity. It offers an opportunity to utilities to add year-round power consumption and smooth out annual power requirements. This is generally a desirable load, because it occurs both in summer and winter. Southern power companies operating in areas where high summer loads already exist due to cooling, like the fact that the Heat Pump's winter operation provides a better balanced year-round load.

What's ahead? In 1953 General Electric is greatly expanding its entire Heat Pump research and marketing program. New distributors and dealers are being added as fast as they can be trained. It is being introduced in additional areas as fast as product design and marketing factors permit. Product development, of course, goes on constantly. The G-E Heat Pump is now completely automatic, including changeover from cooling to heating. As production goes up and new developments are incorporated, both initial cost and operating cost may be expected to drop to a point where all-electric, all-year air conditioning will soon be within reach of the mass market.

Broad usage of G-E Heat Pumps will have a tremendous impact on the electrical industry. It will eventually require a substantial increase in the nation's electric power generating and distributing facilities. Architects are showing tremendous interest, for the Heat Pump can influence home design.

This is the home comfort system of the future... and for many Americans it is already here. For information of any kind, please write General Electric Company, Air Conditioning Division, Sec. GER-2, Bloomfield, N. J.

Progress is our most important product

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