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Rose Technic

Member Engineering College Magazines Associated

January, 1956

Edward J. Stolic, class of '48

speaks from experience when he says . . .

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From his graduation in 1948 with a B.S. degree in Mechanical Engineering, until November of that year, Edward Stolic worked as an operating trainee in the Irvin Works of United States Steel. Following his discharge from the Army in 1950, he returned to work at U.S. Steel. In just 18 months, Mr. Stolic reached a management position as Engineer-Lubrication.

By mid-year 1953, Mr. Stolic was promoted to Foreman-Instrument Repair and Sub-Station. In a recent interview he said: "Opportunities for rapid advancement are almost limitless in U.S. Steel." At 27, Mr. Stolic is supervising a force of 30 men in mechanical and electrical tests as well as instrument repair and maintenance of gas generators, compressors and water purification units. He feels that, "The engineer finds many places to apply the knowledge he garnered in school." The men under Edward Stolic are called on to trouble shoot in any part of the mill. This calls for a wide variety of talents and leads Mr. Stolic to say: "The steel industry has expanded greatly, and with it the need for good men."

If you are interested in a challenging and rewarding career with United States Steel, and feel you are qualified, further information is available from your college placement director. Or, we will gladly send you our informative booklet, "Paths of Opportunity." Just write to United States Steel Corporation, Personnel Division, Room 1622, 525 William Penn Place, Pittsburgh 30, Pa.

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JUNE GRADUATES

A General Motors Representative will be on hand to answer your questions about job opportunities with GM

February 13 & 14, 1956

Our College Representatives speak for all of our many decentralized divisions throughout the country.

They are familiar with career opportunities throughout the entire organization, including staff and divisional operations, and can answer your questions fully.

We cordially invite June graduates, and those graduating this summer, to arrange an appointment through your College Placement Office on one of the above listed dates.

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Salaried Personnel Placement, Personnel Staff, Detroit 2, Michigan

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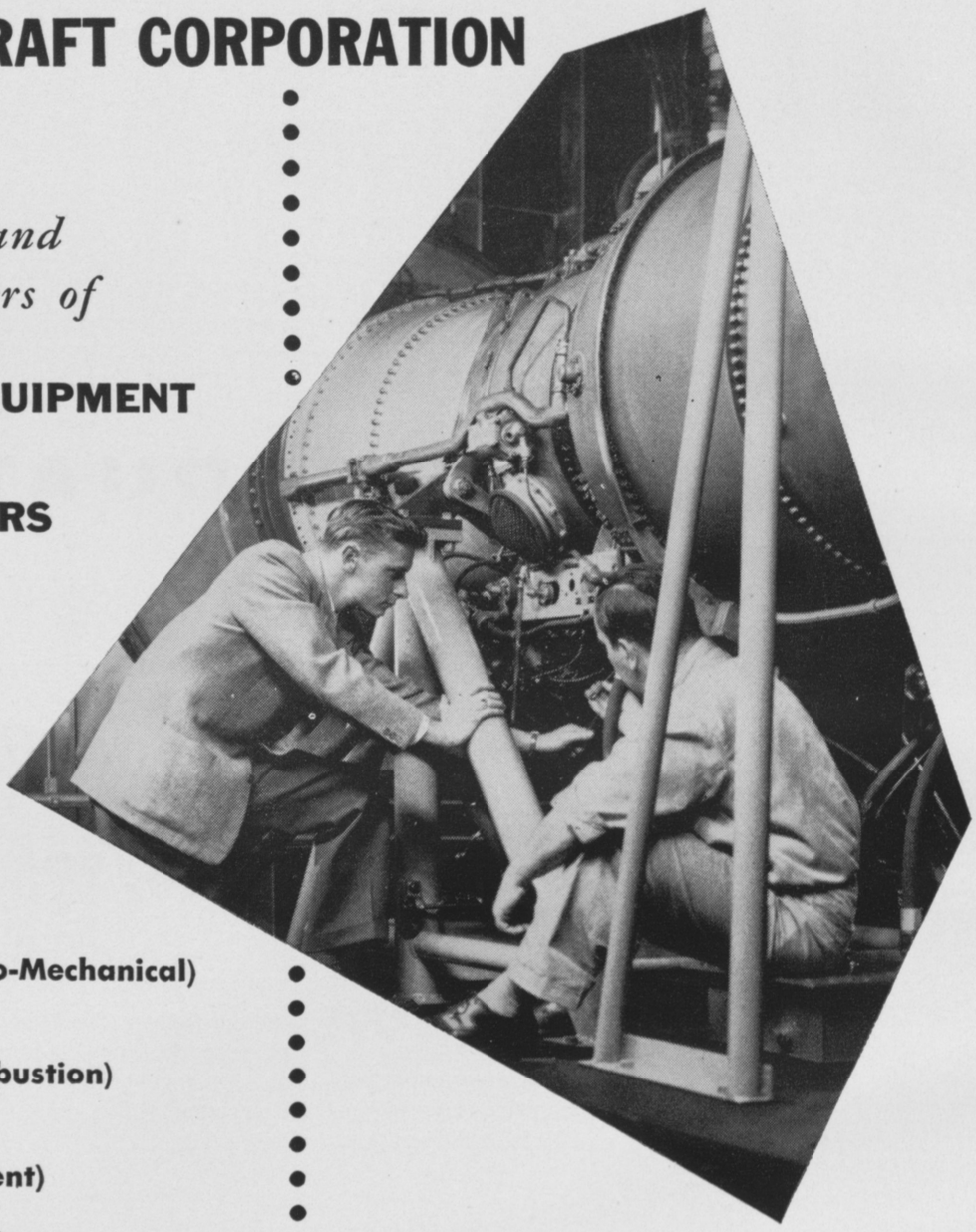

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HAMILTON STANDARD

UNITED AIRCRAFT CORPORATION

HAMILTON STANDARD DIVISION

WINDSOR LOCKS, CONNECTICUT

Rose Technic

VOLUME LXVII, NO. 4 JANUARY, 1956

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The Cover

On our cover is pictured a snow scene showing the front of the main building after a six inch snow fall covered the campus. This signifies the height of the winter season.

PHOTO CREDITS: Cover, Rose Technic Photography Staff; page 14, General Motors Corporation.

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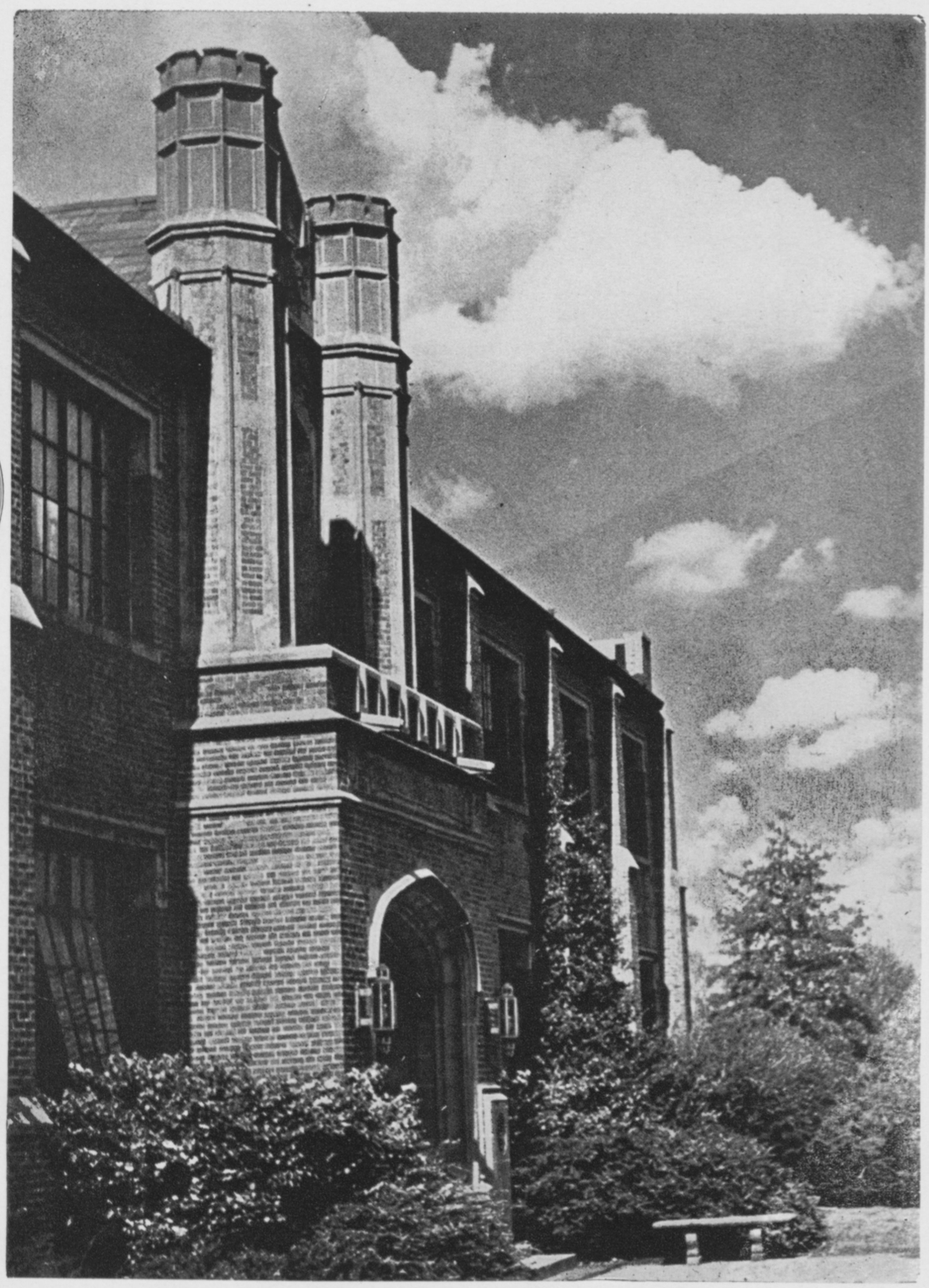

HIGH SCHOOL GRADUATES OF 1956

You are cordially invited to visit Rose Polytechnic Institute during the present school year to learn more about your college entrance and the highly accredited engineering courses available to you at Rose. The next freshman class will be admitted September 10, 1956.

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I am interested in knowing more about your college engineering program.

Please Send

NAME _____

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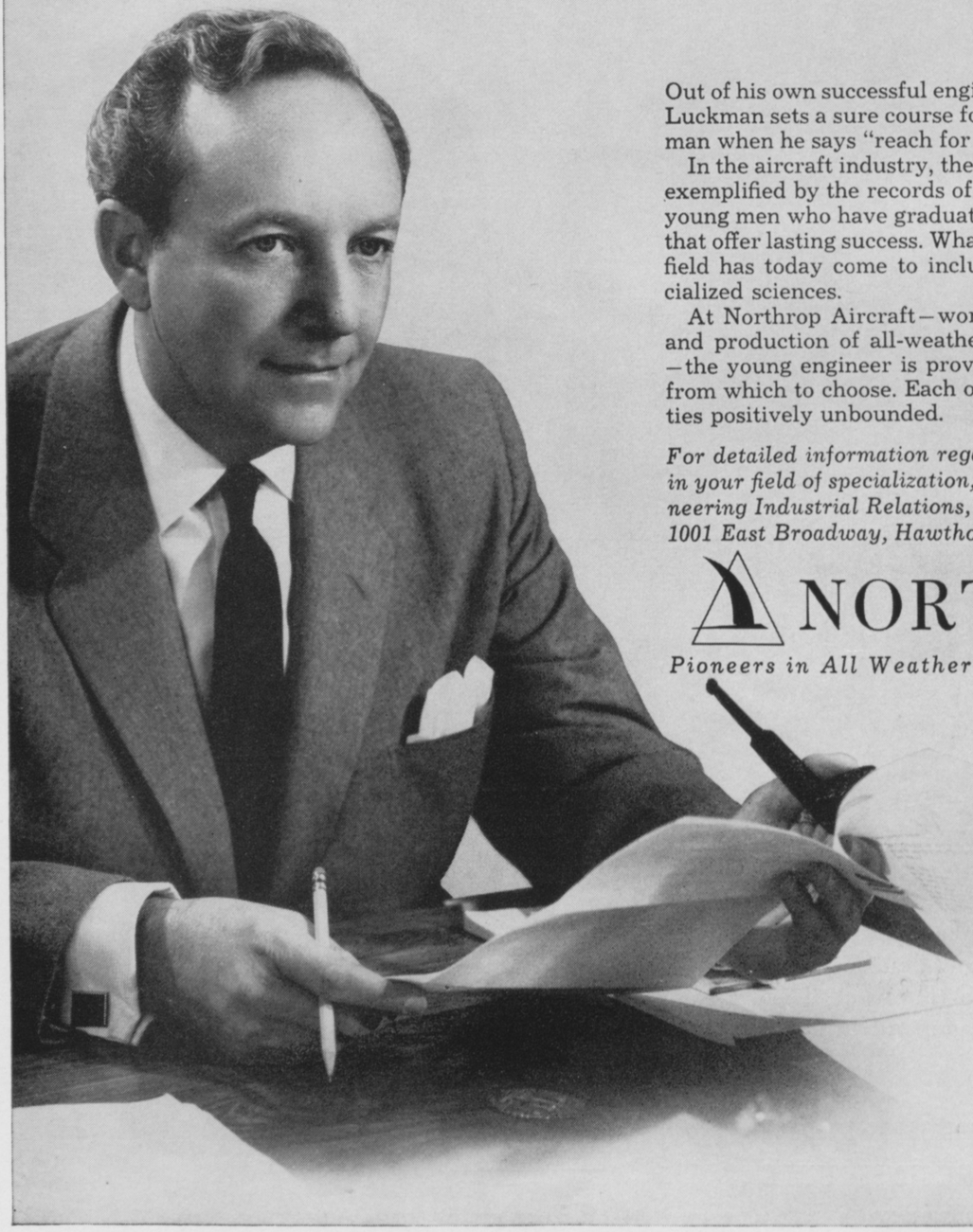
Year graduating from High School_____

"When I look over the fence...

"Since the day when man made his first brief airborne flight, the advance in aeronautics has been little short of fantastic. Tremendous achievements have opened new avenues of progress that were but idle dreams of yesteryear. We live in a new dimension!

"To the young men of today, these new avenues of progress in aeronautics and the related sciences reveal almost limitless opportunities for success. As an engineer in quite another field I am constantly drawn to look over the fence to see what I see. And I am fascinated with the great and fast-growing opportunities that are there. So much so, that to the potent message of a previous century, 'Go West, young man,' I am prompted to add...'Look *up*, young man, reach for the stars, for they lead to great things.'"*

CHARLES LUCKMAN
Partner—PEREIRA & LUCKMAN
Planning—Architecture—Engineering



Out of his own successful engineering career, Charles Luckman sets a sure course for today's trained young man when he says "reach for the stars."

In the aircraft industry, the expression is strikingly exemplified by the records of thousands of far-seeing young men who have graduated into secure positions that offer lasting success. What was yesterday's single field has today come to include a multitude of specialized sciences.

At Northrop Aircraft—world leader in the design and production of all-weather and pilotless aircraft—the young engineer is provided a host of activities from which to choose. Each offers success opportunities positively unbounded.

For detailed information regarding specific openings in your field of specialization, write Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., 1001 East Broadway, Hawthorne, California.

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**From an address to the American Society of Civil Engineers, Los Angeles, California*

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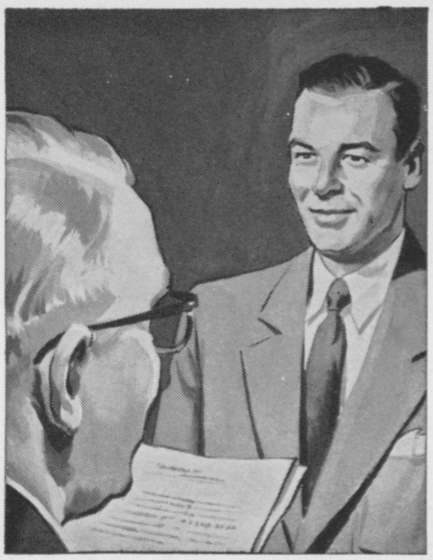

2 You enter into a well-organized training program—a program specifically designed to take full advantage of your particular interests and abilities. You don't just "go back to school." Instead, you *learn* by *doing*, with top-flight supervision.

3 As a trainee you get into every conceivable phase of Delco's engineering operations — engineering laboratory, plant engineering, drafting, sales, processing, standards, quality control. Additional assignments are often made in related departments for broader experience.

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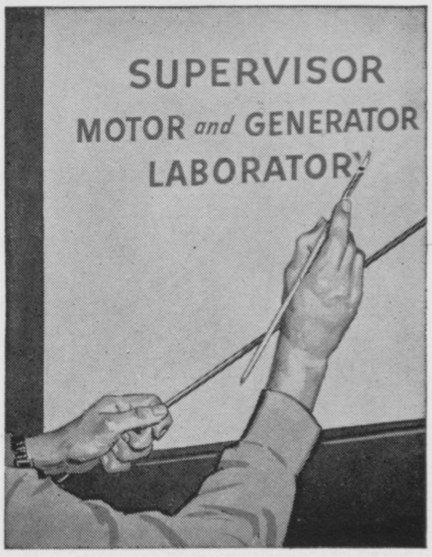

5 With Delco's policy of promotion from within, your opportunities for advancement are virtually unlimited. Not every trainee becomes a supervisor, but some go much farther. Many General Motors top executives today are "graduates" of Delco Products Division.

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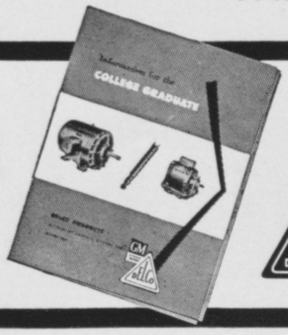


DELCO PRODUCTS

DELCO DAYTON OHIO

GM GENERAL MOTORS

Division
General Motors
Corporation
Dayton, Ohio

Diversification . . .

In these days the demand for engineers is greater than the supply even with the great plea for more engineers by those in our government. Today Russia is graduating about twice as many technically trained people than the United States and hopes to overcome the industrial know-how of our country by using the numerical advantage of technically trained people.

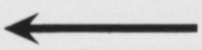
To meet this challenge industry is making it more profitable and desirable to become a technical man. With this incentive many of us tend to specialize only in the technical subjects and become very one sided in our outlook on life. This should not happen as it sometimes does in our colleges.

Every technical school has, or at least should have, a good humanities section to diversify the college man. For a man who knows everything about very little finds it very difficult to see in any direction but the narrow view he takes. Most colleges require some humanities courses, but more should be added to the curriculum.

Everyone should take additional work in this field to broaden the base of their education. The Technic is a fine way to broaden yourself since you can learn about magazine publishing among other things. The staff applications are open to everyone, and those who apply show both school spirit and a desire to broaden their education.

As every February rolls around a new Technic staff takes over the publishing of the magazine. Support them as you have supported us and Rose Technic will continue its long, uninterrupted publication.

C.R.H.



FRONTISPIECE: One of the largest disconnecting switches ever built by Westinghouse is readied for a test in the high voltage laboratory. Courtesy of Westinghouse Electric Corporation.

VACUUM PLATING

By Charles N. Bruner, sr., ch.e.

For the plastic and metal parts manufacturer interested in surface decoration or coating with a metal, a new process has emerged which is destined to rank with other plating processes in many respects. This process, high vacuum metallization, is concerned with applying to some relatively non-porous base material a coating which is abrasion resistent, non-tarnishing, and, where required, pleasing to the eye. This process utilizes a combination of lacquer and a thin film of evaporated metal laid down under a high vacuum.

The greatest use of this plating process is in decorating or applying a reflective coating to such metal articles as die castings, stampings, slush castings, machined pieces, plastic sheets and various novelties.

In the process, three major steps must be considered to produce the metallic finish required. These steps are: (1) Producing a suitable undercoat on which to deposit the plating metal; (2) The producing of the film and (3) Providing a protective coating for the metal film.

The first step mentioned was to provide an undercoat for the metal film. This is necessitated by a number of factors. The small pores in the surface to be coated have to be filled and sealed to rid the piece of any gas traps which would interfere with the plating. Since the surface thickness is in the order of a few millionths of an inch, any and all surface defects would be optically exaggerated by the smooth shiny film. In the case of the base material being metal, the undercoat serves as an insulator against galvanic action between the two metals, and thus prevents corrosive combinations.

This undercoat must meet higher-than-normal standards. Volatiles not evident by examination under atmospheric conditions may come off at the conditions of the chamber while plating and thus cause adverse effects. Good adhesion is important because it largely determines the toughness of the film.

The drying of the undercoat must be carefully controlled. For each material, specified control conditions for moisture, drying temperature and drying time are set up for optimum results.

The second and most important step in the process is the actual metallization under high vacuum. This is actually an evaporation followed by a condensation of some metal, commonly aluminum, in an evacuated chamber. In the case of aluminum the temperature is about 1830° F. and the pressure about one micron of mercury.

The metal boils off and, since it is in a near-perfect-vacuum, travels in straight lines from the point of evaporation until it hits some material on which it can condense. The metal coating is thus provided. This coating has all of the plating metal's properties and characteristics—chemical and electrical. High purity of material is not essential to plating, but the impurities may influence the color of the film.

Although the plating metal is aluminum in 95% of the applications, other metals such as silver, gold, copper, zinc, chromium, cobalt, nickel and selenium may be used. However, aluminum is used chiefly because of its low cost, high reflectivity, and resistance to tarnishing. Aluminum can be easily deposited, and it has been estimated that one pound of aluminum will cover 25,000 square feet of surface area. For aluminum coatings, commercial aluminum wire of 0.0700 inches in diameter may be used in lengths of one-half inch.

The metal is usually evaporated from coiled tungsten filaments so laid out that all surfaces to the object are exposed to at least one filament. The metal to be deposited is hung in small strips on the tungsten filament. As a current is passed through the filament, the metal melts and completely wets the filament so an even distribution is assured. The metal is thus vaporized into the chamber. The current through the filament is regulated by means of a variable transformer. The thickness of the film is then controlled by regulating the current and the evaporating time.

The vacuum in the evaporation chamber is usually obtained with combinations of eccentric cylinder-type oil-sealed mechanical vacuum pump, an oil diffusion pump and a single oil-ejector pump. It is essential that the correct pressure in the chamber is maintained to insure a metallic coating of high quality. With a pressure greater than one micron, dark oxidized surfaces are likely to result.

The time required to reduce the chamber to the normal operating pressure of one-half micron is twenty-five to thirty minutes, compared to the two to three minutes required for the actual deposition of the coating material.

Because the metallic coating is only a few millionths of an inch thick, it has little abrasion resistance, and for many applications a protective coating of clear lacquer must be applied to the product after it has been removed from the vacuum chamber. This coating, referred to as the top coating, is a special lacquer manufactured for this purpose. This coating also provides the medium for introducing color effects. The top-coat must meet all anticipated service abuse, such as abrasion, humidity, solvent attack, impact and exposure to ultra-violet light.

Aluminum is reflective for the entire spectrum; consequently, dye tinting can create a range of appearances varying from all tones of gold through copper, and including all

colors of the spectrum. The colors last from one to two years usually in sunlight, and are perfect for indoor use.

Production rate for a plating system depends not only on the equipment, but also on the size and shape of the object being coated. For a typical system, a toy gun, of which 110 can be metallized per load, can be run on a fifteen minute cycle or 440 guns can be produced per hour. A small airplane, approximately four inches long with a four-inch wingspread can be turned out at a rate of 1250 per hour. A toy chicken measuring approximately one and one-half inches high by one and one-half inches wide, can be processed at the rate of 5300 per hour.

The average high vacuum system costs from $20,000.00 to $40,000.00, depending upon the size of the chamber and the additional equipment used. The equipment needs some care, but there is little cause for stoppages due to breakdown if proper precautions and cleaning procedures are used. Weekly cleaning of all equipment is usually considered mandatory.

A cost comparison of the three coating methods most commonly used today for metals is given in the following table. The figures were derived by a production analysis of an item that was produced in volume by all three methods.

USES

Vacuum metallizing of the type mentioned in the preceeding paragraphs is used in both engineering and decorative service. Most of the engineering work lies in the electrical or electronic fields. Components such as capacitors and resistors are made by coating paper with aluminum or zinc and nickel with silver. Other applications include the coating of television receiving tubes, preparation of infra-red lamp reflectors and the production of printed circuits. An important application is in the production of mirrors for reflecting telescopes and similar equipment. A manufacturer of reflectors has recently converted his finishing department to the vacuum method of finishing. He has increased the reflective power of his reflectors of polished aluminum from 62% to 85%.

In the field of decorations, coatings, particularly on plastics, toys, inexpensive jewelry, Christmas ornaments, buttons and various novelties, are produced by vacuum metallizing.

In the automotive field, transparent plastics metallized on the under surface are used extensively. Every standard make automobile has some parts produced by this method. These include horn buttons, instrument panel escutcheon plates, emblems, pushbutton door openers and radiator ornaments.

The process is used also for the finishing of metals, particularly die castings. Medals, trophies and religious articles are frequently gold or silver plated in this manner. Very thin films have been deposited on glass for special applications. Such films are transparent and have been used to obtain heat reflecting and electrically conducting surfaces on the glass.

Another important application of high vacuum metallization, not already mentioned, is that of applying a reflective and long-lasting coating of metal to various plastic sheets. These metal casted plastic sheets thus formed are used for a large variety of ornamental purposes, including sequins, Christmas ornaments and decorations, printing stock for advertising displays, wrapping paper and many other uses.

As in the coating of the smaller objects, the coating metal is usually aluminum. The method of coating, however, varies a little. Many plastics may be used, but acetate and styrene base sheets are usually used for economical reasons. The plastic sheets can be coated on both sides, but a one-side coating is usually sufficient. As before, the film is protected by a clear lacquer which serves as the medium for the dye-tinting of the film.

The vacuum equipment for production of metallized plastic sheeting consists of two separate units, each having a vacuum chamber large enough to contain the rolls of material, rolling mechanism and other apparatus required for the process. In the first operations, the sheeting is continuously rolled back and forth under vacuum until all volatiles have been removed. After this degassing operation, the roll of plastic sheeting is transferred to the vacuum coating unit.

In the chamber the pressure is reduced down to about one micron of mercury. Then high-frequency (9600 cycles) current is applied through induction coils surrounding graphite crucibles containing the aluminum. In a few minutes the aluminum melts and begins to vaporize as before. The crucibles are positioned about ten inches below the plastic sheet, in order to produce a film of uniform thickness across the full width of the material. For a twenty-six inch roll, one pound of aluminum will cover over 3,000 feet of the material.

The cost of aluminizing acetate sheets, including labor charges, runs approximately five cents to six cents per square foot of material.

All plating methods have their specific advantages. High vacuum metallizing is no exception. In this process the advantages are low production cost (compared with electroplating and silver reduction), fast operations and high production output. However, the process and equipment are still in their early stages and experience is limited and not highly systematized.

	Silver Reduction	*Electro Plating*	*High Vacuum*
Quantity Produced	15,000 units	15,000 units	15,000 units
Appearance	Bright, clear Dulls with age	Bright, slightly rough—May dull with age	Bright, clear Remains bright
Wearability	Good	Excellent	Good
Time Required	9 man days	8 man days	3 man days
Cost per unit	$ .07	$ .13	$ .03

CRYSTAL GARDENS

By John Rhodehamel, sr., ch.e.

Man used only the simplest of some 92-odd elements to begin his civilization. Later he used combination or compounds of these elements as they appeared in a natural state. Then man learned to decompose and to combine both the elements and their compounds until he found a combination to suit his varied needs. Thus, as he gained knowledge and insight into the workings of the elements, he improved his mode of living.

One of the many states of matter which man has always accepted in its natural state has been the crystalline state. Only recently has man experimented and reorganized the crystalline structures of matter.

Since crystals have been put to so many uses, they have created a tremendous drain on the markets supplying them. However science had more or less relied on natural crystals until a period near the advent of the Second World War—a period which created a demand on crystals never before experienced. This demand was for both quantity and quality in the crystalline structure. This excessive demand was the necessary stimulus for all-out research into the crystal field. The demand for the more perfect crystal followed the development of newer audio and television equipment required for both the military and civilian defense needs.

The crystal most in demand was one of quartz—a piezoelectric quartz which once came from now exhausted fields in Brazil.

Until approximately ten years ago (1944), the urgent demand for these quartz crystals went unfilled. Soon after, however, it became known that a Professor Richard Nacken in Germany had successfully grown some large single quartz crystals by a hydrothermal process, an important discovery in the experimental field of synthetic crystal growth. This new process was given the name of the discoverer and became known as the Nachen Process. Its principles are basic and fairly simple, but their applications are difficult, tedious, and somewhat unexplained in parts.

As the process hydrothermal implies, a liquid is placed under controlled thermal conditions and also maintained at a specified pressure. The difficulties involved in these applications, are the pressures of nearly 15,000 pounds per square inch and the temperatures of plus 400° C., needed to successfully grow a perfect crystal. The work is made even more difficult by the amount of time needed for satisfactory crystal growth—anywhere from several weeks to three and four years. Moreover the work is made quite tedious by the uncertainty surrounding the available information concerning the correct concentrations, temperatures, and pressures needed for a saturated solution.

It has been determined that the rate of growth in such "bombs", as the process would require, " . . . utilizes quartz as a nutrient material, is a function of the temperature gradient along the bomb and the size of the nutrient material used."

The synthetic crystal has now had its start and a few of the difficulties of crystal production have been shown.

For perfection in growing crystals, both the industry and the military have carried on research in this field, sharing information from time to time. As a result they now command a relatively new field of science crystalography.

"Crystal research has become fashionable along with the development of the 'solid state' as an important branch of science, and in many instances the two fields are synonymous."

Until recently, early crystal work was concerned mostly with external structural features and was conducted usually by mineralogists and small groups of theoretical scientists.

Upon the discovery of X-ray diffraction, exacting progress on exploration of crystal interiors became possible; and a new field of related physics became known—crystal physics.

While crystals are thought of as crystal upon crystal, most researchers are concerned with as perfect a growth of a single crystal as is possible. Most applications of such "perfect" crystals are connected with optics and communications.

Generally these crystals are used as windows, lenses, prisms, and filters in optical instruments, but perhaps a less known use is that of the quartz crystal in which it displays its piezoelectric properties in the communications system. These crystals are employed for their ability to separate various messages in a transmission network and to control the wave lengths in transmission through the microphones and earphones of various radar and radio devices. Sonar equipment utilizes certain crystals both as the genera-

tor and as the detector of sound in underwater echo-ranging. Some crystals are found to be a source of ultrasonic energy for effecting chemical reactions and physical changes in many materials. The various properties of some crystals create methods for detecting and measuring nuclear radiation.

"The growth of single crystals is achieved by a variety of techniques, but often a particular growth method goes hand in hand with a particular application."

According to engineering viewpoints, the exploitation and development of crystals grown from solution has been highly successful.

One of the pioneers in the production of Rochelle salt for use in audio devices and underwater sound gear has been the Brush Development Company.

"Rochelle salt units still have no serious competition for high-fidelity reproduction equipment, and high-quality units have long been available . . . "

"Early in World War II, a new crystal, ammonuim dihydrogen phosphate, was developed—again largely by the Brush Company—which is considerably more rugged, both chemically and electrically, and has sufficient piezoelectric response to be usable."

Still more recently another new crystal, lithium sulfate monohydrate, has been developed—this time independently by NRL and the Brush Company—for its strong response to hydrostatic pressure.

Many different crystals with many different uses have just been recently developed. A few of these crystals are listed in the article; potassium pentaborate, dipotassium tartrate (similar to Rochelle Salt), and ethylene diamine tartrate for use as low-frequency applications such as telephone circuits; potassium dihydrogen phosphate, developed by the Federal Technical School at Zurich, for very low frequencies.

Quartz remains, however, the only crystal suitable for the oscillator control of American radio and television frequencies. Quartz is the only crystal having a high frequency, a sheer piezoelectric response, and a small frequency change with temperature.

Other crystals, synthetic gems, are being produced much in the same way and under similar conditions to those produced by nature. Often the quality of these synthetic gems is equal to or greater than that of their close cousins.

A major development in the synthetic gem industry has been the successful production of star sapphires by the Linde Company. These crystals are so unusually well-defined that they are being received as expensive stones.

A major threat to the diamond industry has been the development of rutile, which possesses an appreciably higher dispersion than the diamond. This gem also exhibits unique electrical properties.

For producing these different types of crystals, the melt technique for growing crystals was developed on an industrial scale by the Harshaw Chemical Company. This process requires that a crucible with a conical bottom be lowered slowly through a furnace with a sharp temperature gradient at the melting point of the crystal. A single crystal forms in the bottom of the cone as the melted material reaches the gradient section of the furnace, and the remainder of the material deposits on that seed as it in turn solidifies.

An alternate method requires locating a nucleus of material solidified on the tip of a cool rod and slowly withdrawing it from the crucible of the melted material.

The melt technique has been used to produce certain types of semiconductor materials. The best known of these are the silicon and germanium crystals, widely used as highfrequency rectifiers. Recent developments by the Bell Laboratories have created new interest in crystal amplifiers made by this method.

Of particular interest are scheelite and a series of tungstate compounds which are not produced in the natural state but which can be grown in electric furnaces at extremely high temperatures. These synthetic crystals provide a sensitive gauge for measuring nuclear radiations.

Growth methods not yet put into operation include a melt process under high-pressure controlled atmospheres and the use of natural gas to avoid chemical reduction as in the oxyhydrogen flame fusion process.

Army chemists have laid claim to the largest lead chloride crystal ever grown by man. It is slightly larger than an inch and a third long and nearly an inch thick. Preparation of such a crystal was accomplished in a furnace used for growing rare crystals for high-precision equipment.

Small lead chloride crystals are quite common. They may be prepared in ordinary laboratory experiments by cooling a saturated hot water solution of the lead chloride. This chloride compound is readily soluble in hot water but crystallizes in cold water, or as the hot water cools, crystallizes in a confusion of shining crystals.

This large lead crystal was grown by Dr. Joseph M. Ashcroft and Dr. A. Smakula, both Engineer Corps chemists at Fort Belvoir, Va. In the process a melt of purified commercial lead chloride crystals was lowered in a glass crucible through increasing temperatures by slow degrees at a rate of less than half an inch a day. (This was found necessary in order to produce a single crystal instead of the crystalline mass of smaller ones).

Foreign materials which have been absorbed into the crystal do not necessarily alter the habits of the crystal, but it is far more desirable to remove as much of the impurity as possible and to add any desirable foreign ions which aid in crystal development. The addition of foreign elements to crystal solution contributes to many changes in the rate of growth of the crystal and in its properties after growth. An example is the increase of conductivity of the ammonium phosphate crystal by a factor of ten whenever certain con-

Research and Development

By Bill Cade, sr., m.e.

NEW SHOCK ABSORBER

Road shock dampers that give light trucks the steering safety and riding comfort of an expensive automobile have been developed by GMC Truck & Coach Division after a two-year research project.

In revealing the new engineering development today, GMC became the first American motor vehicle manufacturer to bring out such dampers for smoothing out road vibrations before they reach the frame. They will be displayed for the first time at the Chicago Automobile Show January 7-15th.

Mounted behind the trucks' front wheels, the dampers counteract road jolts with "floating" weights that slide downward in metal cylinders when bumps are encountered.

"This development is one of the most significant ever achieved for truck riding comfort," said GMC Chief Engineer C. V. Crockett.

"These dampers not only minimize road jolts, but also tend to keep the wheels in contact with the road surface even under the most severe driving conditions, thus giving the driver more positive control over his vehicle at all times."

The chief engineer said the dampers actually "smooth out" washboard roads and greatly reduce the threat of the vehicle skidding out of control. "Driver fatigue is materially reduced in vehicle equipped with the dampers," continued Crockett, "as the decrease in wheel bounce and skidding on bumpy roads enables the driver to steer the vehicle with a minimum of effort. This is an important safety factor, for it is a well-known fact that a fresh driver is a safer driver."

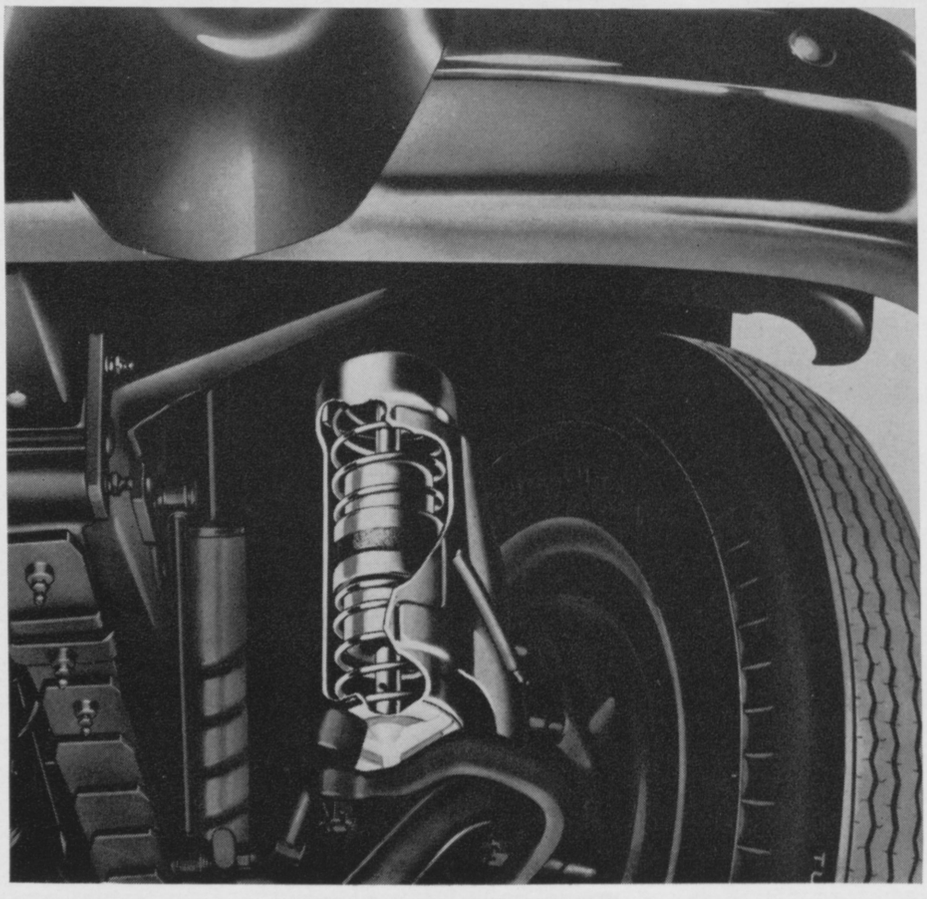
In a series of road tests, it was found that trucks equipped with the dampers could turn corners and negotiate washboard roads easier because of their road-hugging ability.

The road shock damper consists of an 11.8 x 4.4-inch metal cylinder containing a 12-pound steel weight sandwiched between two coil springs. The weight slides along a steel rod running the length of the cylinder.

Tension of the springs has been adjusted so that the vibration frequency (bounce) of the damper weight opposes the vibration frequency of the vehicles' front wheels.

When the wheels bounce into the air, the weight plunges downward in the cylinder, muting the upward girations of the wheels and deadening the vibration normally transmitted to the body of the vehicle.

Due to this deadening effect, softer springs may be used on the vehicle for more riding comfort. For maximum benefit, a damper is mounted on the brake backing plate of both of the vehicles' front wheels.



GMC's unique Shock Damper.

BUILD YOUR OWN

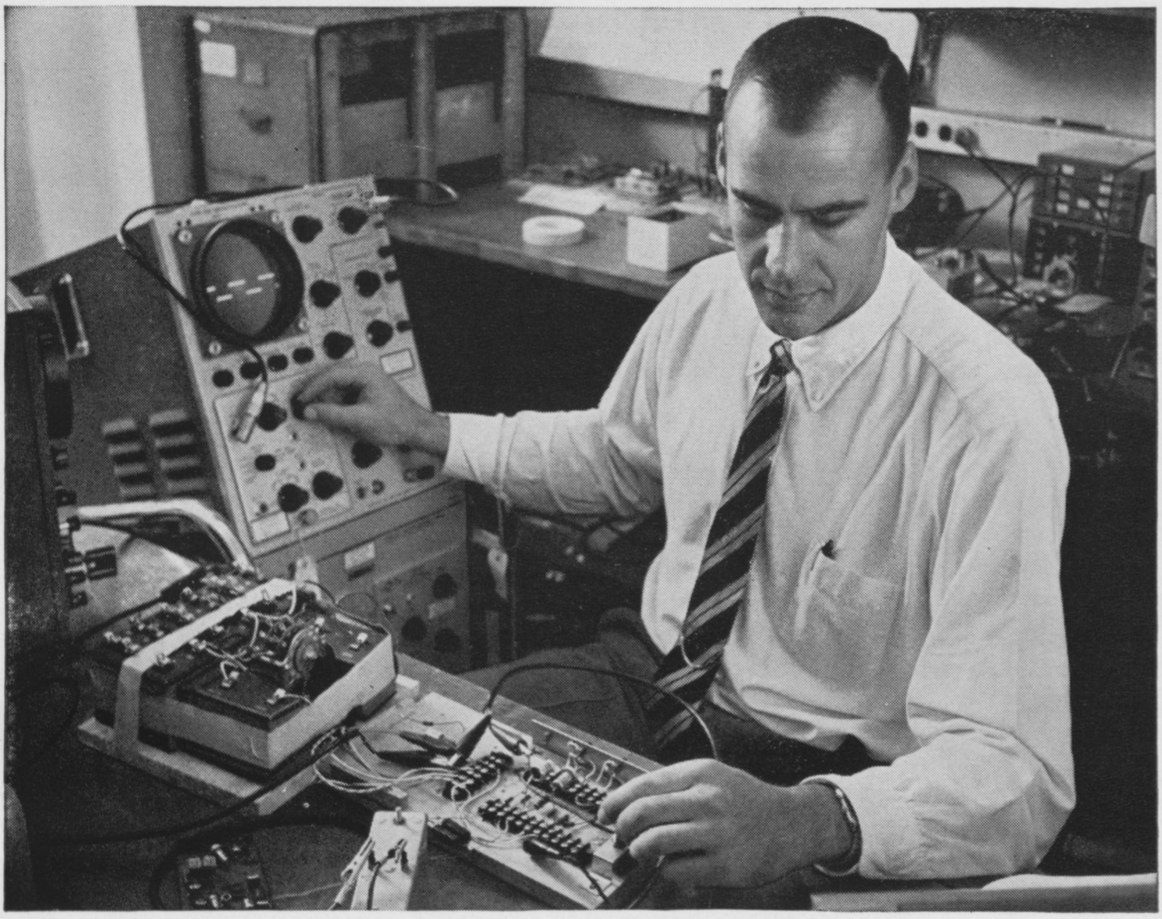
A new transistor, designed to meet the demands of radio amateurs, hobbyists and experimenters for a stable, inexpensive transistor, has been placed on the market by the General Electric Company.

The suggested distributor price of "well below two dollars" for the new 2N107 transistor makes it the least expensive of any transistor currently available.

The 2N107 is the first in a proposed series of transistors General Electric will market exclusively through distributors for use by amateurs and hobbyists.

(*Continued on page* 28)

A Campus-to-Career Case History



Dick Abraham of Bell Telephone Laboratories, here experimenting with closing the loop on a transistor feedback amplifier.

"I'm working with top names and top talent"

That's one of Richard P. Abraham's comments about his career with Bell Telephone Laboratories in Murray Hill, N. J. "In 1954, after I'd received my M.S. from Stanford," Dick continues, "I was interviewed by a number of companies. Of these I liked the Bell Labs interview best—the interviewer knew what he was talking about, and the Labs seemed a high-caliber place.

"The Labs have a professional atmosphere, and I'm really impressed by my working associates. As for my work, I've been on rotating assignments —working with transistor networks and their measurement techniques, studying magnetic drum circuitry, and doing classified work on Nike. This experience is tremendous.

'In addition to the job, I attend Lab-conducted classes on a graduate level several times a week. Besides that, the Labs are helping me get a Ph.D. at Columbia by giving me time off to get to late afternoon classes. That's the kind of co-operation you really appreciate from your company.

"What are important to me are the opportunities offered by the job and the work itself. My wife and I own a house near Murray Hill, and we've found a lot of friends through the Labs. All in all, I think I'm in the right kind of place."

Dick Abraham is typical of the many young men who are finding their careers in the Bell System. Similar career opportunities exist in the Bell Telephone Companies, Western Electric and Sandia Corporation. Your placement officer has more information about these companies.

Bell Telephone System

Library Notes

By Carson W. Bennett and Nina J. Mahaffey

"A book is the best of friends, the same to-day and for ever."—Tupper *Not new but you should read them.*

The following is quoted from the "Reader's News" of the Providence, (R.I.) Public Library.

"All too often when a new year comes, we tend to neglect books we should have read during the past year but didn't. We look through library shelves, notice that the publishing dates are 'last year's' and put the book back so that we can read something more recent."

"Many times by doing this we miss some mighty important books. There are many fine ones at that 'in-between' age (too new to be classics, to old to be NEW). Why not take out one 'in-between' book each time you visit the library? It will be well worth your while."

May we suggest the following as outstanding publications of 1955 which you may have missed but will want to catch up on them this year.

The Day Lincoln Was Shot, by Jim Bishop

The Genius and the Goddess, by Aldous Huxley

From Lexington to Liberty, by Bruce Lancaster

A Slight Sense of Outrage, by Charles W. Morton

Energy and Society, by Fred Cottrell

The Dignity of Man, by Russell Davenport

James Thurber's Dogs, by James Thurber

The Restoration of Learning, By Arthur Bestor

The World We Live In, by Lincoln Barnett and the editors of Life Magazine

Andersonville, By MacKinlay Kantor

The Man in the Gray Flannel Suit, by Sloan Wilson

Sincerely, Willis Wayde, by John P. Marquand.

"Try Your Library First," by Paul W. Kearney is an article appearing on page 12 of the October 1955 copy of *Rotarian.* We commend it to your attention. The basic tenet of this article is that Library bookshelves are warehouses of fact that may save you and your business both money and time. Mr. Kearney also uses the following quotation from the great German thinker and writer, Goethe: "There are three classes of readers: some enjoy without judgment, others judge without enjoyment, and some judge while they enjoy and enjoy while they judge."

* * * * *

Utopia 1976, by Morris L. Ernst is a new book which will undoubtedly have many fascinated and spellbound readers.

Looking only twenty years into the future, Mr. Ernst has drawn a breathtaking and wholly satisfying picture of life in 1976. He has for years been carrying on a love affair with the United States and admits to being an incurable optimist — as have been the creators of other Utopias from Plato on. But the non-believer must at once be told that this Utopia is probably the first based almost entirely on extension of present trends. It is a practical projection of a lively mind along paths already clearly marked out.

What Mr. Ernst sees in store for us is enormously cheering, in marked contrast to the speculation of others. Basing his conclusions on two assumptions, that man will not use the atomic bomb or its relatives in warfare and that new "energies" will relieve us of the scramble for food and shelter, he examines the new uses of leisure which will change us from an "audience society to a fully participating culture."

1976 is fully discussed from all aspects: population, food supply, business, home and family life, education, health, religion, freedom of thought, government, law, and the problems of war, peace and the United Nations. Mr. Ernsts' conclusions are worth everyone's careful attention.

* * * * *

The Pursuit of Happiness, by R. M. MacIver.

The pursuit of happiness is one of the "unalienable rights" attributed to man by our Declaration of Independence. And this book is an account of that inspiring pursuit by a philosopher and man of letters who has observed it at first hand through a long life and found in it a ringing philosophy for our own times.

Moments of insight, when we feel a heightening of experience, and sense the pulse of our union with nature and with man, may best show us the meaning of this pursuit and its profound rewards. That is the subject of the Prologue to the book.

Part One describes the terms of the pursuit — the very meaning of the term, the necessity to be thoroughly oneself. Next come sections on the things to be overcome, on the things we live by (such as truth, art, and love), and on the first and last things, the mysteries of life and death and the deep problem of the religion that mankind may yet attain. Finally, the Epilogue takes us back to those special moments of insight introduced in the Prologue and gives them a new significance.

The Pursuit of Happiness is a simple, non-technical book. Throughout one is in contact with an experienced and wise gentleman of deep cultivation, and one cannot touch the book without feeling a new sense of the dignity of life, and the worth and joy of pursuing happiness even in the midst of the perplexities and often the tragedy of life in the mid-twentieth century.

RCA TV camera encased in special diving bell televises the activities of sea life in sunlit waters off the Gulf Stream.

Now RCA puts TV underwater to help the Government protect marine life

Ten fathoms down, an RCA television camera moves through darting schools of fish. On the surface, U.S. Fish and Wildlife experts hover over an RCA remote control TV monitor. From what they see will come new fishing techniques to help the government protect marine life.

The electronic and engineering skill behind underwater TV is inherent in all RCA products and services. And continually, RCA scientists at the David Sarnoff Research Center in Princeton, N. J., delve into new "Electronics for Living" that will make life fuller, easier, happier.

WHERE TO, MR. ENGINEER?

RCA offers careers in research, development, design, and manufacturing for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. For full information, write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, N. J.

U.S. Fish and Wildlife Service technicians study fishing methods and equipment of an RCA remote control TV monitor.

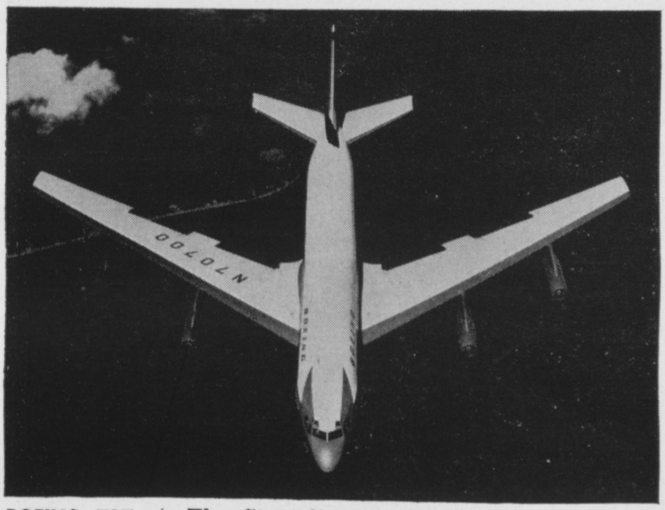
RADIO CORPORATION OF AMERICA

ELECTRONICS FOR LIVING

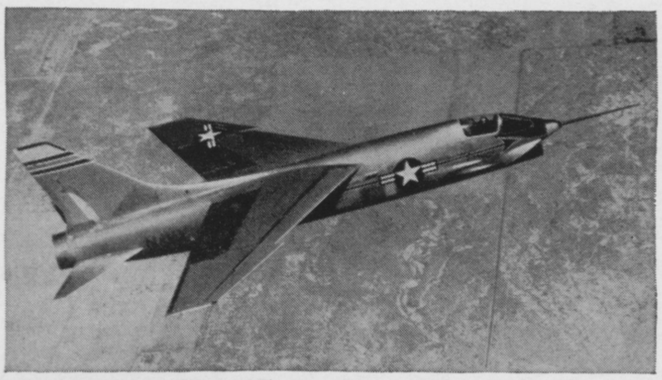
World's most powerful
production aircraft engine
The J-57 axial-flow jet engine with
afterburner, designed and developed
by Pratt & Whitney Aircraft.

McDONNELL F-101 — The Voodoo, an Air Force supersonic fighter that has two J-57 engines with afterburners, is the most powerful jet fighter yet built.

BOEING B-52 — Eight J-57 engines, mounted in pairs, power this all-jet, heavy Air Force bomber.



BOEING 707 — The Stratoliner will usher in commercial travel in the jet age. It is the counterpart of the KC-135, a military tanker-transport powered by four J-57 engines.



CHANCE VOUGHT F8U — Powered by a J-57 with afterburner, the Crusader is the Navy's fastest carrier-based fighter.

The best airplanes... are designed around the best engines

Today's most valuable military aircraft, capable of supersonic or intercontinental flight, include various Air Force and Navy fighters, bombers and transports. Among these are nine types that have a significant feature in common. They all fly on one type of engine — the J-57 turbojet.

Also entrusted to the efficient, dependable operation of Pratt & Whitney Aircraft's jet engines will be the commercial jet transports soon to travel along the air lanes of the world.

The excellence of the J-57 is attributed to the engineering team that has determinedly maintained its leadership in the field of aircraft powerplants. Effort is now being directed toward the improvement of advanced jet and turboprop designs. Still to be anticipated is mastery of current technology's most provocative problem — the successful development of a nuclear aircraft engine.

Many engineering graduates would like to be concerned with the air power of the next generation. One way to fulfill that ambition is to pursue a career alongside the Pratt & Whitney Aircraft engineers who have consistently produced the world's best aircraft engines.

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Fraternity Notes

Theta Xi

Before the close of the first semester, the Kappa's of Theta Xi are awaiting their new furniture for the house. In the meantime the recreation room in the basement is being completed, and the erection of fire ladders is being undertaken. Also Bob Coma and Gene Blastic have been going around the house with yardsticks, and recording measurements for the determination of the quantity of paint needed to give the house a new color scheme to start the next semester.

Congratulations were given Joe Meyers, Soph. C.E., and Gary Leavitt, Soph, M.E., who were pledged on January 10. Handshakes are extended to Dave Smith who pinned Miss Kitty Lusick.

The Kappa iron five has remained the same in the winning column and now have a record of one and four, but the season isn't over yet and they're in there fighting every game.

Jerry Blickhahn.

Alpha Tau Omega

The entire chapter is looking and planning toward State Day to be held in Lafayette, Indiana on February 11. A.T.O. Chapters from Indiana University, University of Illinois, Purdue, Monmouth, Rose Tech, Northwestern, and DePauw will attend.

An "enjoyable evening by all" was the result of a dance at the house following the Rose home basketball game on January 14. Let's have more of 'em.

Ron Reeves directed the painting and general face-lifting which was done on the house in the week between semesters.

Cupid has been a busy "item" for several Taus lately. In the "congratulations due dept.": to Jim Griffith and Sherry Bonham and John Kassebaum and Janet Pryor for their respective engagements; John Williams, who has pinned Miss Dianne Schleicher, a Tri Delt at Butler; Jack Foltz, who pinned Miss Dottie Sebring, an I.S.T.C. freshman.

Jack Foltz

Lambda Chi Alpha

As the new basketball season wears on, Lambda Chi's are enjoying more and more success on the Rose varsity. Five members of the chapter are on the team, with co-captains Bob Bright and Bob Young, and Walt Johanningsmeier holding down starting positions. Key reserves Harold Brown and Jim Oakes have also helped out quite a bit. So far, Bright and Young are showing the way in the scoring column. Theta Kappa Zeta is also off to a fast start in the I-F league, with Coach Frank Molinaro's boys winning three of their first four games.

The pre-Christmas social season at the house was wrapped up with a pair of house parties in December. The first followed the opening home basketball game on Dec. 10, and the second, on Dec. 17, was an open house with the student nurses from Union Hospital. The first party of the new year, and the last before finals, was held after the basketball game on Jan. 14 at the house. Plans are now being laid for the White Rose Dance which will be held with our brothers of the Indiana State Teachers' College chapter on Feb. 25. Social Chairman Jim Roach recently announced the signing of Eddie Howard and his orchestra for the dance. The addition of the famous composer and recording star should insure a successful evening.

Congratulations this month are in order for Brother Terrell Vanover, our vice-president who has done a wonderful job in directing the chapter's scholastic efforts. Lambda Chi now ranks first scholastically among the social fraternities on campus with a house cumulative average of 2.69. Congratulations also to our new pledges, Bob and Fred Fowler.

Jack Shumate

Sigma Nu

All our social plans at Beta Upsilon were overshadowed by the Indiana Sigma Nu Basketball Tourney held for the first time in the Field House at Rose on Jan. 7. Sigma Nu chapters from Indiana University, DePauw University, Butler University, and Rose were represented at the tournament. The results of the games are as follows: DePauw 51, Butler 50 (overtime); Indiana 69, Rose 53; Purdue 54, DePauw 52 (overtime); and in the Championship game, Indiana defeated Purdue by a score of 66-58. The chapter wishes to express its appreciation to Phil Brown who stayed for the games and was called upon for his medical abilities when three players were injured. In the Interfraternity Basketball League here at Rose, Sigma Nu is leading the league with a record of 5-0.

On Jan. 7, an Open House was held at the fraternity house after the Rose-Concordia basketball game for all members of the other fraternities on the campus and their dates. The chapter seems to think that this was a success, since it is the first time that it has been tried, and has hopes that these parties will continue.

Congratulations are in order for Philip Boller who married the former Miss Sue Miller on December 29, 1955 in Anderson Indiana, and for Donald V. Fordyce who married the former Miss Marcia Watson at the St. Joseph Church in Terre Haute on January 28, 1956. Congratulations are also in order for Robert Woldstad who pinned Miss Evelyn Samler of Dumont, N. J. during the Christmas vacation, While, at the same time, I pinned Miss Cora-May Archung of Brooklyn, N. Y.

George B. South, Jr.

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Another especially important part of engineering work at the Timken Company is the design of plants and specialized equipment for making Timken Company products better and faster. An outstanding example is our revolutionary new, completely automatic bearing plant now in operation in Bucyrus, Ohio.

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RECORD OF PIONEERING, PROGRESS The Timken Company was founded 56 years ago. Since then, it has grown to become the world's largest manufacturer of tapered roller bearings and removable rock bits, and a foremost producer of fine alloy steel bars, billets and seamless steel tubing. Our unique combination of experience and research has built an enviable reputation for solving difficult problems for our customers. By constantly expanding and strengthening our technical staff with aggressive and imaginative young engineers and metallurgists, we intend to continue our record of pioneering and progress. And if you possess the abilities and qualities we need, we'll be happy to have you share in that progress.

SEND FOR MORE INFORMATION For more detailed information about The Timken Roller Bearing Company, its training program, and the career opportunities for you, write to the college relations manager for your free copy of the booklet, "*This Is Timken*".

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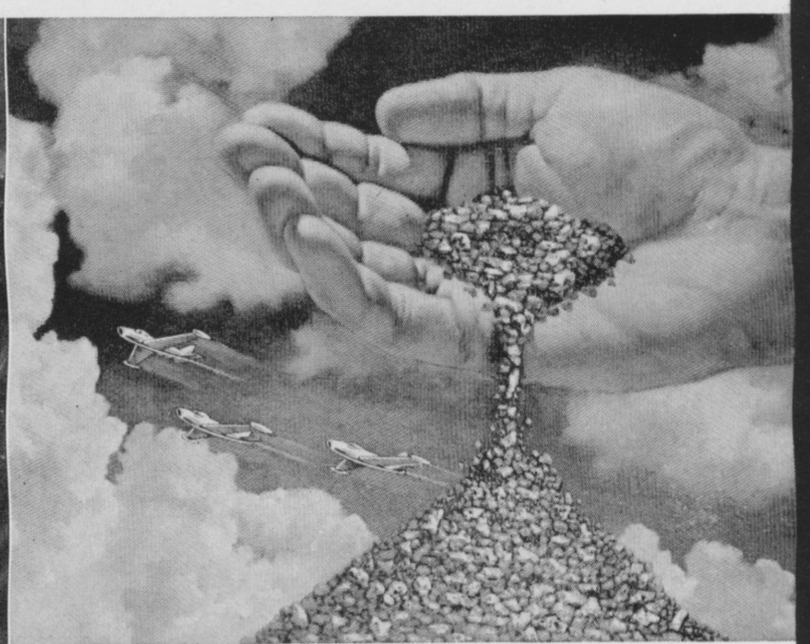

RADIOISOTOPES — Union Carbide's Divisions are leaders in the field of nuclear research and development. One Division, Union Carbide Nuclear Company, operates for the government Oak Ridge National Laboratory, the Nation's chief source of radioisotopes. In medicine, radioisotopes are used to investigate the human bloodstream —how it supplies nourishment, defends against disease, or becomes diseased itself.

TITANIUM — Electro Metallurgical Company is rapidly completing a new plant to produce titanium, the wonder metal whose strength and lightness are combined with resistance to heat and corrosion. The new plant will use a process developed by Union Carbide research, and will have an annual capacity of 7,500 tons of crystalline sponge —half again as much as the total United States production in 1954.

THE HORIZONS ARE UNLIMITED *for engineers, chemists, physicists, and business and liberal arts majors. Union Carbide offers many opportunities to explore those horizons.*

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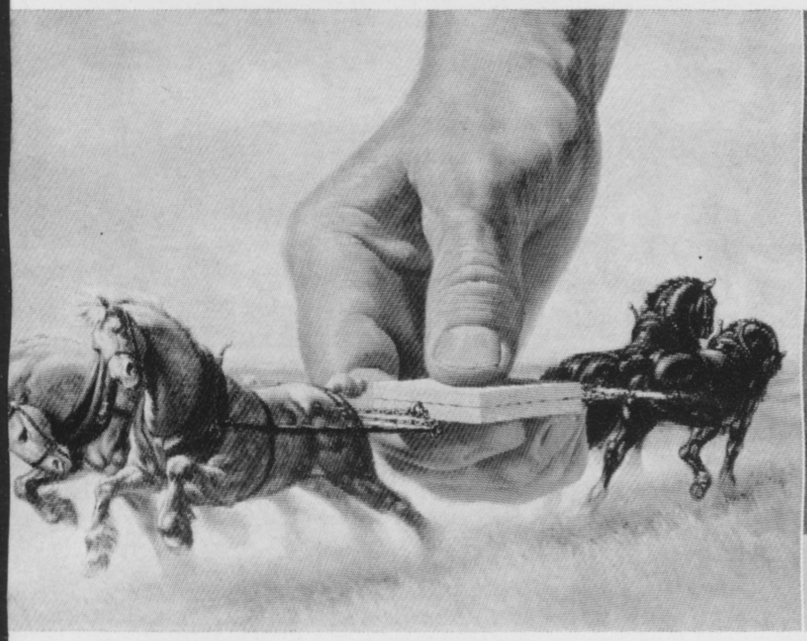
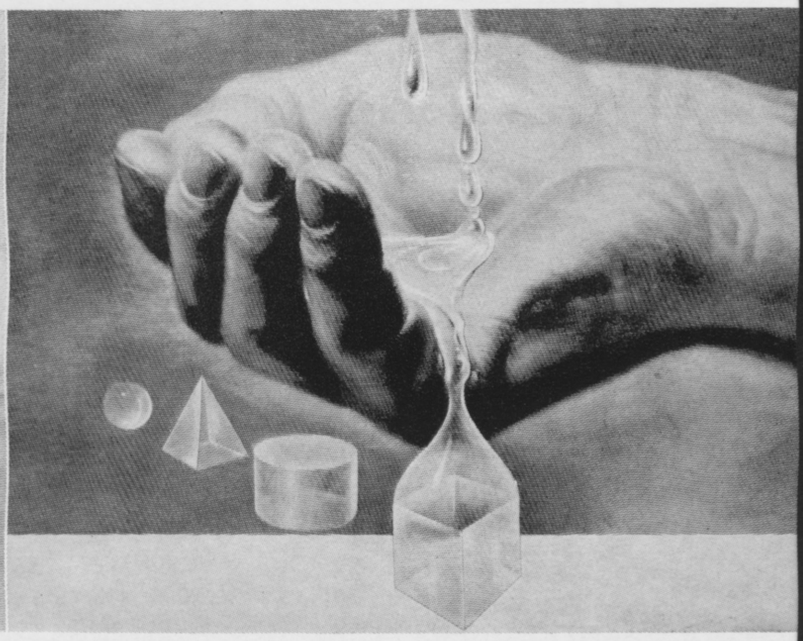
Divisions of Union Carbide in alloys, carbon products, industrial gases, chemicals, plastics and atomic energy. Examples in four of these growing fields are illustrated below.





PETROCHEMICALS — Carbide and Carbon Chemicals Company produces more petrochemicals than any other company in the world. Some are being used to develop whole families of new adhesives and bonding agents. It is now possible to make almost any materials stick together permanently. Union Carbide research into the nature of bonds—mechanical, chemical, molecular—will make possible new and better adhesives.

EPOXY PLASTICS — Bakelite Company is a major producer of most types of plastics, including the sturdy epoxies. Two liquids, a resin and a curing agent, form a tough, dimensionally stable solid when poured together. They are used for long-lasting, accurate patterns for foundry work, for dies that stamp out auto parts and airplane wing sections, for embedding delicate electronic parts to protect them from moisture and vibration.

Contact your Placement Director and make appointments with the recruiting representatives of Union Carbide and its Divisions.
For further information, write:

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Big Bright Bulbs

By John Bloxsome, jr., e.e.

General Electric announced here today "the greatest single improvement in incandescent light bulb performance in 42 years." Developments now being placed in effect will cause increases in light output ranging from 6 per cent for household bulbs to 15 per cent for higher wattage bulbs used in industrial and commercial lighting. No more electricity is required.

The light bonus produced by each bulb as a result of the improvements is seen as worth the entire cost of the bulb to users. Ultimately, the benefit to American consumers in the form of increased light can amount to more than $100,000,000 annually.

In addition, the better bulbs are expected to contribute importantly to improved incandescent lighting for homes, factories, offices, stores, schools, and many other areas.

Herman L. Weiss, general manager of G.E.'s Large Lamp Department, has announced the immediate availability of the improved lamp in the 750- and 1000-watt sizes, which offer the greatest benefits. The new developments will be extended to other sizes within the next few years, as rapidly as equipment can be built and installed to mass produce the hundreds of millions of bulbs used annually.

Vernet C. Kauffman, department manager of engineering, said the increased light output is achieved by the following steps:

Improving the tungsten filament by making basic design changes;

Altering the mount structure, so that the filament is positioned lengthwise, or axially, in the bulb; and

Substituting for the first time coiled-coil filaments for singly coiled ones in lamps of 300 watts and larger.

As a result of these construction changes, lamps of 300 watts or larger will have an increased light output over their lifetime of 15 per cent. The improved 750-watt bulb, for example, will produce an average of 21.6 lumens, or units of light, per watt of electricity consumed. This compares with an efficiency of 18.9 lumens per watt for present 750-watt bulbs.

In the case of household sizes, which already have the benefits of coiled-coil filaments, the light output increase will amount to at least 6 per cent.

Axial positioning of the improved filament, the most dramatic visual change in the improved lamps, does two things to increase light output, Kauffman explained.

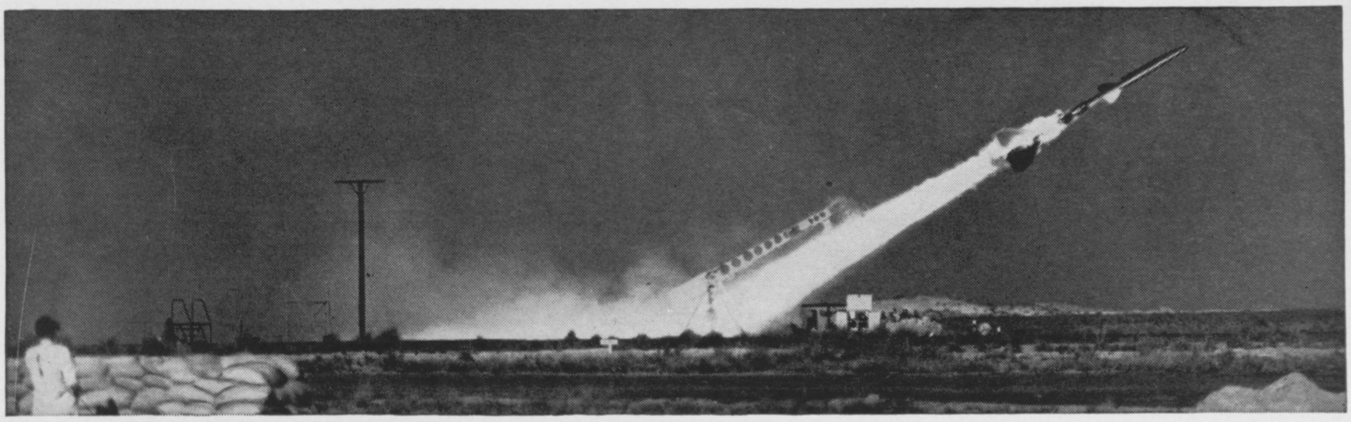
First, it permits the filament to burn to higher temperatures without shortening its operating life. The hotter a filament burns, the more light it produces.

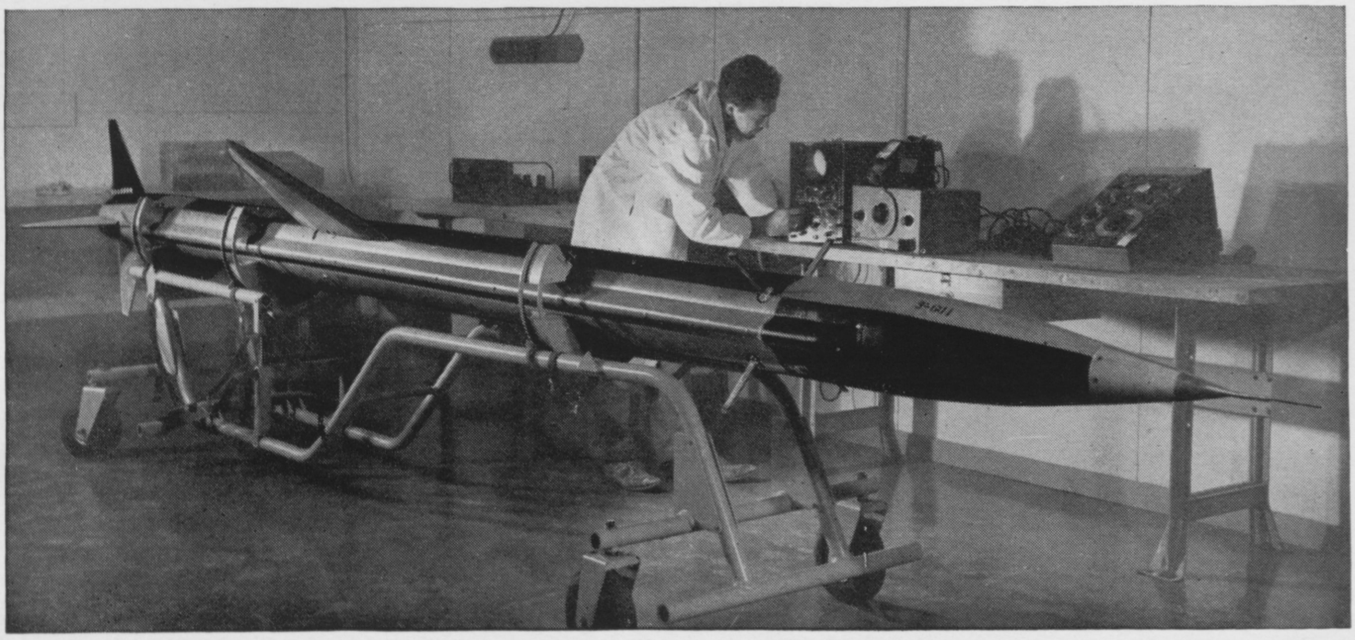
Secondly, it causes bulb blackening to concentrate in a smaller area, and thus permits more light to get out.

Experiments having to do with axial filament mounting and the control of bulb blackening have been underway in G.E.'s Nela Park laboratories for several years.

Since G.E. introduced the coiled-coil, or double coiled filament, in 1937, continuing efforts brought virtually no improvements in incandescent lamp efficiency and it appeared that a top limit had been reached for this type of lamp. The latest design changes have resulted in a breakthrough of this 18-year incandescent light barrier.

Kauffman said the new developments were "the latest in a long series in which General Electric has pioneered since Edison introduced the electric lamp 76 years ago, and the most significant since Nobel-Prize winning Irving Langmuir developed the gas-filled bulb in 1913."





Boeing engineers are insiders on top-secret work

Engineers are doing vital work on significant new developments at Boeing. For example, the Boeing BOMARC IM-99 pilotless interceptor. Its predecessor, the Boeing GAPA, is shown here, because photographs of BOMARC are highly classified. BOMARC is a supersonic long-range missile that spearheads an entirely new weapons system. It is a key weapon in America's defense planning.

BOMARC, as well as other "years ahead" Boeing projects, which cannot be discussed here, are complex challenges to all kinds of engineers. These men find real creative interest in the problems of very high speed flight: heat, compressibility, vibration, rocket, jet and nuclear power, miniaturization, electronic control, and others. Their goal is to design structures and components that will "weigh nothing and take no space," yet withstand extreme velocities and altitudes.

The prestige of Boeing engineers is second to none. They have created such recent aviation milestones as the B-52 global jet bomber, the 707 jet transport, and the B-47. There are superb facilities at Boeing: the multi-million-dollar new Flight Test Center, the world's most versatile privately-owned wind tunnel, the latest electronic computers, and much more.

Boeing engineers enjoy exceptional opportunities for career stability and growth. There are more than twice as many engineers with the firm now as at the peak of World War II. Living is pleasant in the progressive, comfortable-size communities of Seattle and Wichita.

There is room for top engineering talent on Boeing research, design and production teams. If you feel that you belong with aviation's leader, it will pay you to investigate the advantages of a career with Boeing.

For further Boeing career information, consult your Placement Office or write to either:

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Crystal Gardens

(*Concluded from page* 13)

taminants are added. Such a small amount of impurity as six parts per million altered the condition of the phosphate crystal. Also, the size of a sodium chloride crystal can be controlled simply by the addition of a small amount of lead nitrate to the solution.

The permissible growth rate depends partly on the composition of the solution, and this can be varied to some extent. Expanding on the composition of the solution is the degree of supersaturation of the solution.

Other than purity, the second major factor in solution crystal growth is the agitation which removes depleted solution from contact with the crystal surface—decreasing the path of diffusion—and prevents convection currents induced by the heat of crystalization from causing misoriented growth.

Full-grown quartz crystals are cut into plates, roughly an eighth of an inch thick and about one inch long. They are then coated with an extremely thin film of gold, which serves as an electrical connection. They are then mounted in a glass envelope to form the completed crystal unit.

Frequently, in experimental or research work, a crystal of a peculiar or unusual frequency is required. In most cases, ordering a plate of this desired frequency is both too expensive and too time-consuming.

The old method of changing crystal frequencies required the individual grinding of each face of the particular crystal. This practice often resulted in decreasing the activity of the crystal or rendering it completely useless. This old method invariably gave unequal treatment to the crystal faces, and often the abrasive used would become embedded in the crystal, hampering its operational duty.

The newest and perhaps easiest method yet devised for crystal etching involves the use of a fluorine compound, ammonium bifluoride.

A saturated solution of the bi-bifluoride is poured into a plastic container. A crystal whose frequency is known is placed in the same container and its time of immersion is clocked. At a specific length of time, say exactly 60 minutes, the crystal is removed, rinsed with distilled water, and its new frequency determined. The change of its original frequency, as compared to its new frequency, is computed against the 60 minute time of immersion. This time-reaction data can now be used to produce crystals of any desired frequency.

A method for the preservation of the frequency of quartz crystals used in radio and television has been developed at the laboratories of the U.S. Army Signal Corps, Fort Monmouth, N.J. where it was discovered.

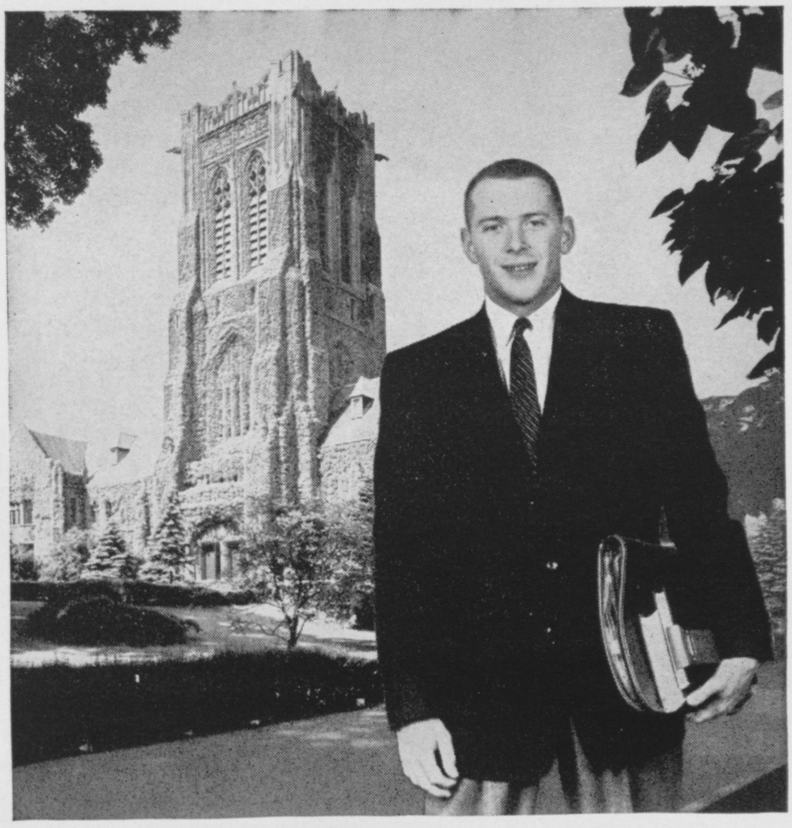
The process requires the superheating of the crystal to about 900° F., followed by slow cooling. Finished blank crystals are placed on a conveyor belt and passed through an electrically heated oven for a period of from two to three hours, then subjected to a cooling interval of about 24 hours.

Before crystals were treated by this method, older crystals in frequent use tended to slide or "drift" away from the desired frequency. This crystal had to then be replaced, often a difficult and costly job.

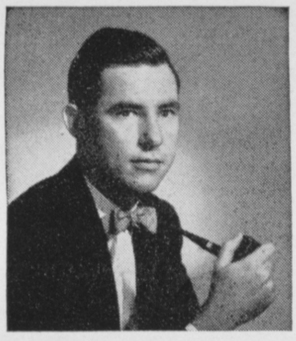
The utilization of these many types and compounds of crystals has been on the increase since a ready supply is now always available. Thus far this new field of synthetic crystal growth has contributed heavily to the radio, television, and sonar devices of both the civilian and military needs. It is expected, however, that further research and development will produce synthetic crystals which fit the needs in all "solid state", giving industry and military the means for accomplishing projects and tasks far beyond the reach of natural crystals.

George Lincoln asks:

What do metallurgists do in a chemical company?



GEORGE M. LINCOLN, JR. expects to receive his B.S. in metallurgical engineering from Lehigh University in 1957. George is active in sports, vice president of his junior class, and a participant in many other campus activities. He's starting his employment investigations early, for he feels that the selection of an employer is one of the most important decisions in a man's career.



CHARLES I. SMITH, JR. received his B.S. Ch.E. from V.P.I. in 1943, served in the Navy as an engineer officer, and joined Du Pont's Engineering Department in 1946. Since then he has advanced steadily through a number of interesting assignments at various Du Pont plants. Today Charlie Smith is technical superintendent of Du Pont's Newport, Delaware, Plant, Pigments Department.

Charlie Smith answers:

They have an almost endless variety of interesting problems to face, George. As a student of metallurgy you know that about two-thirds of all known chemical elements are metals. Many of them are revealing valuable new applications, when highly purified on a commercial scale. Du Pont is greatly interested in several metallic and semi-metallic elements.

My own experience at Du Pont ranges from work on titanium pigments, to metallic titanium production, and to the ultra-pure silicon used in transistors. You can appreciate some of our metallurgical problems when I point out that impurities in transistor silicon have to be below one part in 100 million. That's equivalent to one pound of impurities distributed through a train of ore cars twenty miles long!

Some of our metallurgists carry out fundamental research on new metals, and, in the development stage, they frequently operate pilot plants for producing them. Other metallurgists study problems relating to engineering materials used in construction, carry out research on intergranular corrosion, or investigate fatigue relationships encountered in dynamic, high-pressure operations.

You'll find many challenging opportunities in every phase of metallurgy at Du Pont, George.

Metallurgists and Metallurgical Engineers can find some of Charlie Smith's challenging new problems described in "Engineers at Du Pont." For a free copy of this booklet write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington 98, Delaware.

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Research and Development

(*Continued from page* 14)

It is a PNP audio transistor produced by the G-E fused junction process. Others will include IF and RF PNP transistors made by the fused junction process and RF NPN transistors made by the new rate-grown process.

The 2N107 has the same physical appearance and dimensional specifications as the USAF 2N43a transistor which was designed by G-E engineers and is being specified by the Air Force for their electronic equipment.

The 2N107 has an all-metal case and is hermetically sealed for the maximum in reliability. Hermetic sealing is accomplished by the use of glass-to-metal seals and resistance-welded seams.

According to G-E engineers, shelf life and exposure to full rated temperature will not change the characteristics of the transistor.

The 2N107 in a typical common emitter circuit has a power gain of 38 db. Maximum frequency cutoff is 2.5 megacycles with the design center at 1.0 megacycle. Alpha design center is 0.95. The maximum collector voltage is -12 volts and the maximum junction temperature is specified at 60°C. The new 2N107 is capable of dissipating 50 milliwatts in 25°C. free air.

AIR RIDE SUSPENSION

Development of air ride suspension for GMC trucks, which will introduce a new era of economy and efficiency in the trucking industry, was announced today by Philip J. Monaghan, vice president of General Motors and general manager of the GMC Truck and Coach Division.

The revolutionary new type of suspension, whereby air-filled rubberized bellows replace the conventional metal leaf springs, is now on an experimental GMC truck-trailer combination and will be ready for production late this year, Monaghan said.

Over 400,000,000 miles of operating experience with air suspension on GM coaches, and tests with air-ride trucks at the General Motors Proving Ground, shows that GMC truck air suspension:

Eliminates spring lubrication, repairs and replacement.

Either fully or partially loaded, provides smoother ride for driver, resulting in less fatigue, an important safety factor.

Absorbs vibration and road shocks, reducing breakage of fragile cargo.

Permits lighter-weight less-expensive packaging of goods for shipment.

Increases trailer payload capacity by lowering floor height.

Facilitates loading and unloading by keeping floor at constant height.

Encourages standardization of loading dock heights by assuring constant truck-trailer floor height.

Prolongs chassis life and reduces overall maintenance.

Prolongs body life by lessening road shocks, reducing maintenance costs.

Gives better load distribution by keeping floor level.

Eliminates spring noise and other vibration noise.

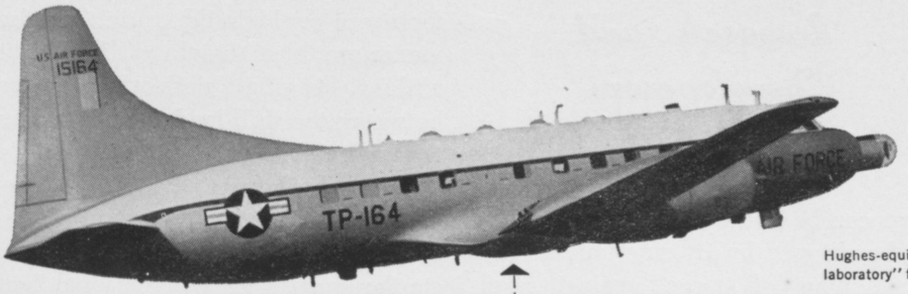
Permits greater traction when needed under the driving axle of tandem-axle combinations using a "dead" pusher or trailing axle, by providing easy adjustment of air spring pressure to throw more load weight on the driving axle.

GMC highway tractors with air suspension would be able to haul trailers and semi-trailers that had either the conventional leaf springs, or air suspension. To find some preliminary benefits of the air suspension system, GMC Truck and Coach purchased a semi-trailer specially designed for air springs and compared it to conventional combinations.

"General use of this new type of suspension in trucks and trailers by the nation's trucking fleets could mean literally millions of dollars gained by increased payload potential, decreased freight damage and reduced maintenance expense," Monaghan said.

"Another area of considerable sav-

(*Continued on page* 30)



Hughes-equipped T-29 "flying laboratory" for systems evaluation.

Flight evaluation of advanced interceptor electronic system uses unique approach.

T-29 "INTERCEPTOR"

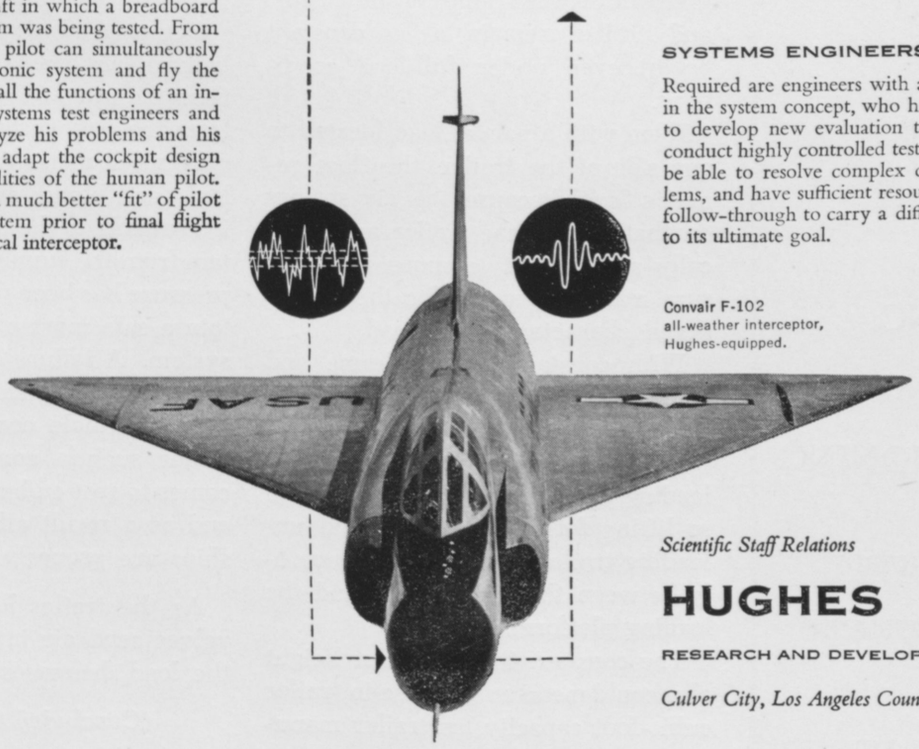
THE DEVELOPMENT OF AIRBORNE ELECTRONIC SYSTEMS REQUIRES THOROUGH FLIGHT EVALUATION OF BREADBOARD AND PROTOTYPE EQUIPMENT PRIOR TO FINAL DESIGN. AT HUGHES, SYSTEMS FOR INTERCEPTORS ARE FIRST TESTED IN "FLYING LABORATORIES" IN WHICH THE EQUIPMENT IS READILY ACCESSIBLE TO SYSTEMS TEST ENGINEERS

One interesting problem recently confronting Hughes engineers was that of evaluating the requirements imposed upon the pilot of a high-speed one-man interceptor. This arose in the development of a new integrated electronic system to control several phases of an all-weather interceptor's flight. Because of the great importance of providing the pilot with the optimum design and arrangement of displays and controls, it became necessary to determine accurately the pilot's work load during flight, and the human factors that affect his ability to carry out his task.

The solution was to install a complete mock-up of the actual interceptor cockpit in a large T-29 aircraft in which a breadboard model of the system was being tested. From this cockpit a test pilot can simultaneously operate the electronic system and fly the T-29, performing all the functions of an interceptor pilot. Systems test engineers and psychologists analyze his problems and his performance, and adapt the cockpit design to the natural abilities of the human pilot. The result will be a much better "fit" of pilot and electronic system prior to final flight testing in the tactical interceptor.

SYSTEMS ENGINEERS

Required are engineers with a basic interest in the system concept, who have the ability to develop new evaluation techniques and conduct highly controlled tests. They should be able to resolve complex circuitry problems, and have sufficient resourcefulness and follow-through to carry a difficult program to its ultimate goal.



Convair F-102 all-weather interceptor, Hughes-equipped.

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CHARLES J. KANTMANN

Research and Development

(*Continued from page* 28)

ings can be in the packaging of goods to be shipped by air-ride trucks. The cushioning of cargo against road shock will permit lighter, less rigid and less expensive crates and containers."

Mounted between the axles and frames of an F552 duo-purpose tractor with a 48,000-pound gross combination weight and a 35-foot-long maximum volume van-type trailer, the suspension system has 10 rubberized tire-fabric bellows filled with compressed air.

As the bellows flex under the jarring impact of road shocks, they form a perfect cushion between the axles and the body, absorbing heavy jolts and virtually eliminating high-frequency vibrations that wear out the tractor and trailer.

As the moving parts of the truck suspension system are rubber-mounted, they require no lubrication and function noiselessly. This eliminates many maintenance operations and materially reduces servicing expenses.

Due to the design of the system and the method of metering air to the bellows, the frames of the tractor and trailer remain at a constant height even under full-load conditions.

Even with a partial load located to one side of the trailer, the floor remains level because the air springs on that side of the trailer automatically are subject to more air pressure and compensate for the unbalanced character of the load.

With constant tractor frame and trailer floor heights (35½ inches in the tractor and 46½ inches in the trailer of the experimental vehicle), loading docks could be standardized so lifting forks for loading and unloading trailers would move smoothly between the trailer floor and the loading platform.

The constant tractor-trailer height also could mean an increase in trailer cubic-foot capacity, as trailer manufacturers could build trailers to the maximum legal height of 12½ feet without leaving "deflection" space between the full-loaded and empty trailer height.

In the experimental GMC tractor-trailer combinations, the trailer has 37 cubic feet more cargo space than similar vans with conventional leaf springs, and refinements in future tractor and trailer design could increase the trailer capacity considerably more.

Due to the air suspension vehicle's air-smooth ride, freight resting on the floor of the trailer would not be subject to as much damage from the weight pressing down from above, aggravated by severe road jolts.

The air suspension system on the experimental tractor-trailer combination is composed basically of air bellows, leveling valves, air beams, air chambers and an air storage tank.

The tractor has a total of six bellows, four in front and two over the rear axle. Two small bellows are mounted on each end of the front axle and a large bellows is installed at each end of the rear axle, giving ample support to the tractor's above-frame structure.

Four large bellows support the trailer. Two are mounted on each side of the trailer between the axle and the trailer's body.

Compressed air is supplied to the bellows, air beams and air chambers from the tractor's air system. It flows from the storage tank to the leveling valves that meter the air into the bellows, and beams and chambers. Air is available to the air suspension system from the supply tanks only when pressure has been developed to maintain a safe margin for the air brake system. A failure of any part of the suspension system cannot cause a loss of vehicle control inasmuch as under such a condition the frame comes to rest on heavy rubber blocks and as a result all linkage relationships are properly maintained.

As the trailer load increases, the valves send air into the bellows; as the load decreases, they release air

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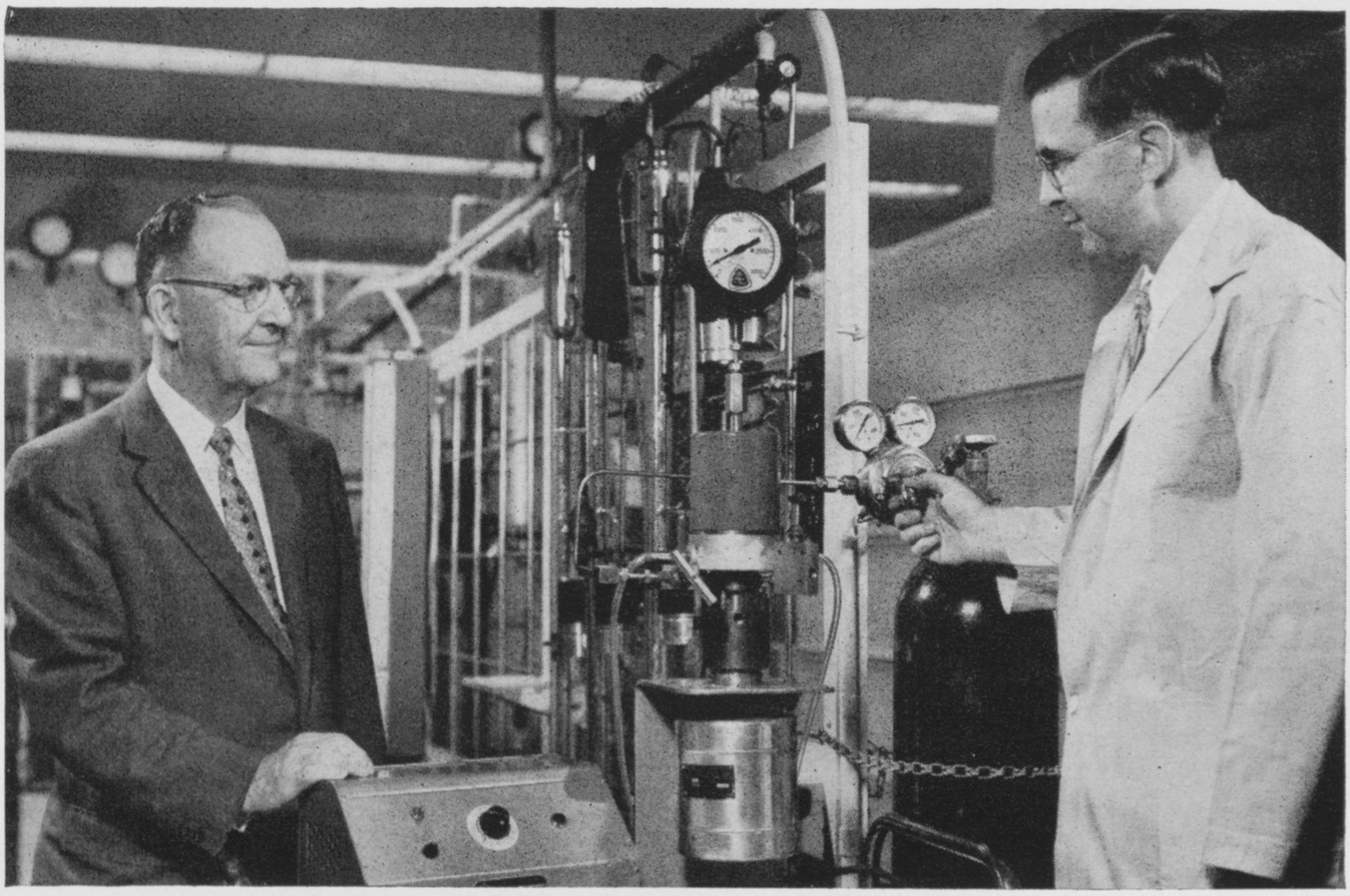

Dr. Ward Kuentzel and Dr. Edmund Field, co-inventors, observe operation of the new Magne-Dash autoclave in Standard Oil's Whiting research laboratory.

Orders for inventions taken here

MODERN RESEARCH creates a need for brand-new types of equipment. In petroleum laboratories, mixing up some stuff in a beaker usually isn't the answer. The research pioneer may have to use high temperatures and high pressures. If he must stir his mixture, he has a tough job. How can he prevent leakage past the shaft of the stirrer?

To meet this and other difficult situations, Standard Oil has set up a "Special Devices Program". A group of scientists creates the apparatus needed to solve today's problems.

An example is the Magne-Dash* autoclave. It has a magnetically operated agitator, and no external moving parts. Leaks cannot occur. Research men now use freely the high pressures that lead to new plastics and other new products.

Like many other inventions made by Standard Oil scientists to solve our own problems, the Magne-Dash is licensed for production and sale by a maker of scientific equipment.

The Special Devices Program is just one of the creative activities at Standard Oil. Young scientists find it stimulating to work in such an atmosphere.

*Manufactured under Standard Oil license by Autoclave Engineers, Inc., Erie, Pa.

Standard Oil Company

910 South Michigan Avenue, Chicago, 80, Illinois

STANDARD

Research and Development

(*Concluded from page* 30)

from the system. Thus the bellows are properly inflated for varying load conditions at all times.

Torque rods, a sway bar and lateral stay bars maintain the positions of each axle against lateral, longitudinal and torsional movement. All linkage is mounted in rubber.

Engineers estimate that the bellows have a life of approximately one million road miles.

NEW TACONITE HARBOR

A new harbor for the transportation of taconite ore is being blasted out of the hard rock shore of Lake Superior, 75 miles north of Duluth, Minn. The operation is part of a $300-million project which will start feeding taconite to the nation's steel industry by 1957, according to Engineering News-Record, McGraw-Hill publication.

Construction of the 30-foot-deep harbor and its 2,444-foot-long concrete wharf requires the removal of approximately 1,000,000 cubic yards of rock over a 35-acre area, much of it under water. Three United States companies and one Canadian company own the Erie Mining Company which is responsible for the project.

The harbor is approximately 4,900 feet long and 1,500 feet wide. Two small islands joined by a rock breakwater will form the outer protection, and other rock breakwaters extending outward from the shoreline will safeguard the sides. Ships will enter one end of the harbor between the breakwaters and leave through the other end.

Contracting work began on the harbor in May, 1954 and is expected to be completed sometime in 1956. The harbor probably will go into operation late in 1957 when the Erie Mining Company's processing plant for taconite, 73 miles inland, is completed.

A new railroad will deliver taconite ore pellets, processed at the plant, to the harbor for loading into lake carriers. Ore cars will travel on a railroad trestle above the bins to discharge their contents. Lake freighters will be unloaded directly from the bins by means of conveyors.

To facilitate blasting and rock removal for the harbor, two cellular steel sheet pile cofferdams (watertight enclosures from which water is pumped to expose lake bottom) are built around the excavation areas. The first cofferdam was divided into two parts so excavation could be carried on in one area while the second part of the cofferdam was being constructed. After the first portion of the main cofferdam was completed, water was pumped out and blasting began.

The harbor will be excavated to leave a vertical wall of rock which will be faced with concrete to form a solid dock. The ore-loading wharf is 1,200 feet long. On it will be mounted 25 concrete bins for loading taconite. Thirteen additional bins can be built on a 624-foot extension of the dock later on, the magazine reports.

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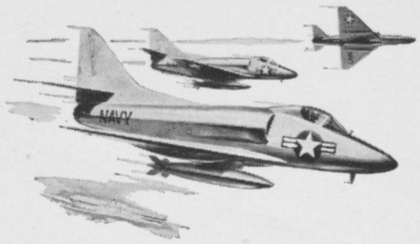
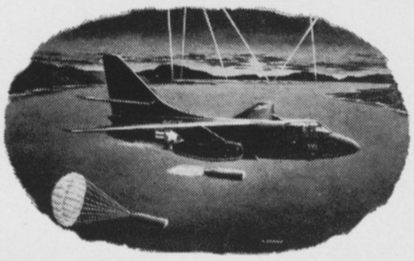


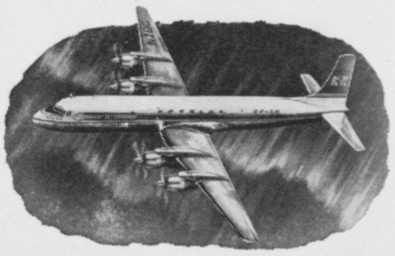
A4D, "SKYHAWK"— smallest, lightest atom-bomb carrier

RB-66 — speedy, versatile jet bomber



A3D, "SKYWARRIOR"— largest carrier-based bomber

C-124, "GLOBEMASTER"— world's largest production transport



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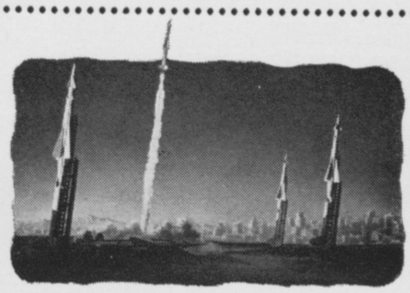
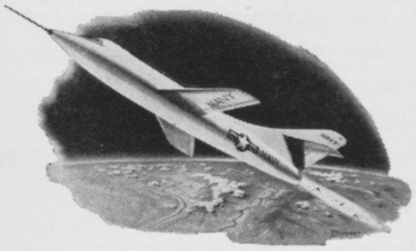


"NIKE"— supersonic missile selected to protect our cities



D558-2, "SKYROCKET"— first airplane to fly twice the speed of sound

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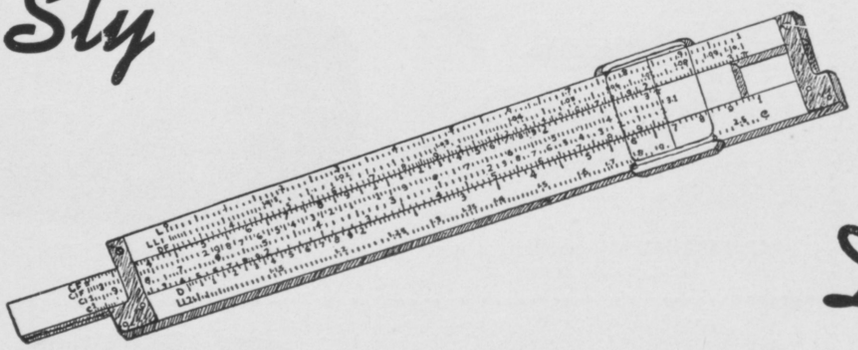


Stolen by Tom Reese, soph., c.e.

Rules for handling women electrically:

If she talks to long—Interrupter.

If she wants to be an angel—Transformer.

If she meets you half way — Receiver.

If she gets excited—Controller.

If she gets up in the air—Condenser.

If she is hungry—Feeder.

If she sings inharmoneously — Tuner.

If she is wrong—Rectifier.

If she is to fat—Reducer.

If she gossips too much—Regulator.

If she wants to get married—Resister.

* * *

The Russian school teacher asked a pupil who the first humans were.

"Adam and Eve," replied the child.

"And what nationality were they?"

"Russian, of course," the child said.

"And how do you know?" asked the teacher.

"Easy," replied the child. "They had no roof over their heads, no clothes to wear, and only one apple between the two of them—and they called it paradise."

* * *

The difference between a married man and a bachelor is that when a bachelor walks the floor with a babe in his arms, he's trying to sober her up.

* * *

The height of bad luck—Seasickness and lockjaw.

The reason for the amber light on traffic signals has finally been revealed: It gives the Scotchmen a chance to start their engines.

* * *

"Now I will illustrate what I have on my mind," said the professor as he erased the board.

* * *

Country girl: "My paw's the best rifle shot in the country."

City lad: "What does that make me?"

Country girl: "My fiance."

* * *

Girls are like newspapers. They all have forms, they always have the last word, back numbers are not in demand, they have great influence, you can't believe everything they say, they're thinner than they used to be, they get along by advertising, and every man should have one of his own and not try to borrow his neighbors."

* * *

A meddling old English woman accused one of the villagers of having reverted to drink because, with her own eyes, she had seen his wheelbarrow standing outside the tavern.

The accused man made no verbal defense; but the same evening he placed his wheelbarrow outside her door and left it there all night.

* * *

Athlete: "What can she do?"

Literary: "What does she read?"

Socialite: "Who are her parents?"

Religious: "What church does she go to?"

Engineer: "Where is she?"

"Uncle, what's a bachelor?"

"Junior, a bachelor is a man who always went out on double dates in college."

* * *

"I'm losing my punch," said the freshman as he hurriedly left the party.

* * *

A girl may be good for nothing, but she's seldom bad for nothing.

* * *

Prof.: (rapping on the desk during class) "Order!"

Sleepy Sophomore: "Beer!"

* * *

"I know a man who has been married for thirty years and he spends every evening at home."

"That's what I call love."

"The doctor calls it paralysis."

* * *

An old-fashioned gentleman took a modern Miss for a ride in his car and after finding a suitable spot to park, kissed her several times lightly on the cheek and then announced, "This is called spooning."

"Okay," she said, "but I think I'd rather shovel."

* * *

The first grade school teacher was getting acquainted with her new class. To one youngster she said, "Billy, whose little boy are you?"

"Oh, I'm my momma's little boy."

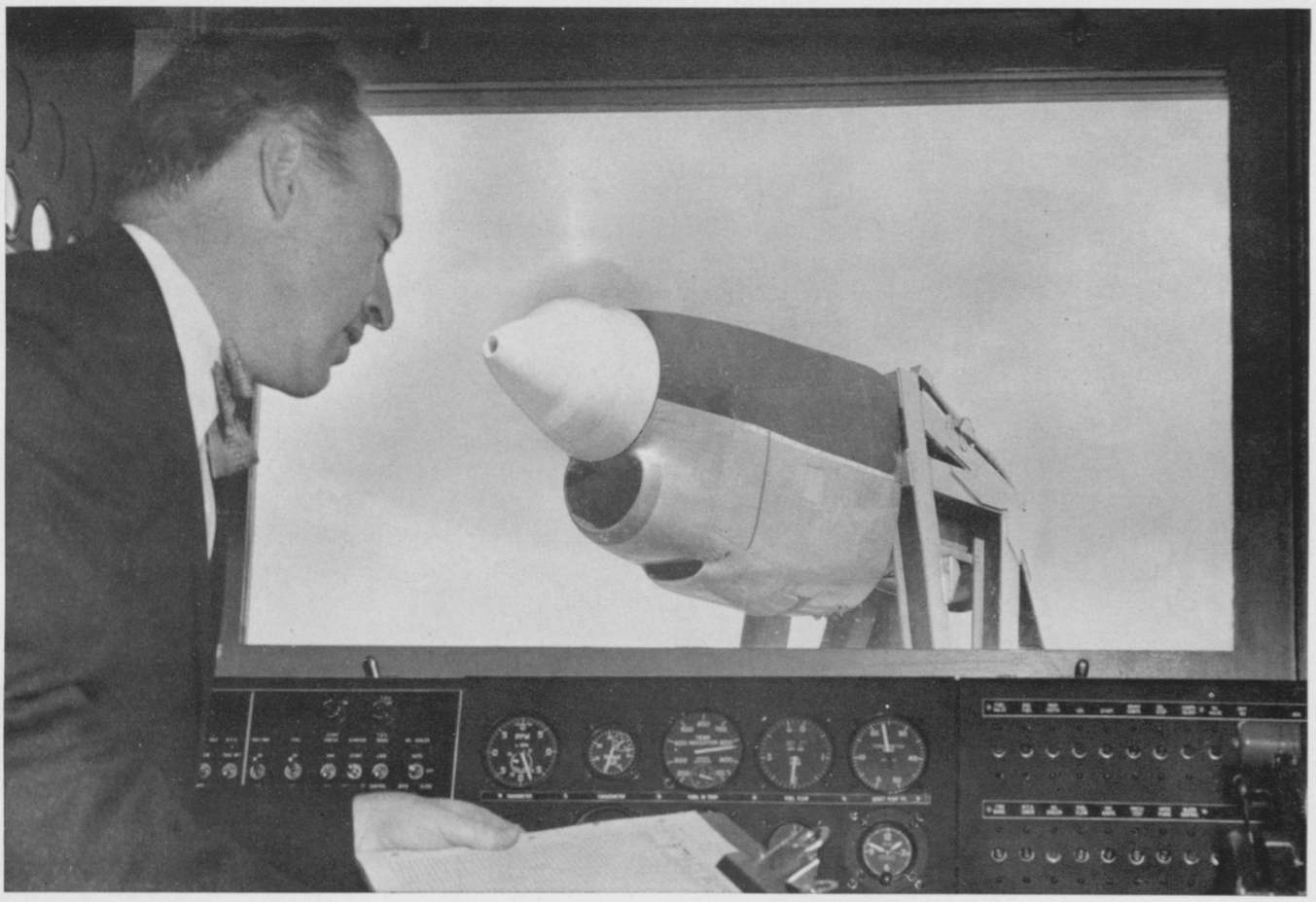
"Sally, whose little girl are you?"

"I'm my daddy's little girl."

"Johnny, whose little boy are you?"

"Ow, cut out da rough stuff, teach. There's been trouble about that at home already."

16 TIMES "AROUND THE WORLD" AND NEVER OFF THE GROUND!



WHAT KIND of double talk is that—"16 Times Around the World, and Never Off the Ground?"

It's like this. With Allison's entry into the commercial airline field, there is a need for flight data on turbo-prop engines before they are put into regularly scheduled commercial service. In the absence of actual data, Allison is running a 1000-hour test schedule with a Model 501 turbo-prop engine mounted on an outdoor test rig.

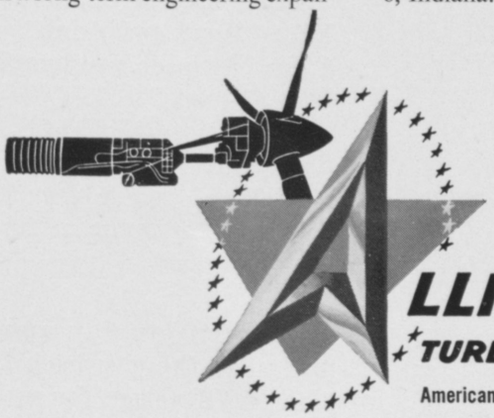
In reality, 1000 hours of flying time represents about 16 times around the earth, is the equivalent of about 4 months of normal, commercial airline usage.

For this test, actual airline operating schedules are used. This means that the engine is run through complete cycles of starting, ground idle, take-off, climb, cruise and descent for landing, and the cycle is repeated continuously 'round the clock as the schedule simulates trips of from 250 to 2500 mile blocks.

One of the young engineers who has been working on the project from the start is Donal J. Nolan, shown above at the test instrument control panel. Don is assistant chief, installation engineering at Allison. After his graduation in '42 from Case Institute of Technology, he came to General Motors in 1943 with a degree in ME.

Commercial acceptance of the Allison turbo-prop engine started with the purchase of a quantity of Allison-powered Lockheed Electras by American Airlines. This initial purchase, plus plans of other leading airlines to adopt the Electra, opens a new chapter in the growth and development of Allison Division of General Motors Corporation. Already a leader in the design, development and production of turbo-jet and turbo-prop engines for military use, Allison is underway with a long-term engineering expansion program covering advanced military and commercial engine installations. This $75,000,000 program, providing for newest engineering and research facilities, intensifies the *immediate* need for engineers.

Opportunity for young graduate engineers is unlimited at Allison. Arrange now for an early interview with our representatives on your campus, or write now for information about the possibilities of YOUR engineering career at Allison: R. G. GREENWOOD, Engineering College Contact, Allison Division, General Motors Corporation, Indianapolis 6, Indiana.



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An elderly gentleman was crossing the street at a busy intersection when a large St. Bernard ran by, knocking him off his feet. He had no sooner picked himself up when a Crosley skidded around the corner and flattened him again. Bystanders helped him to his feet, and someone asked if the dog had hurt him—not having seen the Crosley.

"Well," quavered the old man, "the dog didn't hurt me too much, but that tin can tied on his tail nearly killed me.

* * *

Knock on the hospital door—
"Who's there," came the reply.
"Friend or Enema."

* * *

"Well, we'll have to rehearse that again," remarked the undertaker as the coffin fell out of the back end of the truck.

* * *

"Who gave the bride away?"
"Nobody. I could have, but I kept my mouth shut."

* * *

Two editors gazed admiringly at the beautiful scanty dress of the chorus girl.

"Who made her dress?" one asked his companion.

"I'm not sure, but I think it was the police."

* * *

College girl: "I want some alligator shoes."
Male clerk: "What size does your alligator wear?"

* * *

Then there's the dachshund who met his end running around a tree.

* * *

C.E.: "What do you do all day?"
EE.: "Hunt and drink."
C.E.: "What do you hunt?"
E.E.: "Drink!"

* * *

She tenderly whispered. "Am I the first girl you've ever kissed."

The engineer replied: "As a matter of tact, yes."

* * *

As he felt his way around the lamp post, the overloaded senior muttered, "S' no use, I'm walled in."

Then there was the fellow who had a hobby of collecting rocks and putting them in his bathroom—had rocks in his head!

* * *

An Eastern lady on vacation at a dude ranch in Arizona was very much taken with the quaint bird known as the Road Runner.

Out on a trip on the ranch with the wife of the ranch owner, the Eastern lady suddenly pointed at a Road Runner crossing the trail and exclaimed. "Oh look, there goes one of those cute Street Walkers!"

* * *

The other morning a couple of our profs were downtown and they happened by the fish market. There—neatly arranged in rows were several salmon.

"My gosh!" exclaimed one of the professors. "I've got a class this hour!"

* * *

"Are they very strict at your college?"

"Strict? You remember Jonesey? Well he died in class, and they propped him up until the lecture ended."

* * *

The young thing was sitting on her front porch knitting some tiny garments. And her mother said to a neighbor: "I'm glad to see that she has taken an interest in something other than running around with boys."

* * *

Freshman "What does the Chaplain of Congress do?"

Senior Engineer Student: "He just gets up on the platform—takes a look at the senators and representatives, and prays for the country.

* * *

The Theta, excited about having been pinned by a fraternity man the night before, dressed hurriedly and was walking towards the Student Union when she came upon a group of male friends. Stopping in front of them, the girl proudly thrust out her chest and commanded happily, "Look!"

But in the excitement, she had forgotten to wear the pin.

PHOTOGRAPHY AT WORK—No. 18 in a Kodak series

What's their credit rating?

With Photography and Air Mail working together, the Credit Clearing House of Dun & Bradstreet, Inc., speeds vast quantities of information across the country overnight.

A Southern wholesale confectioner had received an order for $10.00 worth of candy bars from the Horsie Hollow Candy Shop. It was a first order, and when the credit manager didn't find the name listed in the Reference Book, he phoned the Dun & Bradstreet office for a report on the venture.

The reporter assigned to the case located the concern on a dirt road, and he took a snapshot of the premises and its busy proprietors which inspired this illustration. He interviewed the owners and wrote a report which was forwarded to the wholesaler.

It informed him that the enterprise was operated as a partnership by two neighbors who were both "eleven years of age and unmarried"—also that "although the owners are men of limited means, they have a high standing in their community." The financial statement indicated assets of $13.25 in merchandise and cash, with a valuation of $35.00 for the building consisting of a remodeled turkey coop.

The partners were reported as experienced with a five-year record of selling lemonade and cookies with their home pantries as the principal sources of supply. There was no indebtedness as their mothers' terms were strictly C.O.D. The wholesaler took a more liberal attitude and shipped on regular terms. The bill was paid in ten days, and the wholesaler opened an account in his ledger for the "Horsie Hollow Candy Shop."

Even if Dun & Bradstreet reporters photographed every business they investigate, it would not be among the biggest uses of photography this famous credit organization employs.

One most important way makes last-minute credit information in the apparel trades available thoughout the country overnight. Current data and analysts' opinions on more than 150,000 apparel retailers are microfilmed, transferred to micro-cards and flown daily to Credit Clearing offices.

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