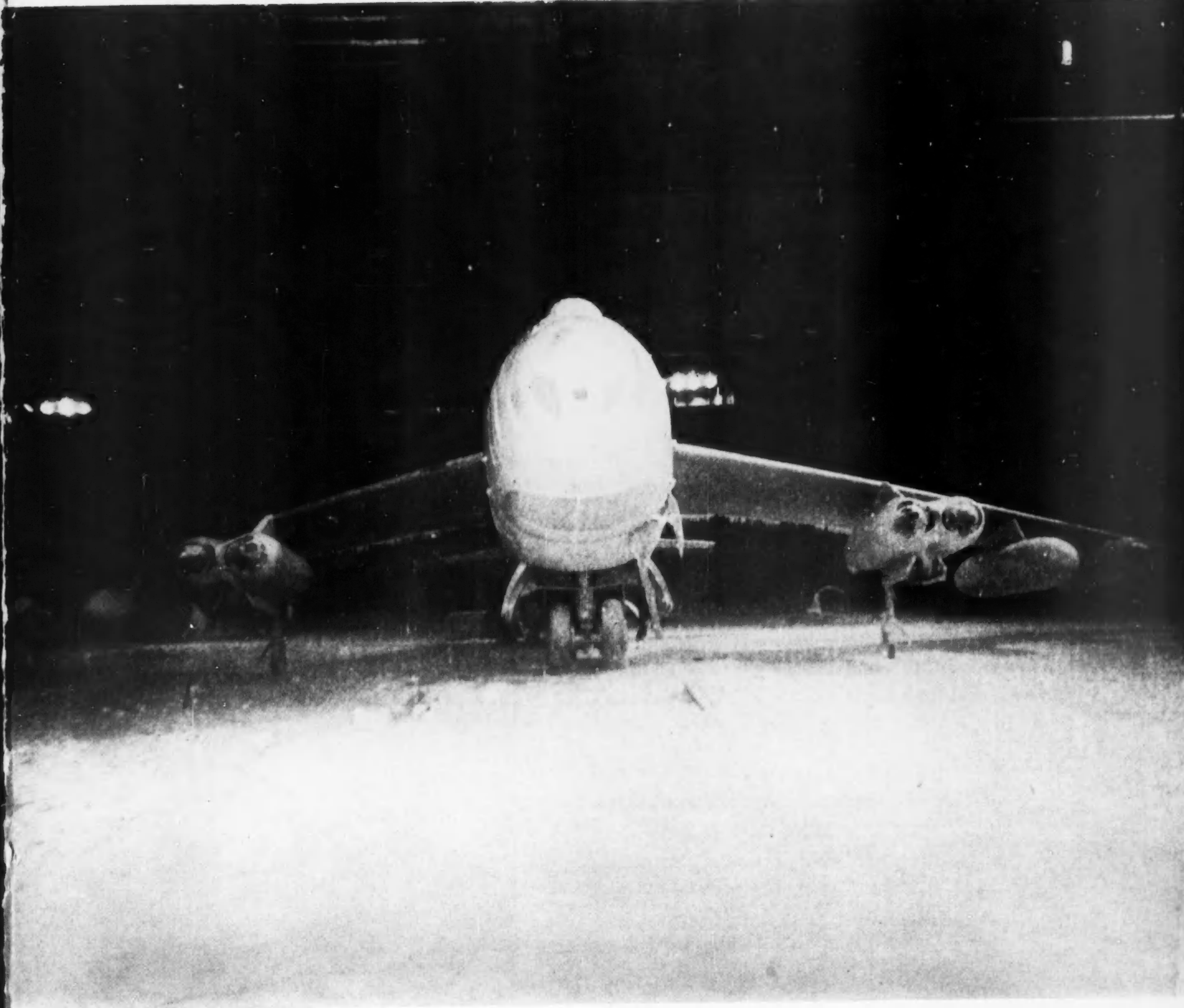
GENERAL ELECTRIC Review



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GENERAL ELECTRIC Review

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

COVER—"Proof by Test" is the motto of the Air Proving Ground Command at Eglin Air Force Base in northwest Florida. One phase involves subjecting aircraft—such as this Boeing B47 Stratojet bomber—to extremes of temperature in the Climatic Hangar where temperatures can be varied well within the −65 to +160 F required by the Air Force. For a first-hand account of some of the activities of APGC, turn to page 8. (Photo page 10 courtesy Boeing; all others from U.S. Air Force.)

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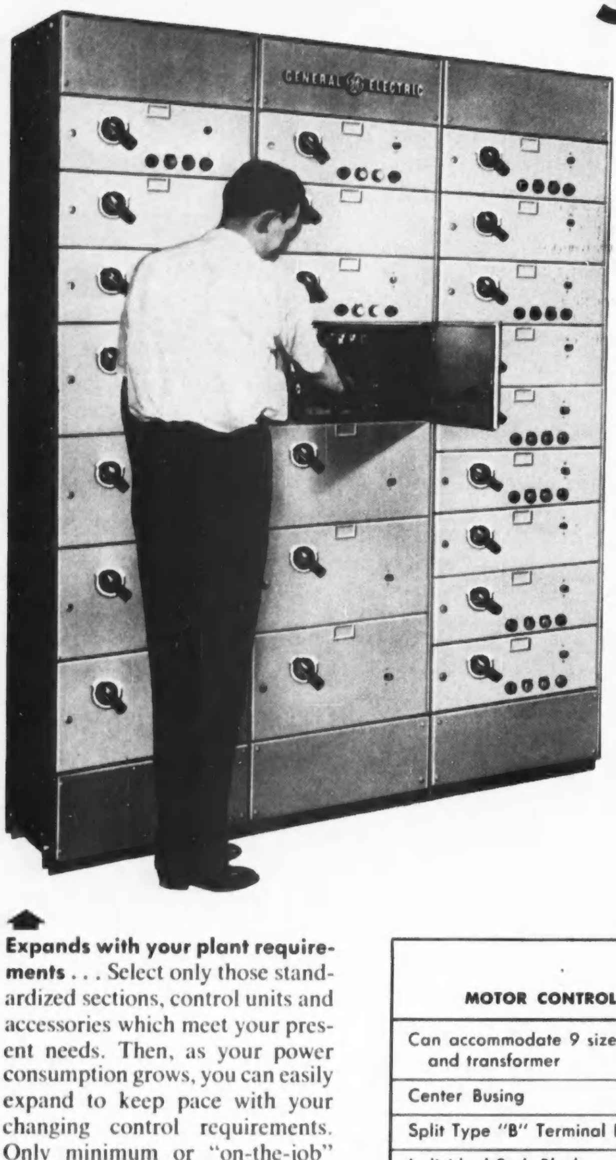
NEW G-E MOTOR

Saves up to



HERE'S a new product that spells savings all along the line . . . from initial purchase to on-the-job operation. G.E.'s all-new Motor Control Center (Type DA7093) puts your motor control capacity in approximately *half* the space formerly required. It takes nine NEMA size one or six NEMA size two control units in one standard 90-inch trough. This means fewer sections to buy, fewer sections to find space for and fewer sections to maintain — a clean-cut case of dollar-and-cents economy.

More than a space-saver, this new Control Center incorporates engineering advances which drastically cut installation time, step up capacity, simplify operation and slash maintenance costs.

Equally important, it embodies new safety features . . . *extra* features that provide *extra* safety to the contractor or plant engineer.

Look at these major engineering advances . . . which bring you unprecedented savings, dependability and safety:

Center Busing doubles vertical bus capacity (from 300 to 600 amperes) . . . leaves top and bottom pull boxes free for wiring within and between sections . . . allows continuous main bus of 600 or 1200 ampere capacity up through five sections.

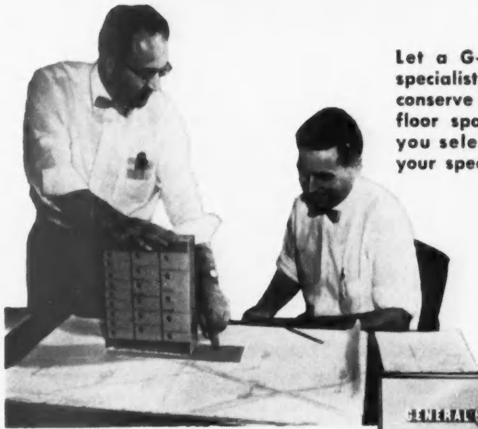
Expands with your plant requirements . . . Select only those standardized sections, control units and accessories which meet your present needs. Then, as your power consumption grows, you can easily expand to keep pace with your changing control requirements. Only minimum or "on-the-job" wiring is necessary.

Compare the DA7093 with other leading competitive Control Centers. Feature for feature, dollar for dollar, you get more with G.E.'s space-saver.

MOTOR CONTROL CENTER FEATURES	General Electric DA7093	Mfg. A	Mfg. B	Mfg. C
Can accommodate 9 size 1 starter units with disconnect and transformer	Yes	No	No	No
Center Busing	Yes	No	No	No
Split Type "B" Terminal Blocks	Yes	No	No	No
Individual Stab Blocks	Yes	No	No	No
Individual bus insulators	Yes	No	No	No
Positive unit grounding	Yes	No	Yes	No
Straight-in wiring to main lugs accessible from front	Yes	No	No	No
No across hinge wiring	Yes	Yes	No	No
Edge to Edge Configuration Main bus	Yes	No	Yes	No
Minimum 4¾ x 6 inch wiring gutter	Yes	No	No	No
Unit Pull handle	Yes	Yes	No	No
Vertical Bus, minimum 5 inch spacing	Yes	No	No	No

CONTROL CENTER

50% in Floor Space



Let a G-E motor control specialist show you how to conserve your motor control floor space. Let him help you select equipment for your specific requirements.

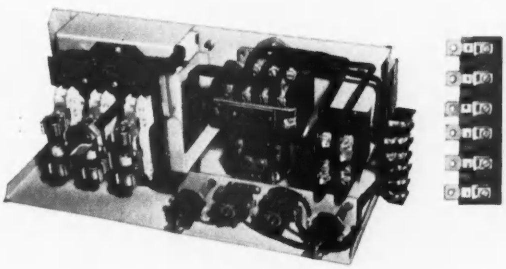
Split Type "B" Terminal Blocks allow you to add, switch or extract control units *without disturbing established wiring.*

Individual stab mountings cut your maintenance costs by as much as one-third because they can be replaced individually.

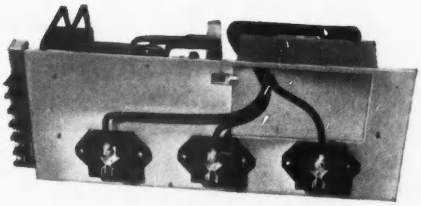
Positive grounding of each control unit *before* units engage bus bars. This, plus locking devices for both the control unit and operating handle, gives *added* protection.

Add a whole host of other design developments and you'll agree the DA7093 is designed for the future — *your* future.

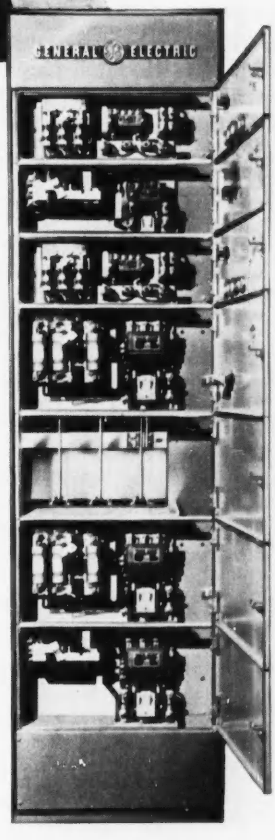
For further details, please contact your nearest General Electric Apparatus Sales or Assemblies & Components Sales representative. Or write for Bulletin GEA-6160 — General Electric Co., Distribution Assemblies Department, Plainville, Connecticut.



Control unit showing neat arrangement for easy maintenance. Type "B" Terminal Blocks (shown right) permit unit to be removed without disturbing wiring. Notice the fusible disconnect that can accommodate either or both Type NEC or Type CLF current limiting fuses.



Rear view of Control unit showing three individual bus stabs of silver-plated pure copper. Re-inforced with heat-treated spring steel, they assure positive contact with vertical bus.



1. Center busing ups bus capacity from 300 to 600 amps . . . leaves top and bottom pull boxes free for wiring within and between sections. Result: more ampere capacity per dollar; quicker, easier installation.
2. Large wiring gutters (4¾" x 6"), plus wiring straps to keep wiring clear of units, simplify installation.
3. Removable cover plates for continuous center busing . . . hasten installation.
4. Doors that open past center so they won't hamper installation or maintenance work.
5. Disconnect handle takes three padlocks for *added* safety.
6. Pilot devices are mounted on control unit, thus eliminating across-the-hinge wiring . . . preclude frayed wiring with resulting short circuits.

Progress Is Our Most Important Product

GENERAL ELECTRIC

TRANSFORMER

Treasure Hunt

General Electric offers a new transformer for oldest G-E unit in ASA range

To promote the benefits of standardized transformers and to commemorate the dedication of its new Repetitive Manufacture transformer plant, General Electric plans a unique monument. The Company is sponsoring a "treasure hunt" to find the oldest G-E (or Stanley Electric) transformer in the RM range of ratings that was still in operation on May 11, 1954, the day the plant was dedicated. The prize, in exchange for the oldest unit, will be a new G-E self-cooled, oil-insulated transformer of equivalent rating delivered free of charge.

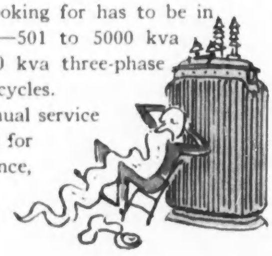
BONUS PRIZE FOR REPLACEMENT BY RM UNIT

If the winning transformer can be replaced with an RM unit having kva and voltage ratings and impedance values which are listed in the ASA standard, there will be an extra bonus in the form of an all-expenses paid trip to G.E.'s new Rome, Ga., plant for a man in the winner's organization.

WHAT TRANSFORMER WILL QUALIFY?

The transformer G.E. is looking for has to be in the ASA range of ratings—501 to 5000 kva single-phase, 501 to 10,000 kva three-phase 69,000 volts and below, 60 cycles.

It must have been in continual service as of May 11, 1954—except for normal periods of maintenance, spare duty or relocation.



WHO CAN PARTICIPATE?

All electric utilities, manufacturing, and transportation companies are invited to take part in this nationwide transformer "treasure hunt."

HOW TO ENTER THE "TREASURE HUNT"

It's easy to enter the treasure hunt. It's fun. And it may be profitable. But, do it right away. Your entry must be post-marked not later than November 1, 1954. If you have a transformer "old timer" still in operation, why not ask your G-E Apparatus Sales Representative for a "treasure hunt" entry blank. Or write for Entry Form GEZ-1046. General Electric Company, Schenectady 5, N. Y.

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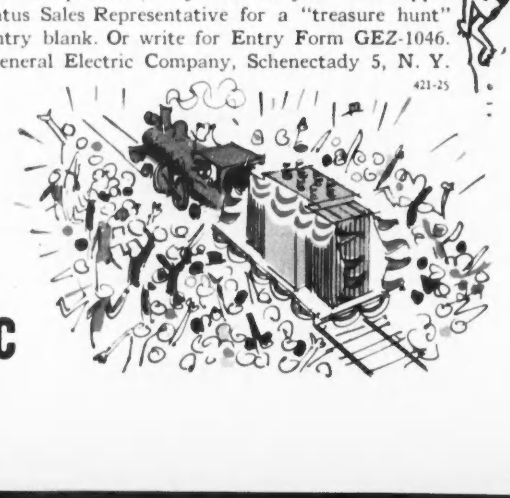


Progress Is Our Most Important Product

GENERAL ELECTRIC

THE ENGINEER AND STANDARDIZATION

Some of you may wonder at the above title—for if there is anyone working in God's great universe who is not standardized it is the engineer. Forever dreaming dreams of the new, and forever striving for a better way, he looks continually beyond the present. And yet, when he wraps up the accumulated knowledge of the past into a bundle of present possibilities and puts it to work in the power of its potential, he gives us a dynamic standardization in all of its fruitfulness. This is the basis of our productivity; this is what has caused our industrial power to provide us with all the things that we have.

In the electrical industry, standardization has been characterized by great names and great ideals. Professor Comfort Adams early brought into the standardization picture the word *co-operation*—a great word which is fundamental to all standardization progress. The classic paper "Temperature and Electrical Insulation" presented by Steinmetz and Lamme before the AIEE in New York, February 1913, exemplified this. Reporting co-operatively the results of much work and study and thought on the classification of electrical insulating materials, it had the effect of establishing a basic structure for standardizing the ratings of electrical machinery. Within that framework progress was provided on an individual basis, and this progress has continued ever since.

The Steinmetz-Lamme report was a historic work of fundamental importance defining the temperature limits of then available materials—limits which have remained unchanged to this day. In the meantime, scientists have brought forth new insulating materials and engineers have evaluated them and put them to work. The new materials have been classified into the standards and extended as necessary, until today, with an avalanche of new synthetic materials, the work of classifying them has reached major magnitudes of international scope. So standards never stifle progress. On the contrary, they accelerate it, bringing out the very best of accomplishment from the very best of talent.

The standardization of apparatus and equipments within a company, allowing them to be manufactured in large numbers to attain lower costs with improved performance, is an essential in our economy. This is standardization at its very best, and it provides for the greatest of trade. It is in this field that the design engineer, the manufacturing engineer, and the tool engineer make their greatest contributions to provide more goods and services for more people at less cost.

Industry technical standards facilitate trade. Where there is an initial co-operative effort to remove barriers and to set up a basic structure, then a maximum opportunity for trade is provided. Thus did the engineers from the earliest days see the need for resolving their different viewpoints—and the result was the American Standards Association. Today there are 1411 ASA standards in use, and in progress for standardization under ASA procedure are 379 new projects by 107 committees of engineers and others.

Standardization on an international front has been prominent from the beginning of engineering. Many of the fundamentals of science have come to us from Europe. The International Electrotechnical Commission had its beginnings in St. Louis in 1904. In this Golden Jubilee Year of 1954 the IEC meets in Philadelphia. There will be meetings of 45 technical committees, ranging in scope from the fundamentals of magnitudes and units to power generation, electric transmission and distribution, transportation, lighting, radio, and communication. Here the engineer associates himself with world problems.

One of the finest examples of standardization in all of its aspects has been established for us in the past few years by the engineers of the radio and television group of the electrical industry. In the late 1930's various systems of black-and-white television were being developed—and yet there could only be one system. The industry's engineers, brought together in the National Television System Committee, evolved the black-and-white system which has brought a new era to millions of people in America.

Then came color, and with it again the need for a single system—with the additional proviso that it be compatible with the black-and-white system. Again the engineers came together in the NTSC and, completely changing their previous concept of color transmission and reception, evolved a compatible electronic color system which has now been officially approved on a national basis. Thus, through the participation of the NTSC, barriers were removed and the resulting progress benefited everybody. And within the structure of the basic system there is still room for individual opportunity to provide the newest and best in performance. That is a great tribute to engineers and engineering and a great tribute to managers and management.

To the engineers who have given their time and ability to standardization and to management which has supported it, we owe a very great debt indeed. Their combined participation, plus standardization, is essential to the solution of the problems of today and of those to come.

Everett S. Lee

EDITOR

"THE B47 IS A SIX-JET SWEPT-WING MEDIUM BOMBER IN THE 600-MPH CLASS CREWED BY THREE AMAZED MEN," SAYS MAJ. JOHN B. STIRLIN

APGC—The Air Force's Toughest Customer

Review STAFF REPORT

You can build fighting aircraft that are fast and sleek and crammed with gadgets, but if they won't stand up under routine operations, they're better off on the drawing board or at some research center. And finding out their defects after they're in full production can be costly in time, money, and lives.

Of all this the U.S. Air Force is acutely aware. What they are doing about it takes place on 800 square miles of pine forest and dry desolation in northwest Florida where the Air Proving Ground Command (APGC) at Eglin Air Force Base tests equipment ranging from jet interceptors to rubber life rafts and heated flying suits. The complete mission of the APGC is tidily wrapped up in the phrase "operational suitability testing."

APGC, under the command of Maj. Gen. Patrick W. Timberlake, also tests new tactics and operational procedures, conducts aerial firepower demonstrations, and supervises all major exhibitions of Air Force aircraft in the United States, such as the National Aircraft Show. It also has primary responsibility for the "operational suitability testing of atomic weapons."

In essence, APGC is a synthetic customer for the Air Force, and it is a relentless one.

Recently I landed at Pensacola's bright municipal airport and met Joe Kirby, GE's lone technical representative stationed permanently at Eglin Field. Kirby, a neat dresser, is an easy-going New Englander. He likes the

WHO IS IN CHARGE OF ONE OF THE B47 PROJECTS AT THE AIR PROVING GROUND COMMAND, EGLIN AIR FORCE BASE IN NORTHWEST FLORIDA.

lingering pace of life in the South but refuses to acquire any of the more cloying speech mannerisms. His pronunciation of "Park Square" remains untainted.

"I came down here on a three weeks' assignment," he told me as we hurtled the 40 miles eastward to Eglin in his new Ranch Wagon, "but it stretched out to six years." Kirby is married, has two children, and owns a home in Ft. Walton Beach, a few miles from the Base. His wife misses the big market places of the North and regularly shops by mail from the *New York Times.*

APGC is important to General Electric, Kirby told me, as it is to all Air Force contractors. "This is one of the few places in the country where you can see all models and modifications of G-E jet engines installed on every type of aircraft. There aren't any 36s here just now, but I think you'll see just about everything else. There's a lot of other G-E stuff here, too—gunsights, the armament system for the Boeing B47, autopilots, and firing devices."

Major John B. Stirling is tall, has a generous smile and short blonde hair, and heads up one of the B47 projects. He has a lot of respect for that particular airplane; I received that impression while we stood under the bomber's wing and he told me about the fine points of 47 operation.

He has a definition of the airplane that sounds completely innocent until you hear the last phrase: "The B47 is a six-jet swept-wing medium bomber in the 600-mph class crewed by three amazed men." He always says it with a grin, but when he tells you some of the things it can do, you begin to realize it is quite a remarkable airplane. "It handles like a fighter," he said, putting the thumbs of his hands together with the palms down and making a wide turning climb. "Some of the boys really rack them around during an approach. They come in mighty fast."

"This is a lot of airplane," he mused, lightly running his finger over a section of the stressed hull.

In the tail of the 47 I saw the hemispherical turret that mounts the 20-mm cannon of the G-E armament system—the plane's sole protection. Above the guns was the small radome of the search radar. In enemy areas the copilot switches the system to "search," and the radar tirelessly sweeps the sky to the rear. When the radar locates an enemy,

RADAR-CONTROLLED G-E ARMAMENT SYSTEM GIVES B47 HEAVYWEIGHT PUNCH TO THE REAR.

it "locks" on the target and tracks it. At the same time the radar begins feeding information to the system's computer that factors in such things as speed and lead, and the copilot watches the enemy on his radarscope. When he sees on his scope that the enemy is a definite threat, he fires the guns by remote control.

One of the chronic problems with jet aircraft, Stirling told me, is getting them off the ground on normal runways with heavy loads. We walked forward and he pointed to a series of slanted holes in the side of the fuselage. "These are for the RATO units—Rocket Assist Take-off—that we sometimes use to get a heavily loaded plane into the air. They do the job but they're expensive—as much as $13,000 per take-off—and you're always lugging around the dead weight of the containers."

"Well," he said, "the next thing developed was a rack affair that went around the fuselage. We call it a horsecollar. The RATO units are fastened to it, and the whole thing is ditched after we get in the air. But they're not too good, either. There's a certain amount of air resistance and you have to watch where you drop them."

Because of the limitations on rocket-assist take-off techniques, Stirling's current project involves getting more thrust out of the G-E jet engines during take-off. The method is simple and inexpensive. A mixture of alcohol and water from two 300-gallon tanks mounted in each wing is pumped directly into the combustion chambers of the jet engines during take-off.

I asked him if the mixture wouldn't freeze in extremely cold weather. "We're not too much worried about that," he replied. "In the first place you rarely need a boost for take-off when it's cold, and in the second place we usually fill the tank and are on our way before it gets a chance to freeze."

Between the new injection system and the RATO units, the 47s, as Stirling expressed it, can now handle a "fantastic increase in gross weight."

I learned later that liquid injection for jet engines isn't new, that G-E engineers have been working on it for a number of years (pages 38-39, July 1952 REVIEW). Sometimes water is sprayed into the compressor inlet to decrease compressor inlet temperature and to increase the mass flow through the turbine. Although injecting a liquid into a combustion chamber doesn't exactly aid combustion efficiency, the increased gas flow and higher compressor-pressure ratio result in a larger amount of energy available in the gases leaving the burner. Variations of these systems boost the take-off thrust from 15 to 25 percent or higher.

That the combustion efficiency is low is demonstrated by the large volume of dense black smoke that pours from the tailcones of the engines. Stirling showed me some movies of a 47 taking off under full thrust from an airstrip in Puerto Rico. The plane appeared to be emerging from a big angry cloud. "Every time I come down the runway," he commented, "I feel like blowing a whistle."

In Florida there's no problem about testing Air Force equipment in hot weather. At times during the summer the temperature goes to such extremes that some projects on the Base work from 4 am to noon.

Arctic testing is the real chore because Alaska is a few thousand miles away and can't always be depended upon for the proper low-temperature conditions. It's expensive to haul men and equipment and supplies up there and then have them wait around for the weather. Another problem is that of coordination between manufacturers' representatives and the Air Force.

In 1946 these problems were effectively solved when the Climatic Hangar went into operation at Eglin. The structure can house a Convair B36 intercontinental bomber and several smaller aircraft at the same time, and the temperature can be varied well within the −65 to +160 F required by the Air Force. And at the same time the planes are in the hangar, you can run up the jet engines and ground-test them, fire weapons, drop bombs, and simulate landings and take-offs. Each hour jet engines can be given one 20-minute full-rpm test without appreciably raising the temperature.

Trucks and jeeps and ambulances can be driven around the hangar and put through their paces in snowstorms or on icy roads.

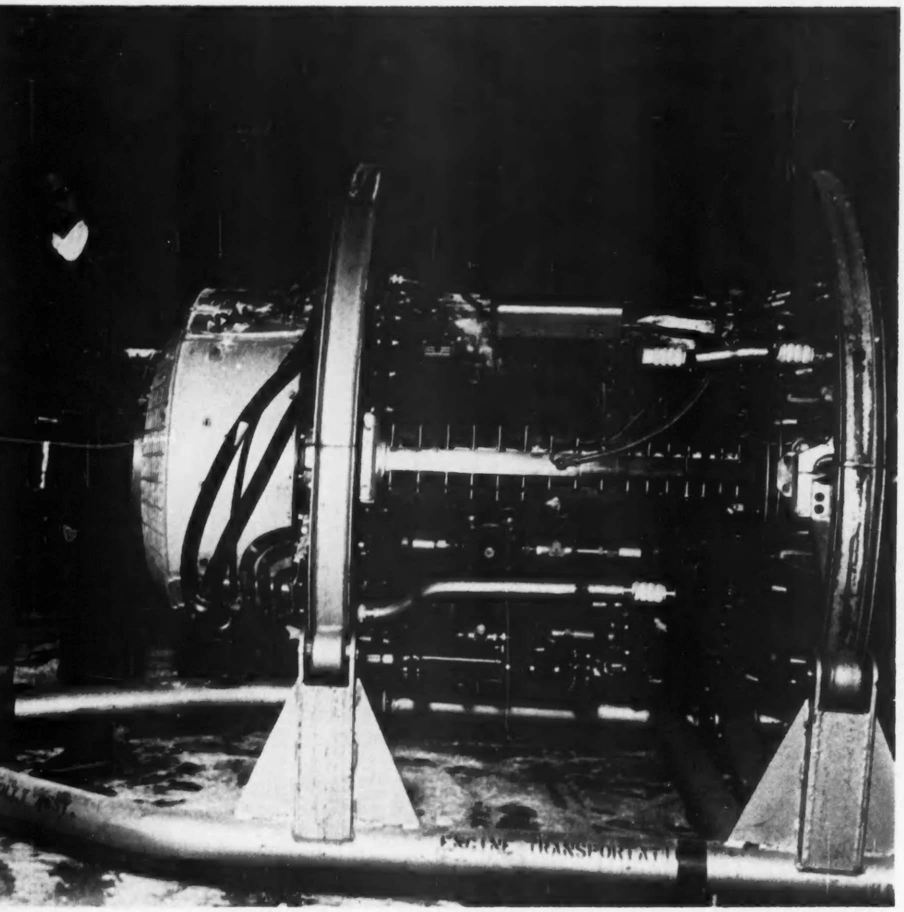
Personnel can be tested under all climatic conditions, at all operating altitudes, and under flight-climb conditions.

The Desert Room has seven percent humidity and noonday sun; in the Tropic-Marine Room you can get salt spray and up to 12 inches of rain an hour; in the Jungle Room you can also get high humidity and introduce molds and fungi to see how they will affect equipment.

There's an All-Weather Room, too, with winds up to 100 mph in combina-

CLIMATIC HANGAR CAN HOUSE A CONVAIR B36 INTERCONTINENTAL BOMBER, IN ADDITION TO . . .

. . . SEVERAL SMALLER AIRCRAFT SUCH AS THIS F86D *SABRE JET* SURROUNDED BY TEST RIG.



JOE KIRBY, GE'S REPRESENTATIVE, KEEPS TRACK OF EQUIPMENT UNDER TEST AT APGC.

tion with rain, snow, sleet, and dust, and temperatures from -40 to $+70$ F. It can also be filled with four feet of water so you can determine how life rafts and immersion suits will work. The primary purpose of this room is the physiological proof-testing of personnel and personal equipment.

The Strato-chamber duplicates the temperatures and pressures found up to 80,000 feet above the earth.

You can also determine how stored equipment will stand up under long-term exposure to the elements.

"Any climatic condition found anywhere in the world can be duplicated in the hangar," Major J. W. Davidson, who is in charge of the hangar, told me in his office. "Short of actual flights," he continued, "there's little about a plane's performance that we can't test in the hangar."

Thorough as these tests are, Davidson said, they're not completely conclusive because they don't include flight. For that final phase a detachment is sent to Ladd Air Force Base near the Arctic Circle in Alaska.

Four test cycles are run off at Eglin's Climatic Hangar in a year, he told me. Each temperature level is held for about two weeks, and the temperature is usually altered in 20-degree increments. When it's down to -65 F, it's held there for three weeks. This really taxes the three Freon refrigerating systems when the outside temperature is in the 90's and 100's during the Florida summer.

From the main observation room high on the south wall we looked down onto the hangar floor. The temperature was 20 F. A British-designed American-built (Martin) B57 Canberra jet bomber was in one corner. Nearby was a Navy search plane and a Navy helicopter. Sandbags held the 'copter to the floor so that the rotors could be operated without the craft taking off. Two Army tanks stood in a corner. Arching overhead are huge ducts that feed frigid air into the hangar. Six 100-hp fans circulate air over cooling coils; for high temperatures, steam is run though the coils.

As we watched technicians work on the helicopter, Davidson told me more about the tests in the hangar. "Above all, they're safe," he remarked. "We can get our data while the aircraft is stationary. We can get to know just how it will operate under natural conditions before we risk our necks in it. That's important."

The Air Force Armament Center is a tenant at Eglin Air Force Base, because it reports to the Air Research and Development Command (ARDC) rather than to the Air Proving Ground Command. As the name implies, its main function is research, development, and testing of air armament weapons.

In a long row of garage-like structures where guns are fired into sandbanks, I saw "Project Vulcan," an amazing device that has been under development by General Electric since 1948. It is not a gun; as Kirby pointed out, it is designated as a "firing mechanism."

It sat on its mount in the middle of the test cell—squat, stark, and simple. The 20-mm shells were fed into its side from a long trough that extended over to one wall of the cell and then up the wall to the ceiling.

"It's not like a gun anymore," an armament officer nearby remarked. "It's like an entirely new animal." Even though it's simple, accurate, and easy to maintain, feeding problems are "sticky," as he expressed it, "because it's such a greedy creature."

I soon saw just how greedy it is. The range safety officer had given the firing run a "go-ahead," indicating that the range was clear. At a signal from the officer in charge we backed against the far wall of the hallway that joined the cells. The device was 15 feet away. I put my hands to my ears because everyone else did. I watched the weapon: out of the corner of my eye I saw a technician jerk his hand as he closed a switch. There was a shattering roar, and I felt the sound waves blast across my chest. Then silence and an awed pause. We let our hands drop to our sides and walked forward slowly. In a wooden box to the left of the device was a jumble of cartridge links and spent shell casings. The feeding troughs were empty. I looked downrange: sand and dust were settling in the pit. The test had happened in the length of time it would take you to slowly snap your fingers.

Kirby pointed out that this device is

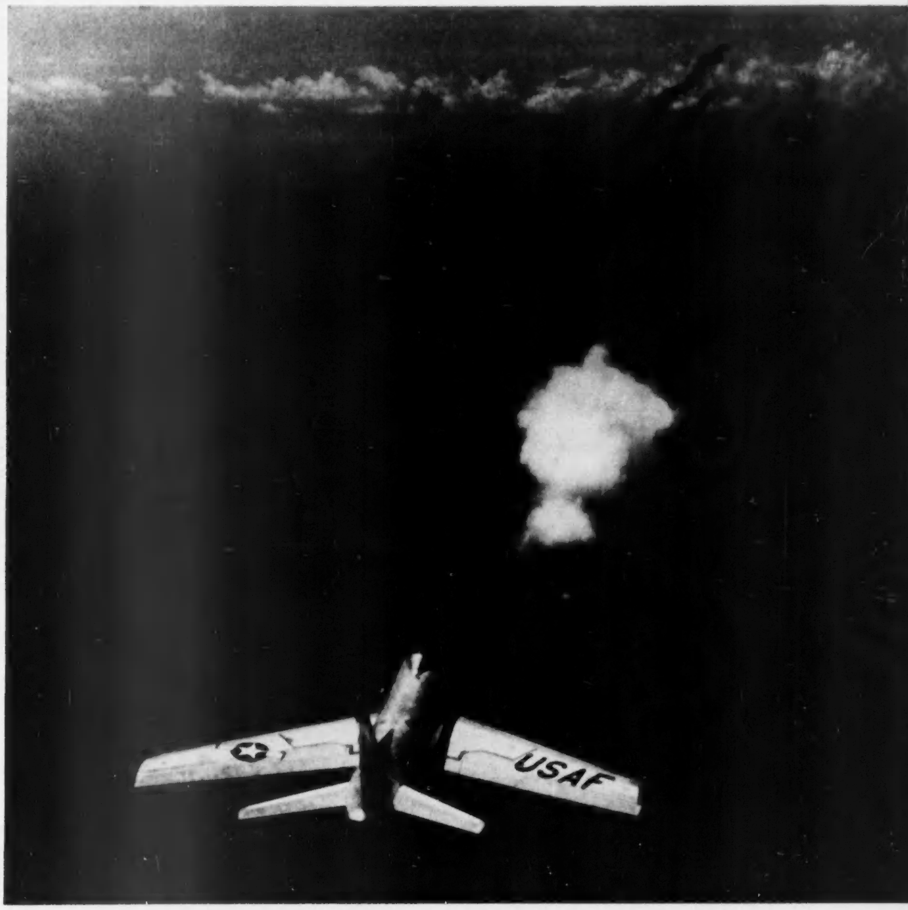
unlike the Ford-Pontiac M39 cannon that was originated by German scientists and operates on the principle of the Western six-shooter with its revolving magazine. This device has a yet higher rate of fire—it even surpasses the term "fantastically high," as Kirby expressed it—and is based on an entirely different principle.

Because today's aircraft operate at such high speeds, it is becoming increasingly difficult for a pilot to get an enemy in his sight long enough for the kill. Range is closed too fast, and properly leading a target is a complex problem. Human judgment becomes obsolete.

That's when the modern gunsight takes over, Lt. A. J. Walter told me in his office at one of the AFAC buildings. Walter—slender, young, a graduate engineer, and a veteran pilot—is the project officer proving out GE's K19 gunsight for fighters.

On his desk pad he sketched out some of the problems of a modern sight.

"Lead pursuit" is the attack used for day fighters and is the basic one for the K19. The fighter sweeps in toward the enemy from a rear quarter and keeps him centered in his gunsight. The pilot sees the enemy in his sight. What he actually sees, however, is not the enemy where he is but where he will be when the rockets or bullets get there. By feeding the proper information into the sight, the computer makes the pilot fly the plane so that it leads the enemy the proper distance.



SABRE JET UNLEASHES ROCKETS DURING AERIAL FIREPOWER DEMONSTRATION AT EGLIN FIELD.

An interlock prevents the pilot from firing until he gets into range. But once he gets there, he can fire in bursts until he either misses and overtakes the target, until it is lost by evasive action, until he shoots it down, or it shoots *him* down.

Lead pursuit allows a relatively long period for shooting, but it's limited because the pilot must always approach from a rear quarter. This is uncomfortable if the enemy jet has a radar-controlled stinger in his tail.

"Lead collision" is a one-shot proposition. Again the pilot gets the enemy in his sight. The similarity with lead pursuit stops right there, because at this point the combination of sight and autopilot plus radar takes over from the pilot and flies the plane on a computed course. At the proper moment the sight fires the rockets or guns and automatically veers the plane away to eliminate a collision. This will give you an idea of the engineering skill involved in designing sights: the system must whip the plane off the collision course quickly after the armament is fired.

This method has an advantage in that the approach can be made from any angle. Night fighters are particularly fond of this technique because it lets the radar-autopilot-gunsight system do all the work in any kind of weather.

The sights used in Korea were accurate, reliable, and easy to maintain, I learned, but the K19 can do the same job with fewer parts and less weight.

Walter took me out to a busy hangar where a number of fighters were being worked over. We went to a North American F86 *Sabre Jet;* it is big and powerful and evil, with a complex cockpit. Directly in the pilot's line of sight is a slanted piece of clear glass about the size of a postcard. A circle of bright dots is used to center the target. The glass is mounted on a small black box recessed into the deck; all other components of the test-installed K19 are hidden.

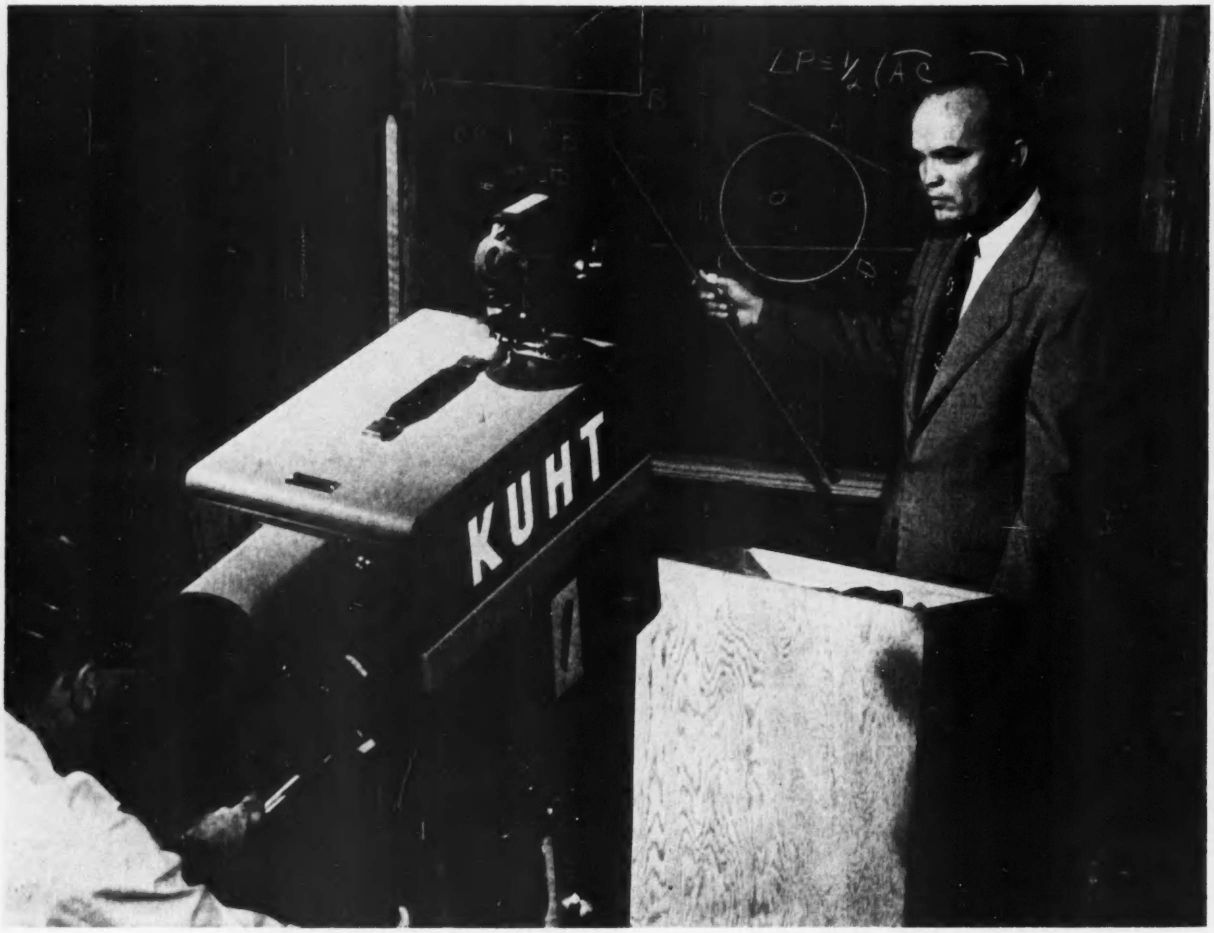
Walter introduced me to Major W. K. Thomas, a pilot with many hours of experience in fighters. He is typical of the men handling the various tasks at APGC—all combat veterans of World War II or Korea.

Thomas particularly likes the D series of the *Sabre Jet* and its G-E J47 engine with afterburner. Peering into the tail section of the plane, he pointed out the ceramic-coated liner in the afterburner that allows higher exhaust temperatures and boosts the power even more than the official 33 percent.

He explained that after the engine puts out full power, the throttle can be notched over to the afterburner position. This feeds raw fuel into the afterburner where it burns to give additional boost.

"It really shoves you back in your seat," Thomas said, moving his left hand slowly forward as if he were pushing a throttle. "And you can get upstairs in a few minutes." He paused. "In fact, in a *very* few minutes."

—PRH



KUHT The nation's first noncommercial educational TV station, which belongs to the University of Houston and the community it serves, has been in operation for more than a year. Programs vary from agriculture to drama and sports.

Educational Television—

By DR. W. R. G. BAKER

That our technology is outrunning the educational system of the United States has been a growing realization in recent years. So great is the advancing scientific knowledge of the past two decades and so rapidly are we opening up new areas of research and development that we face an evident danger of a shortage of trained technical personnel on all levels—from the technician to the PhD.

The underlying reasons for this shortage are many and diverse. And they exist in the face of continued growing awareness of the economic benefits of higher education and in the increasing desire on the part of individuals for knowledge. High employment and rising wages have made it possible for young people without technical or college training to obtain unskilled or semiskilled jobs that pay little less, or sometimes even more, than salaries offered to graduate engineers.

A large percentage of high school graduates find it financially difficult or impossible to attend college or technical schools—sometimes for reasons other than economic. In spite of increased emphasis on career counseling, many high school students do not decide on their careers early enough to take necessary preparatory courses. (To learn how industry is promoting the study of mathematics and English, see page 52, May 1954 Review, and page 56 in this issue.) In addition, there is a shortage of qualified high school science instructors and a decrease in the number of teacher-training graduates prepared to teach in secondary schools. Those trained to teach biology, chemistry, physics,

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Dr. Baker—a Vice President of the General Electric Company and General Manager of the Electronics Division—has frequently contributed articles to the G-E Review. *He has a vital interest in the role of educational television in the training of tomorrow's leaders.*

WRGB In Schenectady, NY, educational television is being integrated into the regular TV commercial programs. This program gave an explanation of the work of the Entomological Office, New York State Museum and Science Service.

An Investment in the Future

and general science dropped from 9096 in 1950 to 4665 in 1953.

In *Scientific American*, Feb. 1954, Fletcher G. Watson, pointing up the crisis in science teaching, predicts that high school enrollments will rise from the current figure of 6,600,000 to 9 million by 1960 and to more than 11 million by 1966. "Where," he asks, "will the teachers be found to handle this increase? The 340,000 teachers in high schools today are barely adequate to staff them. Within six years we shall need 418,000 teachers, and by 1966 we shall need 520,000."

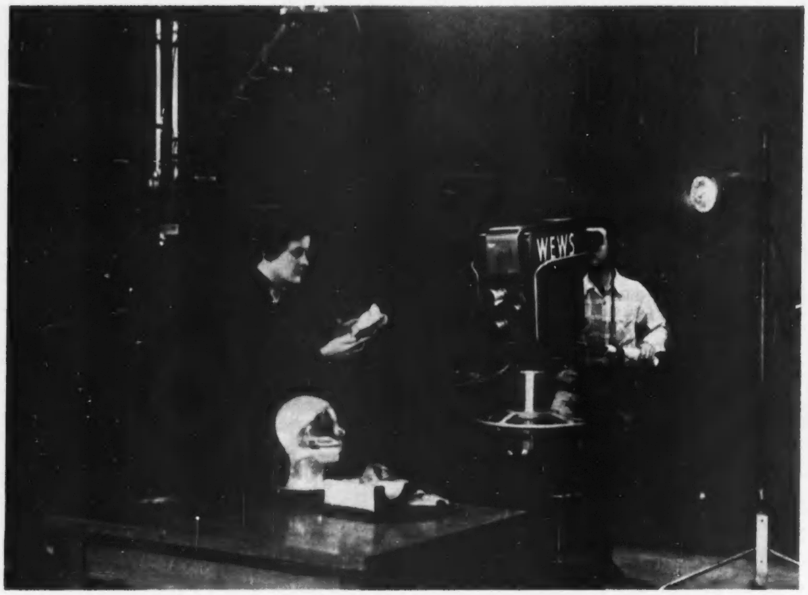
We are, then, faced with two allied problems: a shortage of teachers, particularly at the high school level and in the important science fields; and the need to raise the general educational level within the United States. We cannot take pride in the low level of illiteracy in this country. We must excel in more than the three R's if our technology is to continue to advance and we are to reap the benefits in greater productivity and a higher standard of living.

High Impact

Fortunately, a partial answer to these problems may come from a source that at first glance might seem to have little bearing on education. Television has swept the country as an entertainment medium. More than 400 television stations are expected to be on the air by the end of this month. Before the year is over, more than 30-million television receivers will be in American homes. The rapidity of reaching this degree of television saturation—less than 10 years—is indicative of the impact this method of communication has on our lives.

Psychologists as well as advertising experts have tried to define television's impact. Both essentially agree that it stems from the combination of sight and sound plus a more intangible asset, immediacy, the feeling that what is being pictured is timely yet transient.

WEWS In Cleveland, Western Reserve University conducts classes in speech therapy (*photos*), psychology, art, and music over a commercial station.



Because of this impact, studies have been made in an effort to determine whether television has a specific retentive value. Although the evidence is not conclusive, indications based on controlled experiments suggest that instruction presented via television is retained better and longer than that presented by the usual classroom techniques.

History of ETV

From the time that the earliest of these studies were made, including those of the Navy Special Devices Center at Sands Point, LI, in 1952, a ground swell of opinion indicated that television could be of value in education. The early influence came primarily from educators; but before long individual leaders in industry, government, arts and sciences, and many other fields were insisting that some provision be made for the future development of what is now known as ETV, or educational television.

By that time the Federal Communications Commission (FCC) had established the television freeze. Although 107 television stations were on the air, the FCC stopped granting permits for construction of new stations, pending a study to determine the best allocation for future growth of telecasting. When the allocation plan was released, 242 channels—now increased to 250—were reserved for nationwide educational television.

In a number of states those who could see the benefits of educational television immediately sought educational funds to implement the program. But faced with demands for financial assistance, both from teachers for higher salaries and from local communities to ease their overcrowded schools, state legislatures were reluctant to finance an untried and seemingly radical experiment in education. New York State is such an example; although the Board of Regents strongly recommended that a 10-station network be constructed with state funds, the governor and the legislature balked. As a result, the present fate of educational television in New York lies in the creation of local nonprofit organizations that would finance construction and operation of such TV stations.

Elsewhere in the country similar activities are being carried on, and by the end of this year upwards of 10 ETV stations will be operating. Many are UHF, and because they are located in established VHF areas, they face an uphill fight for an audience.

ETV—Not a Teaching Substitute

That in brief is the history of ETV. But what is educational television, and what does it seek to accomplish? First, let me point out what educational television is not. It is not replacing the teacher in the classroom with a television set—nor a substitute for textbooks or homework. It is not a mechanical device for infusing knowledge painlessly. Rather, it is the integration of the high impact value of television into our educational system as a teaching tool.

ETV is the use of television as an audio-visual aid to speed learning, aid retention, and provide motivation for further learning. This media can provide inspiration and teaching aids to the teachers, push back the walls of the classroom, and make learning interesting. Further, it offers a means of bringing outstanding teachers of the nation into all classrooms. What would be the effect if once a month during the school year you could bring into each class, for inspirational purposes alone, one of the great contemporaries—an Irving

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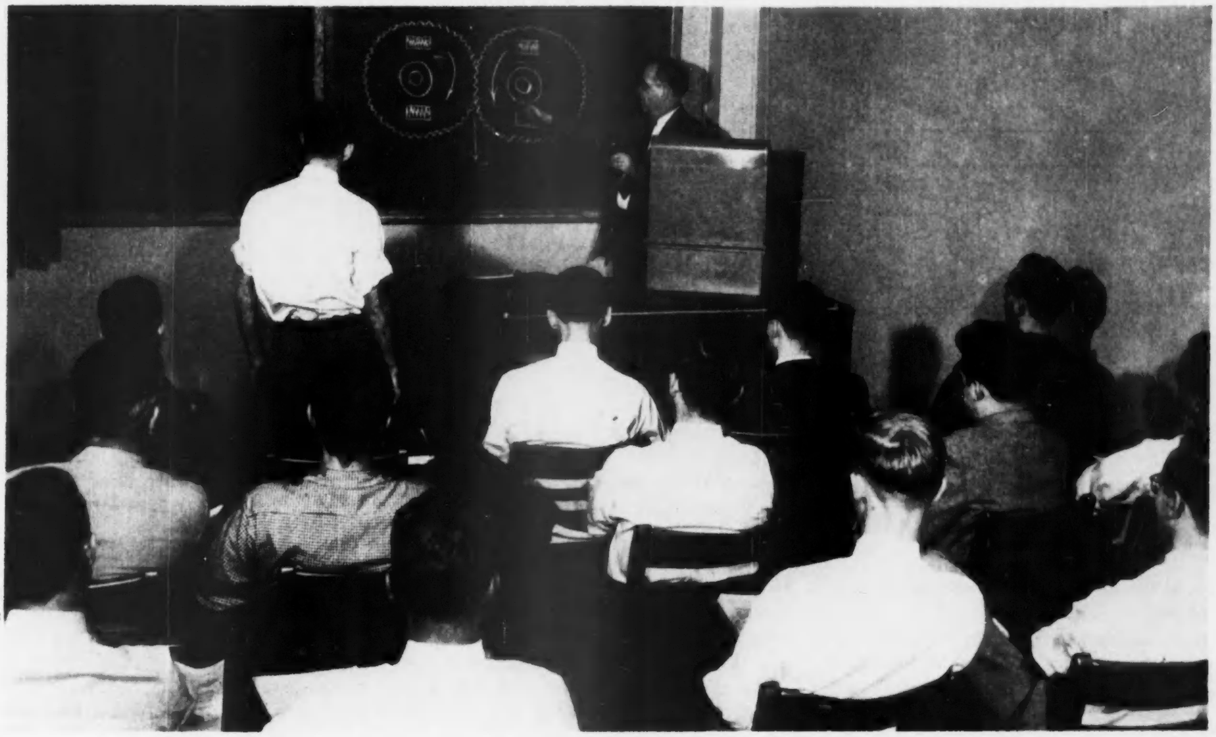

STUDENTS PARTICIPATE IN DISCUSSIONS OF DESIGN PROBLEMS PRESENTED IN COURSE THAT CUSHIONS THE ENGINEER SHORTAGE BY . . .

Teaching Draftsmen Engineering Principles

By H. C. DICKINSON and C. F. TAYLOR

Never before have there been such extensive within-industry educational activities for engineering graduates. This is an effective way to adapt the formal education of new engineers to the specific requirements of product development and design. But what about other personnel within the engineering organization who are not graduate engineers?

In a typical product-engineering group many people contribute substantially to the technical brain power. And prominent among these are the draftsmen. For in addition to preparing drawings for manufacture of a product, they normally contribute much to its design features. Their ability to apply fundamental engineering principles to practical design problems takes some of the workload off the engineer. And this ability can be improved through an effective on-the-job training program.

The Draftsman

A product-engineering drafting group usually consists of *designers* and *detailers*. Design-draftsmen are more experienced and creative than detailers. Their job is to apply mechanical designing and drawing skills to a new or redesigned product on the initial layout. After the adequacy of the product design has been verified, the detailers take over and make manufacturing drawings of its parts, assemblies, and subassemblies. This way the detailers gain the experience and knowledge needed to qualify as future design-draftsmen.

The complete product design is, however, basically the responsibility of the development or design engineer assigned to the project. It is he who gets the drafting group started, who makes many of the major engineering decisions, and who works with both design-draftsmen and detailers as the project progresses.

Extremely close co-operation between the project engineer and the design-draftsman is essential. This is particularly true in the initial layout stage where a large number of mechanical design problems must be solved (photo, top, page 20).

The individual contributions of this engineer-draftsman team are usually hard to measure. But you can be certain that the greater the draftsman's engineering competence the less the engineer must follow the job, and the more effectively will his advanced training be utilized within the organization.

The successful completion of a design project requires the solution of numerous mechanical problems. Many of these are not even recognized at the time the project is initially conceived. It is the design-draftsman who has the best opportunity to recognize them when he visualizes the design in his

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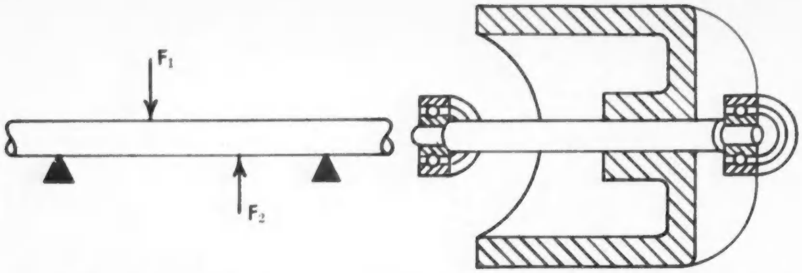
Both Mr. Dickinson and Mr. Taylor are in the Instrument Department, Measurements and Industrial Products Division, West Lynn, Mass. Mr. Dickinson, Supervisor, Engineering Financial Administration, has been with GE for 20 years. Mr. Taylor, an engineer in the Aircraft Engineering Subsection, joined the Company in 1939.



PROBLEM APPROACHES—Academic: What is the maximum fiber stress in the shaft (*left*)? Realistic: Will the shaft of the gyro-rotor (*right*) withstand severe accelerations?

initial layout preparations. Because more engineering ability is often needed to recognize such problems than to actually solve them, the design-draftsman's technical background at this stage of the project is a valuable asset.

Fundamentals Wanted

A well-organized and effectively conducted mechanical engineering course that applies engineering fundamentals to actual design problems will increase the draftsman's self-confidence. It will arouse his enthusiasm for contributing a larger share to the total engineering activity. And the end result will be accelerated progress for both the draftsman and his group.

One such course taught at General Electric for two years—the Mechanical Design Training Course—has been given to selected groups of draftsmen at GE's Meter and Instrument Department in West Lynn, Mass.

When the course was first proposed, we knew that ample preparation and thorough planning would be needed to gain our objectives. And so at the outset we decided that the course should. . .

- Cover those mechanical engineering fundamentals specifically applicable to the design of meters and instruments.
- Use the problem approach, employing actual meter and instrument designs.
- Encourage maximum student participation and co-operation.
- Be offered on a voluntary basis to not more than about 20 draftsmen at one time, preferably to the best qualified on the basis of their technical education and design experience.

You can see that these requirements imply a specialized and relatively difficult engineering course. They emphasize learning by doing rather than just another series of lectures supplemented by reading from a standardized textbook. (For a discussion of the learning-by-doing method applied to engineering education in general, see page 55, March 1954 REVIEW.)

To meet these requirements meant starting from scratch to determine how much emphasis should be placed on each subject. It also meant preparing a specialized textbook, adapting actual design problems to the proper educational level, and deciding what percentage of the course should be allotted to problem exercises.

The mechanical engineering subjects subsequently selected for the course are covered by the academic titles of statics, kinematics, dynamics, friction, strength of materials, and elasticity. Beyond these, however, the resemblance of the course to a conventional textbook approach ends. The student is led into such practical problems as dynamic balancing of gyro rotors, analysis of the forces in an a-c ammeter mechanism, design of meter bearings and gears, and the development of instrument and time-switch springs. Relating theoretical concepts to actual product designs in this manner creates a sense of reality for the student. It maintains his enthusiasm and clearly emphasizes the value of understanding fundamental principles.

The technical level of the course is based primarily on the degree to which mathematical and other analytical techniques are used. Most candidates are either graduates of two-year technical schools or have received at least the equivalent amount of engineering training at night school. They have therefore been exposed to most of the fundamentals covered and have sufficient training in mathematics to handle the practical analysis of many engineering problems. Still, the time elapsed since such formal training varies with each individual—as much as 15 or 20 years.

And so the first chapter of the textbook, plus the initial classroom sessions, is devoted to a review of algebra, plane geometry, and trigonometry. All reference to calculus is omitted from the course to avoid an added educational burden. For, as you know, calculus has a limited practical value in solving certain mechanical engineering problems.

Running for a period of 16 to 20 weeks, the course requires about 10 hours for problem assignments per week, coupled with a weekly two-hour classroom session from 4 to 6 pm. It is offered to draftsmen on an entirely voluntary basis at no personal expense.

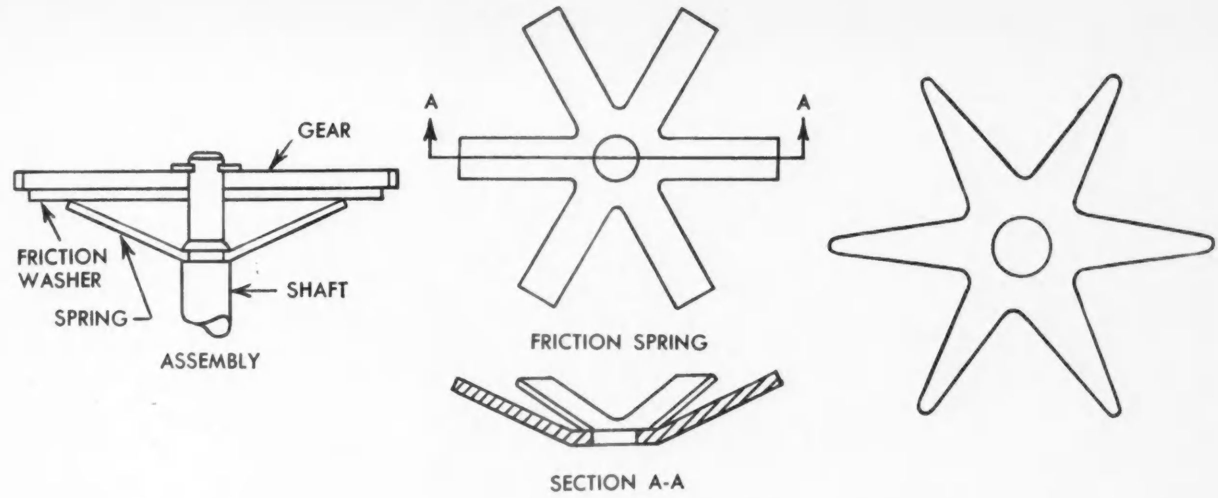
Each course is limited to about 20 students. This way the student actively participates in class sessions, and at the same time the class instructor can adequately follow his progress.

Problem Approach

The instructor, an experienced measurements engineer who previously taught advanced engineering courses to graduate engineers, spent three months preparing the text and problem material for the course. Other engineers and drafting supervisors helped him select design problems, each involving the maximum number of engineering fundamentals. Designs already developed were picked to assure that the student would deal with realistic problems. Incidentally, this practice also avoids any student's criticism that assignments represent new work that he would otherwise do during his regular hours.

Realistic design problems that reflect conditions as they appeared to the original designer are stressed. The typical textbook approach to the illustrated problem (above, left) is to ask the student to determine the maximum fiber stress in the rod. This requires little more than substitution in a formula. However, in the more realistic problem (above, right) the rod becomes a shaft which is part of a gyroscopic-instrument rotor. Here the student is given the severest acceleration expected and the maximum permissible permanent shift in the rotor's center of gravity. Then he is asked if the shaft is strong enough to meet these requirements.

Mathematically there's little to distinguish these two problems. But educationally there is a profound difference. In the actual problem the student must assume a reasonable factor of safety. He must, among other things, determine the most critical direction of acceleration, plus the region and type of maximum stress. In short, he must put himself in the position of a mechanical



PROBLEM: For the time-switch clutch assembly (*left*), design the spring (*center*) so that torque variations caused by manufacturing tolerances will be minimized. Compare design with spring having tapering fingers (*right*), justifying conclusions by physical reasoning.

designer; this distinguishes reality from fiction.

To illustrate the application of fundamentals, a large number of realistic problems drawn from actual experience are used in the text and classroom lectures, in addition to those assigned as exercises. To meet the needs of the course, however, nearly all have required some adaptation without loss of reality. For example, modifications were made to maintain the proper technical level and to avoid complicated mathematical analysis that would waste classroom and assignment time. Much attention is also given to presenting the problems in a manner that challenges the student's imagination, judgment, and creative ability.

One important feature of the course is developing in a student a critical attitude toward all aspects of a situation—that is, teaching him to recognize those factors that can give him trouble with a design. He is taught to define the problem sufficiently to make an objective analysis, or at least to convey it intelligently to a more experienced member of his engineering organization. Among the techniques we use to stress this recognition factor is to state a problem in this form: "Given a specific design, does it meet specifications? If not, determine dimensions, materials, and other factors so that it will."

Occasionally it's worthwhile to omit vital information in stating the problem. Although this may seem disagreeable—even unfair—to the student, it is certainly realistic. For frequently a disagreement concerning a product design is caused by the lack of vital data needed to draw a sound conclusion. Thus training the student to spot missing information is a true-to-life exercise of his judgment and ability to perceive actual situations. (The students have more difficulty with the judgment and perception phases of the problem than with the engineering fundamentals or mathematical analysis involved.)

Enrolling Students

Enlisting applicants and selecting students rank next in importance to preparing the right kind of text and problem material. An announcement is sent to all draftsmen about two months before the course starts. It describes the objectives, content, and the time required, and also explains how and why a limited number of students are selected. To each announcement we attach an application blank, requesting that the applicant list his education and experience. So that there won't be any misunderstanding, the following paragraph is included:

"While the Mechanical Design Training Course is entirely voluntary and its successful completion will not directly affect the status of any participant, it is a unique opportunity for each of you to increase your effectiveness by learning more about how to apply the general technical knowledge you learned in school to our specific kinds of design problems."

This is followed by a statement that the course will be repeated in future years for those unable to participate in the current term.

The first year the course was offered, applications came from more than half the drafting group—a number far exceeding our set limit. Of these applicants the best qualified were selected by a departmental education committee, a group far enough removed from the drafting supervisors to eliminate any suspicion of favoritism. The committee screened all the applications, personally interviewed doubtful cases, and notified those selected. This was carried on in such a way that successful candidates considered it an honor to be selected.

Learning by Doing

The keynote of the course is student participation. Questions and discussions are encouraged at all times during classroom sessions (photo, page 17). By introducing controversial points—and asking for opinions on them—the class instructor stimulates such activity.

Normal classroom procedure is a discussion of problem assignments followed by questions on material already covered. Next, new material is presented on fundamentals and their applications to design. By the time the halfway mark of the course is reached—about nine weeks—the students themselves occasionally present parts of the problem review or discuss the application of fundamentals to their day-to-day work.

More than 80 percent of the student's

PROJECT ENGINEER points out unusual aspects of a design in the initial layout stage. At this point the design-draftsman's creative skill and engineering ability count most.

CONSULTATION with his instructor (*left*) gives this design-draftsman an opportunity to discuss difficult design problems and occasionally introduce some of his own ideas.

time is devoted to problem assignments. We feel that this is the most important feature of the course. For it is the student's chance to learn by doing and to have his results analyzed by the instructor—and frequently by his fellow students. Because no formal examinations are included in the course, this practice allows the instructor to measure the extent to which the student is absorbing his teaching.

About 12 homework problems are assigned during the course, with some extending over a two-week period. To develop co-operative habits and broader viewpoints, the students are encouraged to discuss these assignments with one another and with engineers in the organization. In addition, the instructor is always available for consultation (photo, lower). Here, particularly knotty problems are thrashed out, and the instructor himself receives many worthwhile suggestions for improving the course. In fact, several problems used in the latter part of the course were suggested by the students.

Assignments are graded as outstanding, satisfactory, or unsatisfactory. Students are encouraged to rework any problems in the last category, because all assignments must be satisfactorily completed to obtain credit for the course.

Problem Solution

One problem suggested by the students, exemplifying the training provided in the exercise of judgment, involves a time-switch clutch assembly that's to be mass-produced.

In the assembly (illustration, left, page 19) the friction between the spring and the washer must be sufficient to cause the shaft, on which the spring is rigidly mounted, to follow the gear without slipping. (The gear is driven by a timing motor.) The operating cycle is adjusted by manually shifting the angular position of the shaft with respect to the gear. And variations in friction torque between the shaft-mounted spring and washer must be held to specific limits. The student is asked to design the spring (center) in such a way that torque variations caused by manufacturing tolerances of the various parts will be minimized.

In this problem the student learns to appreciate that controlling performance characteristics—all critically dependent on uniformity of such properties as mechanical dimensions and coefficient of friction—may be costly, especially

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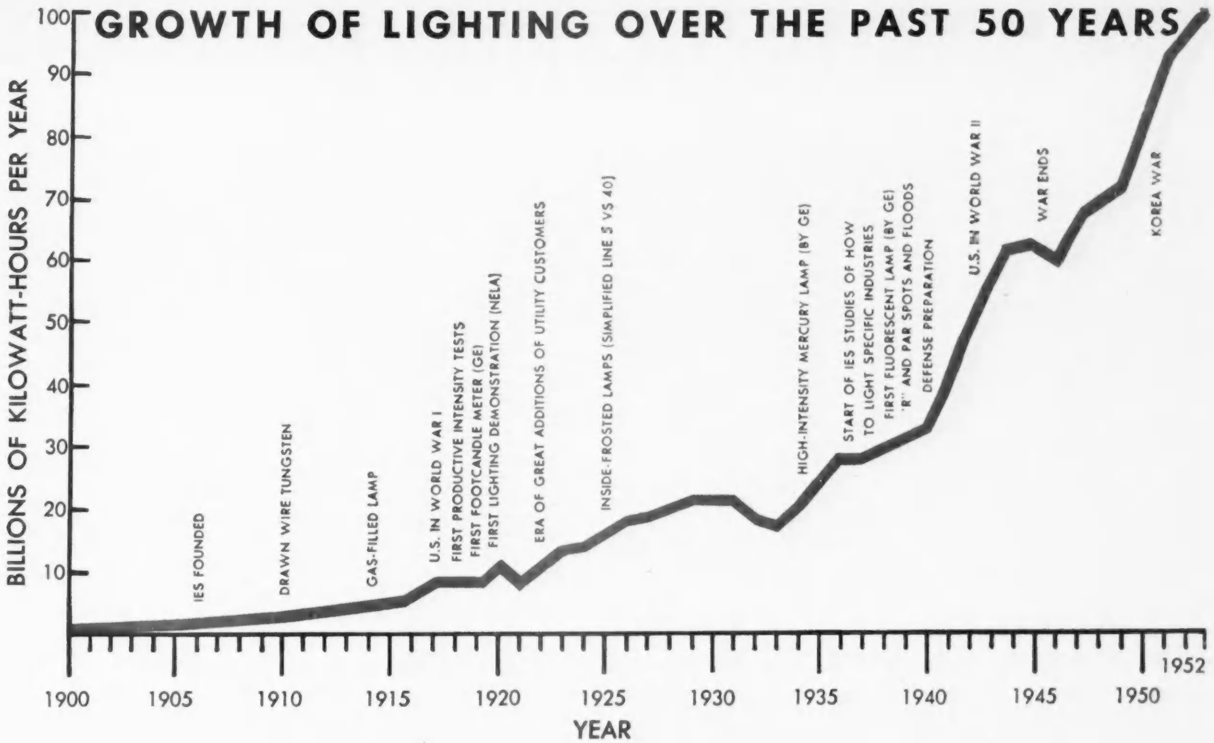

Lighting Progress Accelerates Its Rate of Climb

By WILLARD C. BROWN

In its beginning the vast electrical industry was only an idea. The genius and will of Thomas Edison converted the idea into a lamp and made it a practical fact when he conceived and developed a generating plant and the distribution system. These initial creative acts have grown into a system of power plants—a veritable system of institutions that well represent the tremendous upsurge of industry in the United States.

The central elements of this epic, the lamp of 1879 and its successors, have paced the swift chain of development in our industrial history. Or to put it another way, the foundation that we needed for our growth has literally depended on modern electric lighting—the instrument that has freed us from the limitations of darkness and so multiplied our powers of sight that we have been able to do things and go places our grandfathers could not have imagined.

We are still going places—into areas of achievement even greater in magnitude than we can now imagine, a prediction based on today's large lamp family. Lighting will show us the way with wonderful new lamps, or light sources, that are tailored to a growing array of needs. In recent years some of the most prominent lamps have been developed.

More and More Lamp Efficiency

Forty years ago I chose the lighting business because its heart, the light source, was the most inefficient—10 percent of maximum theoretical efficiency—of all electric devices. We were sure to be able to bring about great improvement and we have: three times the efficiency in just these 40 years. But there is still a long way to go.

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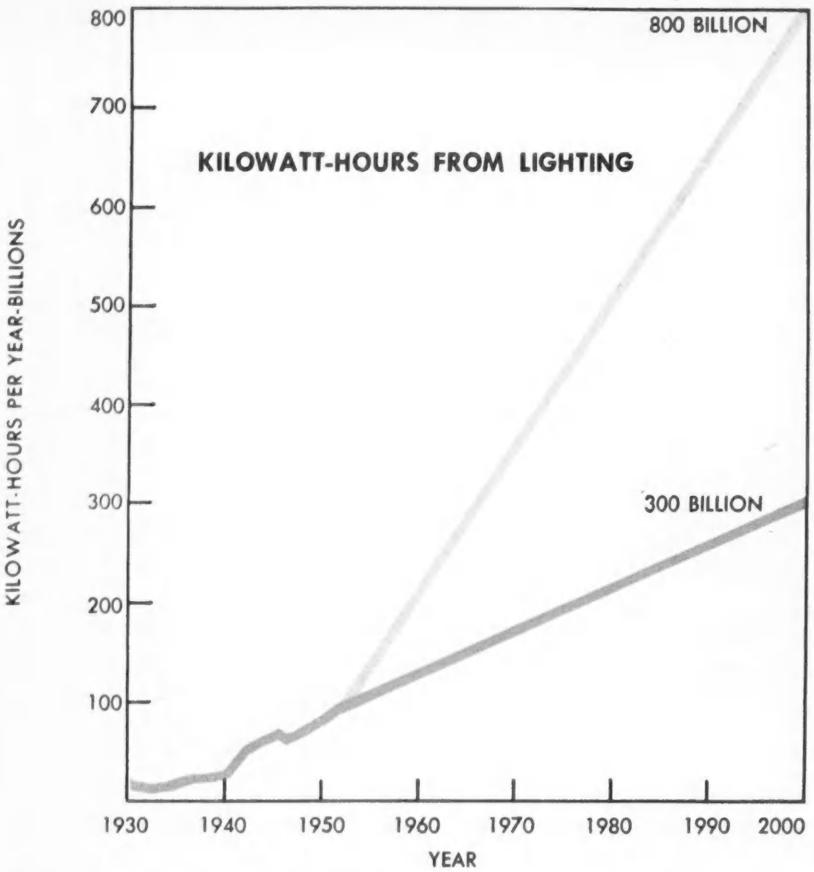
Mr. Brown is Manager of the Application Engineering Department, Lamp Division, Nela Park, Cleveland. In his 34 years with General Electric he has pioneered in many applications of lighting in a wide variety of fields, including automotive, industrial, office, farm, and school.

And epochal gains in efficiency of light production must continue if there is to be a constantly lowered cost of light.

Periodically these great strides in efficiency have caused much concern in some high places that the lighting load would shrink and that progress in the development of electric energy would halt.

Such fears either overlooked or forgot that the public's appetite for light has always grown much faster than the increases in lamp efficiency. The science of seeing has shown how people benefit when more and better lighting is provided for their seeing tasks. Consumers have seized on every advance to satisfy what appears to be an accelerating demand.

To follow our innumerable activities with greater ease and efficiency, with greater comfort and safety, we do need more light. Americans are not content merely to live. They demand to live well. Indications of this attitude are the use of lamps for beautiful lighting effects



PREDICTION—Based on household growth in next 50 years, experts see 300-billion kw-hr consumption. Growth comparable to pre-World War II could push it to 800-billion mark.

and the way that engineering tasks of advancing lighting practice are more and more concerned with comfort and aesthetic satisfaction. Not only is this true in the home but also the railway coach, the restaurant, and the department store—lighted as the architect or designer has planned—subtly employ lamps to please the eye. The modern industrial plant, primarily designed for functional needs, nevertheless seeks appearance refinements in its lighting system.

Your automobile uses many more lamps than it did as little as 8 or 10 years ago. Numerous safety and comfort features built into our new cars depend wholly or partly on improved lighting. Aviation also utilizes the lampmaker's skill to provide pilots, passengers, and airports with illuminations to insure swift, pleasant, and scheduled flying. The family of lamps for this service grows and improves each year.

Today, lamps for photography alone run into hundreds of millions, exceeding the entire output of all large lamps 20 years ago. It's difficult to realize that flash bulbs were then a novelty for the amateur. Now a new flash lamp—so small that a package of a dozen fits into a man's coat pocket—gives a powerful flash that is excellent for most snapshots.

New Applications

For years we have thought of lighting as something for man's activities in homes, stores, streets, factories, and playing fields. But now the curtain is rising on other promising areas. An immense potential market has opened in the application of lighting to the process of photosynthesis. Also, there's a possibility that lighting will become the key to farm-crop control. (See pages 42–46, May 1954 REVIEW.)

In this 75th anniversary year of Edison's wonderful invention, we could cite many other instances of new lamps serving human needs outside the field of general illumination.

But the bulk of lamp use is primarily for light for useful purposes, light to see with.

Past Progress

Let's take a quick review of the progress in light-source efficiency and split the 75 years into three eras.

The first 25 years or so was the period of the carbon and GEM lamps. Efficiencies ranged from 1.4 to some 4 lumens per watt.

The second era was that of the tungsten-filament lamp with more than three times previous efficiency, starting at about 12 lumens per watt and going up to 20, where we are today with the 500-watt lamp.

Presently we are in the middle of the third era—the electric discharge lamp—that started with the 400-watt high-intensity mercury lamp, developed at the G-E Vapor Lamp Company Laboratory nearly 20 years ago. At first it was 40 lumens per watt, double that of the filament lamp, and is now up to 52 lumens per watt in the 1000-watt size. With this efficiency increase, small wonder that the mercury family has blossomed out—first with 250 and 400 watts, then up to 1000 and 3000.

Today we have mercury lamps with color-improving phosphor on the bulb to add some of the red rays that are missing in ordinary mercury-lamp light. And even newer are mercury lamps with their own built-in reflectors for use in high mountings and places where users can't or don't clean their reflectors.

But the announcement in 1938 of the first practical fluorescent lamp was the high spot of the era. This new source, with its essentially white light, jumped from the 20 lumens per watt of the filament lamp to 35. And today's 8-foot slimline lamp is 69 lumens per watt—a far cry from those of Edison's times.

What of the next 25 or 50 years? We still have far to go to increase the efficiency of light production. Although we are just short of 70 lumens per watt, about 220 lumens per watt is the theoretical efficiency for producing white light.

Filament Lamps

Tungsten has the highest melting point of any metal—6120 F. Carbon has a higher melting point (6510 F) but is not so good for filaments because it starts to sublimate long before it melts. And we can't operate tungsten at anywhere near the melting point. If we shorten lamp life, such as in the photoflood lamp, we can get the efficiency up to 38 lumens per watt, but 22 lumens per watt is about as high as we have been able to go for normal lamp life.

New discoveries are being made each day. For instance, the development of jet engines has resulted in many new alloys and materials that tolerate unbelievable temperatures. Who knows when we will hit on other materials that will push the operating temperature of a filament well above that of tungsten? So don't write off the filament lamp, which is actually going stronger than ever; it's just that the fluorescent lamp is growing even faster

Fluorescent Lamps

As you can see, in 15 years we have practically doubled efficiency, largely because of our superior fluorescent powders. And the colors have also improved. Everyone should be familiar with the deluxe lamps that show colors as they should appear: deluxe warm for a filament-like atmosphere and deluxe cool for a daylight atmosphere.

Probably numerous things are ahead in fluorescent-lamp development that we do not foresee. For example, we are already on the verge of higher frequency operation. With 360 cycles and a square-wave shape we can get up to 77 lumens per watt with today's fluorescent lamps, a 12 percent increase. And more of this may be ahead.

Nowadays we hear a lot about electroluminescence. (For a more detailed discussion on this subject, see pages 46–49, July 1954 REVIEW.) Because of its erratic life and low brightness that's difficult to maintain, its development is now in about the carbon-lamp era. Perhaps someday it will give useful quantities of light, possibly illuminating entire walls. But if you really want to speculate on lighting that might exist 50 years from now, why not go farther than luminous walls and light the air—activated, of course, by short-wave energy from central stations? But perhaps I am going too far.

Electric Energy

Let's turn now to electric energy and see where we are today. **How much is** used for lighting?

From government reports we know the number of each type of lamp used annually in the United States. Because we also know the life and the watts of these lamps, we can readily determine the kilowatt-hours required to burn them out. The calculations are more complicated but not difficult for the longer-lived lamps, such as the fluorescent, that do not burn out in a year's service. And we are assuming normal voltage operation. Unfortunately, undervoltage is prevalent here and there. Because two percent undervoltage on a filament lamp would increase the kilowatt-hours over its life some 25 percent, our figures are conservative.

AUTHOR and Mrs. Brown use light in their window valance for decoration and the swing-arm for seeing comfort. (They pay their respects to an older light source on the mantel.)

The illustration (page 21) shows the annual kilowatt-hours for lighting, plus some of the economic and industrial events that have affected the curve.

Lighting represents about 25 percent of the total kilowatt-hours but is one third of utility revenue.

What will the lighting load be in the next 50 years or so? Let me quickly lead you through some forecasts.

First, let's consider population. Using the widely accepted estimate of 175-million people by 1960, we calculate 250 million by the year 2000.

We can then apply various yardsticks to relate the total electric energy from lighting to population. I have chosen to do this by reducing the population to households which today average about 3.3 persons. On this basis we would have 76-million households in 50 years.

Now if the total kilowatt-hours for lighting merely grow parallel with the households, we will have one curve. However, if it grows faster—as it did in the years before World War II partly because of industry's promotional efforts—we will have an entirely different curve (illustration, page 22). The possibilities are colossal, and it is well that leaders in electric utilities are foresightedly planning for the future. For other uses of electric energy will be found in addition to the inevitable new applications as yet unthought of.

There is virtually no ceiling on lighting. In all the larger markets for illumination, the average use is well below the standard of practice. The really advanced installations are years ahead in their contribution to work and living needs—a constant reminder that Americans choose to live well.

Meanwhile the lampmaker's art continues with increasing versatility, stimulated by the spirit of enterprise. Every so often an unsuspected use develops a whole new area of service with lamps.

Lamps have a destiny linked, therefore, with lighting and the ever-widening category of its uses. In this jet-atomic age we are taking Edison's invention into vast new realms of service. And our rate of climb is accelerating. Ω

CHEST Although the chest freezer requires more floor area, it holds more packages and may be used as a counter top.

UPRIGHT Easily fitting into the kitchen, the upright has numerous conveniences, such as roll-out baskets.

Home Freezers—Upright or Chest?

By ROBERT B. FARNON

Ice cream—one of the first foods to be marketed and widely used as a frozen food—differs from what we now call frozen food in that it is eaten in the frozen state. But this important product contributed to the early development and use of low-temperature display cases and local delivery trucks—facilities later utilized by the pioneers in the frozen food industry to display their goods.

These counter-height reach-down cases displayed the product during dispensing; further, the containers did not have to be moved for dispensing purposes. Later they proved somewhat less handy for removal of packaged ice cream.

The earliest food freezers were made from ice cream display cases because the form was somewhat universal, and manufacturers of display cases could readily adapt their tooling to the young business. The open tops with disk covers were replaced with a single flat lid and a refrigerator-door gasket to form the first chest freezer.

A few early manufacturers made upright freezers in the larger sizes, but until 1953 the bulk of production was of the chest type. The merits of the two designs are in continual controversy: Usually the convenience and esthetic advantages of the upright design are pitted against modest technical and practical advantages of the chest type.

The chest freezer will hold more packages than the upright because to be usable the volume of the upright must be divided by shelving. But the upright presents more of the packages to view for identification, and removal is easier because of the location of the relatively greater access area. On the next page you'll find a list of the most controversial points.

During the infancy of the freezer industry, the practical considerations of the chest design outweighed the commercial advantages of the upright design.

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Mr. Farnon—Engineering Supervisor in the Specialty Refrigeration Products Department, Major Appliance Division, Erie—began his career with GE in 1943. Formerly with the Food Freezer Cabinet Unit, he is now working on room air conditioners.

Thus most manufacturers relied on the chest freezer to fill out their product line.

In the last few years, however, there has been considerable agitation to utilize the natural advantages of the upright design. Engineers have designed around its disadvantages so that the customer may enjoy not only the services it offers but also the many convenience features that can be built into the upright plan. Their design constitutes one of the extra engineering problems encountered in the over-all design of an upright freezer.

These major freezer problems—convenience features, door seal, refrigerant tube seal, liner mounting, evaporator design, sweating, power consumption, frosting rates, and noise—have been complicated or created by the upright freezer and are here discussed in detail.

Convenience Features

To fully justify the engineering effort necessary to compensate for the inherent complications of the upright design, it became apparent that engineers would have to exploit this freezer's natural advantages: more special features can be built in, smaller floor area required allows freezer to be located in the kitchen, and large access area.

Because of the upright's position and general layout, more features can be built into it. The door lends itself to food storage because its closed position is in the same horizontal plane as its open position. Packages located in the door are easily identified, removed, and stored.

This space also lends itself to special designs that accommodate a particular kind of package, such as frozen juice cans and packaged ice cream. To make spooning easier, you can keep ice cream at a slightly higher temperature by using the pocket in the inner door. Use of a perforated combination door and baffle in front of the pocket is one way to control the cool convection air currents and to create only a small increase in the heat leakage in the cabinet.

The cabinet interior adapts itself to the use of rolling baskets: lower space in the upright is more accessible by rolling the packages out for easy identification and removal. Somewhat the same function is served by the combination sliding-shelf dry-freeze tray and sorting shelf. This tray can be used to individually freeze such foods as peas. Vegetables frozen dry do not stick together, and you can use as much at one time as you want.

The small floor area consumed by the upright freezer makes it desirable for kitchen placement and thus handy to use. In this location you can live out of it instead of hoarding food in it—a common practice when the freezer is not convenient to the kitchen—as consumer surveys indicate. Unfortunately, many freezers are located in out-of-the-way places, filled during harvest season, and emptied only during the winter. To use a freezer most efficiently, buy your food when the price is right, store it in the freezer—best located in or near the kitchen—and use it continually.

DISTINCTIVE POINTS IN FREEZER STYLES

UPRIGHT FREEZER	CHEST FREEZER
More food is readily accessible.	Holds a little more food for the same volume.
Allows use of shelves to increase freezing surface.	Not as much cold air spills with each lid opening.
Less floor area required.	Interior frosts up more slowly because less air is transferred with each opening.
Features are easy to build in to make freezer more convenient.	Lower cabinet height reduces potential temperature gradients both inside and outside.

Door Seal

The door seal of the upright food freezer was one of the first problems encountered. The design was assumed to be more critical than on an upright refrigerator because of the greater temperature differential and because of the actual temperature in the freezer—around 0 F. The greater temperature differential would tend to circulate outside air through an accidental gap in the door seal. In a refrigerator this leak would result in a small heat pickup, causing moisture to collect in the form of frost on the evaporator, higher power consumption, and more frequent defrosting. In a freezer there would be a greater heat pickup for the same gap in the door seal, with moisture depositing as frost on the first surface below 32 F. Later it would move more slowly to colder evaporator surfaces. Thus a frost deposit would tend to build up at the edge of the liner, on shelf fronts, or even between the breaker strips and the inner door. This build-up of frost would possibly increase the gap in the door seal and lead to greater difficulties.

The door seal also was assumed to be more critical than on a chest freezer because of the chimney effect. If there were two gaps in the door seal of a chest freezer, no pressure head would be on either of the gaps because they would occur at the same elevation and temperature. In the seal of an upright freezer these same two gaps would probably occur at different levels, and a circulation of air would result as the cold air spilled from the lower gap and was replaced by warm, moist outside air at the upper gap.

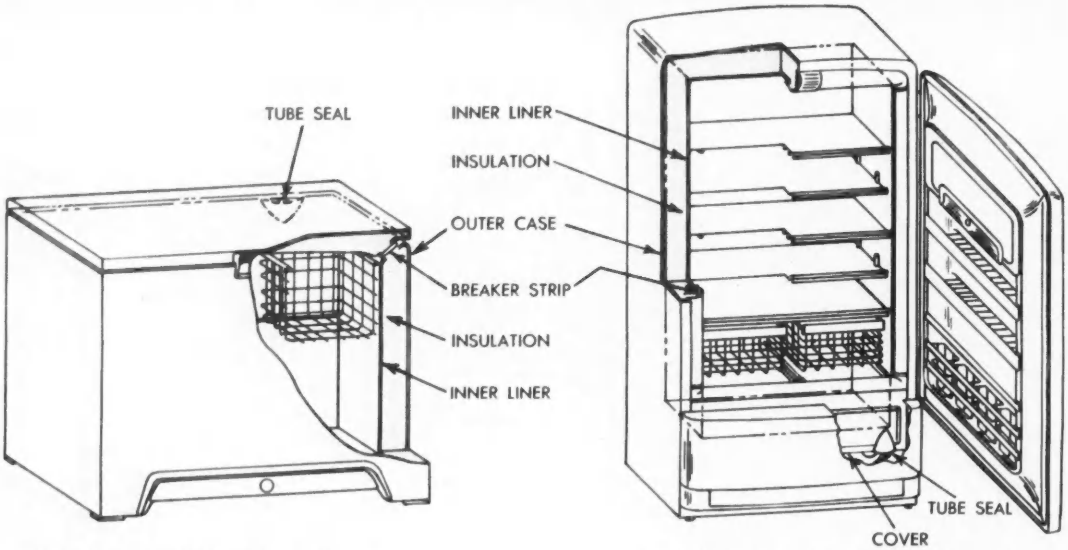
All these factors prompted us to improve the door seal in the upright design. To achieve this, we developed a new latch design—one that would produce a positive pull-up of greater force over a greater distance. In conjunction with a new gasket design utilizing a new material, this overcame the resistance of the high points between the door and the case and enabled the gasket to fill in the low points.

Refrigerant Tube Seal

A food freezer is essentially a food-storage device. Experiments show that significant temperature variations throughout the freezer or temperature variations between the OFF and ON time of the refrigerating mechanism impair food quality and appearance. Thus the refrigeration tubing must be as evenly distributed as possible. This results in an evaporator as large in size as the liner, making a back-mounted unit undesirable. (The illustration on page 26 shows the various parts of the two types of freezers.) A full-size back opening would have to be closed at final assembly, involving costly gasket construction to seal the entire back. But the hazard of moisture leaks that could impair the function of the insulation would still exist. So the upright freezer was designed around a front-assembled liner. A new seal design differing from the chest-type seal—because of the different sealing planes and the gasket location—was required for the entry of refrigeration tubes into the cabinet. On the chest freezer the gasket is attached to the tube seal side, making a semipermanent gasket seal. On the upright freezer it is attached to the door, and sealing action over the tube seal plate occurs each time the door is opened and closed. The tube seal plate was combined with the cover plate to limit the amount of sealing area. Because the liner is longer than the door, the cover plate must be added at final assembly to provide a seal for the door. Front-mounting was thus obtained with no increase in the number of potential gasket leak points.

Liner Mounting

Our desire to make the upright freezer a kitchen model with improved appearance led to the use of contoured thermoplastics breaker strips. Because these



G-E 11-CUBIC-FOOT CHEST FREEZER

G-E 15-CUBIC-FOOT UPRIGHT FREEZER

strips would not carry the weight of a full food load, separate liner supports were located at the front and the back of the liner. (A liner when loaded can carry as much as 40 pounds per cubic foot. Thus in a 14-cubic-foot freezer the food can weigh as much as 560 pounds.) The back supports carry part of the food load and prevent the liner from tilting back under load and damaging the breaker strips. The rest of the load is carried by the front supports that position the front of the liner with respect to the outer case. The breaker strips may then be assembled without undue strain. The front supports must have sufficient strength and wheel base to position and hold the liner but still not have enough cross section to conduct sufficient heat to cause sweating on the outer case. Sweating is no problem on the back supports; heat from the natural-draft condenser keeps the temperature of the back above the sweating temperature. But this condenser heat puts a premium on the quality of the back insulation, requiring that the liner supports disturb it as little as possible.

Evaporator Design

The average storage temperature in a freezer must be kept at 0 F. For most foods the value of lower temperatures has not been proved, but unacceptable rates of food deterioration do occur with higher temperatures of only 5 to 10 F. At or below 0 F, the variation of temperature from OFF to ON in the compressor cycle is important. Too large a variation in the storage temperature tends to pull the moisture out of the food when the temperature goes down. This moisture deposits itself on the inside of the packages. When the temperature rises, before the next compressor running period, this moisture does not return to the food. Further cycles cause a gradual but definite drying. The upright freezer, because of its greater height, has a greater potential temperature-variation problem than does the chest freezer—a problem overcome by providing five prime refrigeration surfaces: top, bottom, and three shelves. The surfaces near the top are much closer together than those near the bottom. More refrigeration is thus concentrated at the top where it is needed to counteract the natural convection inside the compartment. This increase in the amount of prime refrigeration surface in relation to the refrigerated volume results in a very low temperature differential between the refrigeration tube and the air, and thereby reduces both drying out of food and power consumption necessary to hold a 0 F average cabinet air temperature.

Sweating

The added height of the upright freezer creates a greater sweating problem. As already pointed out, the warm air tends to collect at the top of the food-storage space, and the cold air at the bottom. In a chest freezer the insulation is most efficient near the bottom because a door doesn't open with its attendant source of heat conduction. Not so with the upright: the door opening extends the full height and is adjacent to both the lower and upper temperature areas.

The warm air of the room gets colder as it contacts the cooler cabinet exterior and tends to drop to the floor where its temperature is reduced even more. This air, plus the inside air near the bottom of the freezer, appreciably reduces the outer-case temperature at the bottom of the door opening to below that of the outer case near the top of the door opening. Thus there's a greater tendency for the lower part of the upright cabinet to sweat than there is for the chest type at any point near the lid opening. To achieve a similarity in design between the upper and lower halves of the upright cabinet, all the supports, liner details, and inner and outer doors are designed around the sweating requirements at the bottom of the door opening.

To reduce this tendency to sweat, the outer-case temperature was raised by increasing the thermal resistance between the outer case and the liner. In comparison with the chest type, a longer

TEXT CONCLUDED ON PAGE 60

HOW MUCH DOES IT COST WHEN YOU OPEN THE DOOR OF YOUR FREEZER?

The upright door, while providing a large access area, increases the potential transfer of warm moist air into the freezer during a door opening. When the freezer is full of food, this effect is minimized because there is less air to be transferred. But the effect is theoretically increased by the greater number of door openings probable on an upright freezer located in the kitchen.

The amount of heat transferred by both the air and the water vapor can be calculated by assuming a room temperature, a moisture content, and a food load. For an empty 15-cubic-foot freezer in a 90 F room with 75 percent relative humidity, the heat gain is approximately 60 Btu's per door opening. Tests can determine the effect of door openings on the power consumption of the upright and the chest. But the major problem remains: how can we duplicate the conditions under which the freezer will actually be used? Engineering models of new freezers are tested in actual homes as well as in our laboratory. The comparative data presented here were obtained from tests of G-E 14- and 11-cubic-foot freezers. The curves show the power consumption per month (30-day period) as a function of the door openings per month.

The two marks on the left ordinate show the average power consumption of a number of these freezers under laboratory conditions of 90 F ambient temperature and 0 F cabinet temperature, with no door openings. On consumer test, chest and upright freezers were separated and further segregated as to location in the home—in either a heated or an unheated area.

The light blue curve shows that with 75 door openings per month in an unheated area the upright freezer uses approximately 52 kw-hr per month, whereas the chest freezer uses about 45 kw-hr per month as indicated by the gray curve. In addition, these curves point out that when both types are located in heated areas, closer to the living quarters, the upright freezer is opened more often than the chest freezer at about the same power consumption. They further indicate that at a door-opening schedule of 75 per month the power consumption of the upright would be *less* than that of the chest type.

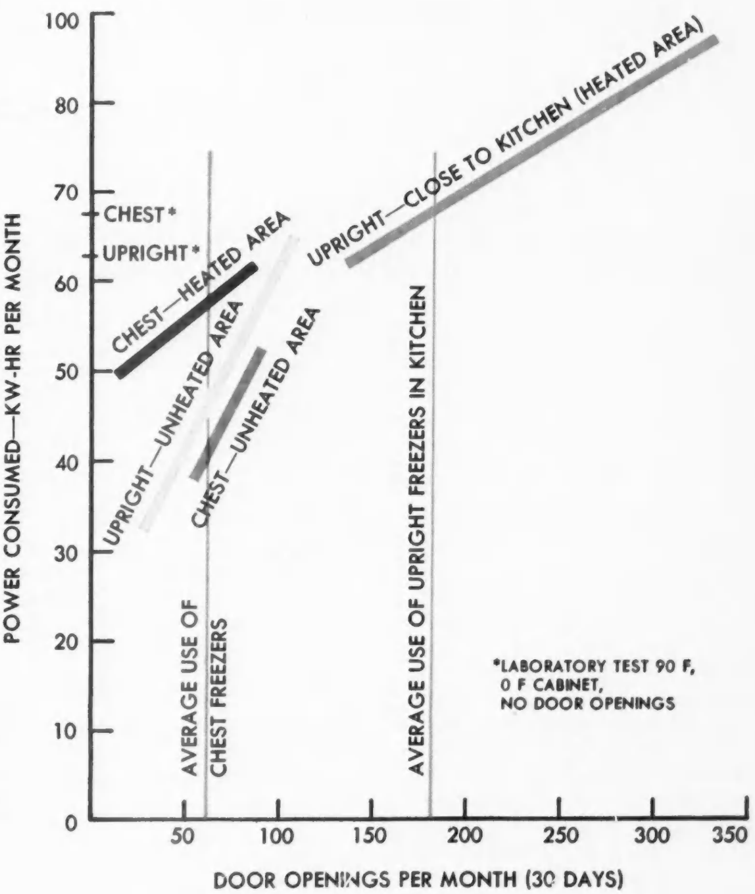
Another factor is the different duration of door-opening time for a chest and an upright. The upright in a convenient location is opened for only a short time because packages are easily removed. The chest freezer even in a convenient location is left open much longer each time just to retrieve the packages from under the baskets or under the top layer. The bright blue curve indicates, however, that the upright freezer in a convenient area can be opened about 150 times without consuming any more power than a chest freezer opened 75 times (black curve). But for the average number of door openings for upright freezers (184 per month) and chest freezers (60 per month) in heated areas, the upright freezer uses about 67 kw-hr per month and the chest freezer 58 kw-hr per month.

When the two freezers are opened about the same number of times because of an inconvenient location, the upright uses about 7 kw-hr more per month. Based on a power rate of 2½ cents per kilowatt-hour, this would amount to an increased operating cost of 17½ cents per month—certainly not enough to justify the purchase of one type of freezer over the other.

In an inconvenient location the upright is probably open as long each time as the chest because you want to accomplish as much as you can each trip. For example, you generally remove enough food for a whole day's meals during one door opening, and this could take almost as long in an upright as it does in a chest freezer. Therefore, the increased air spillage of the upright is probably responsible for a large part of the 17½ cents more power consumption. Even in five years this amounts to only about $10 and is hardly the basis for selecting a freezer.

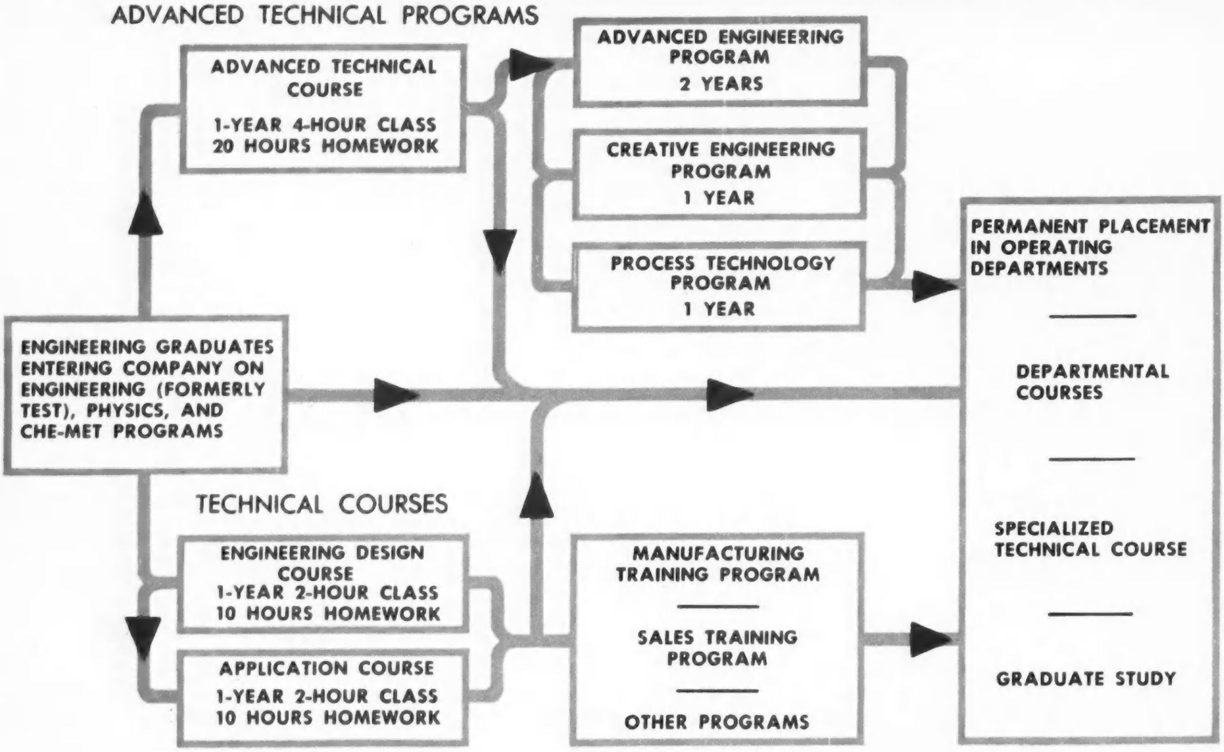
This is true especially when you consider that as the freezers are brought closer to the living quarters, the usage of the upright freezer changes, and it is no longer feasible to make a direct door-opening comparison between the upright and chest types. The only conclusion that can be made is that the upright in a convenient area is opened about three times more than the chest type and in the process uses about 15 percent more power.

Although theoretical calculations and laboratory tests indicate that the upright gains more heat per door opening than the chest type, actual use tests show that other factors—such as location and number of door openings—have a greater effect on total power consumption.



UPRIGHT FREEZER in a convenient area is opened about three times more often than the chest type and in the process uses about 15 percent more power.

EDUCATIONAL ENGINEERING PROGRAMS AT GE



New Course Emphasizes Unique Problem Approach

By L. W. WARZECHA

Industry has long felt the need to provide further educational training for men who have already obtained their engineering or scientific degree.

The reason is simple: The college graduate has generally received a good basic education, but he sometimes has difficulty applying this knowledge in the solution of actual engineering problems. For example, he may have taken a curriculum of study that included electric circuits and machinery, mechanics, fluid mechanics, heat transfer, and thermodynamics. And yet he may experience difficulty in applying this knowledge to an engineering problem involving fundamental physical laws in all these fields. In engineering work it's not uncommon to find many kinds of technical knowledge involved in a single problem such as you would encounter in the design of a magnetic relay, electric fan, welder, jet-engine control system, or almost any other system or device.

To aid the engineering graduate in developing an approach to the solution of engineering problems, we recently organized the Advanced Technical Course for presentation to our new engineers, primarily for members of the Engineering (formerly Test), Physics, and Che-Met Programs. On these training programs, men obtain work experience in a variety of engineering assignments.

Selection and Organization

Each summer, upon application, members for the Advanced Technical Course are selected from among all members of the three training programs. A few qualified engineers from operating departments are also selected each year, with the approval of their department managers. Selections are based on technical ability, character, personality, and initiative, plus interest in and suitability for this type of training and the work that it equips the men to do. The course is designed primarily for men interested in design and development work, but it is also helpful to men going into application, sales, and manufacturing.

Each year the Advanced Technical Course is offered on a synchronized schedule in all the major plant locations of the Company. This permits a class member to transfer from one location to another during the course, thus giving him an opportunity to become acquainted with the various types of work and the various products manufactured. In this manner he is better able to

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Company-wide Supervisor of the Advanced Technical Course, Mr. Warzecha is located in Schenectady in the Technical Education Services Section. He joined General Electric on the Test Program in 1948.

choose the product department where he will later begin his career. And so an opportunity is provided for him to apply, on a variety of engineering assignments, the techniques he is learning in the course.

At the conclusion of the Advanced Technical Course, the class members, aided by the class supervisor's counsel and guidance, choose a subsequent educational course or program. Future educational option selections are thus made on the basis of actual performance in the first year. The options available and their length are: Advanced Engineering Program, 2 years; Creative Engineering Program, 1 year; Process Technology Program, 1 year; or permanent placement in an operating department.

The relation between the Advanced Technical Course and the other courses and programs open to new engineering graduates is shown in the illustration on page 28.

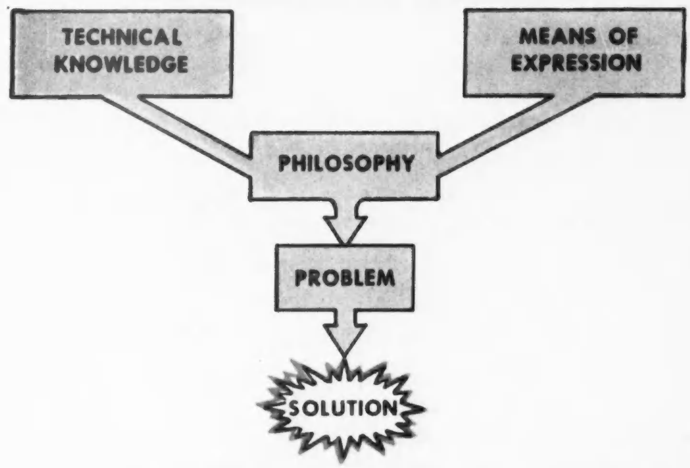
Classroom and Homework

Beginning early in the fall, the course extends for 34 weeks. Class sessions normally meet for four hours weekly during regular working hours. Class time is devoted to lectures and discussions on new subject material and discussions of homework assignments. To accomplish the development of a sound technical understanding in such typical fundamental fields as dynamics, vibrations, fluid mechanics, heat transfer, statistics and probability, and materials, graduate-level technical material is presented. And the emphasis is on such things as understanding of the physical picture involved, practical aspects, order of magnitude, and engineering horse sense.

Lectures are given by authorities in the various fields under study. The class supervisor is a graduate of one of the advanced technical programs; he has considerable engineering experience and knowledge of the Company and its products. He spends a large amount of time counseling and helping individual students with class work and applying their new knowledge to the work of their training-program assignments.

Each week, homework assignments are given that require about 20 hours of preparation time outside of working hours. Most of these assignments involve problems actually encountered by some engineering section of the Company in the course of its business (see the typical weekly homework assignment on page 30). These assignments have proved

ELEMENTS OF A PROBLEM



EIGHT-STEP PROBLEM APPROACH

A good approach to the solution of engineering problems is of utmost importance to any successful engineer. Here is a formalized approach consisting of the eight basic steps necessary to the solution of any problem . . .

RECOGNITION	Recognize the unsolved problems that exist around you. Constructive discontent is very helpful in this area.
DEFINITION	Determine what the specific problem is that you can undertake. You must decide what portion of the problem you will solve, what assumptions you can make, and what specific results you desire. Here you make your investigation of the problem and set the specifications on the solution. Your technical understanding plays an important part in this phase.
SEARCH FOR METHODS	Apply your creative imagination to ascertain what methods may possibly be used to arrive at the desired solution. Such techniques as brain-storm sessions are extremely helpful in this area; several people try to generate ideas that are possible solutions. In such a session an attempt is made to suppress judicial thinking while creating ideas, their merits to be judged later.
EVALUATION OF METHODS	Evaluate the various methods under consideration, using such things as analysis, experiment, and testing.
SELECTION OF METHOD	Compare your evaluations and choose the method that seems most desirable.
PRELIMINARY SOLUTION OR DESIGN	Make a preliminary design or solution, using the method you have chosen.
INTERPRETATION OF RESULTS	Interpret the results of your preliminary solution as a check point before completing the solution or design. At this point your original specifications may be altered somewhat.
DETAILED SOLUTION OR DESIGN	Perform the necessary follow-through action, as dictated by your interpretation of results, such as the detailed solution or design.

HOW WOULD YOU SOLVE THE PROBLEM OF THE BUTTER CONDITIONER?

A Typical Advanced Technical Course Homework Assignment

We have all experienced the difficulty of spreading hard butter on a piece of fresh bread, and likewise we have experienced the unsatisfactory taste of warm, greasy butter. These two extreme conditions prompted the Household Refrigerator Department to install in some of their deluxe models a "butter conditioner." This device maintains the butter at spreading temperature which by test has been found to be 60 ± 5 F.

The present design (Fig. 1) consists of a compartment capable of holding one pound of butter in a conventional butter dish. This compartment is deep drawn of 0.040″ aluminum and is installed in the door of the refrigerator. A thermostatically controlled heater is installed in the bottom of the compartment. The heater is a simple enclosed resistance-type heater.

This butter conditioner has a compartment-ambient characteristic similar to that shown in Fig. 2 when the thermostat is set to hold 60 F in the compartment.

When the room ambient exceeds a certain amount, the heater no longer operates and the temperature in the butter conditioner starts to increase because of heat leakage through the insulation.

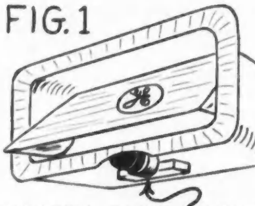
We would like to know the lowest wattage heater that is required to maintain the butter-conditioner temperature for room ambients as low as 60 F.

The initial cost of a heater and thermostat and the associated wiring is high. Assuming that the ambient always surpasses good spreading temperature and the cabinet air temperature is always less, it appears that some method of controlling the heat leakage could be used to maintain a butter conditioner temperature that is adequate.

Some of the systems proposed to do this give a characteristic as shown in Fig. 3.

This is not completely satisfactory, for the ideal would be a horizontal line. The question at hand is: How can the heat leakage be controlled so that the slope of the butter conditioner temperature-ambient temperature characteristic is decreased?

FIG. 1



HEATER, THERMOSTAT AND CONTROL KNOB

FIG. 2

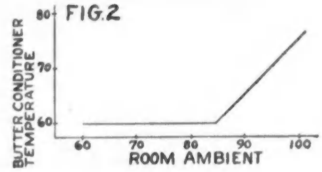


FIG. 3

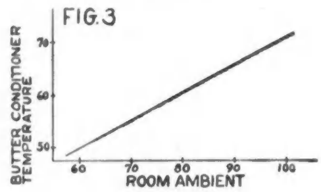
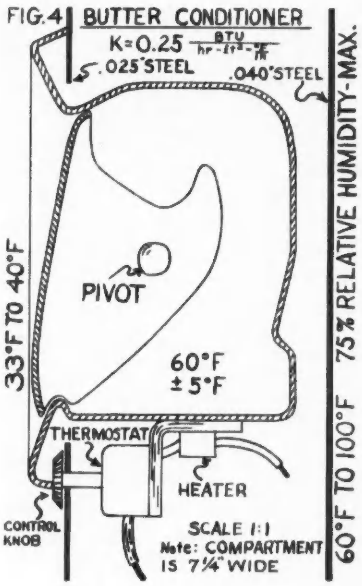


FIG. 4



There may be other ways of keeping butter at the right temperature. What suggestions can you make along this line?

For next week, the Advanced Technical Course is asked to look into some of these problems that face the refrigerator design engineers. Determine the power requirements necessary to keep the butter at good spreading temperature and investigate other methods of storing butter for table use.

to be a valuable part of the learning process of the individual class members.

Problem Approach

The procedure for solving problems is interesting, and it is one of the fundamentals of the Advanced Technical Course.

Let's consider the question: What is necessary for the solution of *any* problem, whether in the field of engineering, human relations, accounting, or manufacturing?

The three basic elements are: technical knowledge, means of expression, and philosophy. (Their relationship is shown in the illustration on page 29.)

Technical knowledge essentially is the general background of the area you are studying or applying. Perhaps in a problem of an engineering nature, it might be the actual technical material, whereas in a problem of human relations, it might involve some experience or familiarity with human-relations situations and how they are handled.

The second area is the means, or modes, of expression—the devices you use to express your technical knowledge and understanding to others and to express that knowledge, nature's laws and behavior, to yourself. That is, you use these various means of explaining to yourself and others what you actually know. They might include oral and written presentations and sketches. In the engineering field, mathematics is an important means of expression.

The third major area is what we term "philosophy." It includes the problem approach, in addition to such things as your general attitude and outlook—whether you are a man who is naturally discontented with what you see around you or a man who is observant of what exists around you. Philosophy is the only word that really describes it. And it is in this area, we find, that the young people coming out of college are weakest.

It's the problem-approach area that receives the most emphasis in the Advanced Technical Course. By problem approach we mean an organized approach, or method, for the solution of problems. An eight-step approach (see page 29) is presented in the course. We

USING THE PROBLEM APPROACH TO SOLVE BUTTER CONDITIONER PROBLEM

RECOGNITION—The problem has been recognized before being presented to the class.

DEFINITION—The problem definition can be considered in four basic steps. . .

Initial word statement—An initial statement of the problem is given in the written problem statement. Ordinarily this serves to insure that you and the boss have agreed on what you are trying to determine from your study.

Initial specifications—Several important initial specifications are included in the written problem statement. Consider that there may be others, such as cost and space limitations.

Investigation—Study the butter conditioner intensely, using any analytical or experimental techniques you feel necessary. For instance, you may study the heat flow around the butter-conditioner unit by making a "small squares flux plot" or by making a quick calculation of the heat lost. On the other hand, you may desire to build a model and perform a calorimeter test. With any method, from this phase you determine the power required and the heater wattage rating.

Modify initial specifications—From your investigation you have learned certain information that permits you to make modifications of your initial specifications. For example, you may learn that the present size or spacing of the butter conditioner are inadequate. You will later judge your results on the basis of these final specifications.

SEARCH FOR METHODS—Now you consider other possible designs of the device: How about a moving door controlled by a thermostatic spring? perhaps a set of louvers controlled by a thermostat? or could you let warm air in from the outside by varying the insulation properties in some way as a function of heat required? List as many ideas as possible so that you have a maximum chance of thinking up a really good one.

EVALUATION OF THE METHODS—Develop each idea a little farther so that you can begin to judge it's worth. Ask yourself: What are the good points of each? how is it better than the others? Also consider the disadvantages of each.

SELECTION OF METHOD—Choose the design of butter conditioner that seems most promising for further development. You must choose a method that will fit the final specifications set down earlier.

PRELIMINARY DESIGN OR SOLUTION—You now further develop your chosen design. Determine such things as shape, size, weight, and cost. Draw a detailed sketch. Make certain that it can be manufactured with available facilities. Determine the changes that will be necessary in the current manufacturing technique.

INTERPRETATION OF RESULTS—Critically appraise your preliminary design: Does it meet your specifications? will it maintain the required butter temperature? is it too expensive to produce and market? is your design—the best solution you have found—really better than the present design? is the idea really worth more effort? If so, continue to the next step.

DETAILED SOLUTION OR DESIGN—Complete your design, preparing it for manufacture. Remove the last few bugs that you discovered during your recent interpretation of the results of your design.

(In this solution we have applied the problem approach in a step-by-step fashion. In some problems these steps might be arranged in a different manner. For example, after performing your interpretation of results, you may find that you must again modify your specifications because of new information learned. If so, you may have to revert back to the third step, search for methods, and follow through the succeeding solution steps again.)

HERE'S THE SOLUTION CHOSEN FOR PRODUCTION

In solving this homework problem, the Advanced Technical Course class did not have the responsibility to choose a solution or make a decision. The refrigerator engineers responsible for the design made the following design changes. . .

1) The butter-conditioner case could be made entirely of plastics.

2) For some refrigerator models the design specifications were changed to provide slightly broader limits of allowable temperature variation. This permitted a design with no heater. A design was evolved that, by proper control of cabinet heat leakage, allowed heat to be supplied to the butter conditioner from the external ambient air.

3) In some models where more definite temperature control was necessary, the heater was retained, with a new design resistance heater being used.

recognize that an individual, after he completes the course and even while taking it, will develop his own variation of this approach, using a slightly different one for each problem he faces. However, these eight steps are a fundamental skeleton approach that can be adapted to any situation confronting the engineer. And it applies to small and large problems equally well. Frequently, the larger problems are resolved into several smaller ones, each being solved by application of the eight-step approach.

(An example of the application of the problem approach to the solution of a typical homework assignment is given above.)

The homework on the problem-approach phase of the class member's philosophy consists of a balanced series of readings, exercises, experiences, and other specialized techniques. One of these techniques is the "individual investigative assignment." Each man is given a new, but as yet unsolved, problem to work. He must perform an intensive investigation and make recommendations for future action. In working such an assignment, the young engineer really learns to apply his technical understanding by means of his problem approach for the solution of real engineering problems. The class members learn by doing—the basic thesis of GE's training programs. In the area of technical material, major technical problems are assigned each week for homework to provide experience in the actual application of the principles and techniques studied in class.

The End Result

Some graduates of the Advanced Technical Course are chosen to continue their educational training in further advanced programs. Others assume full-time engineering responsibilities in the operating departments, wherever problems arise sufficient to challenge engineers with this high level of training.

They have a firm, broad, technical understanding and an excellent approach to problems encountered in design or development engineering. These men are trained to organize their work and time and to solve their problems quickly, accurately, and effectively. Ω


GENERAL ELECTRIC

Steel-mill installation rehearsed to speed costly change-over

World's record holder for monthly bloom tonnage, a 41-year-old blooming mill was changed over last year to all-electric drive—and went on to set a new record. A maximum of 10 days was allowed to dismantle the original steam-engine drive, rebuild the foundation, and assemble the electric drive. But it took only 7 days, 14½ hours. Here's how:

A wooden scale model of the motor drive was built for piece-by-piece assembly. Using this, G-E application engineers, working closely with the customer, planned steps needed to install the new drive. The drive-regulating system was studied on an electronic computer to predetermine electric equipment design. Finally the electrical system was engineered so all electric equipment except the motors could be installed and tested *before* the old drive was shut down.

Application Engineering like this is one of many engineering services available through General Electric. G-E Product Development, Analytical Engineering, and Project Co-ordination assure that you will receive the right equipment properly applied and installed on schedule. Field-Service Engineering and Maintenance Service help protect your equipment investment throughout the equipment life.

Whether you are a *direct user* of electric equipment or whether you *incorporate electrical components* in your product, your G-E Apparatus Sales Representative can put these engineering services to work for you. Contact him early in your planning. Meanwhile, for the full story on G-E engineering services, write for brochure GED-2244 to General Electric Co., Section 672-14, Schenectady 5, N. Y.

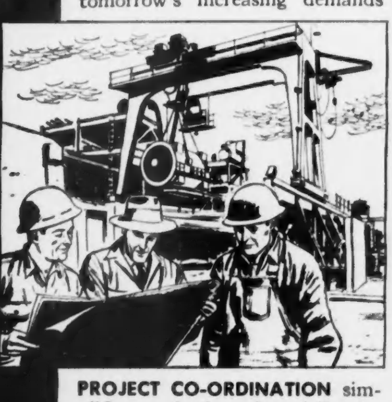
GENERAL ELECTRIC

THESE G-E ENGINEERING SERVICES HELP PROTECT YOUR EQUIPMENT INVESTMENT

PRODUCT DEVELOPMENT provides improved equipment to meet tomorrow's increasing demands

APPLICATION ENGINEERING combines latest products and techniques into efficient electrical systems for your specific needs

MAINTENANCE SERVICE helps keep your plant electric equipment operating at peak efficiency



PROJECT CO-ORDINATION simplifies purchasing, plans deliveries to speed construction schedules

FIELD-SERVICE ENGINEERING facilitates equipment installation, expedites start-ups, helps train personnel for proper operation

ANALYTICAL ENGINEERING solves complex system problems, cuts time used in system design

INSTRUMENT SOCIETY of AMERICA

By PORTER HART

Of all the advancements that have swept American industry during and since World War II none are more challenging or promising than the trends in instrumentation. Industry trusts instruments because they have been designed to measure the innumerable operating factors leading to supervisory control by making the adjustments for general operation.

Today, machinery and processes must be designed and built for automatic control so that their operations will produce the maximum safety, productivity, and quality of product. This is instruments' contribution to a sound economy.

Accompanying these trends to instrumentation has been the vigorous growth of the Instrument Society of America. Its objective is the development of the arts and sciences that are connected with the theory, design, manufacture, and use of instruments in science and technology. The Society provides a common meeting place for educators, executives, designers, researchers, engineers, and instrument men and leaders to band together for coordinated information sources of common interest.

National Organization

Wartime emphasis on instrumentation in scientific, industrial, and military applications stressed the need for an organization in which to discuss the advancement of the common interest in measurement, testing, and control. In nearly a score of the nation's principal cities, people with these interests began to form local societies under a variety of names and organizational patterns.

With the end of the war in 1945, industry looked forward to a full-scale application of the instrumentation techniques that had been spurred on by military needs. Significantly, the ISA—the first nationwide organization of scientists, engineers, technicians, and instrument men representing the users and builders of instruments—was even then in its first phases of formation.

Following organizational meetings of these local societies in New York, Chicago, and Pittsburgh, the formal organization of the ISA was completed in 1946. At the time of its first conference and exhibit in Sept., 1946, the Society was composed of 21 sections and 1075 memberships. The first officers were President, A. S. Sperry, now President of the Panellit Corporation; Vice President, Carl Kayan, Professor of Mechanical Engineering at Columbia University; Secretary, Richard Rimbach, President of Instruments Publishing Company, Pittsburgh; and Treasurer, Clark E. Fry, Instrument Engineer for Westinghouse Electric Corporation.

The Instrument Society of America is incorporated as a nonprofit organization under Pennsylvania laws. Control and management of its affairs, property, and funds are invested in the Council made up of delegates representing each ISA section. The voting power of each delegate at the Council's meeting is weighted in accordance with membership of the section he represents.

No review of ISA's formative years could be complete without special acknowledgement of the services and support given by Richard Rimbach. As President of the Instruments Publishing Company, he was an early and constant advocate of an organization for all those working with instrumentation.

Moreover, Mr. Rimbach gave generous physical and financial support to the new group by serving without recompense as ISA's Executive Secretary until 1951 and as the first Exhibit Manager for a two-year period. Also, in the early years his office served as the Society's national office. The ideas he brought into being for the National Conference are of even greater importance to the ISA.

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Mr. Hart, Past President of the Instrument Society of America, is associated with the Dow Chemical Co., Freeport, Texas.

Mr. Rimbach is also Managing Director of the Society's first International Instrument Congress and Exposition convening this Sept. 13-25 in Philadelphia. Preparation included a European trip, which he and I took together, visiting various instrument centers. Result: more than 60 foreign firms will show their instruments at the international show.

Membership

Membership in ISA is open to both individuals and corporations having an interest in instruments. Any person subscribing to the objectives of the Society may be admitted as an individual member. Those interested in instruments but having other fields as their primary interest may become Associate Members. Persons living outside the United States or its possessions, Canada, Mexico, or the areas included in the foreign sections of ISA, may join as Foreign Members.

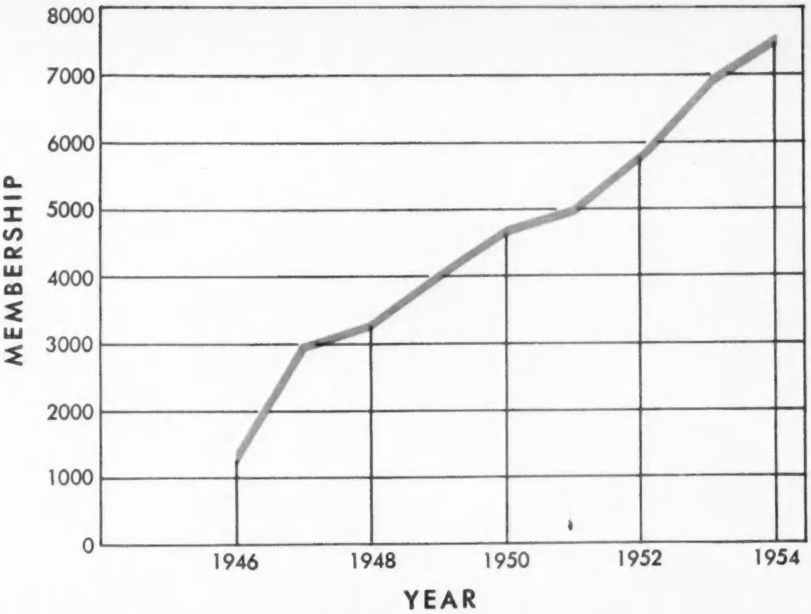
Student Membership in ISA is open to those studying for and planning on entering instrument work. Both full-time students and apprentices in the first two years of an organized instrument apprentice course are eligible for such memberships.

Corporate Memberships are available to corporations wishing to contribute to the welfare of the Society. Each Corporate Membership appoints a representative to the Society.

Honorary Memberships recognize outstanding individual contributions to the arts of instrumentation. Nominations made by any member of the Society must be in writing and require the endorsement of 10 other members. A majority vote of ISA's Council is necessary for election.

Local sections form the basic unit of ISA's national organization. In June, 72 active sections had a total membership of 7348—including one in Aruba, Netherlands West Indies, and 83 Foreign Members.

Each of these sections takes an active part in the government of ISA by elect-



MEMBERSHIP CURVE OF ISA INDICATES RAPID GROWTH OF POSTWAR ORGANIZATION.

ing one of its members plus an alternate to serve on the Council. In addition, Council delegates from all sections within each of ISA's seven geographical zones choose one of their members to be the zone's representative on the Society's nominating committee.

Election of officers is among the governmental responsibilities of the Council. From the nominees designated by the nominating committee, the Council chooses a president, four vice presidents, a treasurer, and a secretary. The presidential term is for one year, all others are for two years; two of the vice presidents, the treasurer, and the secretary are elected in alternate years. No president or vice president may succeed himself in office.

All officers are members of ISA's Executive Board, which also includes the Society's latest living past president, as well as up to two other members elected by the board for one-year terms.

Current membership of the Executive Board includes President, W. A. Wildhack, National Bureau of Standards, Washington, DC; Vice Presidents: W. H. Brand, Carbide and Carbon Chemicals Company, Oak Ridge, Tenn.; H. B. Freeman, Economy Equipment Company, St. Louis, Mo.; D. C. Little, Army Medical Research Laboratory, Fort Knox, Ky.; Dr. A. H. Peterson, Mellon Institute, Pittsburgh, Pa.; Secretary, R. T. Sheen, Milton Roy Company, Philadelphia, Pa.; Treasurer, J. T. Vollbrecht, Energy Control Company, New York City; Past President, Porter Hart, Dow Chemical Company, Freeport, Texas; and Executive Board Member, C. W. Covey, Carbide & Carbon Chemicals Company, Paducah, Ky.

Activities

Activities of ISA are directed through 31 committees set up in five divisions, each of the last four assigned to one of the Vice Presidents. . .

- President's Division deals with the Society's organization.
- Operations Division handles finance, meetings, exhibits, and publications.
- General Relations Division supervises such activities as intersociety relations, government relations, and corporate membership.
- Technical Division has committees working on specific applications of instrumentation.
- Recommended Practices Division.

In keeping with its original purpose of bringing together those having a common interest in instruments, ISA conducts an extensive program of meetings: local sections, joint meetings of closely located sections, national conferences and exhibits, and campus gatherings. In the latter the Society joins with colleges and universities, government agencies, research organizations, and other societies to present instrumentation conferences.

At the first International Instrument Congress and Exposition in Philadelphia this month, ISA will sponsor 50 sessions in which 166 technical papers, plus 8 panel discussions, will be presented.

Nine co-operating societies taking part in the Exposition plan more than 30 sessions to present nearly 60 papers.

Exhibits will reflect the full international scope of current developments in instrumentation. Displaying their latest products—and on hand to discuss them with ISA members and other visitors—will be 345 American firms and 65 foreign manufacturers of instruments. In addition, 15 societies, government agencies, and research and educational organizations have been allotted free display space.

Local section meetings are the most numerous of all ISA gatherings. Held at least eight times during the year by each section, they bring members together for the presentation of papers, plant trips, discussion of common problems, and similar activities.

Where conditions permit, local chapters introduce joint meetings into their annual program, allowing members to consider technical problems that have specific interest in broader geographical areas.

Climaxing each year's program is an annual National Instrument Conference and Exhibit. Held in such centers as Pittsburgh, Philadelphia, Houston, and Chicago, they have done more than draw large attendance. The Chicago meeting in 1953, for example, included not only 21 technical sessions by ISA but also sessions by co-operating technical societies, including ASME, AIEE, and IRE.

Conference visitors could hear their choice of more than 100 papers on instrumentation in such fields as continuous process controls, scientific instruments for research, medical instruments, and an array of others. In the concurrent exhibits, manufacturers displayed more than $10,000,000 worth of instruments.

Services

Service to those who use instruments is an essential part of ISA's work within its objective of advancing the science of instrumentation. Continuous programs set in motion by the Society to provide this service include work for greater standardization, assistance in training, increase in technical information, and stimulation of research.

Being a young and vigorously expanding field, instrumentation needs stand-

MANUFACTURERS EXPLAIN THEIR PRODUCTS IN MAINTENANCE CLINICS HELD DURING THE ISA ANNUAL INSTRUMENT CONFERENCE AND EXHIBIT.

ards even in the most basic aspects such as terminology. Through the efforts of ISA, practices in coding, piping, and installation methods supply a steady flow of recommended standards to those who use instruments and control devices. To speed the development of standardization, ISA has 19 different committees.

In the Society's training-aids program, instrument users find assistance in training personnel for instrument work. These aids range from ISA-prepared films to detailed course outlines, listings of textbooks, and bibliographies of technical publications. Course outlines are shaped to the needs of both industrial and institutional instrumentation training.

All sciences and technologies have long recognized the literature as an integral part of their foundations. In their field, ISA serves as a directing agency for the gathering of all types of technical data. The Society has drawn on a variety of originating sources to assemble reports, standards, manuals, pamphlets, and papers for dissemination to those having a need for or an interest in such data.

A natural outgrowth of the Society's program and service activities has been the increase in emphasis on research for instrumentation. By providing a sounding board for the interchange of ideas and techniques, ISA meetings have stimulated generalized and widespread acceptance of research and—the critical test—have spurred on many instrument men to launch studies that already show promise of great value.

Special meetings and clinics sponsored by ISA are other service approaches to problems met in instrumentation. Joint meetings of instrument manufacturers and instrument users are one example. During ISA's annual meeting, special clinics on maintenance of industrial and scientific instruments are held for instrument men and researchers. Other maintenance clinics on topical subjects of particular interest to instrument users in any given area are sponsored throughout the year on both a regional and a local section basis.

Society Publication

The history of the ISA *Journal* is as long as the Society's. From 1946 through 1953 it reached the membership as a special section incorporated in *Instruments* magazine.

In Jan., 1954 the *Journal* made its first appearance as a separate publication. Reception of successive monthly issues assures its continuation and success. The *Journal* presents editorial discussions on matters of interest to the Society's membership and other readers, technical papers by authorities on various phases of instrumentation, feature articles, and national and local news.

Growth

Beginning with a total membership of 900 in 17 local sections, in the eight years ISA has grown to include 7348 individual Members, 72 local sections, 212 Corporate Members, and 83 Foreign Members. A justifiable conclusion is that ISA makes a great contribution to the inevitable professional and technical needs of men engaged in an expanding field of science and technology.

Among ISA's members are educators, executives, design engineers, process engineers, test engineers, researchers, instrument department heads, and instrument mechanics who come from the campus, the process and machinery plants, the research laboratories, and instrument manufacturers and shops.

So diverse are their backgrounds and occupations that it can generally be said that ISA's members have but one interest in common—instruments and how to make and use them better. As individuals, these men see in instrumentation the key to technical advance in every field of science and industry. As a group banded together in the Instrument Society of America, they are contributing to speed that advance. This effort ISA is pledged to continue. Ω

The phenomenal growth of the electric power industry has been accomplished so smoothly that even its technical personnel are apt to overlook the many economical and technical achievements that were necessary to sustain this growth. One of the most important contributing factors has been the excellent service reliability provided to the consumers of electric energy. Good relaying is necessary to good service. As our power system grows, the protective requirements become more rigid. And relay developments must keep pace with system growth.

CARRIER RELAYING PANEL is part of two complete terminals of all-electronic relays installed to protect the 132-kv line owned by the Appalachian Electric Power Company.

Tomorrow's Relay Requirements

A simplified description of tomorrow's system, say within 10 years, will be sufficient to define its relay requirements.

The big brother of today's system, it will use higher transmission voltages, will have two to three times the present load and capacity, larger generators and stations, and greater short-circuit capacity—25-million kva or more, 2½ times present capacity!

The bulk-power generating and transmitting facilities will be in constant jeopardy from the results of short circuits. Both the stability problem and the risk of extensive permanent damage due to fault currents of 20,000 amp or more will demand ultrahigh-speed fault clearing. And this high speed must be obtained with complete reliability. Prolonged disturbances that may produce a complete system shutdown must therefore be prevented, because a time-consuming and careful process is required to restore the system to normal operating conditions.

Electronic Relaying for Tomorrow's Power Systems

By L. F. KENNEDY

The protective-relay engineer will have the task of providing first-line relaying that will be fast enough to prevent any appreciable deviation from normal operating limits. In addition, he must provide secondary, or back-up, relaying that will prevent major interruptions even in the event of equipment failures.

Thus tomorrow's relay system for first-line protection must be fast and reliable. The back-up relaying must be complete so as to limit the results of an equipment failure to the smallest possible portion of the system.

How to Obtain Faster Relaying

Not many years ago the time-overcurrent relay was the basic element used for transmission-line relaying. Operating times of several seconds were not uncommon. As the electric system grew, the operating time of the relay had to be reduced. The distance relay, which measures the impedance of the line, was then introduced. Operating time in parts of a second for both ends of the faulted line was then available. The need for further reduced time brought about the use of a carrier-current link between the line terminals to further reduce operating time.

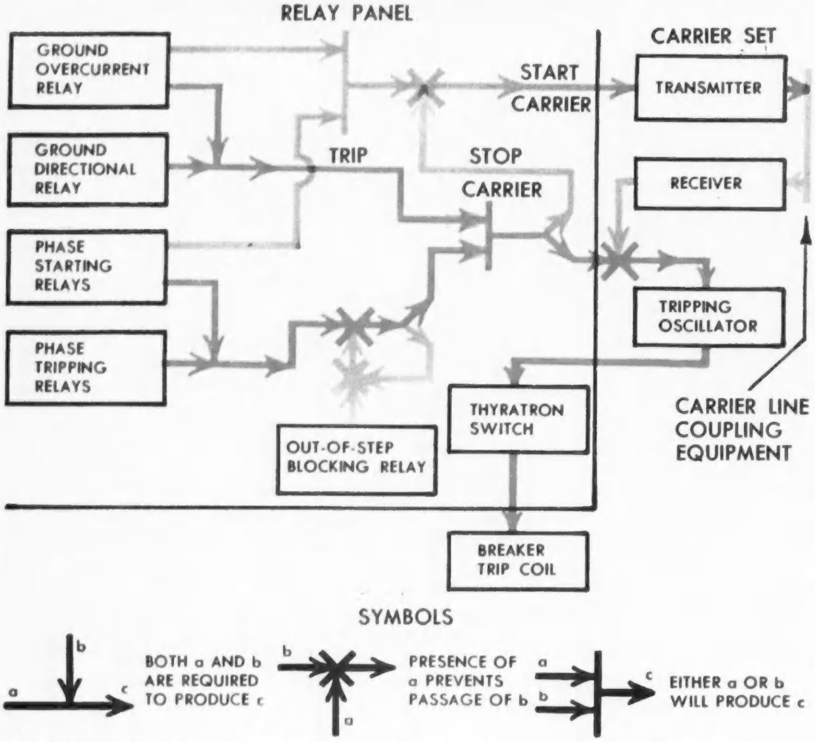
Present-day relay equipment for use on major transmission systems provides operating times in the general range of one to four cycles (a cycle is 0.0166 second). To reduce these times, either the operating forces must be increased or the inertia decreased. Because relays must operate from limited energy supplies, such as current and potential transformers, and must also keep within a reasonable temperature rise, it does not appear feasible to solve this problem of faster operation by increased force.

Inertia could be decreased, but this would mean lighter moving elements and probably shorter contact gaps. Although faster operation could be obtained, new problems of shock, vibration, and contact action would arise and tend to reduce reliability.

Electronic methods offer inertia-less characteristics and require less power to

Mr. Kennedy—Manager of System Relaying, Electric Utility Engineering, Schenectady—has been with General Electric for 32 years. He has just returned from Europe where he attended CIGRE and visited many power plants to study their operations.

ALL-ELECTRONIC ONE-CYCLE RELAY



ELECTRONIC UNITS measure the distance and direction to a short circuit between conductors by comparing the voltage on the line with the current flowing to the short circuit.

operate the relay. So the final question to be answered concerns the reliability of electronic devices. This must not be confused with its life. For example, vacuum tubes have a certain limited life, but tubes should be acceptable if the life expectancy is long enough to meet normal protective-relay maintenance programs. Reliability is the characteristic of providing consistent performance under normal service conditions. Electronic methods have proved reliable when conservative design practices are followed.

A careful review of all factors indicated that electronic methods offered the greatest opportunity to produce the relay performance required by tomorrow's system.

All-electronic System

It was decided to develop a directional-comparison carrier-relaying system using electronic principles. Directional comparison has been successfully used for more than 20 years and is the most widely applicable form of transmission-line protection.

Basically the equipment consists of electronic units that measure the distance and direction to a short circuit between conductors by comparing the voltage on the line with the current flowing to the short circuit. Similar units measure the amplitude and direction of the short-circuit current from any one of the three conductors to ground. This equipment is duplicated at both ends of the line. A carrier-current channel is provided to enable the two relay terminals to "discuss" where the fault lies and what should be done about it. And this discussion and final operation must be completed within one cycle. The key to the performance is that a short circuit external to the protected line section is detected by the relay terminal nearest the short circuit. To prevent tripping, it then transmits a continuous-carrier signal back to the other terminal. But if the short circuit is within the protected line section, then directional relays at both ends of the line will stop all carrier transmission and initiate tripping of the breakers.

The illustration indicates functions of various electronic relay units and how they are combined electronically to compare the direction and distance with a short circuit via the carrier-current equipment and to initiate the thyratron switch that trips the breaker if the short circuit is within the line.

Field Tests

Two complete terminals of electronic relays were installed for test on the Roanoke to Lynchburg, Va., 132-kv line (photo, page 37).

Between August 8 and 10, 1953, the performance of the all-electronic relays was verified by actually applying short-circuit faults on the 132-kv line to prove that the relays would correctly operate and initiate tripping of the breakers within one cycle. Faults were also applied on adjoining line sections to verify that the relays would correctly block tripping during external faults.

Oscillograms taken during the field tests showed that the trip current began to flow in approximately one-half cycle after the fault was initiated.

On the whole the results were gratifying. The field tests revealed some errors in the connection of the test circuits and pointed out a need for shielding some interconnecting conductors as well as revising the transient-blocking circuit.

Modifications were made, and in Dec. 1953, additional fault tests were made with completely successful results.

The relays have been operating to protect the 132-kv line since the August tests. Correct operation has been experienced for both internal and external faults on several occasions.

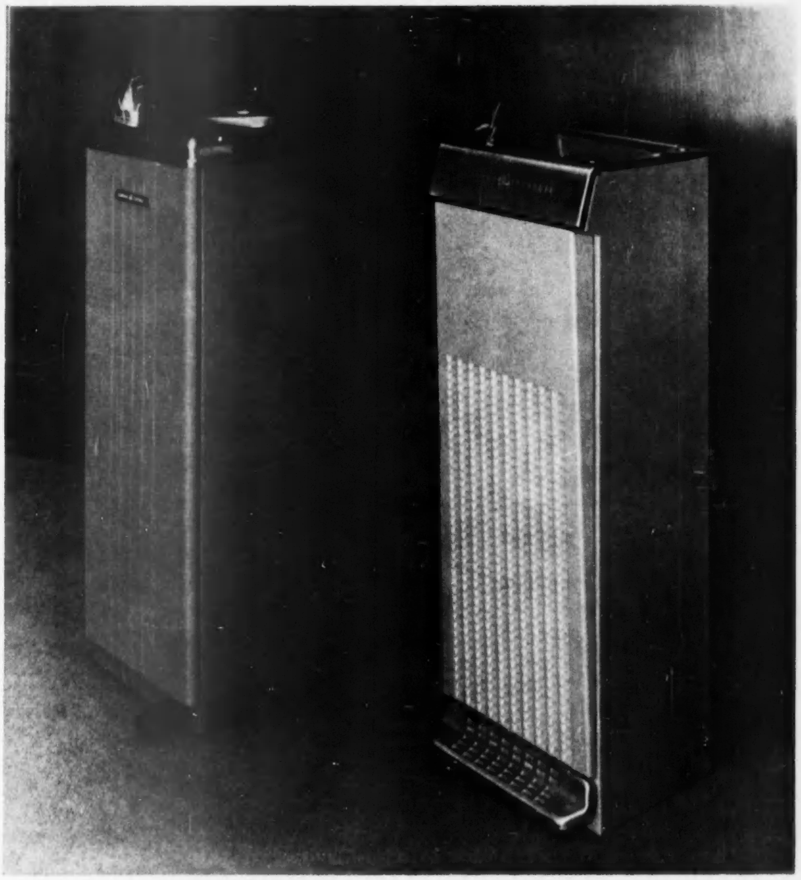
A continuous check is being made on the relaying installation by means of automatic recording equipment to compile a record of performance on the 132-kv line during the trial period.

What is believed to be the first wholly electronic relaying system to be applied in regular service on an important system will be used on the 330-kv line of the American Gas and Electric Company. No mechanical relays are used until after the breaker trip coil has been energized.

As the electric power systems continue to grow, protective relaying must be made faster and more reliable. Electronic methods have proved capable of providing the desired improvements for transmission-line relaying. With operating experience, electronic methods will unquestionably be improved and applied to other forms of protection. New developments in electronic components, such as the transistor and the like, are constantly being studied and evaluated for their place in protective relaying equipment. Ω

ELECTRIC WATER COOLERS GET THE NEW LOOK

By F. BURGGRAF
and
B. E. FREITAG



WATER COOLER WAS REDESIGNED *(RIGHT)* TO IMPROVE APPEARANCE AND REDUCE COSTS.

WANTED: A device to furnish a stream of pleasingly cool water—instantly and at a given height—at the press of a child's foot or that of a 250-pound man. It must appeal aesthetically to user and customer alike; comply with various health, sanitary, electrical, and safety codes throughout the nation; and be suitable for economical mass production.

Briefly, that would fit a description of the General Electric water cooler pictured above with its predecessor. Until last year the older model had been in production without change since 1946, except for some internal improvements made in 1950. In an industry where the normal design life of a water cooler is generally five years, a basic redesign was overdue.

But how do you go about redesigning a product that is basically good? This was the problem facing us early in 1953. The answer was found by posing three major objectives . . .

Improve the product
Give it a new distinct appearance
Effect a major cost reduction

The achievement of these objectives makes an interesting story of what happens when mechanical engineers and appearance designers team up on a product design.

Modern Slant

To make certain that the function of the new cooler would be integrated with its appearance, we made appearance and design studies simultaneously.

Cost reductions were brought about by simplifying the design. For example, the cabinet of the old cooler consisted of four major parts: a base pan or support, two side panels, and an internal panel to support the refrigerating mechanism. The cabinet of the new cooler, however, consists of only two major parts: sides and bottom, formed from one sheet of steel, and a rear internal panel, also formed from a single sheet of steel.

As it progresses downward, the front panel tapers inward to provide a convenient recess for operating the foot pedal. It is a combination access panel and ventilator for the refrigerating unit compartment. Providing ample air-flow but no unsightly "see-through" effect, the ventilators, or louvers, of the panel are small, crisply defined depressions. They provide what we feel is an interesting textural effect, balancing the strong attraction of the stainless-steel top.

In the new model, as you can see, the foot pedal is a natural continuation of the front panel. This not only integrates the pedal into the design of the front but also provides a full-width treadle for easy operation. You'll see, too, that the foot pedal has an upward curved portion, preventing the user from scuffing the painted front panel and thus preserving the appearance of the cooler. Note also the antiskid surface on the foot pedal. For an added touch of harmony and blending, these antiskid depressions were made to resemble the louver design of the front panel so that, in effect, the louver design is continued into the foot pedal.

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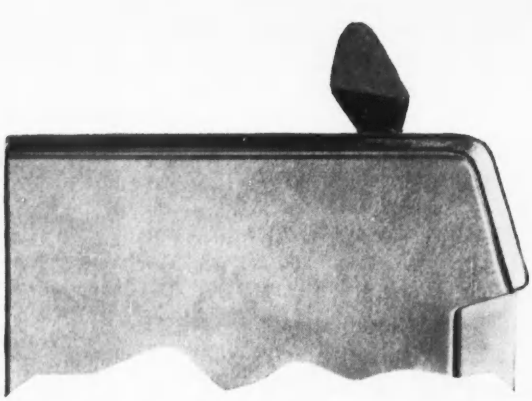
Both authors are with GE's Commercial and Industrial Air Conditioning Department of the Air Conditioning Division, Bloomfield, NJ. Mr. Freitag—industrial designer—joined General Electric in 1947. Mr. Burggraf, development engineer, began his career with the Company in 1942 as Test Engineer and has developed designs for both room air conditioners and water coolers.



STAINLESS-STEEL TOP SHOWS MOST NOTICEABLE CHANGE. SIMPLIFIED BUBBLE GUARD *(RIGHT)* HELPS TO INSURE SANITARY DRINKING.

Focal Point

Perhaps the most noticeable departure in appearance from the universal water-cooler look is the stainless-steel top (photo, left).

Because of its high appearance value and relatively high cost, the top came under our early scrutiny. Serving as both catch basin and drain, it is subjected to repeated wetting and to the corrosive actions of certain types of drinking water. In addition, it is periodically scoured with various cleaning abrasives and scratched by rings, watch bands, and the many other personal objects that, curious as it may seem to you, find their way into the basin of a water cooler.

We considered and evaluated many materials for the top. Should we continue to use stainless steel when it costs approximately eight times as much as ordinary steel? Painted steel, molded plastics, glass-reinforced plastics, zinc die castings, and many other materials were appraised. But in the end we decided to continue with the excellent protection offered by stainless steel. It alone resisted to a better degree the deteriorating effects that a cooler top is exposed to.

Still, this decision to go ahead with stainless steel hadn't reduced the cost of the top, which was what we were after. So we went about the problem in another way. After close examination, it became evident that the excellent but costly protection offered by stainless steel was needed only for the bowl itself and the upper part of the front panel. Thus it was possible to reduce the deep side and rear flanges of the top from the two inches used on the older model to only half an inch, while the front protective flange was increased from two to four inches. In this way we achieved a 30 percent cost reduction. In appearance, however, the cooler seems to have more stainless steel because it's on the front where it can be seen.

(On first thought you might think that this solution was an obvious one. Not so, however. It required a number of months and many clay-model studies before the water-cooler top, as you see it now, was evolved.)

The water-bearing portion of the top, or basin, is designed for a minimum of splashing as the drinking stream falls. This required that the basin be shaped at a certain angle where the stream hits it so that the water is gently directed toward the drain. In addition, we kept curvature radii small to give the basin a crisp look. Definite planes formed the sides and bottom of the bowl, thereby eliminating the wash-basin appearance of conventional water-cooler tops.

The focal point of the top design is the front flange, or apron. We found it an excellent location for the General Electric signature name plate. Stamped into the front apron, the signature is filled with one-color baking enamel to produce a highly legible, pleasing, and permanent name plate.

Electropolishing was chosen for the finish of the stainless-steel top. We selected this finishing method not only for its appearance but also because it hides finger marks and slight irregularities in stamping. It has the highly desirable effect of passivating the surface of stainless steel to give better corrosion protection. Although the electropolishing process is an economical finishing method, it does require a smooth finish on the raw material and careful handling during processing for good results.

Beauty and Utility

Also greatly simplified on the new cooler is the bubbler guard (photo, right). We accomplished this simplification by moving the valve mechanism for turning the bubbler on or off—housed in the guard on the old model—to a position beneath the guard.

The bubbler guard is economically produced by chrome-plating and polishing a zinc die casting. One of its functions on a modern water cooler is to insure that no mouth drippings will fall on the bubbler. In addition, it prevents a person from placing his mouth over the bubbler itself. It must be easy to clean and have no grooves or other depressions that would create unsanitary conditions.

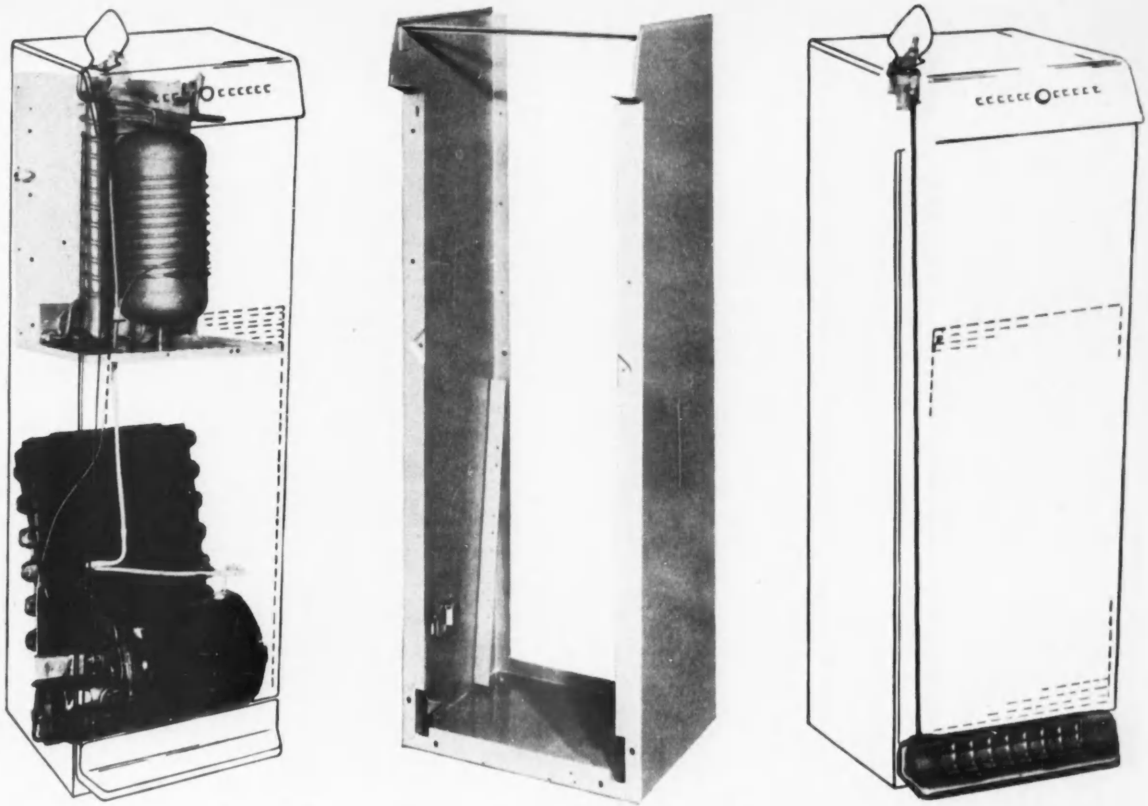
Our first attempts at the bubbler-guard design produced a stubby appearance because a relatively broad footing was needed to rigidly anchor it to the stainless-steel top. But by "necking down" that portion of the guard just below the base, we were able to eliminate this visual effect. The footing width was narrowed in the process, but the bearing surface maintained was sufficient.

Many clay studies of the guard's design were made before all conditions of protection, sanitation, and appearance requirements were achieved.

Four Goals

From the outset our initial objectives in the internal design of the cooler were fourfold. We wanted a removable refrigeration assembly so that all parts would be accessible for ease of manufacture and maintenance. By more efficient grouping of working components, we hoped to achieve a smaller floor plan for the unit and at the same time obtain a simple, sturdy case construction. Finally, for simplicity, lower cost, greater reliability, and less noise, we wanted to incorporate in the design a static condenser—one that didn't require forced-air cooling.

Of course, these over-all objectives



CASE CONSTRUCTION—One-piece side-bottom-side (*center*)—provides a simple chassis for mounting the removable refrigeration assembly (*left*). Connecting the foot pedal with the water valve are a relief spring and an operating rod.

were complicated by a host of detailed problems that arose during the development, all of them subsequently solved. Here, is what we accomplished . . .

Refrigeration Assembly—The removable refrigeration assembly (photo, left) includes all the refrigeration system's components plus all the water-circuit components. Because of the metal-to-metal contact necessary for good heat transfer between the refrigerant and water, these two groups of components could not be separated. The removable assembly is not self-supporting. When assembled into the water cooler, the case supports the components. (A special jig holds the components while they are being assembled and tested in the factory.)

Case Construction—A one-piece side-bottom-side arrangement, the case in its final form (photo, center) provides a simple, strong chassis on which all major components can be mounted. This contrasts with the multipiece construction of the older model with its possible weak joints, need for complex spot welding, and higher manufacturing cost.

Floor Plan—With a more effective grouping of the working components, we were able to reduce the rectangular floor plan of the new cooler 21 percent over its predecessor. Aisle space taken up by the cooler is also significantly decreased because the shorter dimension of the rectangle projects from the wall.

Static Condenser—On the smaller-sized water coolers a static condenser is utilized. This was difficult to achieve without a fan for air movement because the heat that must be dissipated is about double that of an average home refrigerator. Besides, the area available for a condenser in a water cooler is only about half as wide and one third the height of that in a home refrigerator.

To increase the effective heat-radiating area of the static condenser, a unit with large plate fins is used. The condenser is sloped for better performance. This way, heat radiating from its lower parts is kept from blanketing the tubes.

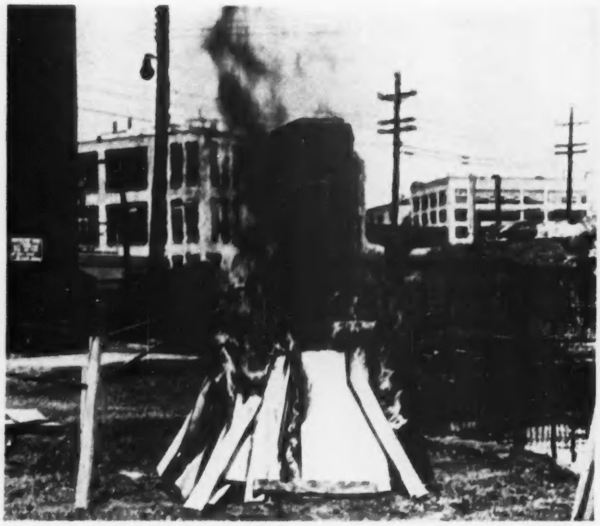
Controlling Water Flow

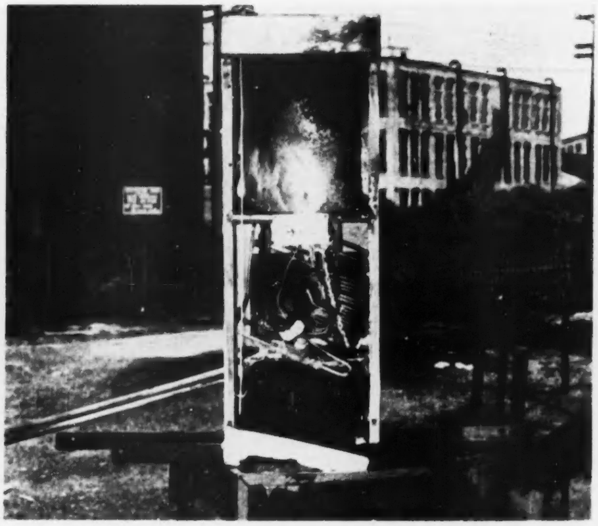
Typical of the attention we paid to details in the over-all design is the valve that controls the drinking-water stream and its associated components. This design can be broken down into . . .

Foot pedal
Connecting operating rod and relief spring
Water valve and hold-down bracket
Mounting block and water outlet

An across-the-front foot pedal was decided on because you can use it with ease and convenience. As we mentioned earlier, the back part of the pedal is an antiscuff plate. The pedal itself is an aluminum stamping with a continuous flange all around the sides to give it rigidity and a neat appearance. Because its fulcrum point is placed low and far back, it operates with a nearly vertical motion.

Connecting the foot pedal with the water valve are an operating rod and relief spring (photo, right). We kept this mechanism as simple as possible to minimize lost motion and deflection. Screwed into the foot pedal is a vertical connecting rod with a spring retainer cap at its top. The connecting rod transmits a quarter-inch motion of the pedal to directly operate the valve. Because the valve linkage requires only an eighth-inch motion of the rod to open it, a relief spring takes up excess motion





DESPITE HIGH TEMPERATURE OF FIRE TEST, PRESSURE BUILD-UP WAS MINOR WITH NEW COMPRESSOR. THE COOLER PASSED ITS FINAL EXAM.

without overstressing the valve parts. We thought this excess movement was necessary so that adjustment of the linkage would not be critical. At the same time it would allow for minor variations in manufacture.

The water valve is a small, readily removable component. It combines the functions of an OFF-ON valve and an adjustable water-pressure regulator that prevents annoying variations in the height of the water stream. For ease of maintenance in the field and to simplify construction, the water valve was made removable from its mating valve block.

This special valve block is designed to give a smooth, steady stream of drinking water. It allows no turbulence or breaking up of the water stream until the latter is beyond the drinking point in the parabola of water flow.

As a final gesture of good will, the outlet nozzle of the valve proper is slotted to guard against anyone mischievously squirting the water stream.

Final Exam

We pointed out in the beginning that a water cooler, like most appliances, has to meet various codes and standards. An unusual test, and one you perhaps wouldn't associate with water coolers, was required by the Underwriters' Laboratories, Inc., an independent testing organization that establishes the degree of safety of potentially hazardous equipment. The UL standard specifies various safety devices to ". . . prevent development of hazardous pressures in the event of fire."

In our new design we had changed to an improved compressor and in doing so had eliminated the pressure-relief means provided on the older model. On that model, neoprene-rubber gaskets around the wiring terminals of the sealed motor-compressor unit served two purposes: 1) they insulated the leads coming through the steel motor-compressor case and 2) they served to relieve refrigerant-pressure build-up in the event of a fire because the neoprene would burn out. In the new compressor, on the other hand, glass insulates the wiring terminals from the steel case. The glass serves the same insulating function but does a better sealing job in preventing refrigerant leaks. It does not, however, provide pressure-relief means because the glass will not melt or burn out.

Although our information indicated that there wouldn't be significant pressure build-up in the event of fire, on application to the Underwriters' Laboratories, Inc., it was decided that a fire test would be required.

For the test we mounted the water cooler on a three-foot-high rack with the space below it filled with enough wood to create a "hot wood fire." Insulated gage lines were connected to the high- and low-pressure sides of the compressor, with gages located 10 feet distant. In the presence of an observer for UL, the fire was started with kerosene and allowed to burn for 10 minutes (photo, left).

The water cooler was really ruined (photo, right). No paint remained, all plastics parts disappeared, the aluminum pedal melted, and finally, with a slight hiss, one of the silver-brazed joints inside the case melted, indicating a temperature of more than 1100 F.

But despite this high temperature, the pressure build-up was minor. The cooler passed the fire test satisfactorily.

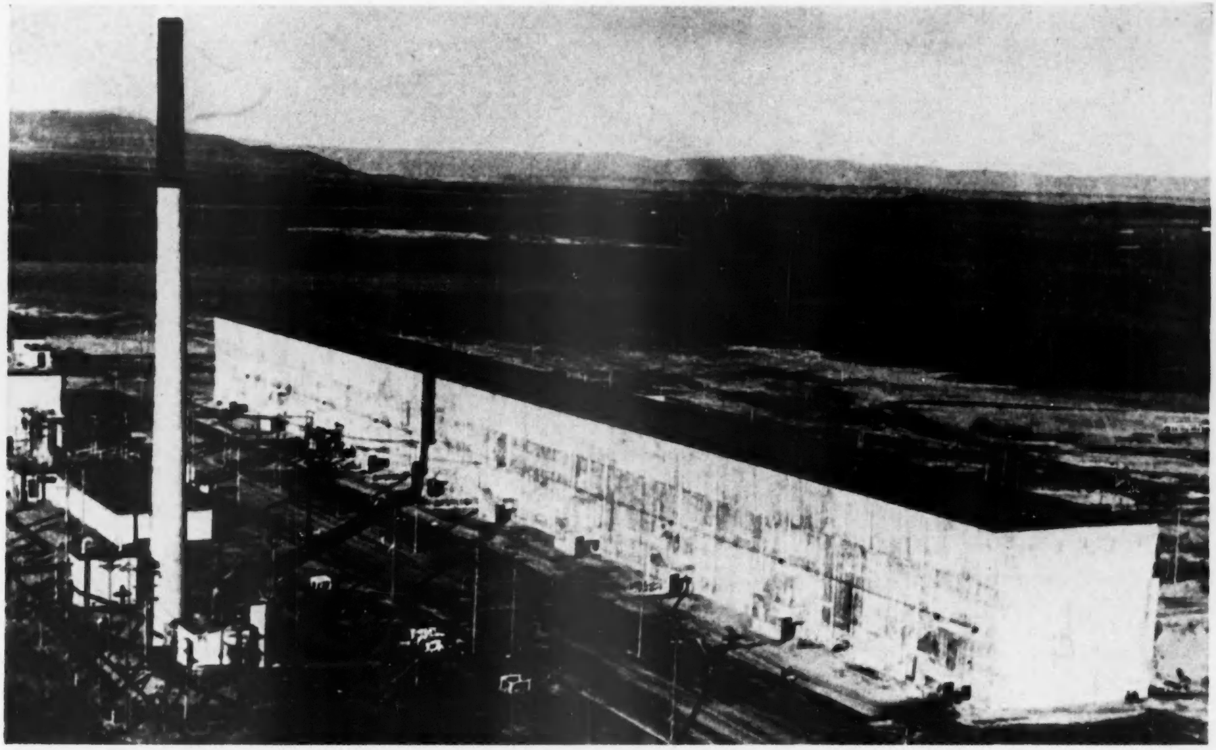
Crystal Gazing

The new cooler is not only lower in cost but also better constructed than the older model. What's more, it has a greater number of features that the user will appreciate—the full-width foot pedal, for instance—and in appearance it is more attractive.

Still, we know that this design isn't the final answer to all our problems: it is only the beginning of many further advances. For example, we've already considered another model incorporating a drinking attachment for small children, the market being schools and similar institutions.

Looking farther into the future we visualize further simplifications in construction by molding the entire cabinet in one piece—perhaps glass-reinforced plastics. The top might also be plastics, provided it had the proper wearing qualities. Something that might have great sanitary and safety advantages is a disappearing bubbler that projects only while a person is drinking. To eliminate the foot pedal, an electronically actuated proximity control for the drinking stream might also become feasible.

And so, you can be sure that many further advances can and will be made on a device that today most Americans take for granted—the electric water cooler. For no product design is ever really finished. Instead, it is only temporarily halted to make it available for service to the public. Ω



HIGH-DENSITY CONCRETE FOR BULK SHIELDING IS USED IN MANY OF THE FACILITIES AT GE'S HANFORD ATOMIC PRODUCTS OPERATION.

Concrete Shields—Their Preparation and Use

By DR. HAROLD S. DAVIS

The two kinds of invisible products and by-products of atomic fission that we must guard against are subatomic particles and radiation. Subatomic particles consist of alpha and beta particles and neutrons; radiation consists of gamma rays.

The nature and amount of shielding required for protection against them depend on which ones are involved. Sometimes a sheet of paper will do the trick. At other times shielding can be provided by thin sheets of aluminum. Some even require several inches of lead.

The stopping power of shielding depends on its weight. Six inches of lead, for example, is about equivalent to a foot of iron, three feet of ordinary concrete, six feet of water, or about 100 feet of air.

Concrete is commonly used for reactor shielding—it's relatively inexpensive and does the job. Often, high-density concrete is used because not so much is required to get the same shielding effect.

At the Hanford Atomic Products Operation (photo) operated by General Electric for the Atomic Energy Commission in Richland, Wash., we required high-density concrete for certain bulk-shielding applications. Unfortunately, special requirements for the job made it impossible to use any of the high-density concretes that had been developed and used successfully at other AEC installations.

What we did was to develop new types of high-density concretes that possessed the physical and shielding properties to fit our particular requirements. Our investigations also made it possible for us to shield reactors for about two fifths of the cost of early shielding.

How the program developed is an interesting story—even more so when you consider that we were dealing with commonplace materials.

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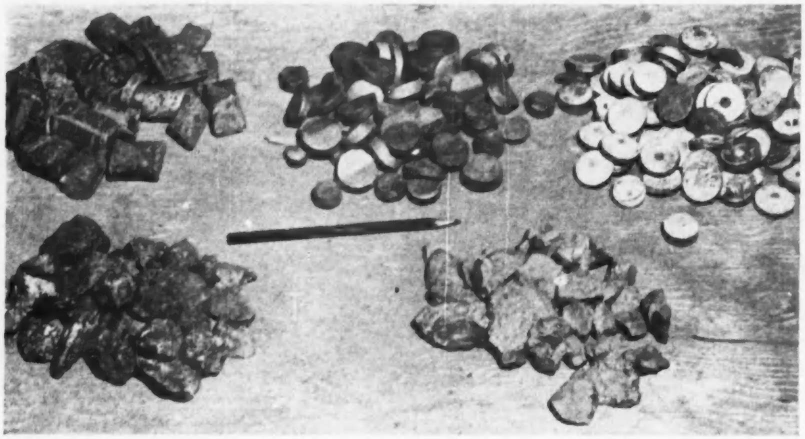
Dr. Davis joined the Company three years ago at AEC's GE-operated Hanford Atomic Products Operation in Richland, Wash. As structural engineer, Engineering Dept., he has supervised developmental programs on high-density concrete and the design of shielding structures.

Aggregates Are Important

Concrete made with ordinary aggregate weighs about 150 pounds per cubic foot and on a weight basis is usually the cheapest type of shielding concrete. But concretes with greater densities are desired for less shield thickness.

You can get densities up to about 240 pounds per cubic foot by using natural aggregates processed from heavy ores, such as magnetite. To get densities greater than that, you can use steel aggregate, consisting of punchings or



HEAVY AGGREGATES—steel punching and sheared bars (*top*) and natural aggregates of magnetite and limonite—are used in preparing high-density concrete by the prepack method.

sheared bars, in combination with the natural heavy aggregates (photo).

The homeowner laying a new concrete patio wants aggregate in the same condition we do: clean, hard, and strong, and free from foreign material. The similarity ends there, however. Aggregates of high-density concrete not only must fulfill these conditions but also have a high specific gravity.

At one of the early stages of our development program, investigation showed that of more than 60 minerals having specific gravities greater than 3.5, about 10 mineral groups were commercially available. Further study showed that barite, limonite, and magnetite were the most suitable. But barite was eliminated from the list as soon as we found a local source for magnetite of greater density at less than half of the cost of barite. Because freight charges from the mine to Richland are usually greater than the cost of the ore, we must always consider transportation, as well as the actual cost of the aggregate.

The next phase of the investigation was to ask about 50 potential suppliers to submit samples. Half of them did so. We tested these samples for specific gravity, iron and silica content, fixed water content, and suitability for use in concrete. Spectrochemical analyses were also made. Results: Ten vendors could supply us with quality magnetite having a specific gravity greater than 4.5 and an iron content of more than 55 percent; five dealers could furnish limonite-goethite having a specific gravity of more than 3.4 and an iron content of more than 50 percent.

This phase of the investigation not only gave our purchasing division a list of suitable vendors for heavy aggregate but also gave us important data that proved to be of great value in writing specifications of materials and expediting the procurement of quality aggregates.

Cost savings were also realized. In 1951 we were obtaining graded magnetite aggregate with a specific gravity of 4.2 for $40 per ton. Today we are getting graded magnetite with a specific gravity of 4.6 for only $18 per ton. During the past year we bought graded limonite-goethite aggregate with a specific gravity of 3.4 and a fixed water content of 11 percent for $38 per ton. Previously, graded limonite of slightly greater density but having a water content of 8 percent had been obtained from a source at the Great Lakes for $50 per ton.

Water Content Critical

Maximum density, unfortunately, isn't the only factor we have to worry about in designing high-density concrete. True, it is a major requirement for gamma shielding, but both density and hydrogen content are required for slowing down and absorbing neutrons. To obtain the proper shielding for specific applications, it's often necessary to use aggregates such as limonite or goethite to provide the required density and to retain proper amounts of water in the concrete. For a particular shielding job a balanced composition of heavy material and hydrogen is therefore desirable.

The cement is also important. However, our investigation was limited to concrete made with portland cement. From previous experience we were sure that concrete made with portland cement and acceptable aggregates would possess satisfactory structural and hydrogen properties. To confirm this experience we made additional tests to determine how much water could be retained in portland-cement concrete under job conditions, how much water was required for effective shielding, and what the physical and shielding properties were of several types of concrete made with heavy aggregates.

Another Problem

Steel aggregate poses a problem when mixed with a mortar consisting of limonite, sand, portland cement, and water. If the mortar is too fluid or vibrated too vigorously, the steel aggregate separates from the mix; if the mortar is too stiff, you can't flow the concrete in restricted areas or around imbedded items.

One solution to this problem is the so-called prepack method. It not only minimizes segregation of aggregates and shrinkage in the concrete but also offers certain advantages over the conventional method for pouring concrete containing steel aggregate. First, we mix the steel aggregate with coarse limonite; then we compact the mixed aggregates in the forms dry. This gives a uniform distribution of coarse aggregate (photo, top, opposite page).

The next step is to fill the void in the aggregate mass with an intrusion mortar of cement, high-density sand, and water (photo, lower, opposite page).

Because of high costs the use of steel aggregate in high-density concrete can be justified only when shield thickness must be a minimum.

Encouraging Results

Several types of high-density concrete have been developed and adapted for use in constructing shields for future reactors. Savings from one project alone will exceed $7 million. (In addition, shielding structures constructed with high-density concrete possess greater resistance to lateral forces produced by earthquake and bomb blast.)

By using natural rather than costly steel aggregates, shielding costs were reduced by about $440,000 on a recent project.

It is our belief that future concrete shields having shielding effectiveness equivalent to those built earlier can be constructed for about two fifths of the previous cost. This is indeed a comfortable saving and possibly a little startling when you consider that we are working with material of such a prosaic nature. Ω

MAGNETITE-LIMONITE AGGREGATE IS PLACED IN LESS CRITICAL AREAS OF A SHIELD *(FOREGROUND)*, STEEL AND LIMONITE AROUND BEAMS.

IN THE NEXT STEP, PUMPS FILL VOID IN THE AGGREGATE MASS WITH AN INTRUSION MORTAR OF CEMENT, HIGH-DENSITY SAND, AND WATER.

The Contributions and Benefits of . . .

Standardization—What It Means to You

By R. C. SOGGE

Most businessmen will admit that standardization and standards are necessary for business administration. Most engineers will assure you that standards are essential to carry out the technical requirements of our modern-day scientific work in research, design, and testing of materials and products. But standards are not limited to industrial organizations; they are deeply integrated in our day-to-day living habits. Standard time, standard working hours, and American standards for kitchen utensils, acetate and rayon fabrics, and even bed sheets are a few examples.

The individual industrial company makes practical use of standards in many phases of its business with standard specifications for the purchase of materials, standards for drafting room practice, standards for processes and practices—all contributing to increased economy. In a large organization some standards may be prepared and used exclusively in a single department; others are developed through the joint efforts of several departments and have company-wide application. In a number of industries that have had outstanding growth, considerable credit for their success has been given to the extensive use of standardization and standards. Although standards have been utilized to advantage in the development of trade, they perhaps have their greatest use in science and technology.

Though standards have a broad acceptance in many phases of today's business, the idea is of comparatively recent origin. The real recognition of standardization is closely identified with industrial evolution. In the early part of the 13th century, people used legs, arms, and fingers to measure short distances. The English Parliament legalized the standard yard in the early 1800's, but opinion varies as to whether the metric or the English feet and pounds system is preferred.

To mention only a few of the numerous standards, we have those for definitions, symbols, and abbreviations; weights and measures; money as a definite medium of exchange; accounting; purchasing; and office routine. Others include standards for electric and magnetic measurements to meet the requirements of applied science; standards for material specifications, products, dimensions, test methods, and surface finishes; standards for installation, performance, and safety; and standard methods of sampling and certification marking.

What Is Standardization?

For our purpose we may define standardization as the organized solution of recurring problems. It establishes recommended rules or models that should be followed. In its broadest sense, standardization not only applies to such matters as weights, measures, and material objects but also permeates most fields of human activity. Folkways, moral codes, educational procedures, business customs, industrial practices, and even languages are all forms of standardization.

Standardization has a special significance for products and practices in connection with technology, industry, and business. It is a management tool for progress, relegating to their proper routine the already solved problems and leaving the creative faculties free for the unsolved problems.

What Are Standards?

Standards are the records of solutions of recurring problems. They may cover accurately defined characteristics, nomenclature, processes, sizes, qualities, performance, or recommended practices, to suit given sets of conditions. Some standards eliminate superfluous variety; others satisfy requirements that are necessarily different. They educate, simplify, conserve, and certify—truly a basis for increased productivity.

Probably the most important group standard ever developed in the United States was the railroad's standard-track gage and system of interchangeable brakes and couplings, making possible the exchange of rolling stock among virtually all railroads. Most of the early American railroads had their own gages; the changeover to the present standard gage of 4 feet 8½ inches was made about the time of the Civil War and is also used in Great Britain, Canada, and most of Europe.

Standards have been used to an increasing degree in industry, especially where mass-production has been adopted. Perhaps the electrical industry has been more fortunate than many others, because it grew by producing not only power equipment to operate industry but also the control and utilization equipment to use that power. Electrical service made possible accurate control and measurement, subsequently raising the question of additional standardization.

Contribution of Technical Societies

In the early days some of the technical societies did considerable work on standards for products. They assisted their members in keeping abreast of new developments and in developing standards needed to get the most use of the technical advances. As business grew, standardization and standards were soon covered by trade-association organizations. Several felt so strongly about the importance of standards that they included provisions in their charters to permit them to develop standards. Sometimes their standards conflicted with those of other organizations whose activity overlapped their field causing some duplication. In 1918 the American Engineering Standards Committee—most standardization was then in engineering—was organized to harmonize conflicting standards and to provide a

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Mr. Sogge—Manager, Standards Services Department of the Engineering Services Division, Schenectady—has been with General Electric for 38 years. President of the U. S. National Committee of the IEC, he is also an officer of the NEMA Codes and Standards Committee and a member of the Standards Council of ASA.

IEC EXECUTIVE GROUP discusses plans for the Golden Jubilee meeting in Philadelphia Sept. 1–16, 1954. Left to right are: Dr. C. C. Chambers, University of Pennsylvania; L. R. Barnhorst, Bell Telephone Co. of Pa.; Louis D. Day, Jr., University of Pennsylvania; Virgil M. Graham, Radio Electronic Television Manufacturers Association; Dr. F. B. Silsbee, National Bureau of Standards; J. W. McNair, ASA; Mrs. Jean Murphy, Jubilee Headquarters; P. H. Chase, Philadelphia Electric Company and chairman of the Jubilee General Committee; R. C. Sogge, General Electric Company; Dr. H. S. Osborne, IEC President; Orville Haas and W. L. Healy, General Electric Company; Dr. S. R. Warren, Jr., University of Pennsylvania; and Cullen T. Pearce, Western Electric Company.

recognized procedure for national standards. Many other organizations liked this idea and became members. To encourage standardization on a broader basis, in 1930 the Committee changed its name to the American Standards Association (ASA), and greater attention was given to consumer standards.

The ASA does not formulate standards but provides a procedure whereby all who have an interest can participate. Standards adopted through the ASA procedure are known as American Standards.

The story of standardization in the United States is well known. We have grown to accept standardization on company, industrial, and national bases, and recently we have taken an increased interest in international standards. This has been evident through the increased attention given proposals for international standards by various committees in the States and the larger number of delegates sent for the past three or four years to meetings in Europe on electrical standardization.

During the past century, progress in the electrical industry was made simultaneously on both sides of the Atlantic, and the need for meetings to discuss mutual problems in this field soon became apparent. The first International Congress of Electricians was held in Paris in 1881, when names for the principal electrical units were proposed and adopted. The success of that meeting led to further International Congresses in 1893, 1896, and 1900, fostering the idea of co-operation on an international basis in the electrotechnical field. Before the turn of the century, the AIEE considered the question of rules for electric machinery. In 1904, at a meeting of the International Electrical Congress in St. Louis, the question of standardizing the nomenclature and ratings of electric apparatus and machinery was considered. When they recognized a need for a permanent body designed to give methodical and continuous study to problems of standardization in the electrical field, they adopted a resolution establishing the International Electrotechnical Commission (IEC). Its goal is to facilitate the co-ordination and unification of national electrotechnical standards not already covered by the statutes of any other recognized international organization.

The first conference, bringing together delegates from 13 countries, was held in London in June, 1906, under the auspices of the Institution of Electrical Engineers. Lord Kelvin was elected the first President of the Commission. Charles Le Maistre, appointed General Secretary, contributed much to building up the IEC. He remained an ardent supporter and counselor—greatly influencing the organization's affairs for almost 50 years.

Except during World Wars I and II the Commission has held numerous meetings that resulted in the publication of a substantial number of important international standards.

The first IEC meeting held in this country was in New York during April, 1926. The electrical industry extended an enthusiastic reception to delegates from 17 foreign countries.

International Standardization

In 1947 the IEC decided to affiliate with the International Organization for Standardization (ISO) as its Electrical Division, with IEC retaining both its technical and financial autonomy. In 1948 the headquarters of the IEC transferred from London to Geneva where it is housed in the same building as the General Secretariat of the ISO.

IEC membership is open to any self-governing country, and in accordance with its statutes any country wishing to participate in the work of the Commission can form a National Committee of its own. Close co-operation is always maintained between the IEC National Committee and the national standards body of any country. Thirty nations are

MEMBERS OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

Argentine Republic	Israel
Australia	Italy
Austria	Japan
Belgium	Netherlands
Brazil	Norway
Canada	Poland
Chile	Portugal
Czechoslovakia	Spain
Denmark	Sweden
Egypt	Switzerland
Finland	Union of South Africa
France	USSR
Germany (Federal Republic)	United Kingdom
Hungary	United States of America
India	Yugoslavia

now members of the IEC, having in their number representatives from every continent (Table). The IEC is administered by two governing bodies: the Council, which meets at least once every three years, and the Committee of Action which meets annually.

The Committee of Action is composed of the President of the Commission and nine Vice Presidents or their duly accredited deputies. This committee may deal with administrative matters in the intervals between the meetings of the Council, making any decisions it considers necessary to facilitate the operation of its technical work and reporting them to the Council.

The Commission's work is financed by annual contributions determined by the Council and paid by its National Committees. The annual budget is about 240,000 Swiss francs, or $56,000 U.S. currency.

IEC recommendations are published in the Commission's three languages: English, French, and Russian.

Technical work is carried out through international technical committees and subcommittees—now more than 40—each dealing with a particular subject chosen by its members. Standardization of terms and definitions is considered important, and a new International Glossary is expected to be approved for publication this year. Such projects as classification of insulating materials, electric and magnetic magnitudes and units, and standard voltages and safety rules for various types of electric equipment have an application in all countries. Considerable work is being done on projects established for various types of electric apparatus.

Recommendations approved by the appropriate technical committees are recognized by all member countries as expressing as near as possible an international consensus of opinion on the subjects considered. Each country makes every effort to harmonize its national standards with these recommendations insofar as national conditions permit. If something different is required, the standards can be guides to assist in achieving greater harmony in the future.

From the time IEC started in 1904, its membership has been distinguished by leading men in the electrotechnical field. Some idea of the importance attached to international standardization is indicated by its officers. Lord Kelvin's presidency was followed by Professor Elihu Thomson of the United States in 1908. Then in 1919 Dr. C. O. Mailloux, also of the United States, was elected President. James Burke, President of the Burke Electric Company, represented this country as President of the IEC in 1935, and Dr. Harold S. Osborne, former Chief Engineer of the American Telephone and Telegraph Company, became IEC President in 1952.

The U.S. National Committee of the IEC is the official member for the United States. Our participation in IEC was supported by four engineering organizations under the leadership of the AIEE until about 1930, when the responsibility for the U.S. National Committee was transferred to the American Standards Association. Since that time the U.S. National Committee has been identical with the Electrical Standards Board of the ASA, plus representatives from the ASME and a number of members-at-large.

Over the past five years the United States has had a large delegation attending the IEC Annual Meetings held in Stresa, Italy; Paris; Estoril, Portugal; Scheveningen, Netherlands; and Opatija, Yugoslavia.

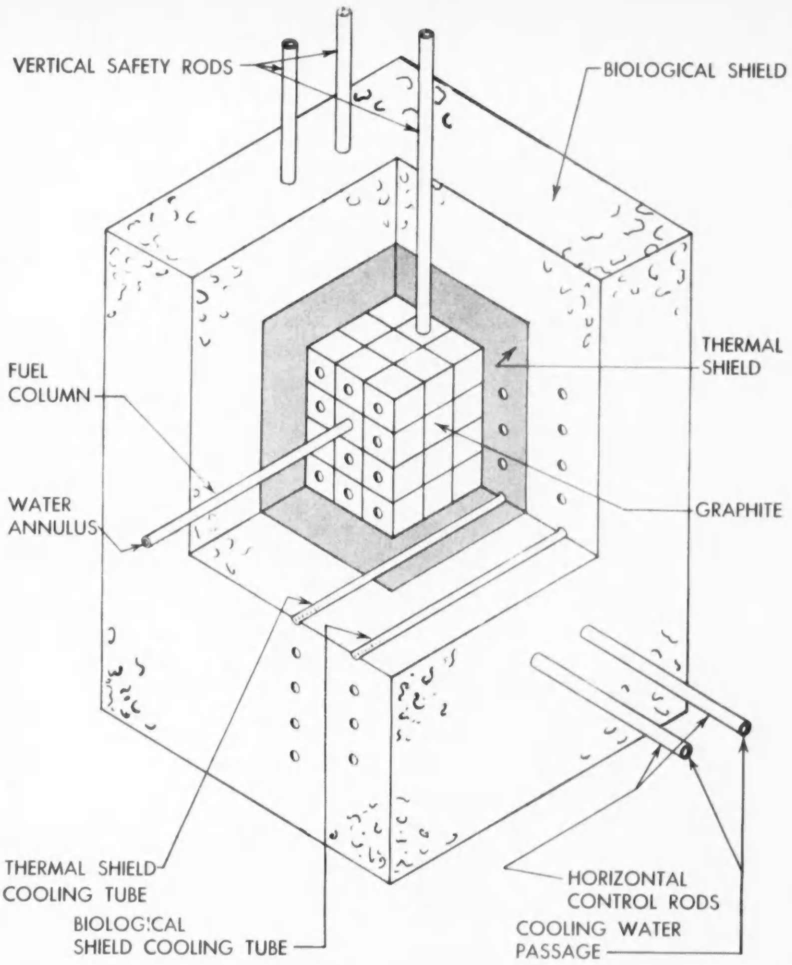
The 1954 Annual Meeting of the IEC will be held at the University of Pennsylvania in Philadelphia, Sept. 1-16 (photo, page 47). The U.S. National Committee will be host to more than 400 delegates from about 25 nations. A General Committee, under the Chairmanship of Philip H. Chase of the Philadelphia Electric Company, has made plans for 224 meetings of more than 40 technical committees. Walker L. Cisler, President of the Detroit Edison Company, is Chairman of the Finance Committee, which will provide the necessary funds to carry on the 1954 Jubilee Meeting in the U.S.

The IEC will be 50 years old this year, and an appropriate Jubilee Day Program is being planned for September 9. Four speakers of international prominence, under the Chairmanship of Dr. Harold S. Osborne, will deliver addresses commemorating the occasion: M. P. Ailleret of France will speak on power; Dr. Haaken Sterky of Sweden on communications; Lord Waverly of the United Kingdom on foreign trade and general; and Dr. L. A. DuBridge, President, California Institute of Technology, on science. The U.S. National Committee will be host to the foreign delegation at a banquet; Don G. Mitchell, Chairman of the Board of Sylvania Electric Products, Inc., will be the principal speaker.

Economy Is the Keynote

The one basic reason for standardization is economy. A number of supplementary advantages—obtaining a better or more uniform quality, simplification, and convenience in doing business—may be apparent. But these, too, have a direct bearing on cost, and the final result is that with standardization the costs are less than they would be otherwise. Out of this economic picture grow so many advantages that we can say standards make for greater productivity for a higher standard of living.

On an international basis, standardization meetings provide an atmosphere and an opportunity for mutual technical help, a better understanding, and a sound basis for working together, thereby building mutual respect and gaining friends. Sharing our vast experience in the use of standards with friends and allies in the western world can help them become stronger, improve their personal security, and help them provide a higher standard of living. Ω



GRAPHITE-MODERATED REACTORS similar to this will produce commercial power in 5 to 10 years. Still a major concern of the reactor engineer is the design of facilities for . . .

Cooling the Nuclear Reactor

By G. M. ROY and G. L. LOCKE

Removal of thermal energy—heat—is the principal item that affects the cost of producing plutonium from uranium in the graphite-moderated reactor (Table, next page). For a given reactor the amount of plutonium produced is directly proportional to the thermal energy generated. Reduced to its simplest terms, a major concern of the reactor engineer is the design of facilities that will generate and remove the maximum quantity of heat for the minimum number of dollars.

Many problems are associated with the design of graphite-moderated reactors (illustration) at the Hanford Atomic Products Operation in Richland, Wash., operated by GE for the Atomic Energy Commission. Once a reactor is built, for example, its design cannot be altered to any major degree because of the importance of the spacing and the size of every part. The design must be essentially correct before the reactor is constructed. Even maintenance can be accomplished only with great difficulty and cost because reactor materials are contaminated with radioactivity.

Another consideration is that the reactor's structural materials—their quantities and physical geometry—must be evaluated from the nuclear as well as the heat-transfer standpoint. By improper design in this respect, the ability of a reactor to sustain a nuclear reaction can be destroyed, because the neutrons required to keep the fission process going can be absorbed by the structural materials (page 41, March 1954 REVIEW).

Big Problems

The fission of uranium-235 (U-235) when it captures a neutron results in the liberation of large quantities of energy; most of this manifests itself as thermal energy, or heat. The largest portion of this energy is generated on the spot in the fuel element where fission takes place. A smaller percentage is generated in the moderator. Other secondary sources of thermal energy are the control rods and shields.

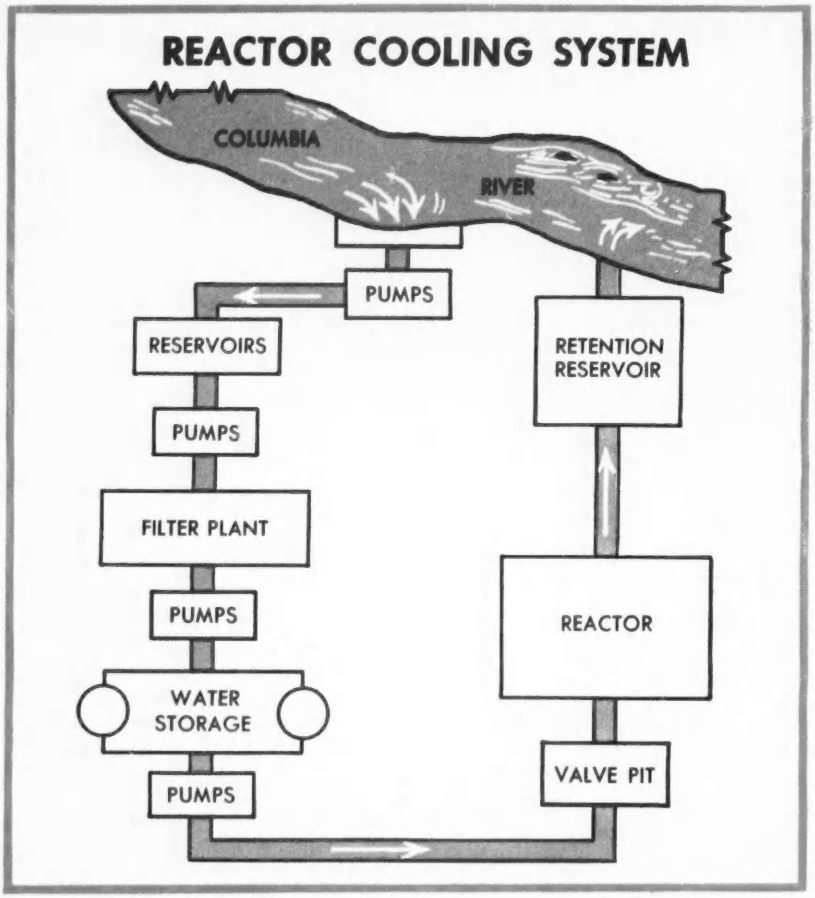
Several unique problems are involved in cooling a reactor. The most significant are . . .

- Loss of coolant—The coolant is a neutron absorber, and its loss in certain reactor designs could result in a rapid increase in the rate of energy generation.
- Coolant stoppage—It's impossible to instantly shut off the total source of thermal energy; hence, stoppage of the cooling water must be gradual.
- Neutron absorption—Structural materials and geometry of the cooling system within the reactor must be such that the materials of the system won't compete with uranium for neutrons.

The first two considerations make reliability of the cooling system (illustration, next page) of utmost importance.

Although the operating temperatures within the reactor are not high, the energy intensity is. Loss of cooling water for even an instant would quickly cause the temperature to rise and could result in permanent damage to the pile materials. You get a better idea of the seriousness of this situation when you consider that loss of cooling water in certain designs makes available a large number of neutrons for additional fissions—increasing thermal energy generation at an extremely rapid rate.

Because the generation of thermal energy persists for some time after all control rods are in, a complete stoppage of water at the time of shutdown isn't



UNIQUE PROBLEMS involved in cooling a reactor include loss of coolant, coolant stoppage, and neutron absorption. The first two make reliability of the system extremely important.

PLUTONIUM FROM URANIUM

Plutonium—a man-made radioactive element—has essentially the same fissionable characteristics as uranium-235 (U-235) and an unusually long half-life of 24,100 years. Thus it can be used in place of U-235 and stored almost indefinitely without deterioration, making it particularly valuable as fission material.

Graphite-moderated reactors are used to produce plutonium from purified uranium ore. Purified uranium consists of 139 parts nonfissionable U-238 to one part fissionable U-235. And essentially the process involves converting U-238 to fissionable plutonium.

For every neutron captured by an atom of U-235, an average of two to three neutrons having high kinetic energy are released. (Kinetic energy is proportional to the square of speed.) But these neutrons are useful only when they are captured by U-238 or other U-235 atoms. Neutrons captured by U-238 produce atoms of plutonium; those captured by U-235 atoms release more neutrons. Thus to sustain the chain reaction, at least one neutron per fission event must be captured by an atom of U-235.

The probability of a U-235 atom capturing a fission neutron is small, however, unless the neutron's speed is reduced about 10,000 times. In practice, fission neutrons are slowed down by collision with atoms of the moderator—graphite in this instance.

permissible. To insure that a sufficient amount of water will flow through the reactor at all times, emergency water supplies must be incorporated into the cooling system. Should power to the pumps fail, flywheels can be used on the principal pumps (photo, top, opposite page) to supply adequate water for the high transient flow requirements. After a few seconds, a smaller emergency water supply is sufficient to cool the shutdown reactor.

The third consideration in the design of a cooling system is the choice of structural materials and the system's geometry. Because the bulk of all thermal energy is generated in the fuel element, the emphasis here is on good heat transfer from the fuel element to coolant. Accordingly, the system is so designed that the coolant flows next to the fuel element.

Control of the nuclear reaction and the shielding of operating personnel introduces additional heat-transfer problems. For energy is generated by the capture of neutrons in both the control rods and the shield. Cooling water to these points is therefore diverted from the main pumps at the valve pit (photo, lower, opposite page).

The control rods must be cooled merely to keep them from reaching temperatures that would destroy the materials they are made from or shorten their lives by corrosion and warping. On the other hand, the shield is in part a structural member of the pile and cannot tolerate the weakening effect of high temperature gradients. High temperature would also destroy its shielding properties. (Cast iron might be used for the inner shield, heavy aggregate concrete for the outer shield.)

Liquid vs Gas

The large quantity of heat transferred in a reactor dictates the choice of a liquid instead of a gas as the cooling medium because of its superior heat-

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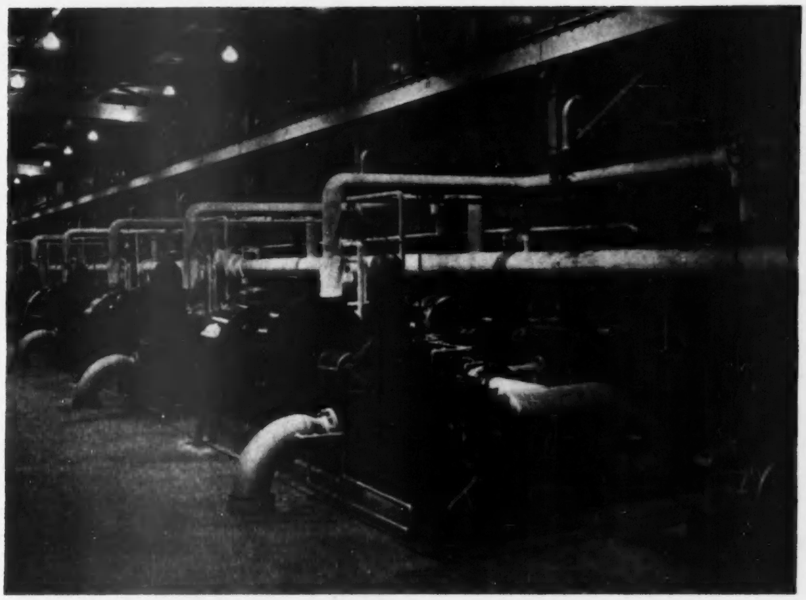
As Study Engineer, Atomic Power Study of the Atomic Products Division in Schenectady, Mr. Roy is responsible for reactor design phases of studies to determine the engineering and economic merit of reactors for the production of electricity from atomic fuels. He joined General Electric five years ago. Mr. Locke, who has been with the Company since 1950, is an engineer in the Reactor Design and Development Unit at AEC's GE-operated Hanford Atomic Products Operation in Richland, Wash.

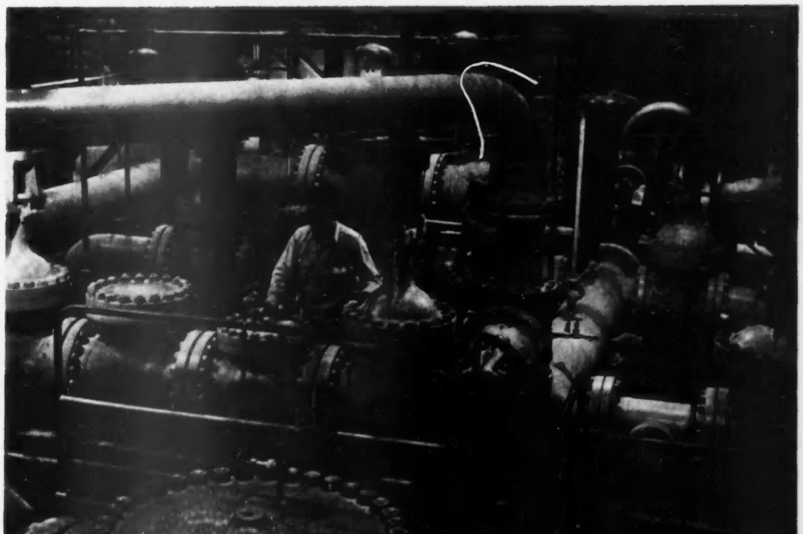
transfer characteristics. This choice can't be made purely from heat-transfer considerations; it must also satisfy several criteria of neutron physics. The main criteria are that 1) the fluid shall have a low probability for neutron capture and 2) the fluid shouldn't become highly radioactive in going through the reactor.

Fortunately, water can be made to satisfy both the physics and heat-transfer requirements by the proper choice of geometry and water velocities. So great is the heat-transfer intensity that high water velocities must be used to decrease the heat-transfer resistance between water and fuel elements. This resistance is caused by an extremely thin, slowly moving film of water that clings to the surface of the fuel element. The greater turbulence of the high water velocities reduces the film's thickness.

There's a possibility of reducing pumping costs through the use of larger flow areas. But these cost reductions must be balanced against the loss of neutrons that results when a large quantity of water is within the reactor.



MAIN PUMP SETS supply coolant for the reactor's high transient flow requirements. Each set consists of a steam-turbine-driven pump in series with an electric-motor-driven pump.



VALVE PIT is the cooling-water diversion point where coolant from main pumps is directed through the reactor and to other points, such as control rods, where energy is generated.

Power Recovery

The quantity of energy being wasted in the production of plutonium makes its recovery unusually attractive. To recover this energy would, however, require a change in cooling-system-design philosophy; previous systems were designed to assure adequate cooling by discarding thermal energy at low temperatures.

In the present graphite-moderated reactor large quantities of thermal energy are transferred to the cooling water. The temperature of the water leaving the reactor is kept low because of thermal limitations on the present flow-tube materials. And even though all the energy generated in the reactor is transferred to the cooling water, little can be converted to useful work—by turbine-generators, for example—because of the water's low temperature.

It is basic in thermodynamics that the higher the temperature of the energy source the greater is the portion of energy that can be converted to useful work. Accordingly, if cooling water left a reactor at high temperatures, more of the energy in the water could be converted to electric power. One way you could accomplish this with present graphite-moderated reactor designs would be to utilize a heat exchanger in the reactor's outlet water line. Thermal energy could then be transferred from the reactor's cooling water to lower-pressure water in the heat exchanger, transforming the latter into steam. This steam in turn could be fed to a turbine-generator set.

By selecting reactor flow-tube materials to withstand high water temperatures and pressures, it would be possible—and feasible—to construct graphite-moderated reactors that would produce both plutonium and large quantities of electric power at commercially competitive rates. Ω

Industry Promotes Study of the Three R's (PART II)

- **Whatever career a young person in high school or college chooses, his success will depend largely on how well he has studied the English language.**

- **To be proficient in the art of communicating one's thoughts and ideas is a requirement both of making a good living and enjoying a full life.**

Our May issue carried a reprint of General Electric's booklet "Why Study Math?" as Part I of this series. Response from our readers continues to be overwhelming—requests exceed 10,000 copies. It's even more overwhelming when you consider that the Company distributed 1½ million copies before the reprint appeared in the REVIEW.

It is gratifying to our staff to receive these requests and note the sincerity and earnestness that prompts them. From the excerpts that follow you'll see the varied uses for copies. . .

I am anxious to obtain two or three copies of "Why Study Math?" for my use in guidance clinic work.
Research Dept., Ray-O-Vac Co.
Madison, Wis.

As a member of our Education and Training Committee, I feel that copies of "Why Study Math?" will assist our efforts.
Manager, Engineering Laboratory
Pangborn Corp., Hagerstown, Md.

Members of our Counseling Center read with appreciation "Why Study Math?" It expresses . . . aspects of a problem which confront counselors.
Counselor, George Washington University
Washington, DC

The Ridgway Section of AIEE sponsors a yearly $1200 engineering scholarship. "Why Study Math?" will be valuable for the schools involved.
AIEE, Ridgway, Pa.

As a member of the Board of Education, I will be presenting diplomas to my son's Junior High class and would like to give each one "Why Study Math?"
Tool Supt., Weaver Manufacturing Co.
Springfield, Ill.

Does it seem somewhat strange that General Electric, a large industrial manufacturing company, is also interested in promoting the study of English? Not when you consider that the study of one's own language is basic—a necessity far exceeding all other study. In our complex society the written and spoken word is the key to all communication.

And industry eagerly looks for the articulate young man or woman who can readily express his ideas, thoughts, and even feelings. The application of our language to the art of communication can mean the difference between relating an incident expressively or boringly; writing imaginative or stuffy letters; reading articles so written that you eagerly read on and regret coming to the end or articles that you plow through and toss aside before you're half finished.

Both in and out of industry the articulate can progress along many avenues. Even the scientist, the engineer, and the technician must rely on their own ability to communicate to others in the form of letters, reports, articles, and the spoken word.

If you are closely associated with high school students who turn thumbs down on English, or if you have sons and daughters of your own to influence, one young man's experience may help them understand its importance.

After graduating from college and serving in the army, he went into the advertising business. About two years later he remarked to a friend that the men he came in contact with—the space salesmen, account executives, and some vice presidents—all had his admiration because they had plenty on the ball. "Do you know," he related, "that these men quote Shakespeare—the Bible, too, and many of the greats in literature and history! And what's more, it helps them to make their point. They make the wisdom of these writers live by applying it to life."

"When I was in college," he continued, "I thought that stuff was strictly for the birds. I was required to take some English and literature, but I slept through most of the classes. I thought I was so smart. Now I see how really stupid I was." Six months later this chap quit his job and returned to college to *retake* the classes he'd slept through. He is now a Dean in a large Eastern college and, we're certain, guiding and counseling young men to absorb as much as they can from *all* their classes.

If one can be counseled to open his mind to the pleasures of these subjects, he will be amazed at how fascinating and thought-provoking poetry or the major classics can be. And to be well-grounded in such a background opens new areas for the enjoyment of living. The literary magazines of our day—filled with fascinating, timely articles pertaining to science, history, travel, philosophy, art, music, psychology, technology, and most phases of modern living—are read by only a small percentage of our population. If our young people can be educated to become an articulate enlightened generation, their contribution to this age will be manifold.

Briefly, these are some of the reasons why General Electric is so interested in the study of English, and why the REVIEW is reprinting the article on the following pages. After reading it, if you would like to obtain free copies, you may do so by writing to Public Relations Services Division, Dept. 107-2, General Electric Company, Schenectady 5, NY.

—EDITORS

YOU CAN PROMOTE THE STUDY OF MATH AND ENGLISH . . .

By using your influence in various guidance activities with youth groups.

By emphasizing its importance in Career Day programs in high schools.

By encouraging appropriate PTA activities to assure broad mathematics and English programs.

By counseling students of its necessity in any recruiting programs you may participate in.

By transferring your enthusiasm and realization of its need to your own children.

GENERAL ELECTRIC'S ANSWER TO . . .

why study ENGLISH?

IF WHAT Peter Drucker says is true, and we believe it is, you had better do something about your English.

Mr. Drucker wrote an article for the May, 1952, FORTUNE called "How to Be an Employee." He said that the ability to express ideas in writing and in speaking heads the list of requirements for success.

"As soon as you move one step up from the bottom, your effectiveness depends on your ability to reach others through the spoken or written word. And the further away your job is from manual work, the larger the organization of which you are an employee, the more important it will be that you know how to convey your thoughts in writing or speaking. In the very large organizations, whether it is the government, the large business corporation, or the Army, this ability to express oneself is perhaps the most important of all the skills a man can possess."

It pleases us at General Electric to go on record as supporters of Mr. Drucker's statement. We know, of course, that there are many skills and personal qualifications leading to success. There is no doubt in our minds, for example, that you should have a genuine desire to exchange your best efforts in your employer's behalf for the chance to tackle increasingly more important, more challenging, and more rewarding assignments. We think that you should be able to look a fellow employee, including your boss, in the eye; that you should be reasonably neat and clean.

But right now we have much to say about English.

The top engineer upstairs is on the telephone. He says to us: "Right before my eyes is a brief report made out by one of our young engineers. I have to guess what the fellow is driving at.

I'm no English shark, but I find myself getting a little angry when I see four sentences tied together into one with commas. He has *principle* for *principal*, and he has also misspelled *accommodate* and *Cincinnati*. What if some of this fellow's bad sentences get into the hands of our customers?"

We sympathize, and we say somewhat lamely that it's up to him to suggest that the fellow hire a tutor.

The top engineer is wound up. "At the last meeting of our Association, representatives of all the major companies complained about the way their younger men were putting down their words—and futures—on paper. Can't someone tell us what to do?"

We reach for an answer.

"When boys and girls began avoiding mathematics like the plague," we remind him, "we began printing facts. It is now our duty and privilege to beat the drums for English! Our motives are partly selfish, because we want American business to succeed even more than it has in the past. But our motive is more than self-interest. We know because we rub shoulders with people, at work and in the community, that a solid background in English is prerequisite to happiness and well-being. Without a reasonably good command of English—as a means of communication—and without knowledge of what the best minds of all time have put into print, we are not educated for personal happiness, apart from the job, or for personal success in the exciting business of making a living."

"But I thought all boys and girls took English in high school and college?"

"Yes, they have put in their time. Their teachers have spread the feast, but some of them haven't been very hungry. Perhaps they will listen to us. Their teachers can tell them a thousand times that English is important, but they will say, 'Teacher means well, but she's trying to sell us on the importance of her subject.' Perhaps when a manufacturer of turbines, generators, jet engines, lamps, room air coolers, toasters, refrigerators, and 200,000 other electrical products says English is of tremendous importance, they will listen. After all, English is almost as important as math in our business, isn't it?"

The engineer's answer is deliberately emphatic: "Change the word *almost* to *just*, and, brother, you've said a mouthful! Tell them that English is important to them—and to us—because very soon their ability to read and to know and to remember what they have read, and to speak and to write well, will make all the difference, whether they and we or some other company of their career choice will succeed together."

At one time or another, all of us try our hand at writing.

A group of engineers applies the new principle to the development of a revolutionary type of gadget. The results of this effort are summed up in a typewritten report to the head of their department. The report is then mimeographed for the benefit of others in the organization.

The company prepares to put the new product on the market. Writers prepare literature describing its virtues, or explaining how to use it and keep it in working order.

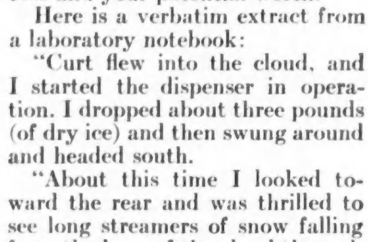
This is indeed useful writing. No piece of company business can begin, progress, and achieve its purpose without the use of words. Writing, together with reading, is as much an integral part of the electrical manufacturing business (or any business) as your bones are part of your body.

Every day in your future you will be called upon to speak and write, and when you open your mouth, or write a letter or report, you will be advertising your progress and your potential worth.

Here is a verbatim extract from a laboratory notebook:

"Curt flew into the cloud, and I started the dispenser in operation. I dropped about three pounds (of dry ice) and then swung around and headed south.

"About this time I looked toward the rear and was thrilled to see long streamers of snow falling from the base of the cloud through which we had just passed. I shouted to Curt to swing around, and as we did so we passed through a mass of glistening snow crystals! We made another run though a dense portion of the unseeded cloud, during which time I dispensed about three more pounds of crushed dry ice . . . This was done by opening the window and letting the suction of the passing air remove it. We then swung west of the cloud and observed draperies of snow which seemed to hang for 2–3000 feet below us and noted the cloud drying up rapidly, very



similar to what we observe in the cold box in the laboratory . . . While still in the clouds as we saw the glinting crystals all over, I turned to Curt, and we shook hands as I said, 'We *did* it!' Needless to say, we were quite excited."

This extract is from the laboratory notebook of Vincent J. Schaefer. It is of historical significance because it describes the first artificial snow making outside the General Electric Research Laboratory. Without such record, other men could not have understood the purpose, procedure, and effect; would not have had a starting point from which to take off on their own investigations.

Since its beginning in 1900, the Research Laboratory has published nearly 2000 papers in technical journals, and these have recorded new facts, new basic discoveries, and new theories. Many are recognized the world over as classics, and are cited as authoritative references in their fields. Some opened up wholly new fields for exploration. Others cast new light on known phenomena. Some disclosed new tools for research.

But the recording of ideas and facts is not confined only to the

engineering and scientific laboratories. Each year, thousands of General Electric mechanics, stenographers, accountants, and others write down their suggestions for improving company products and procedures. To each whose suggestion is adopted is given a certain amount of money, but we suspect that the real gain—for company and employee—is the focusing of attention upon those persons who can think of a better way and who can tell about it with words on paper.

We thought little of it at the time, but one night several of us were visiting over the back fence, and a college boy, home for the summer, joined us. He told us how he was enjoying his summer job as helper on a General Electric truck. We asked him who his boss was and how he liked him. He gave us the name and said, simply, "I like him very much. He is a well-spoken man." We think that you, too, if you will stop to think, prefer well-spoken men and women.

You will probably grant that General Electric knows a thing or two about its various specialties, but you may question whether our expertness extends to the English part of the education field. Let's get off the hook directly: your English teacher has probably forgotten more about the teaching of English than we will ever know. As a matter of fact, if someday your employer finds you wobbly in English, he will be critical of you, not some long-suffering teacher or parent.

One of our business colleagues, who would hate us if we gave away his name, has an interesting background. Early in his growing-up years, he dropped schooling so he could earn enough money to buy a Stutz roadster. Eight years later, after working in a shoe factory, another powerful desire took possession of him. He wanted a Harvard degree. For one year he studied all the specified high school subjects; he read everything he could lay his hands on. Then he took all the required high school examinations and passed them with an average of 95 per cent. At Harvard, he kept on reading everything he could squeeze into four years' time. To make a long story short, he's now doing better than all right.

Attitude makes all the difference!

If you are one of those "dese" and "dose" guys, and if it "don't make no sense" to you that your school and your employer "wants" you to become a literate person, all the teaching skill and the modern facilities can't win you over.

Did you ever hear of a mental block? It's a massive barrier in your mind, but like the Maginot Line, it can be penetrated.

That block may be mathematics or history or spelling or perhaps a feeling that no one likes you or something else. Do you remember how you learned to swim? You had flailed the water and sunk like

a stone. But then a fortunate stroke propelled you forward, and now it doesn't occur to you when you dive off the board that you may not be able to swim to shore.

Too, your mind may be blocked because you imagine all well-read, literate persons are precious, prissy characters who go around spout-

ing Shakespeare. There may be a few of those people, but that is not Shakespeare's fault. We are just realistic enough to believe that some of the master poet's gracious writing style will rub off on you. We know that in a sense we become a part of what we read, and that what we call writing style is born from our unconscious attempt to imitate what we like.

We hope it has occurred to you that English extends beyond a single classroom; that your success or failure in your other classrooms is largely due to your ability to read, to understand, to speak, and to write. English is just as all-embracing in a business organization. Whether we are at drafting board, desk, machine, or calling on customers, we are involved more or less in communication.

We say that English—especially to American boys and girls—is an easy language to learn. Making English behave may be a little troublesome. You can play safe by writing dull little sentences, and they, of course, are less frustrating to the reader than involved wrong sentences. But since the sentence you write or speak is what the reader or listener uses as a criterion in judging you, it is good sense to learn how to become its master.

We know from our experience at General Electric that too many of our younger employees say to themselves before spreading their wings for a flight with words: "But if I write that report the way I *feel* it should be written, my boss will think that I am a child." If an engineer, for example, is testing an insulating material and it chars and smells like burned string beans, we can think of no reason why he should not say so.

Our business world needs young people whose minds are packed with facts, but with the boldness of imagination to release them in a form that is easy and pleasant to take.

We have on our desk copies of the GENERAL ELECTRIC REVIEW and the SCIENTIFIC AMERICAN—both written for thousands of top-flight engineers and scientists. The editors of both magazines know that factual reporting is necessary so that their readers, who are so brilliantly expert in many fields, will have confidence in the authority of their articles. But they know, too, that men and women, whatever their job or profession, are willing to begin and stay with an article only if it is well-written. Only you can guess how many books and articles you have thrown aside after tasting the first few paragraphs. Everyone who reads and listens is so very human.

Without interested readers, whether the magazine is SCHOLASTIC or SCIENTIFIC AMERICAN, its survival depends upon

the skill and labor-of-love that editors and authors lavish upon it. Your survival, too, as the adult you are aiming to be, depends upon your ability, desire, and courage to put your best foot forward in a world that will judge you by your words as well as your actions.

Who is the next most important man or woman in your life? We aren't thinking of the next prom date, but an understanding person who is sitting at a desk studying a filled-in application blank. Whether he's a college admissions or an employment officer, he hopes he is so right before saying *yes* or *no.*

Can you live up to your expressed desires? Will you fit in? Have you enough preparation, enough intellectual background? Can your brain direct your hands in performing skills? Can you stand the pace of competition? Can you accept responsibility? Will you worry a workaday problem, like a dog with a bone, till you have conquered it—and then brace yourself for a tougher assignment?

If what you have said on the application blank shows a glimmer of hope, you are brought in for a personal interview. This can be rough going if you haven't habituated yourself to accurate and well-organized expression.

The interviewer across the desk from you has been charged by his college or company to weigh your worth; he has accepted the responsibility of determining the future of the organization he represents—any good organization is but the lengthened shadow of qualified men.

Your job interests. Your participation in school activities. Your subject preferences. Your hobbies. Your ambitions. These and many other topics are brought forward for you to discuss.

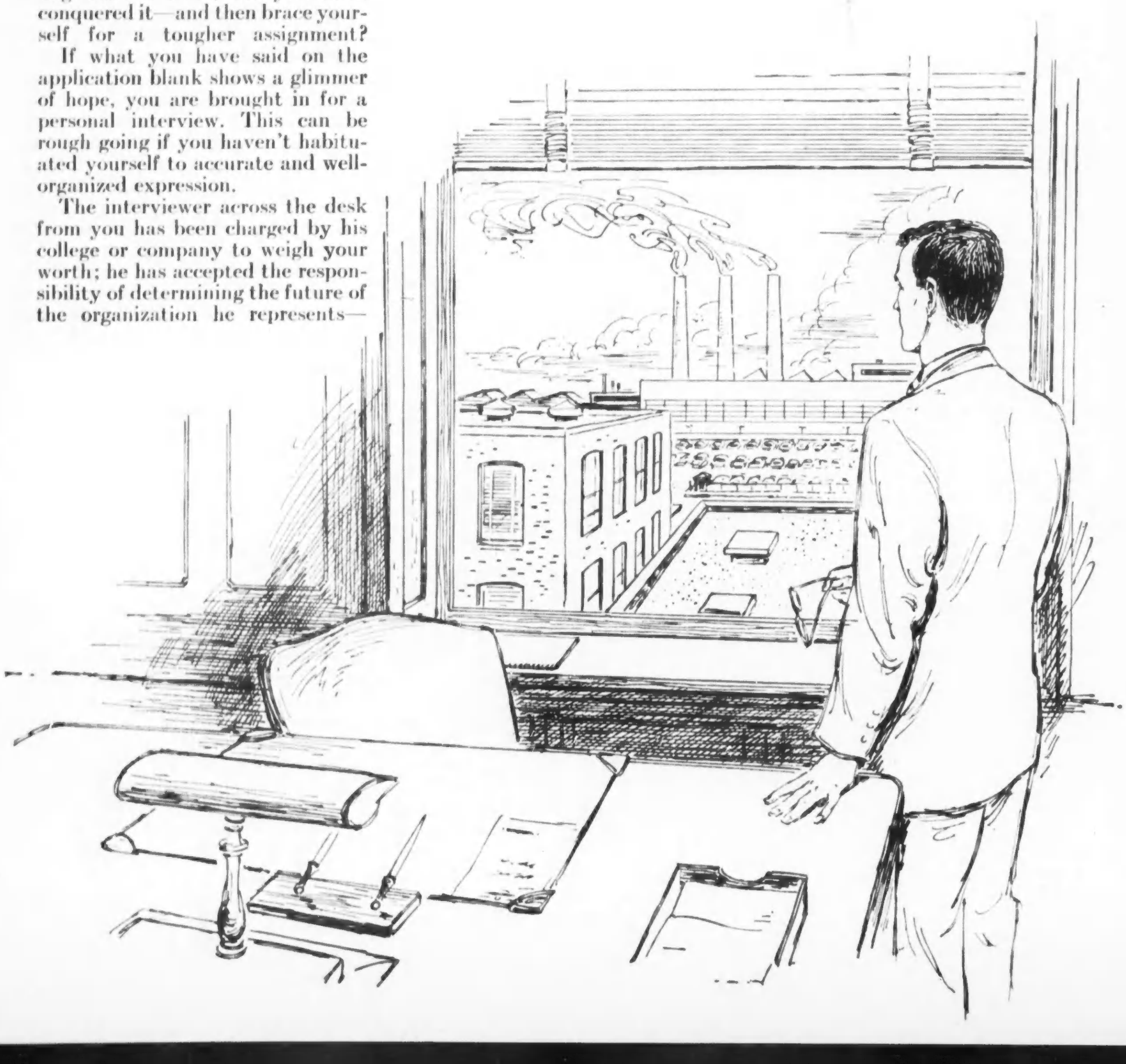
The minutes speed by. You summon up the skills of presentation you have practiced in English and other classes. It strikes you, as you talk, that in neither writing nor speaking can you conceal your inadequacies.

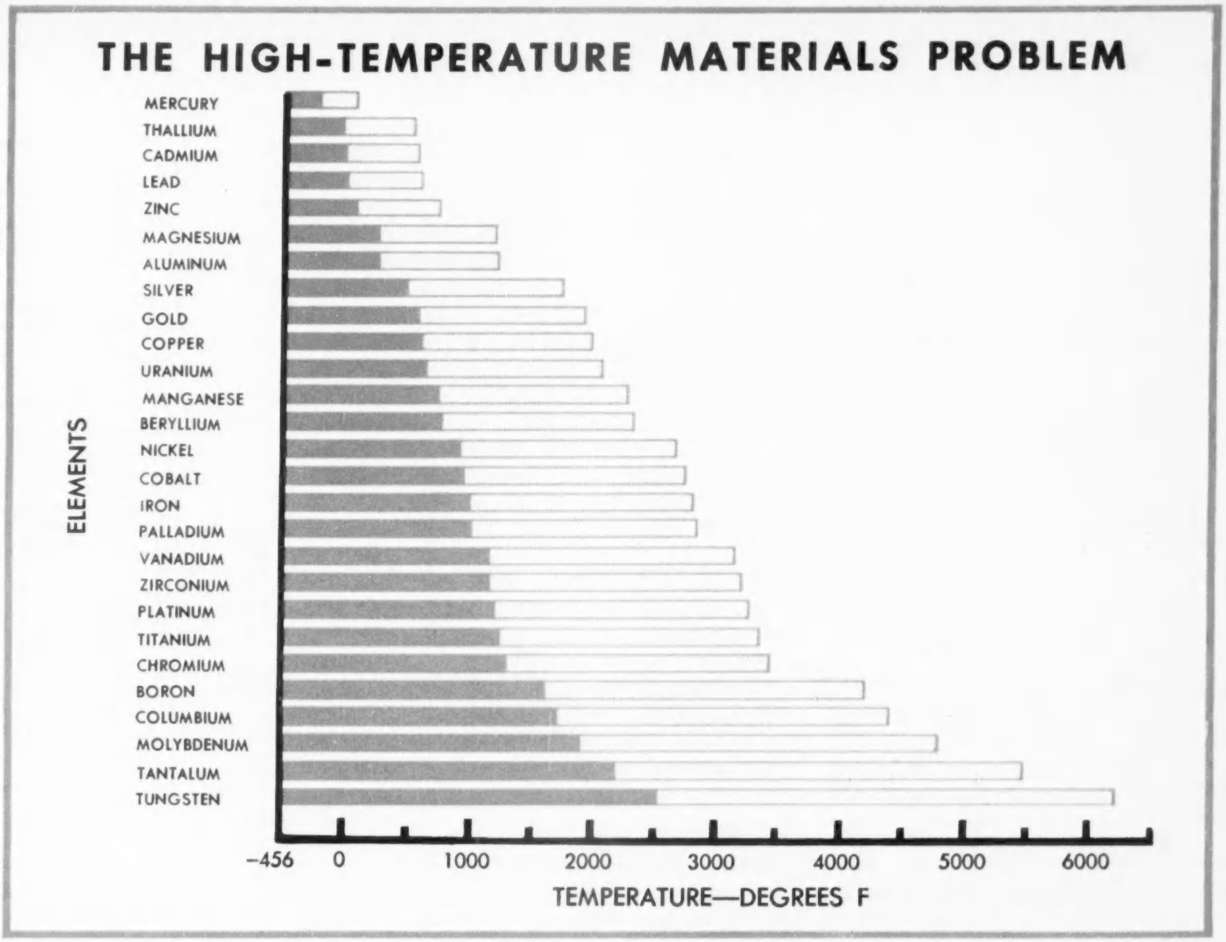
As you move up the success ladder, what you write and what you say will determine in part your rate of climb. It is neither too early nor too late to become practiced in the art of communication; certainly not too late to accumulate background through reading experiences. . . .

We pause and listen to the unceasing whine of a motor across the yard. In the distance three green-gray columns of smoke are rushing upward from three yellow-brick chimneys. We see them as symbols of mechanical might controlled by the will, the wit, and the intelligence of earnest men. And these men, adventurers and pioneers of industry, can move ahead with their plans, because their own thought processes have been built upon such logical disciplines as history and math—and English.

GENERAL ELECTRIC

SCHENECTADY, N. Y.





DEMARCATION LINE BETWEEN HIGH AND LOW TEMPERATURE BEHAVIOR IS ABOUT HALF THE MELTING TEMPERATURE OF A METAL.

Some Problems of High-Temperature Alloys

By DR. W. R. HIBBARD, JR.

Over the past 10 years, in this age of jet aircraft and atomic power, the importance of high-temperature alloys has been glamorized. The efficiency of power-generating equipment improves considerably with increasing temperature, but the useful strength of metals and alloys decreases rapidly in the high-temperature region. For a long time the limitations of using metals with respect to temperature have been known to restrict the design engineer.

The term "high temperature" is relative—a function of the melting point of the material involved. For example, the melting point of rare, exotic gallium (85.5 F) is a high temperature in relation to room temperature (68 F). On the other hand, temperatures well below zero are high temperatures compared with the very low melting point of mercury (−37.9 F). Usually the line of demarcation between high- and low-temperature behavior is approximately one half of the melting temperature of the metal or alloy concerned (illustration). This temperature separates two different types of behavior when the metal is subject to loads and strains in service, and their distinction is a relatively simple one.

Let's compare the characteristics of a copper paper clip (1981 F) being bent back and forth at room temperature until it breaks with those of a piece of lead (620 F). The paper clip will actually become harder and more brittle during the deformation resulting from the bends. After several bends it will break. But the piece of lead can be bent repeatedly at room temperature without failure and with little evidence of strain-hardening. The casual observation of the plumber installing a lead pipe confirms this point.

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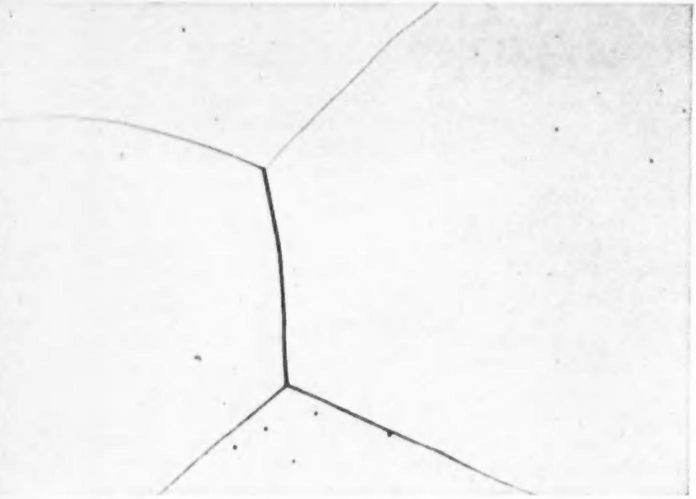
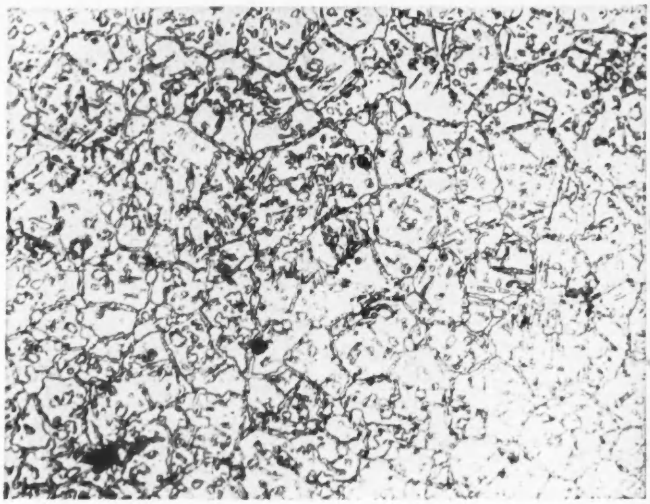
Dr. Hibbard—Manager of Alloy Studies Research, Research Laboratory, The Knolls, Schenectady—has been with the Company three years. His work is primarily concerned with the relationship between properties of alloys and their metallurgical structure, controlled by composition and heat-treatment.





TYPICAL METAL-CRYSTAL structure—at about 100 magnification—appears similar in principle to table-salt crystal but is much smaller. The super-alloy crystal (*above*) containing growth-preventing and strengthening particles is magnified more than 500 times.

Such behavior for lead indicates that in the high-temperature region metals do not strain-harden effectively. Instead they undergo a slow yielding, or stretching, known as creep. Combating creep behavior and developing higher and higher melting materials for higher and higher temperature service are the key problems in high-temperature alloys.

Some Early Developments

During the past 40 years the temperatures of operation for power-generating equipment have risen until during World War II materials were suddenly required for jet engines that operate at as high as 1500 F. The experience involved in this problem was limited, having been approached and solved on an empirical trial-and-error basis.

The fundamental problems in the behavior of metals at this temperature were not well understood. Existing stainless steels were modified with high-melting elements until useful and superior alloys were developed. These alloys sometimes contained as many as 10 elements—nickel, cobalt, iron, chromium, tungsten, molybdenum, titanium, aluminum, columbium, and carbon.

An interesting fact is that one alloy, Vitallium, was originally developed as a dental alloy for cast dentures. Subsequently its high-temperature properties were discovered. These multicomponent alloys consist of a complex mixture of several solid phases—likened in type to concrete, consisting of a matrix of cement with a sand and gravel dispersion. Since the war, steady progress has been made in identifying the various components of these complex alloys and in rationalizing their contribution to high-temperature strength.

The major problems in the rate-controlling processes of creep are now generally recognized, and work is under way to understand and control these processes.

Problem of Creep

Metals consist of a cohesive mass of crystals, or grains (photomicrograph, left), similar in principle to the crystals of ordinary table salt, but they are much smaller and are held together at crystal boundaries. At low temperatures the crystals, and therefore the metal, deform under stress and become stronger as a result of the deformation process. The strengthening is known as strain-hardening. Also, at low temperatures the smaller the crystal size the stronger the metal will be. At high temperatures, thermal energy removes the strain-hardening effects and, in fact, may cause growth of crystals to a point where they become large and weak (illustration, left, next page). In addition, the inherent strength of metals and alloys decreases rapidly with increasing temperature in the high-temperature region.

Therefore, one problem in avoiding creep is the prevention of this strain-induced crystal growth. A solution may be locating small particles of a second type of solid, such as the sand in concrete, at crystal boundaries under conditions where they serve as a barrier to the growth of crystals. These growth-preventing particles should be strong and stable at operating temperatures. Often they consist of components of the type used in cemented-carbide tools, known for their strength at high cutting speeds and temperatures.

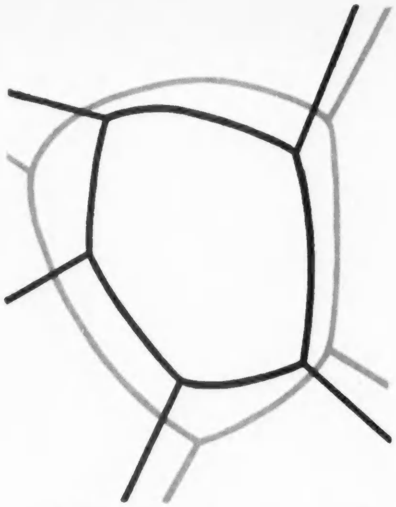
Another problem is increasing the inherent strength of the metal. Strengthening may be accomplished by dissolving in the metal other elements that are effective solution hardeners. The formation of a dispersion of small particles of other phases, such as the gravel in concrete, throughout the interior of the crystals causes effective strengthening.

These phases should also be strong and stable at operating temperatures. A typical crystal structure of a super alloy containing growth-preventing and strengthening particles is shown in the photomicrograph, above, right.

Problem of Melting Temperature

Because the melting temperature of the metal determines the range of high-temperature behavior, it's not surprising that the high-melting metallic elements are the promising candidates for service in the red-hot range. Elements such as tungsten, molybdenum, and chromium are being studied. From inspection of the illustration on page 53, you can see that molybdenum and tungsten experience low-temperature behavior at a temperature of 1500 F and might even be useful at temperatures up to 2000 F. Tantalum and columbium, although high-melting metals, are too rare, strategic, and expensive to be used in larger quantities in these applications.

The knee in each of the typical strength-temperature curves for various



HIGH TEMPERATURES can weaken crystals by causing boundaries to grow (*blue lines*).

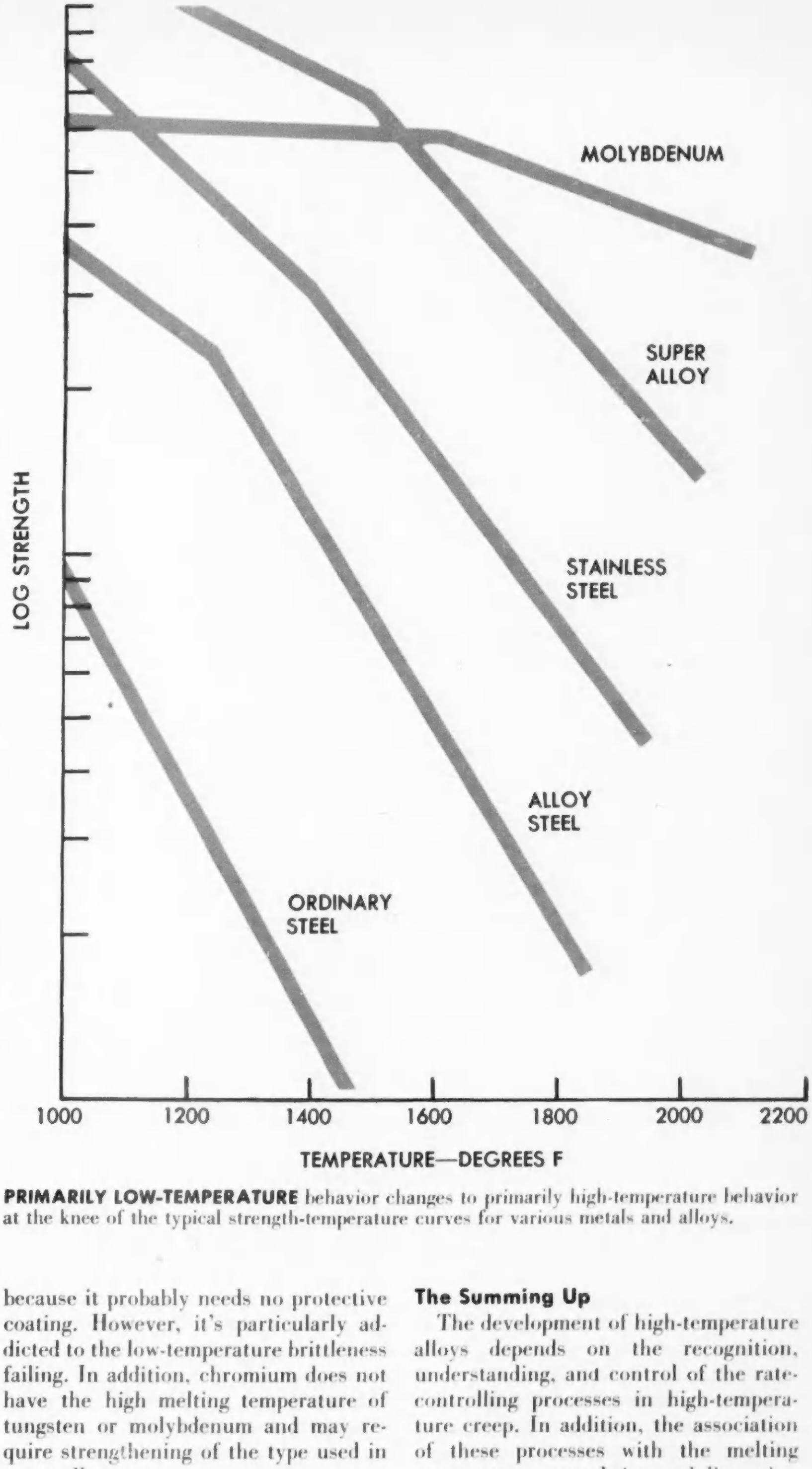
materials (illustration, right) shows the change from primarily low-temperature behavior to primarily high-temperature behavior. At 1500 F and lower the super alloy is superior in strength. At higher than 1500 to 2000 F the superiority of molybdenum increases with increasing temperatures.

For molybdenum, tungsten, and chromium, strength and resistance to creep are not the major problems. Their tendency to be brittle at room temperature is a limiting factor in their use. Under these conditions you can't grind or machine chromium into useful shapes. It thus becomes necessary to study the low-temperature embrittlement of these materials in order to understand the cause of cracks and their extension into fracture so that you may know how such cracks can be avoided. In this area you can apply metallurgical phenomena such as purification, control of crystal size, presence of second phases, and the application of established techniques in manufacturing tungsten and molybdenum lamp filaments to aid in the manufacture of more massive parts such as turbine buckets.

Another problem associated with molybdenum and tungsten is their poor oxidation resistance at high temperatures. In the presence of air they form volatile oxides that deteriorate the solid metal. Thus a method must be developed to protect the surface of these metals from air. Studies of protective coatings are under way, and solutions may be on the horizon.

In one respect chromium is attractive because it probably needs no protective coating. However, it's particularly addicted to the low-temperature brittleness failing. In addition, chromium does not have the high melting temperature of tungsten or molybdenum and may require strengthening of the type used in super alloys.

Tungsten and molybdenum, however, are considerably heavier, or denser, than chromium. Thus they are at some disadvantage as rotating parts because of larger centrifugal stresses, resulting from the weight of the part.



PRIMARILY LOW-TEMPERATURE behavior changes to primarily high-temperature behavior at the knee of the typical strength-temperature curves for various metals and alloys.

The Summing Up

The development of high-temperature alloys depends on the recognition, understanding, and control of the rate-controlling processes in high-temperature creep. In addition, the association of these processes with the melting temperature, crystal size, and dispersion of additional solid components must also be considered.

Other problems that confront the metallurgist include low-temperature brittleness of refractory alloys and protection from oxidation. Ω

Educational TV—

(*Concluded from page 16*)

Langmuir into a physics class, a Maurice Evans into an English class?

But increasing the amount of classical or technical education for students will not be ETV's only contribution. Other areas of education could prove of great benefit to the adult population. Because it can be received by home television sets, educational television could offer evening courses especially tailored to adult audiences. Classes in public safety, public health, how-to-do-it-yourself programs, and many others would be of value.

Courses in elementary psychology such as pioneered by Station KUHT in Houston—the country's first noncommercial educational station—can create new understanding. And courses specifically designed to inspire broader and deeper interest in self-education might well produce an upsurge in learning among adults with sweeping and long-lasting effects.

One of the major criticisms of educational television is its cost. Placing a commercial television station—including transmitter, studio equipment, building, and tower—on the air varies widely in cost. But most commercial operators claim that it can be done for $500,000. The U.S. Office of Education estimates the cost of new classrooms at about $33,000 for each. Using this rule of thumb, one ETV station will cost as much as one 15-room school but conceivably can reach an audience of hundreds of thousands.

Predictions

In spite of exceedingly active opposition to it, I believe we will have educational television in the United States. This I believe because the American people are aware of the great sociological and technological changes that are taking place. They look forward eagerly to many new developments, new devices, new products, and to their advantages measured in less drudgery and more leisure.

Laboratories are pushing back the frontiers of human knowledge. And the pressure always exists to speed new developments and to bring them into completion and use. A civilization that demands such progress will not patiently stand for hesitation and reluctance to make use of the new medium of educational television as an investment in the future. Ω

Teaching Draftsmen—

(*Concluded from page 20*)

in mass production. And because these characteristics are difficult to predict, mathematical analysis tends to be more useful as a guide rather than a firm basis for design. Although formulas indicate relatively critical factors, they do not provide accurate numerical results. For example, the spring force is directly proportional to the thickness of the fingers cubed, to the first power of their width, and inversely to the cube of their length. But when standard manufacturing processes are taken into account, the thickness of the spring stock is the most critical of the three variables.

Next, the student must compare his spring design with the alternative design (illustration, right, page 19). The basis for comparison is left entirely to his judgment; no mathematical analysis is required, but he must justify his conclusions by physical reasoning. Students find this more difficult than mathematical analysis.

Looking Ahead

Although the initial session of the Mechanical Design Training Course was intended to run for only 16 weeks, it was extended to 20 weeks because of an emphatic appeal by the students for further training. What's more, the second year the course was offered, the number of applicants was—like that of the first year—substantially greater than the previously set limit of 20. In short, it appears to be a popular course.

But to what degree are the benefits and objectives of the course achieved? To get an answer to that question we have to analyze the reaction of the students and the opinions of others in the organization—particularly the engineers. For it is the engineers who are in a position to judge the real effectiveness of the course.

An informal opinion survey of engineers who worked closely with students before and after they completed the course had highly satisfactory results. Typical of some of their remarks were: "It's much easier to get across our ideas." "We got the right answer faster." And, "They spotted some troubles that otherwise wouldn't have been caught up with 'til we made a sample—maybe not even then."

We can only conclude from such remarks that design-draftsmen, as a result of the training they received, are effectively increasing their contributions to the total engineering activity. Ω

Home Freezer—

(*Concluded from page 26*)

breaker strip of a thinner, more thermal-resistant material was designed, and a smaller gap was maintained between this breaker strip and the inner door. No strength is required of this new material; the liner is held structurally by the liner supports.

Frosting Rates

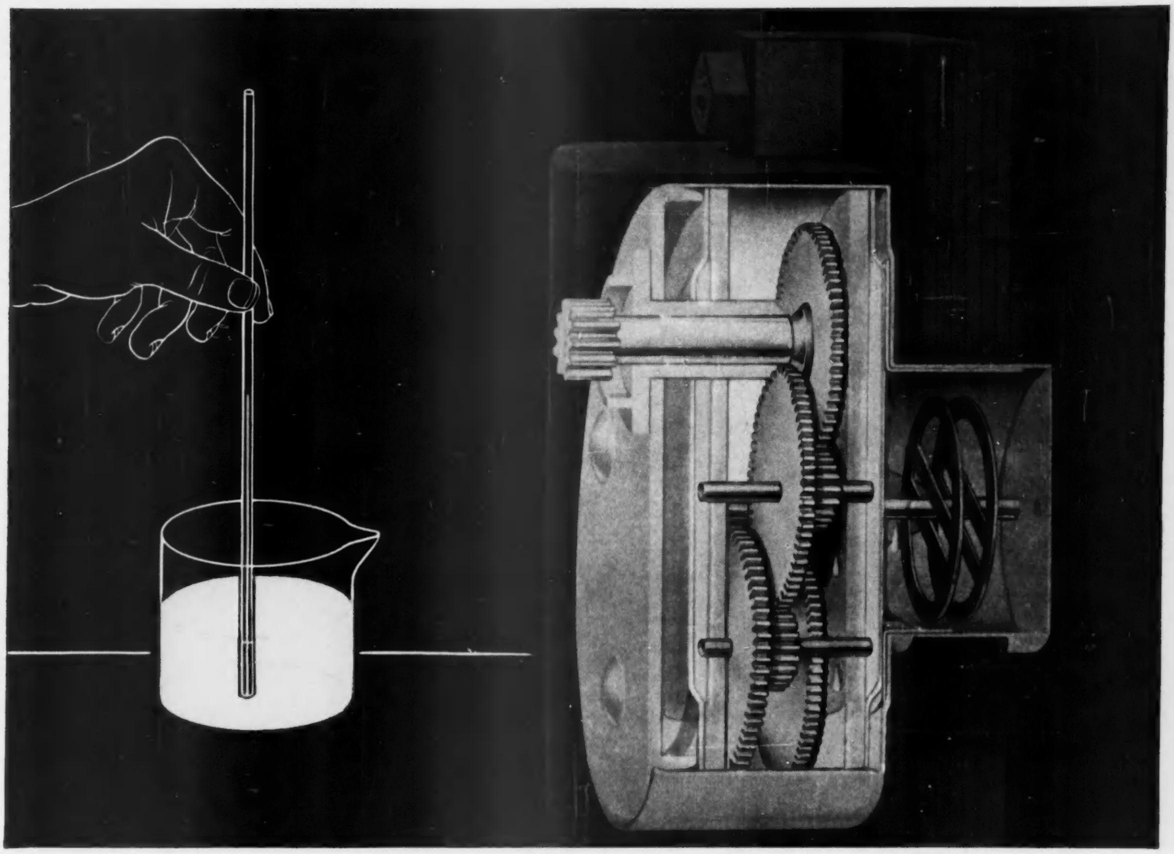
The warm air entering with each door opening brings moisture with it that forms frost on the interior. The upright is reputed to collect frost at a greater rate than the chest because of the greater air spillage. We made tests of this in our laboratory and found that a greater *weight* of frost is collected by the upright than by the chest for a given number of door openings. We then ran a survey of the engineering test freezers in homes and made this conclusion: all freezers need defrosting once or twice a year. To the customer there is no advantage of one type over the other. Although more frost gathered in the upright types, it was fairly evenly distributed over the refrigerating surface and was concentrated near the top of the chest liner. Thus the upright freezer could collect more frost than the chest before it begins to interfere with the operation of such features as baskets, dividers, or shelves. But both freezers require defrosting the same number of times per year.

Noise

The trend to bring the upright freezer closer to the living quarters has led to a greater awareness of freezer noise. Because essentially the same compressor is utilized in both the chest and the upright, the noise level had to be reduced by using accoustical insulation on the compressor case and around the cabinet. By a judicious placement of fibrous glass sound-absorbing panels, the noise decreased to an acceptable level.

Summing It Up

The commercial advantages of the upright freezer were sufficient to cause refrigeration engineers to take another look at its practical and theoretical shortcomings. At a second glance they didn't seem to be nearly so insurmountable. Some problems evaporated; others were easier to solve than was first thought possible. Result? Every major manufacturer of food freezers now offers an upright freezer to the consumer. Ω



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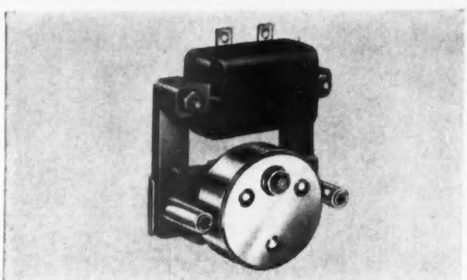

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