SPARTAN ENGINEER

IN THIS ISSUE:

MAY, 1958

PRICE 25c

ARTICLES ON

JET STREAM
HIGH VOLTAGE FINISHING
ENGINEERING EXPOSITION
SIGMA PHI DELTA
AND OTHERS


rewarding
Chemistry stands at the threshold of a new age of discovery
It has been said **that** more significant scientific advances have taken place in the last fifty years than in all the centuries that have gone before. One fact is indisputably clear. The use of applied science in American industry today is progressing at a rate so fantastic it staggers the imagination of the boldest visionary!
This is particularly evident in the vast, highly diversified field of industrial chemistry. Here, products, materials and processes that were unknown a few years ago are in wholesale use today. The accomplishments of chemical research are being felt in every area of human endeavor. The prospect of further advancement in the immediate future appears limited only by man's imagination and his desire for improvement.
Our society stands at the threshold of a new age of discovery that offers an infinitely better way of life as its reward. A host of courageous, creative industrial chemists will help lead the way.
. . . and you, too, can help shape the future
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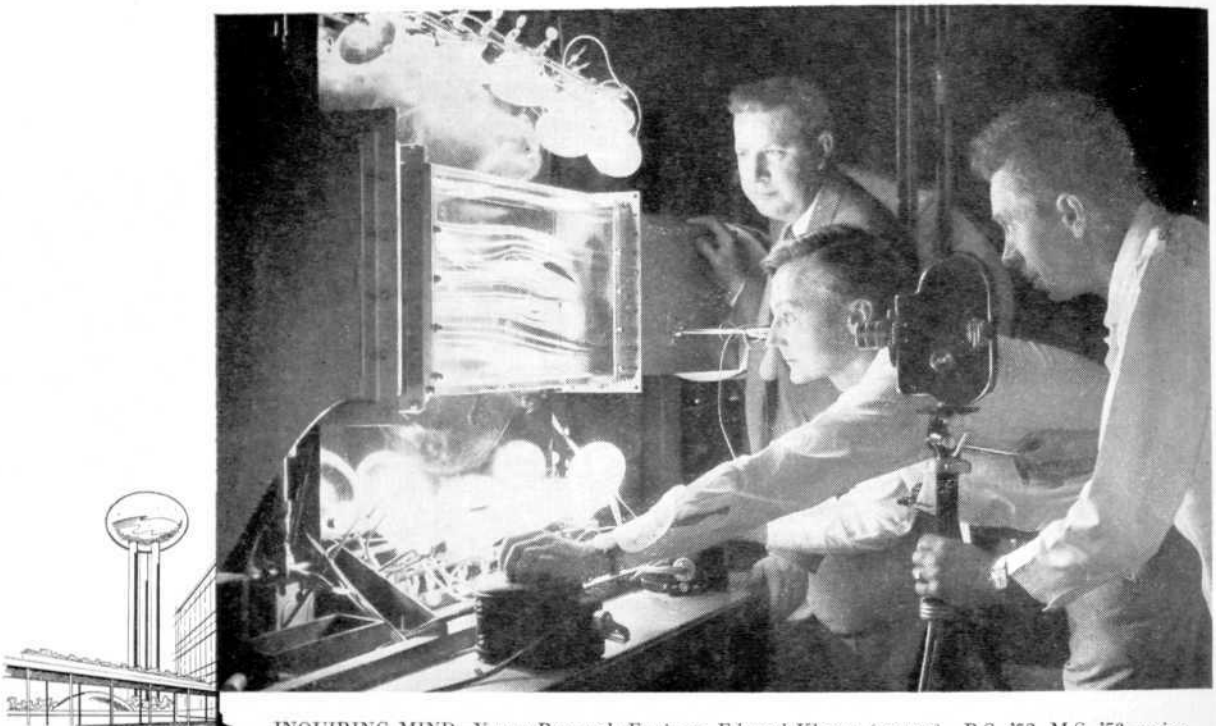

INQUIRING MIND—Young Research Engineer Edward Klomp (center)—B.S. '52, M.S. '53—using smoke tunnel to investigate stall propagation of axial flow compressors. His work is guided by William Turunen (top left)—B.S. '39, M.S. '46—head of the Gas Turbines Department at GM Research—and results recorded by technician George Josie on motion-picture film.

"I'm in the business and I know..."

"Not too long ago I was in the same situation you fellows are in now. Senior year and the hig decisions. What am 1 going to do with my education? What am 1 going to do for a living?

"Well, 1 talked to a number of people and did as much letter writing and looking around as I could. The way 1 figured it, 1 wanted op-portunity... a fair chance to put my capabilities to work and to be recognized for what I could do. Of course, 1 wanted to be well paid, too. It all seemed to add up to the aircraft industry... and to me it still does.

"In the space of just a few years I've worked on quite a few projects, important projects that some day may mean a great deal to this country. They sure meant a lot to me. And I wasn't standing still either. My salary and my responsibilities have increased with each promotion. That means lots of challenges, new and tough problems that we have to solve, but that's the way I like it. So, if you- want some advice from this "old grad," choose the aircraft industry. It's the wisest choice, I'm in the business and I know."

probably no other industry in America has grown so fast *and advanced so far* in a short time as has the aircraft industry. And yet there is no limit to how far man's inventiveness and imagination can push the boundaries. Radical new concepts that would have been unthought of just a few years ago are the drawing-board problems of today.

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H. BROWN BALDWIN
B. S. Mech. Eng., U. of Vermont, 1949.
Began as Cadet Engineer, Boston Gas Co., 1950. Became Staff Engineer in Distribution Development Section, 1952; Staff Engineer in charge of Development, 1955; Distribution planning Engineer, 1956. Worked closely with company's natural gas conversion programs. Now advisor to Distribution Department charged with developing processes, machines, specifications. Assists management in preparing cost estimates, job analyses, other projects.

W. C. DAHLMAN
B. S. Gas Eng., Texas A. & I., 1938.
Began as Engineer trainee with Lone Star Gas Company after graduation from Texas A. & I. with first four-year Gas Engineering degree offered by institution. Joined Houston Natural Gas Company in 1942. Became District Engineer in Texas City and then District Manager in Beeville and El Campo. Dahlman is currently Chief Engineer with full engineering responsibility throughout the twenty counties in the company's Texas Gulf Coast System.

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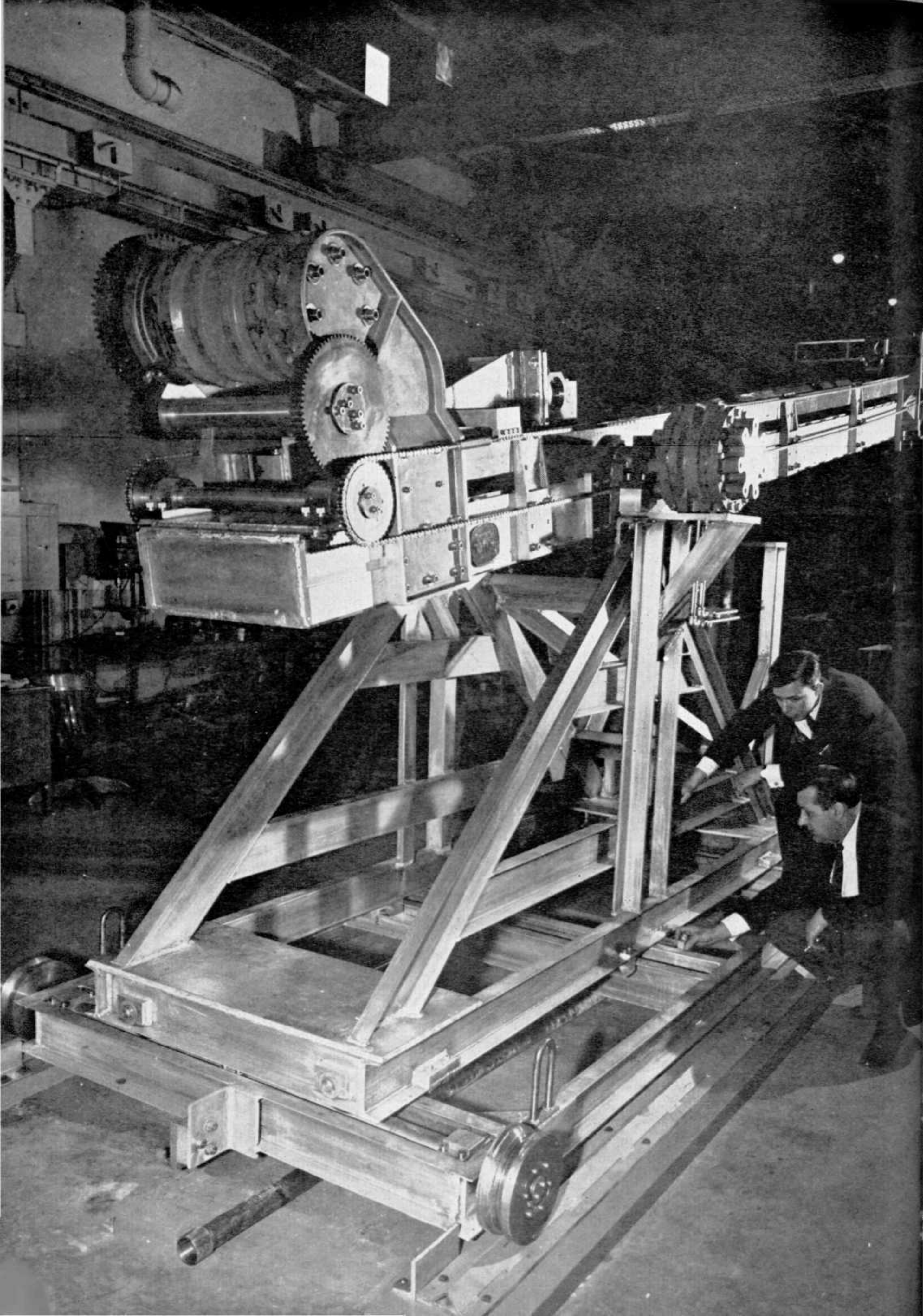

of michigon state university VOLUME 11 NO. 4 MAY, 1958

FRONTISPIECE: This machine is used for handling radioactive materials under 18 feet of water and operates on its own railroad track. It will be installed this year in the world's first industry-owned nuclear materials testing reactor at Waltz Mill, Pa. (Courtesy of Westinghouse)

Cover: Air Force Jet Flying the Jet Stream

MEMBER ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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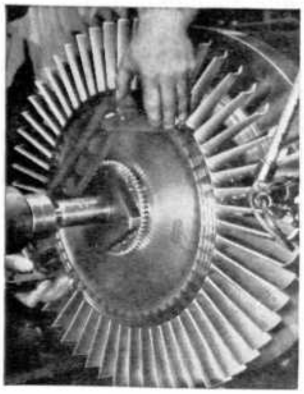
See answers below

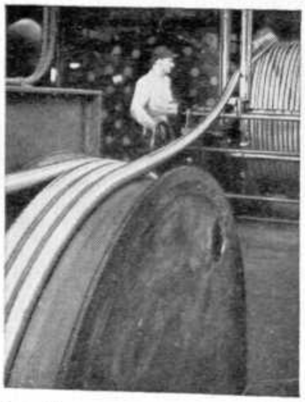
☐ **Oil well drill collar** — Needed: non-magnetic metal with high strength. Which Inco Nickel Alloy . . . ?

☐ **Jet engine flame tube**—Needed: oxidation and corrosion resistance at jet engine temperatures. Which Inco Nickel Alloy . . . ?

☐ **Radar platform "leggings"** — Needed: resistance to abrasion and marine corrosion. Which Inco Nickel Alloy . . . ?

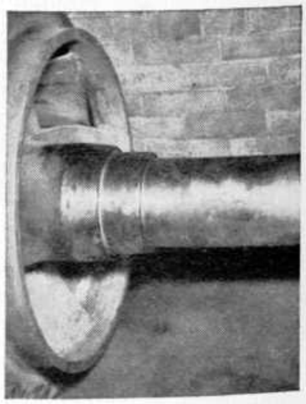


☐ **Gas turbine blades** — Needed: hot strength up to 1500°F., low coefficient of expansion. Which Inco Nickel Alloy . . . ?



☐ **Submarine cable sheathing** — Needed: non-magnetic metal resistant to marine corrosion. Which Inco Nickel Alloy . . . ?

☐ **Ultrasonic drill**—Needed: high magnetostrictive ability to produce ultrasonic vibrations. Which Inco Nickel Alloy . . . ?



☐ **Shaft sleeve for salt water pump** — Needed: extra-hard casting alloy that resists corrosion. Which one . . . ?

You may have to take this kind of quiz *again*. You may be designing a machine which requires a metal that resists corrosion . . . or wear . . . or high temperatures. Or one that meets some destructive *combination* of conditions.

When you start to design equipment, you will have to select the proper material to meet given service conditions. Over the years, Inco Development and Research has successfully solved many metal problems, and has compiled a wealth of information to help you.

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Oil well drill collar: 3. "K" Monel; Jet Engine flame tube: 4. Inconel; Radar platform "leggings": 5. Monel; Gas turbine blades: 6. Inconel "X"; Submarine cable sheathing: 7. Monel "403"; Ultrasonic drill: 2. Inco Nickel; Pump's shaft sleeve: 1. "S" Monel

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makes metals perform better longer

STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Co., Inc.

Here at Douglas we're involved in a greatly accelerated missile and space program. This requires one of the most intensive engineering and research efforts in our history.

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Douglas Aircraft Company, Box 6102-J
Santa Monica, California

FLYING HIGH

The jet stream, an aid to airborne economy, is becoming a new weather-forecasting factor. . .

by Althea Butler, Chem., '59

LAST **year ;i pilot** flew from California to Massachusetts with the aid of the Northern Hemisphere's jet stream in three hours and forty-seven minutes. This jet stream first became known in 1922 by meteorologists when weather balloons, released in England, landed four hours later near Leipzig, Germany, 570 miles away. At that time not too much was thought about this phenomena, and it was decided that it had **just** happened by chance. Then near the end of World War II, pilots on bombing missions over Japan would relate to their commanding officers that they couldn't hit their targets because of headwinds so strong that the planes could make little or no headway. The pilots claimed they would be almost over the targets at altitudes of 25,000 to 30,000 feet with the throttles wide open and the planes would stop completely. At first no one believed them, but, as more and more reports of the same nature came in, investigations began.

The scientists started probing and found that there are four main ribbons of high speed winds that encircle the globe. Three of them flow from west to east and one flows from east to west. These jet streams flow in waves like a shaken rope around the middle latitudes of the earth. The one that flows from east to west travels across Southeast Asia and Africa. The other three supposedly travel in the northern hemisphere.

Until a few years ago, it was believed that the jet stream had speeds from 75 to 300 miles per hour. This was disproved when a balloon sent up from Philadelphia was clocked at 392 miles per hour. Recently, the winds have ranged up to 450 miles per hour.

The altitude of the jet stream varies considerably. Reports have varied from 15,000 feet to 50,000 feet. The stream that flows around the northern hemisphere starts to rise from lower altitudes in March, and continues rising until mid-October when it begins to descend again. This makes it difficult for the meteorologists to know exactly when and where the jet stream will be when they want to study it.

These jet streams are thought to be caused by masses of cold air from the polar regions coming down and meeting masses of warm air from the tropics. The two masses of air compress a layer of neutral air between them with such force that the neutral air is squirted out like toothpaste from a new tube. This force results in tremendous air velocities. The rotation of the earth also adds to the velocity of the stream. It has been found that the stronger the jet stream, the thicker the entire stream. In most sections it is 300 miles wide.

The stream we are most concerned with starts west of the Himalayas. It splits up and heads north to Japan, where it attains speeds up to 450 miles per hour at an altitude of 35,000 feet. It continues, though at a slower pace, across the Pacific, over the California-Oregon coast, then accelerates again due to pressure over the Cascade-Sierra Nevada slopes. It completes its merry-go-round by streaking over the Rockies, across the mid-western plains to the east coast, over the Atlantic and Europe and finally back to the Himalayas.

Airline operators became aware of the economies of operation if they could utilize the air stream. The aid of the tail winds on east-bound flights, and absence of head winds on west-bound flights would reduce fuel consumption and flight time. For these reasons dependable stream tracking was imperative.

There are four cloud formations which indicate these paths:

1. Cirrus streamers, white feathery wisps with tufted trails, seen moving at high speeds and high altitudes.

2. High cirrocumulus, small white rounded clouds in patches often scattered at random, but sometimes shifting rapidly to cirrus streamers with delicate wave patterns.

3. Altocumulus-fleecy, nearly stationary formations with lens-shaped clouds, piled layer upon layer at middly altitudes.

4. Billowing altocumulus clouds which often extend from horizon to horizon, with parallel waves running at right angles to the direction of air flow.

Althea Butler, the student author of this article is a junior from Wyandotte, Mich., majoring in Chemistry. Miss Butler is Vice President and Pledge Trainer of her Sorority, Delta Delta Delta. She has also been a member of Student Government, Wolverine Staff, J-Hop Committee, and Swedish Gymnastics Team.

Althea Butler

Other telltale signs include gustiness at ground level; persistent cool, crisp air; generally blue skies, with visibility unlimited; precipitation often limited to sporadic sprinkles of rain or snow, and rapid changes in cloud cover from one tenth of the sky to nine tenths and back again in less than an hour.

There are also three criteria used **to** determine whether the jet stream is near.

1. At least three of the four basic cloud types must be present.
2. The high clouds must be moving **at** jet stream velocities.
3. The clouds must exhibit a coherent pattern extending for a considerable distance along the axis of the jet stream.

Generally the feathery cirrus clouds stretch from horizon to horizon along the path of the jet stream, immediately to the south of the core. To the north °f the core the air is usually clear and the sky is dark blue.

Another theory on finding the jet stream is that the path they follow may be outlined by fast-twinkling stars. The higher and faster the winds, the faster the stars twinkle.

There are indications from other scientists that radio stars twinkle, and that this twinkling is also related to the speed and altitude of winds on the earth. Radio stars are radiation sources which, invisible to the eye or telescope, can be heard on certain types of radio receivers.

In 1955 Jerome Namias theorized that the jet stream might be responsible for the new lanes of hurricanes witnessed in the last few years. A recurring weather funnel has shaped up since the mid-1930's, formed on the west by the wandering jet stream and on **the** east by an intermittently built-up mountain of air off Labrador. The new **jet** stream tends to pull the hurricanes due north along the east coast of the U. S., instead of them veering cast and dissipating their fury in the Atlantic. This **theory** tends to account for the expectantly wanner winters, since it pulls up warm air from **the** tropics along the Atlantic seaboard.

The erratic behavior **of the jet stream** (for instance, last year the jet stream followed **a** varied path—in the spring it shifted **far** to the south and brought cold air in from **the** north—by August it was well to the north, crossing Southern Canada) is **believed** to be the explanation for the relationship *hv*-tween the typhoons in the Pacific, the hurricanes in the Atlantic, and the presence of tuna in the North Sea. This is so, as the jet stream affects ground weather in that it changes the pattern of lower-air movements. A jet stream can cause lower air to rise. As this air rises, it expands, cools, and its moisture condenses in the form of rainfall.

Vertical air movements also result in shifts of air that cause horizontal air movements on the earth's surface. These horizontal air movements reveal themselves in low-pressure areas, storms and cyclones. Generally, the air is moist if the jet stream is approaching and dry after it has passed high overhead.

As was mentioned before, there is a southern counterpart to the jet stream in the northern hemisphere. It, too, is apparently caused by encounters between air masses of different temperatures. The South American jet stream travels at an altitude of 36,000 feet, and at a velocity slightly slower than the one in North America. Its core sometimes reaches a width of 180 miles, which is quite a bit narrower than the other. The South American jet stream also

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METALLURGY from Adam to Atom

by Dr. D. D. McGrady
Metallurgical Engineering Department

METALLURGY has been mankind's stepping stone to new horizons ever since the first cave man picked up a piece of meteorite and noticed that it was unlike the stones he was using for tools and weapons. Our cave man could not chip or break the iron-nickel alloy of his meteorite fragment, but he could pound and form it into some shape he needed.

There is ample evidence that metal was used in Egypt at least as early as 4,000 B.C. and in India by 2,000 B.C. Man and metals have been allied through the ages.

Metallurgy is one of the oldest branches of engineering and historically it has been of such outstanding importance that the great eras of history have been named in accordance with metallurgical developments. We have, thus, the Bronze Age, the Iron Age, and now the Age of Alloys.

The science of metals has evolved largely in the past 50 years. A particularly rapid development of the scientific aspects of metals and alloys has occurred during the past decade.

Modern metallurgy includes not only the science of extracting metals from their ores but also the science of the metallic state. A major effort is presently underway to correlate the atomic structure and arrangement of metals and alloys with their chemical and physical properties, nature, and behaviour.

Dr. D. D. McGrady, Assistant Professor Metallurgical Engineering, is the author of "Metallurgy —From Adam to Atom."

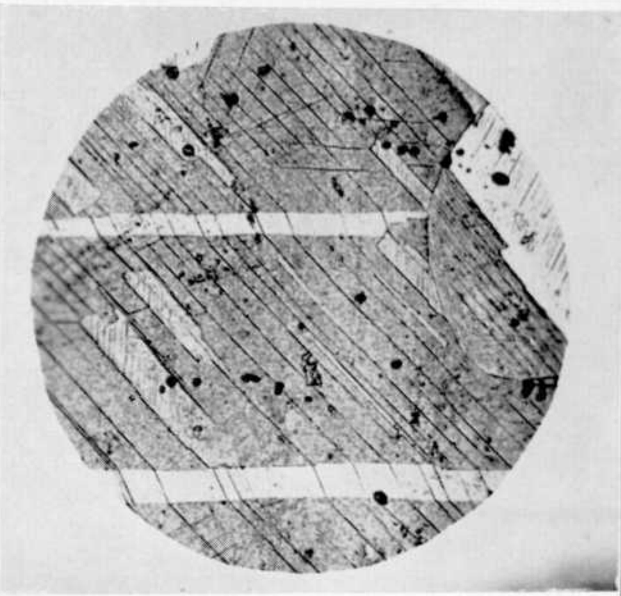
The science of metallurgy undergirds all other areas of engineering. For example, the civil engineer improves the design of his bridges and buildings and the mechanical engineer reduces the dead weight of his transportation equipment because of the metallurgical development of a new series of low-alloy, high-strength structural steels. The electrical engineer interested in light-weight, rugged, compact communications equipment has been greatly assisted by the metallurgical development of high purity germanium and silicon metal for transistor tubes. Newer types of corrosion-resistant, high-strength stainless steels are widely used by chemical engineers in the construction of petroleum refineries and chemical plants in which high temperatures and pressures are encountered.

Every phase of life today is dependent upon metals whether it be transportation by sea, land, or air; communication by telephone, radio, or television; or food processing by canning, quick freezing, or dehydration.

Metals are unique among materials for they are, at present, the only materials that possess both the properties of high strength and plasticity.

In recent years the metallurgist has been faced with a host of new challenges. Engineering design is now frequently limited by the metals at hand. Metals and alloys are often the critical limitation in the performance of an engineering design. Dr. Cyril Smith, Director of the Institute for the Study ot Metals, has said, "The design of gas turbines, rocket motors, and nuclear power plants are all crucially dependent on the development of better materials.

The Fingerprints of Steel
(Pearlite in annealed S.A.E. 1090 steel, magnified 800 diameters.)



Slip Lines in Yellow Brass
(Plastic deformation indicated by the parallel dark lines. Magnified 500 diameters.)

Throughout most of history, the important figures in metallurgy have been those who, through improved chemical processes or handling methods, have cheapened and expanded production. In the future, the important figures will be those who permit the development of better and better properties."

The development of nuclear energy has put the spotlight on uranium, plutonium, beryllium, zirconium, niobium, hafnium, and titanium. Material requirements for new jet engines, supersonic aircraft, and guided missiles have accelerated the development of molybdenum, vanadium, and complex alloys of iron, nickel, cobalt, chromium, tungsten, and columbium in the search for metals to operate at high stress for long periods even though red hot.

As an example of the severe requirements placed on materials, consider the recently completed commercial atomic power plant at Shippingport, Pennsylvania on the Ohio River. This 60,000 kilowatt plant is America's first big atomic power station for civilian use. The reactor, which is a pressurized water type, was built at a cost of $72,000,000 and was successfully completed only after five years of inconceivably frustrating, frequently heartbreaking work to develop special metals and equipment. Materials and devices for such a power plant must be ultra-reliable for long Periods with a minimum of human attention. They must be reliable despite high temperatures, high pressures, severe corrosion attack and the effects of nuclear radiation. In order to meet these unprecedented requirements, scientists and engineers have Pioneered different, higher standards of metallurgy and fabrication.

The reactor pressure vessel in which uranium atoms split in a continuous chain reaction to create heat rests in a huge carbon steel, stainless-clad cylinder **33 feet** high, 9 feet across, with walls *8 1/2* inches thick. This vessel is the largest that American industry has ever made, and the plate, clad with 1/4 inch of stainless steel, the thickest ever rolled in this country.

The construction of the reactor vessel was such a tremendous undertaking that conventional methods of machining, welding, and heat-treating had to be abandoned. More than two years of painstaking effort went into its fabrication. Some parts of the vessel went into the heat-treating furnaces 15 times.

The nuclear core proper, only 6 feet long and 6 feet in diameter, weighs 58 tons. It is composed of 165 pounds of highly enriched uranium "seed" surrounded by 14 tons of natural uranium. Core materials must not only withstand potentially destructive radiation conditions but also must not capture or absorb too many flying neutrons—else the chain reaction be slowed or stopped. Here, then, was the dilemma: The metals that were impervious to radiation effects also absorbed neutrons too readily.

The search for a suitable core material finally narrowed down to the metal zirconium, then relatively unknown. Zirconium was destined to become a major "wonder" metal of the Atomic Age. It not only withstood the high temperatures needed for good thermal efficiency, and resisted corrosion, but also had a very low affinity for absorbing neutrons.

By way of contrast it should be pointed out that not all reactor materials should be transparent to neutrons. In fact a very high neutron absorption is wanted for the control rods that are lowered into the core to control the speed of the reaction or to shut it down

(Continued on Page 36)

Under a slide rule arch, the new initiates of the Knights of St. Patrick were tapped by Joan Loveless, The Engineering Queen, at the 1957 May Hop.

BIG DOINGS

MAY 9-10...

by Fran Weihl, E.E., '59

The 1958 Engineering Exposition Features Exhibits, Auto Race, Engineering Queen and Dance.

ONE of **MSU's** greatest displays of engineering talent, applications, and practical know-how will be featured at the tenth annual Engineering Exposition, May 9 and 10.

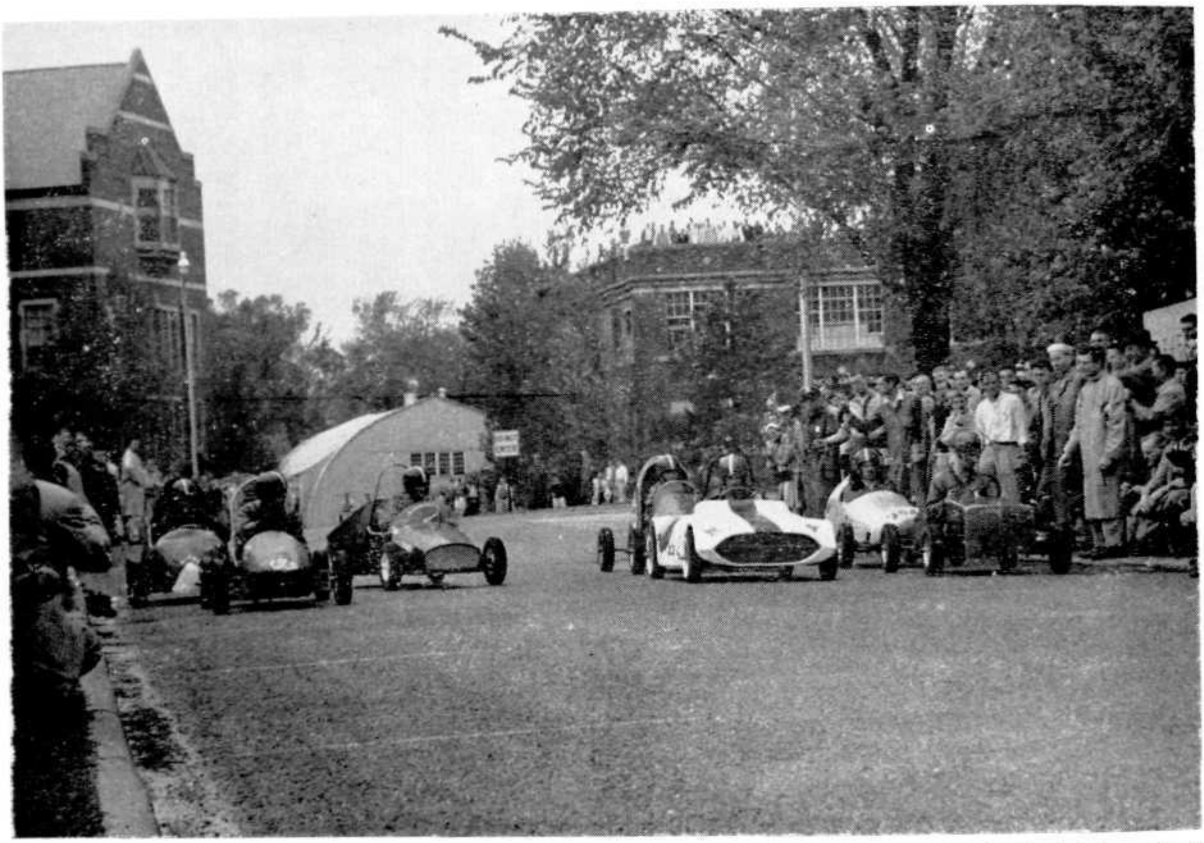
Sponsored by the Engineering College and supervised by the Engineering Council, the engineering students will be competing for awards granted for technical ingenuity.

Immediately following last year's Exposition the Engineering Council commenced their plans for a bigger and better exhibition than ever before. One main improvement that was unanimously approved was making student exhibits the primary feature. The Exposition culminates a year of achievement for the Engineering Council.

One of the featured student exhibits that will be on display is a supposedly unbeatable tic-tac-toe machine that will match wits with visitors. Everyone attending may observe a colorful golf ball discriminator in action, automatically washing, drying and sorting various colors and sizes. Profound displays by organizations and individuals will be of great interest to non-technical as well as technical observers. All of the student exhibitors will be competing **tor** the six-inch slide rules that will be awarded to the outstanding exhibit.

(Continued on Next Page)

Single file around the corner, Mechanical Technicians lead the Civil Engineers.



Lined up at the starting line for the 1957 Auto Race, left to right—Chem. Engrs., Mech. Technicians, Civil Engrs., SAE, Ag. Engrs., ASME.

The EE entry grinds into turn behind the Chem. Eng. Bldg.

Above is a student exhibit of Oregon-Washington layout by Dave Welty.

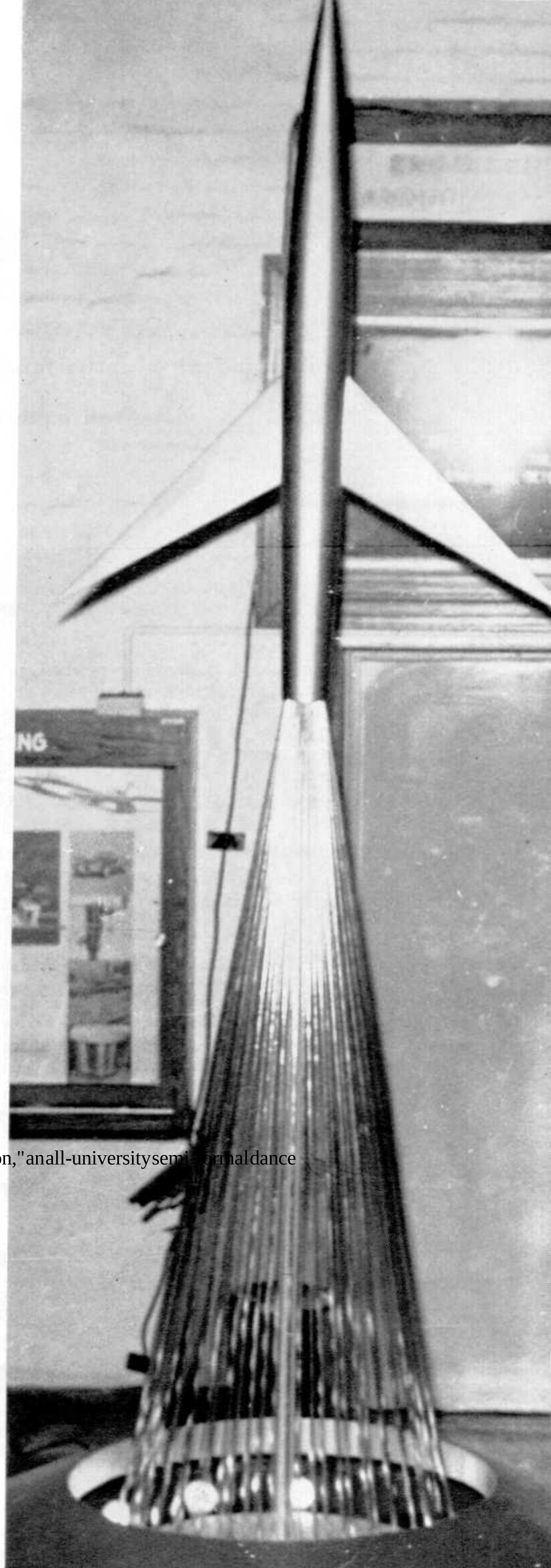
JETS (Junior Engineering Training) Clubs from Michigan high schools will also have many exhibits on display.

Industrial exhibits will feature IBM, DuPont, John Bean and other products as well as a complete array of old vintage autos from the Vintage Motor Car Club of Lansing.

These displays may be seen Friday afternoon and all day Saturday at Olds Hall, Electrical Engineering, and the Agriculture Engineering buildings.

Since 1954 the auto race has been the main center of attraction on Saturday afternoon. Starting at 1:00 p.m., cars sponsored by Triangle, ASME, Ag. Engineers, Chi Epsilon, Technicians, SAE, IRE. Chemical Engineers and Civil Engineers will attempt to finish the **forty** one-half mile laps around Kedzie. Hay bales and board obstacles will be placed m the road to make the race more difficult.

The climax of the Exposition will be the May Hop, "Blue Moon," an all-university semi-formal dance Saturday night at Kellogg Center. Besides dancing to the music of Tiny Piper, awards will be presented to the winning exhibitors of the Exposition during intermission. During this time the Engineering Queen will be crowned, the prizes for the best student exhibits and the Dean's trophy for the most outstanding department exhibits willbe awarded, the outstanding senior engineer will be honored, trophies will be awarded to the winner of the auto race, and new members of the Kinights of St. Patrick will be tapped.



Right: This rocket exhibit was one of many displays set up at the 1957 Engineering Exhibition.

Don', miss the 1958 Engineering Exposion.

FALLOUT---

FACTS ABOUT EFFECTS

Hazardous nuclear weapon—testing threatens the health and safety of all earth inhabitants .. .

by Carole Frazier, Home Econ., '58

Tills entire tree world is currently perched on **the precarious** fence between defense and destruction. It **is** not only the United States that **is** faced **with the** problem of imperiling its population **with the** effects of radiation hazards produced by nuclear weapon tests, but every other nation is involved in this fight for freedom and struggle for survival as well.

The question we must now ask ourselves is that of a lesser of evils. Can we, as a nation, withstand the **effects** of the radioactive materials that are (lumped into the atmosphere each time a weapon is tested, or must we ignore the dependency for defense **the** free world has upon the United States so that we **may** avoid at all costs the consequences of strewing radioactive debris in our own backyards? Ours is the dilemma of the undecided gambler. It is this **quandary** that forces us to weigh the two alternatives thoroughly and thoughtfully and to trust that, when we finally place our bets, we have chosen wisely. To do this, we must first familiarize ourselves with the nature as well as the cause and the effects of radioactive fallout.

It should be understood that during the course of his life, man involuntarily subjects himself to certain amounts of radiation that occur in naturally existing materials as well as in the cosmic rays from outer space. In addition to this normal dose of radioactive materials, there exists some non-weapon man-made sources of radiation such as radium, radioactive waste products, and X-ray machines.

Man's natural life-time exposure to radiation from strontium-90, an H-Bomb radiation product that collects in the bones of man, is greater than that encountered from external fallout. These two sources of radiation, natural and external, present two biological problems to the human race.

First to be considered are the immediate hazards of radioactivity to those now living, and second, the long-term genetic hazards to millions still unborn. The immediate radiation effects range from skin burns and radiation sickness, to stress, premature aging, and premature death. These non-genetic effects apply only to the individual receiving the radiation and not to his descendants. The increase in the incidence of non-genetic effects is, of course, proportional to the increase in doses of radiation the individual receives. The contention is, however, that radiation is only one cause for some of these non-genetic effects, and the existence of other causes makes a definite proportional relationship almost impossible to prove.

Turning now to the long-term hazards, may irradiation of the genetic materials of the reproductive cells, genes or chromosomes, will damage the cells regardless of how minute the dose. This damage prevails in the form of a chromosome break. Chromosomes are considered the carriers of heredity and normally one chromosome break in 100 cells occurs. This is known as the spontaneous breakage rate. However, if this breakage rate increases due to the effects of radiation, a significant number of heredity defects in our future generations can be expected. The actual amount of radioactive material required to produce this defect is questionable, but many scientists have agreed that there is no "safe" dosage.

There is no such thing as a nuclear weapon that does not produce some radioactive materials. There are two principal nuclear processes associated with the energy production of the explosion. The first process is that of fission, which is the splitting of the atomic nucleus into fission products, neutrons and energy. The individual species of fission products are sources of much radiation. The other process is that of fusion which is the combining of the atomic

Carole Frazier, senior from Des Plaines, Illinois. Graduating in Institution Administration. Will start an administrative internship with Eastman Kodak in Rochester, New York in July. Activities in Hotel, Restaurant and Institutional functions.

Carole Frazier

nuclei into new nuclei, neutrons, and energy. It follows then, that the part of the explosion energy yield that results from fission or from fusion processes is directly related to the quantity of radioactive fission products produced or fusion products produced.

Neutrons are always produced in the explosion and they induce radioactivity into surrounding materials, but the radioactivity induced from these neutrons released as fission products is considered to be more dangerous to mankind. There are certain characteristics of nuclear weapon explosions that determine the nature and the amount of the fallout resulting. These are: the size of the explosion, expressed as megatons of T.N.T. explosion equivalent, percentage of total energy resulting from fission processes, the type of detonation (high in the air, under water, etc.), and the nature of the surface material where the explosion took place, such as water, rock, sand, or coral.

Two types of fallout result from nuclear explosions, local and non-local. The local fallout materials are the larger particles of matter originally thrown UP into the air by the explosion. These particles fall-out within a few hundred miles radius within a few days. The immediate effect on man is that of high level radiation from beta and gamma rays, and isotopes such as iodine 131, cesium 137, and strontium 90 which may be taken into the body along with foods. These effects further produce the acute and chronic symptoms of the non-genetic nature as well as some of the long term genetic hazards.

The local fallout from megaton size explosions can cover thousands of miles. One megaton equals the explosive force of 1,000,000 tons of T.N.T. In addition, it may be stated that multiweapon attacks of 200 to 300 bombs of megaton size could blanket one half or more of the United States with lethal radiation levels from local fallout alone.

Even though strontium 90 is considered as a non-local fallout product, the strontium 90 units from the local fallout of a one megaton attack could amount to 100 to 300 times the number of strontium units considered permissible in the human bone. This level would be one microcurie of strontium per 90 grams of calcium or an average concentration of 100 strontium units. The seriousness of such an attack From local fallout alone is apparent

The non-local fallout is considered the more delayed and widely distributed particles. There seems to be a nonuniform distribution of this more widespread fallout. Local weather directly Influences the distribution of the non-local fallout to the ground, For example, rain is one means by which radioactive particles are removed from the atmosphere to the earth. From 50 to 70 per cent of the total non-local fallout is expected to deposit in the ocean, since the oceans cover about 71 per cent of the earth's surface. The question of the uniformity of this non-local fall-out is an important one. It is imperative that we know the whereabouts of the fallout in the air and where it will come down, both for the sake of avoiding radiation hazards and for forecasts of future amounts of radiation at ground level resulting from future testing.

The non-local fallout products enter into the earth's processes in a manner consistent with their individual chemical natures. For example, the strontium 90 particles falling to the earth may be present in upper layers of soil and taken up this way by plants, or it may be directly deposited on the surface of plants. Either way, the chemical is taken into man's body through eating these contaminated plants. Once in the body, the strontium 90 seeks the bone and behaves in a manner similar to calcium. However, the body discriminates between the two chemicals

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HIGH VOLTAGE FINISHING

The application of the electro-static principle is increasing the quality of products while reducing production costs

by Carl A. ***Helqulst,*** **Ag.** ***Engineering*** *'59*

THOSE of you who notice that the gleaming finish on your new automobile won't stand too close an inspection, or who find thin spots in the paint after several polishings, take heart. Certain new painting processes may be the answer to both the consumer's desire for better quality and appearance, and industry's quest for greater manufacturing economies.

Considering modern technological advances in industry, which have brought us engineering marvels and the new so-called "glamour finishes," it is paradoxical that application methods for these finishes lag so far behind the other advances in industry. A recent giant stride—"electrostatic spraying"—shows promise of bringing this phase into step with the rest of industry.

In the early days of the automobile industry, painting was done by hand with a brush. This method, although considered almost an art, involved much time and painstaking labor with resulting production bottlenecks. During the twenties the introduction of fast drying nitrocellulose lacquers brought about the use of spray painting, in which protective coatings are applied in a finely atomized mist or spray by an operator using a specially designed gun. This method of paint application is still in wide use today with very little change, even though with the most skilled operators, it is almost impossible to obtain a coat of consistently uniform thickness and quality. However, to reduce this human factor, automatic spraying systems have been developed.

In spray painting a large percentage of material isn't deposited on the object being painted, **but** escapes as a fine mist into the surrounding air. This mist, called over-spray, aside from being wasted paint, settles on walls, floors, equipment, men, as well as objects being painted. It is also a cause of fire, explosion, and health hazards. This necessitates ventilated spray booths to keep the air clean. Some of these booths are of a water wash type incorporating a curtain of continuously recirculated water. In this system all the fumes and over-spray must pass through the water.

In large installations the over-spray is often reclaimed from the water and sent back to the paint manufacturer for reprocessing. Even with the ventilating systems the booths acquire a large build-up of over-spray and must be cleaned frequently. A disadvantage of ventilated spray booths in a cold climate is that such a large volume of air is exhausted that heating system capacities must be much greater.

Another method of paint application that has been used for many years is "dipping." The object to be painted is dipped in a tank full of paint, and any excess paint is allowed to drain off. The nature of the articles that can be painted in this manner are limited mainly to shapes which allow good drain-off. Since the dip tank must accommodate the article to be dipped, this requires a relatively large volume or paint.

An offspring of the dipping method is called "flow-coating." Here the work passes through on a conveyei and is drenched with paint pumped through hoses or nozzles allowing the excess to drain off into a reservoir. An advantage of this system over dipping is that a smaller volume of paint is tied up. This system is widely used in the automobile industry for priming hoods, fenders and other automotive parts-

Carl Helquist started school at MSU in 1950, majoring in Ag. Economics. He entered the Army in 1954, and after receiving his discharge, worked at the General Motors Proving Grounds. At present he is on a leave of absence to complete work for an Ag. Engineering degree.

Carl Helquist

Until recently, methods of applying protective coatings in industry were restricted to conventional spraying, dipping, and flow-coating. In 1950 a new method of paint application was developed, based on the attraction of electrostatically charged particles to a surface which is at an unlike polarity. There are several types of these systems in commercial use today.

The earliest method developed uses a conventional spray gun mounted in a position so that it is not aimed directly **at** the work. A grid or series of wires suspended alongside of the work is charged at an electrostatic potential of approximately 100,000 volts. The object to be painted is grounded at an opposite polarity. The atomized paint particles pick up a negative static charge as they pass through the electrostatic field between the grid and the work and are attracted to the work.

On another system an electrostatically charged field is created **at** the ends of the gun. This, **in** turn, charges the atomized paint which is directed towards the grounded work. Both **of** these systems use greatly reduced fluid and air pressures even further decreasing over-spray.

A third system operates without the use of compressed air. A rotating bowl or disc replaces the conventional spray gun. Paint, fed **at** a constant rate to the bowl is spread out **uniformly** over the surface of the bowl by rotational forces. This bowl or disc is kept at a high electrostatic potential and the work moving past on a conveyer is grounded. The resulting strong electrostatic field causes the paint to be pulled from the edge of the bowl in the form of charged nne particles which are attracted to the grounded worK.

Electrostatic spraying results in a smooth, even coat of consistently uniform thickness and quality, and has the advantage of being able to "wrap-around or sprav around corners. The attraction of some particles is so great that they can reverse their direction as much as 180 degrees. Also, in the **last method** discussed, over-spray is almost completely eliminated. This means maximum efficiency in the use of the coating material and no paint **reclaim problem.** Some additional advantages of this method are: (1) automatic operation which means less labor is **required,** (2) reduction of health hazards, and (3) reduction of maintenance and cleaning **requirements.**

This system is finding wide **acceptance** in industry, especially with manufacturers who have **special** painting problems. They may produce articles of such a shape or **size** that conventional spraying methods result in an extremely high percentage of over-spray, yet which **aren't** adapted to dipping **or** flow-coating methods. An example of this type ol article might be a small electric motor. It is obvious that dipping or flow-coating would result in paint getting into unwanted places, yet because of its small size a great deal of the **spray** aimed at the motor would get past and be wasted. An **extreme** instance of this type of over-spray can **be** seen if one **visualizes** a painter trying to spray a set ol bed springs. Most of the spray would pass **through** the springs.

One typical installation which illustrates the **potentialities** of the electrostatic spraying system is in the plant of the Regina Corporation in Rahway, New Jersey. They produce a floor polisher-scrubber and a vacuum cleaner. The component parts of these machines are small and difficult to spray-paint without a lot of waste. This company adopted an electrostatic-spray unit which uses a rotating disc. It was found that one unit accomplished the work of eight hand sprayers, gave a more uniform coat, and, although production on some models was up fifteen percent, it used fifty percent less paint. Also, over-spray was virtually eliminated, and there were fewer rejects.

Similarly, the International Business Machine Corporation using the same type of system to paint electric typewriters, found that, along with increased production, they could paint three times as many pieces per gallon of paint as they could with the former hand spray method. Rejects were cut from a high of thirty percent to a maximum of three percent.

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Future plans of the organization are discussed by the Executive Council. Seated left to right are: Advisor—Lyle D. Oleson, Applied Mechanics Department; Neal Schroeder, Schuyler Rogers, Gerald Trabbic, and Gerald Wensloff.

LOCAL GOES NATIONAL

*by Herb **Harman,** E.E., '59*

Informal discussions over a cup of coffee create a spirit of friendship among members.

Sigma Phi, a local, social engineering fraternity, has been installed as the Omicron Chapter of Sigma Phi Delta Fraternity of Engineers . ..

NATIONAL officers and chapter **representatives** initiated the Sigma Phi group as the Omicron Chapter of the Sigma Phi Delta Fraternity of Engineers on Saturday, May 3, 1958, at Michigan State University.

During the past year, the Sigma Phi members and their advisor, Lyle D. Oleson, Department of Applied -Mechanics, encountered and overcame many obstacles for recognition on the campus. On April 30, 1957, a group of engineering students met with Mr. Oleson for the purpose of later petitioning for a charter in the Sigma Phi Delta Professional Engineering Fraternity. After several such meetings in Mr. Oleson's home, the group met twice a month in Olds Hall of Engineering due to the large number of interested students.

On February 26, 1958, the student congress at a regular session granted a temporary charter to the Sigma Phi Engineering group as a professional fraternity on the Michigan State University campus. Thus the road was cleared for sending in the petition for charter to Sigma Phi Delta. Included in the petition for charter was a letter from Dean Ryder, Dean of Engineering, indicating his welcome of the proposed affiliation of the Sigma Phi Engineers with the national organization of Sigma Phi Delta.

Sigma Phi Delta is an international fraternity of engineers founded at the University of Southern California on April 11, 1924. Restricted to engineering students, it is therefore a professional social fraternity.

It is a relatively young fraternity, and is thus small insofar as number of chapters and total membership is concerned. Nevertheless, it is well organized, and its chapters are carefully supervised by the national officers and by faculty and alumni advisors.

Sigma Phi Delta was organized to promote the advancement of the engineering profession and engineering education, to encourage excellence in scholarship, and to develop in its members the highest ideals of Christian manhood, good citizenship, and brotherhood.

Fraternity activities are organized to promote the above aims, and include professional talks, industrial tours, research, educational movies, and related work.

At the present time there are 21 charter members, several pledges, and four advisors. The officers are:

Chief Engineer . . . . Schuyler Rogers

Ass't Chief Engineer . . . . Neal Schroeder

Secretary . . . . Gerald Trabbic

Treasurer . . . . Gerald Wensloff

The future plans of the fraternity are to petition for status as a professional social fraternity on campus. Once this has been granted, the group will acquire a chapter house.

During the past year, the Brothers of Omicron Chapter have worked hard to attain their national affiliation. We certainly hope that they continue to work hard "to promote the advancement of the engineering education; to instill a greater spirit of cooperation among engineering students and organizations."

Ward Edwards welcomes a prospective new member's interest in the organization. Left to right: Neal Schroeder, Wm. Zilch, Charles Balzarini, and Ward Edwards.

Members investigating the ASCE entry in the auto race, and planning Sigma Phi's Racer for next year.

NEW DEVELOPMENTS

Edited by Norm Dill

New Progress Toward Television-on-the-Wall Made by Westinghouse Scientists

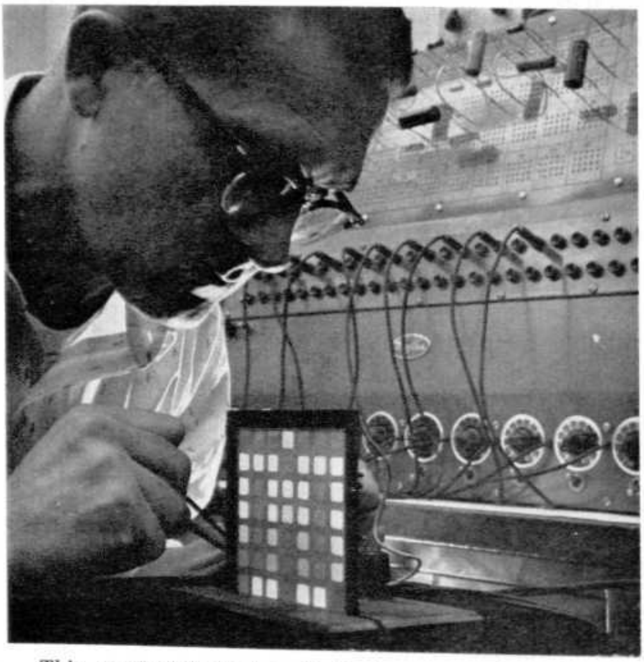
A new **experimental** television display screen—**brighter** than any previously reported and no thicker than a picture frame—has moved the idea of "television-on-the-wall" a step closer to reality.

Developed by scientists at the Westinghouse Research Laboratories in Pittsburgh, Pa., the new display screen is an important step in efforts to replace the bulky, high-vacuum television picture tube with a flat, bright "solid state" display screen.

The new Westinghouse display is called an Elf screen, getting its name from two words: electroluminescent and ferroelectric. It combines in a single structure an electroluminescent panel—man's newest source of light—and a flexible, built-in storage and control structure' made of ferroelectric materials.

Display Screen Needed

In describing the development, Dr. E. A. Sack, manager of the dielectric devices section of the **research** laboratories declared, "A satisfactory solid state display screen is an important objective of modern electronics research. When such a screen is fully developed, it will do such things as display radar pictures or other information in aircraft, show the ever-changing air traffic pattern around an airport, or bring television-on-the-wall to the average American living room. Recent progress in the development of bright and efficient electroluminescent phosphors leads us to believe that they offer the best approach to such a flat, efficient solid non-vacuum state display."



This small "checkerboard" display screen has moved the idea of "television-on-the-wall" a step closer to reality.

Elf Screen Has Advantages

Dr. Sack described the major disadvantages of the conventional cathode-ray picture tube as: inconvenient size and shape, limited maximum brightness, and susceptibility to flicker of the displayed picture.

"In a cathode-ray tube the picture is 'painted' on the phosphor-coated inner surface of the tube by a beam of electrons which periodically sweeps across the phosphor surface, causing it to glow in accordance with information supplied by the beam," the scientist explained. "For television service, 30 such pictures, or frames, are painted each second. Between frames, the phosphor should continue to glow long enough to retain a given image, thus displaying what looks like a continuous picture to the viewer.

"Many military applications, however, require fewer than 30 frames per second, which brings on a serious problem of flicker of the picture. This fact, plus the low maximum brightness of the tube, has placed limitations on its usefulness in a variety or situations.

"The Elf screen overcomes the problems of low brightness and excess flicker by providing for continuous—not interrupted—excitation of the screen. The built-in ferroelectric cells store and control the information to be displayed. They distribute excitation to the screen in accordance with an applied electrical charge. Once this charge distribution is established, the screen is excited without interrupting throughout the complete frame, or picture. Then the charge distribution is changed to form a new picture. The result is a picture of high **average** brightness and very low flicker."

Present experimental models of the Elf screen are less than a quarter-inch thick and have a bright-

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KEITH LYNN, B.S.E.E., PURDUE, '52, INVITES YOU TO

"Spend a day with me at work"

"I'm an Equipment Engineer for Illinois Bell Telephone Company in Chicago. Speaking personally, I find Bell Telephone engineering darned interesting and very rewarding. But judge for yourself."

"8:30 a.m. We start at my desk. I'm studying recommendations for additional dial facilities at the central office in suburban Glenview. This is the beginning of a new engineering assignment for me."

"10:20 a.m. I discuss a proposed layout for the additional central office equipment with Supervising Engineer Sam P. Abate. Since I'll want to see the installation area this afternoon, I order a car."

"11:00 a.m. At an interdepartmental conference I help plan procedures for another job I'm working on. Working with other departments broadens your experience and know-how tremendously."

"2:00 p.m. After lunch I drive out to the Glenview office. Here, in the frame room, I'm checking floor space required by the proposed equipment. The way our business is growing, every square foot counts."

"3:10 p.m. Then I drive to the office at nearby Skokie where a recent assignment of mine is in its final stages. Here I'm suggesting a modification to the Western Electric installation foreman."

"3:30 p.m. Before starting back to Chicago, I examine a piece of Out Sender equipment being removed from the Skokie office. This unit might fit in just fine at another office. I'll look into it."

"Well, that was today. Tomorrow will be different. As you can see, I take a job from the beginning and follow it through. Often I have a lot of jobs in various stages at the same time. I think most engineers would agree, that keeps work interesting."

Keith Lynn is one of many young engineers who are finding rewarding careers in the Bell Telephone Companies. Find out about opportunities for *you*. Talk with the Bell interviewer when he visits your campus. And read the Bell Telephone booklet on file in your Placement Office.

BELL TELEPHONE COMPANIES

NEW DEVELOPMENTS

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ness three times that of a conventional television **screen. The** contrast ratio between light and dark-areas of **the** screen is as high as 2(X) to 1.

Images can be stored on the Elf screen for several minutes or, due to the flexibility of the ferroelectric **storage and** control, can be changed many times per second. **The** idea **of** using ferroelectrics for this purpose originated with Westinghouse research scientist, Dr. P. M. G. Toulon.

There are no inherent limitations of the size of the glowing **Elf** screen; in **fact,** with appropriate electroluminescent panels, a display the size of a window would be easier to construct than one **the** size of the usual television picture **tube.**

Dr. Sack said that a practical form of the Elf screen was still in its early stages of development, with commercial screens several years away. A practical **screen,** is fabricated by preparing **a** laminated "sandwich" of electroluminescent and ferroelectric layers which have been divided into the many separate components required to produce a detailed picture. Coarse displays of this type have been made **experimentally.**

Scanning Problems Not Yet Solved

"The one outstanding feature of the cathode-ray tube which will not be easy **to** duplicate is the ease of scanning, or signal distribution, inherent in the tube," Dr. Sack declared. We now regard this as the major problem **to** be overcome in perfecting the Elf solid state screen. Continuous excitation of the screen **by** means **of** a system of storage and control was the **obvious** first **step** toward a successful device. Now we are attacking the problem of distribution of signal information, which is done so capably by the scanning beam in the cathode-ray tube.

"We cannot say how soon this phase of our work will graduate from its early research stages. Ultimately, we feel sure the problem will be solved, and the Elf screen well may be the long-sought television-on-the-wall display."

World Time Clock Measures Time Of any Phenomenon, Anywhere on Earth, To the Nearest Thousandth-Second

BOSTON-A "world time clock" which measures the exact moment of any event, anywhere on earth, to the nearest thousandth of a second, was described here today by Edgerton, Germeshausen & Grier, Inc. who developed it primarily for use in testing nuclear devices.

The clock was developed to help determine the exact world time of nuclear detonations, but EG&G men have foreseen many other useful applications for it. Ernest F. Wilson, development engineer, explained:

"Suppose that a thermonuclear device is to be fired at Eniwetok. At another location, perhaps a thousand miles away, we have an associate who is to record some scientific data related to the explosion. If he is to relate his data accurrately to the event, he must know exactly—to within a tiny fraction of a second—the moment when the detonation begins. This world time clock will tell him."

Time signals are taken from WWV, the radio station operated by the U. S. Bureau of Standards. These signals are extremely accurate at their point of origin, but in traveling great distances around the earth, they develop inherent errors due to many variables: the speed of radio waves, atmospheric conditions which vary that speed, the so-called "bounce" or reflection between earth and sky and certain other conditions. The world time clock may be set so as to compensate for these variations and obtain an "approximate" time, correct to within a few hundredths of a second. Then comes the task of setting the time exactly, to a split-second.

"This is done," went on Wilson, "by means of a differential gear and precision gear train, used in conjunction with a stroboscopic device. The dial has the usual hour hand, minute hand and sweep second hand; but in addition it has a hand that registers tenths of a second and a milli-second hand. This latter hand records thousandths of a second, by virtue of rotation at a speed of 10 revolutions per second around a dial divided into one hundred parts.

"Obviously, no human being could possibly follow such a motion with the eye. For that reason, we have a stroboscope which creates the familiar optical illusion of making moving objects appear to stand still. This is a special strobe, however. By means of special circuitry, its pulse which is at one-second intervals can be changed so as to be brought into coincidence with the time-ticks from WWV in such a manner that the instrument can be set precisely. Thereafter it acts simply as a super-accurate stopwatch in timing phenomena."

While it may seem incomprehensible to the layman that any event need be timed to such precise standards, the company stated that its engineers are working on versions of the clock which will be able to record in the microsecond range . . . millionths of a second . . . "because there is an actual need for a world time clock which will offer this order of accuracy. The major problem that remains is the rapid and accurate setting of the clock to world time to microsecond accuracy. This is approaching solution in the study of very low frequency radio propagation."

Germanium Resistance Thermometer

A germanium resistance thermometer having high sensitivity and exceptional stability in the temperature range near absolute **zero** has **been** developed. Once calibrated, this thermometer is reproducible to better than a few ten thousandths of a degree at the boiling point of helium (4.2°K) even after repeated cycling from room temperature. Such characteristics indicate that this thermometer might be useful for the accurate measurement of temperatures in outer space, when mounted in a suitable space vehicle.

Continued emphasis on low-temperature research has highlighted the need for a thermometer which would indicate low temperatures accurately and reliably, and would not need continued recalibration. Such a device would be of great help in low-temperature calorimetric work. The germanium resistance thermometer meets these specifications.

The heart of this thermometer is a very small "bridge" cut from a single crystal of arsenic-doped germanium. Actual size of this bridge is about 0.025" x 0.020" x 0.210". Current and potential leads are attached to the bridge, and it is supported in a strain-free manner in a platinum-glass enclosure containing a small amount of helium gas to aid in thermal conduction. The resistance is determined by measuring the potential drop when a small (approximately 10 microamperes) known current is passed through the bridge.

Germanium can be doped with arsenic to produce a high and fairly constant temperature coefficient of resistance at temperatures near the boiling point of helium. For example, a typical thermometer had a resistance of about one ohm at room temperature, 14 ohms at 10°K and 216 ohms at 2°K. Both the temperature coefficient and the actual resistance vary widely with minute changes in the amount of doping, making it possible to fabricate a thermometer having any of a wide range of characteristics. Such a thermometer will retain its calibration despite repeated cycling from 300°K to 1°K.

To avoid excessive heating when measurements are being made, the resistance of the thermometer should be kept as large as possible. However, for simplicity in measurements, a low resistance is desirable. For a specific application, a compromise can be reached by controlling the doping of the germanium crystal.

Westinghouse Displays Machine For Handling Radioactive Materials

Picture on Page 6

A unique machine for handling radioactive materials under 18 feet of water and which operates on its own small railroad track was shown for the first time at the 1958 AtomFair in the International Amphitheatre in Chicago.

The machine will be installed this year in the world's first industry-owned nuclear materials testing reactor now under construction at Waltz Mill, Pa., about 30 miles from Pittsburgh.

Requirements for the safe handling and transportation of large radioactive samples between the reactor core and the "hot cells" of the facility led to the design of the new machine. It will be capable of operating at all times under 18 feet of water which is used as protective shielding during transportation and storage.

The machine is about 22 feet long, 6 feet wide and 8 feet high. It has been designed to handle experimental containers, or thimbles, 18 feet long and 2'A inches in diameter. The thimbles will be moved about 100 feet by the machine along a small railroad track and then by remote control inserted through the bottom of the reactor vessel into the core for testing.

Experiments will include testing of various types of reactor materials, such as uranium oxide and aluminum alloy, which may be suitable for reactor applications.

The AtomFair, one of four major activities at the 1958 Nuclear Congress, is sponsored annually by the Atomic Industrial Forum.

NEW AVIATION FUELS

Powerful new aviation fuels to deliver longer range with smaller fuel loads will soon be in use in civilian and military aircraft according to a report delivered in Dallas. Several types of fuel are now in production and others are being considered and tested.

R. A. Wells, staff engineer for the Gulf Research and Development Company, in a paper outlining the new types of fuel, noted that they cover the whole range of aircraft from conventional piston engines to liquid-fueled rockets.

A new high-energy gasoline additive, now in production, will give piston engines more power per gallon, thereby enabling commercial flights to increase either their paying cargo or their flying range. Despite a higher cost for the fuel, Mr. Wells said airlines should realize a net saving in operating cost of approximately 3%, not even taking account of anticipated savings in engine overhaul cost.

For jet planes pyrophoric fuels (liquids that ignite spontaneously in air) seems to produce much better overall results than any other type tested so far. Three types of pyrophoric fuels under examination are triethyl aluminum (TEA), triethyl boron (TEB), and trimethyl aluminum (TMA). They can be produced in large volume at reasonable prices, said Mr. Wells, and permit the same amount of thrust to be taken from a smaller, less complicated and more reliable engine than do other fuels. A ram-jet engine that burns pyrophoric fuel has been designed for constant altitude target drone or missile application. It weighs only 18 pounds and can develop a volo'city one and a half times greater than the speed of sound. A $600 engine is possible compared with a

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NEW DEVELOPMENTS

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price **of** up **to** $10,000 **for a** similar **unit** using **conventional** fuels.

Another **advantage of pyphoric** fuels **is** that they virtually eliminate "flameout," a condition in which **the jet engine goes out** in thin air, forcing the pilot **to** drop to denser air to relight the jets. Mr. Wells also said that small amounts of these fuels added to hydro-carbon fuels have been found to improve burning, reduce screech in rockets and allow more reliable operation at higher altitudes.

Sadly enough for proponents of their use, said the engineer, pyrophoric fuels have some unfortunate characteristics. TEA and TEH arc extremely destructive **to** living tissue and cause deep burns and scarring. They ignite spontaneously if accidentally exposed to air and react violently or even explode in contact with water and hydrogen compounds. Mr. Wells indicated **that** packaging these fuels could eliminate many problems, but that the Navy has not looked kindly on materials that react with water.

The most widely-publicized of all the high energy fuel programs was started in 1952 by the Navy, joined by the Air Force in 1955 and resulted in a major fuel technology **breakthrough** in the form of a new series of hydrogen-carbon-boron compounds retaining much of the high energy of borones but with more stability and less toxicity. Boron hydrides, as they are called, have **a** high reactivity, which means that an aircraft can fly higher with less danger of flameout.

Although boron **hydrides** are 50 times more expensive than petroleum-type fuels, they might be used **economically enough** in some military planes, especially long-range bombers. These planes require servicing en route to a distant target. By removing the **need** for refueling, as these compounds might, it might be **possible** to eliminate costly bases, personnel and **equipment.**

Millionth-of-an-Inch 'Rust' Films Used in Westinghouse Research

Scientists are using aluminum foil-household variety—in delicate scientific experiments and in the construction of experimental electronic tubes.

However, the scientists do not employ the complete foil itself-only about one-thousandth of an inch in thickness. Instead, they discard about 99.9 percent of it by chemically dissolving away all the aluminum metal and saving the thin aluminum "rust" or oxide which coats the foil to a depth of less than a millionth of an inch.

The scientists use this film of aluminum oxide to support the layers of sensitive material required in electronic imaging tubes. Because of its extreme thinness, electrons traveling through the tube can penetrate the sensitive layers without being interrupted by a supporting structure.

Preparing an aluminum oxide film to serve this purpose is not easy. To work at all, it must be extremely thin, but it must also be large enough to serve as a miniature screen within the tube. While the films themselves have been known for several years, only recently have they been made thin enough and large enough to be practical.

In spite of their delicacy and exactness, the ultrathin films are prepared by simple techniques which require no unusually precise apparatus.

A piece of aluminum foil, free of wrinkles, is pressed flat. The aluminum oxide coating on one surface of the foil is removed by rubbing with a solution similar to common lye, exposing the aluminum metal underneath.

With the oxide on one side removed, the foil is washed in distilled water, dried, and placed in an acid solution. The acid "eats" away all the aluminum metal, leaving only the thin coating of oxide on the other side of the foil. This film is washed, dried and mounted on a round metal ring of the desired diameter.

Since the ordinary oxide coating on the surface of aluminum foil is usually too thin, the scientists may first "build up" this coating before preparing the film. To do this they electrically deposit an additional oxide film of the foil in an acid solution. By controlling the voltage a perfect coating of any desired thickness can be prepared.

The scientists estimate that their aluminum oxide films are only from 25 to 50 molecules thick. The films are almost perfectly transparent and colorless, since their thickness is only about one twentieth of the wave length of the light rays passing through them. Yet, for their thickness, the films have tremendous strength; they support themselves over relatively large surface areas and withstand comparatively large external forces applied to them during their preparation and normal handling. The tensile strength of the films is estimated to be about equal to ordinary steel.

Another feature of the films is their unusual uniformity. Measurements show that a film may vary in thickness over its entire surface by not more than a single molecule. The measurements are made by interference of light-the same effect which produces the colors seen in thin films of oil and in soap bubbles.

In addition to films of aluminum oxide, the Westinghouse scientists report equal success in making films of many other materials, including various metals and their oxides. Besides being useful in electronic devices, the films can be used in research on the basic properties of matter. They represent, essentially, two-dimensional solid matter-a solid having **length** and width but no thickness.

Leave New York at 10:00 A.M. Arrive Los Angeles 7:40 A.M. (Same Day)

The X-15, which will fly man higher and faster than he's ever been, will actually glow red like the iron in a blacksmith's forge as it plunges back into the earth's blanket of air.

Built of new stainless steel alloys to combat these high temperature conditions, the research vehicle is now being assembled at North American Aviation's Los Angeles, California, plant. It is expected to make its first flight from Edwards AFB early next year as a joint project of the Air Force, Navy and National Advisory Committee for Aeronautics.

In SKYLINE, a North American magazine released to employees today, the X-15 was described as **a** "pencil-thin ship with wings like cleaver blades and which has stubs of control surfaces and a ventral fin."

"The importance of the X-15 is not only in its role as the first manned craft to probe outer space," the magazine pointed out. "Manufacturing techniques now being worked out on the new metals will set the pattern for future families of airplanes."

Chief Engineer Harrison Storms said solving heat problems is the key to the X-15 design. "Temperatures ranging down from about 1,000 degrees to 300 degrees below zero-that of its liquid oxygen-will be encountered by the airplane," he declared.

"The X-15 will get as hot as would a normal size bedroom with 80 home floor furnaces going full blast in it!"

Storms said the speed of the X-15, which is better than one mile a second, would permit it to fly from New York to Los Angeles and land two and a third hours *BEFORE* it took off. The pilot could **eat** lunch and **arrive** on the West Coast in time for a late breakfast.

Special controls will permit the pilot to keep the X-15 on course with wrist motion only because his arms will be pressed tightly into his seat by the tremendous "G" forces to be encountered. To keep the airplane in its proper altitude during its flight above the atmosphere, hydrogen peroxide jet streams in the nose and wingtips will be used for the first time. Acting just like jets of steam, they will push the plane in the opposite direction to their force.

Because the flight path of the X-15 is expected to take it at least 100 miles high, there can be no explosions once it leaves the earth's atmosphere as there is not enough oxygen to support combustion.

In the event of an emergency, the entire cockpit can be utilized as a built-in "escape capsule. This insulated area will protect the pilot from the scorching heat of extreme speed and should his cabin lose its pressure, a tailor-made "space" suit encloses a normal pressure and atmosphere environment.

(Continued on Page 34)

Men at work...on tomorrow!

Young men like Dr. Wayne E. Smith are helping to shape the future through research in the exciting and challenging field of polymers in the laboratories of Standard Oil.

In just a few years time, petrochemicals have mushroomed into a major industry—and there is still much pioneering work to be done.

Specifically, Dr. Smith is working on the fundamental chemistry of catalysts—an area in which Standard is a leader. From such basic research will come new and useful products for the future. Used in making polyethylene, our catalysts are also proving useful in preparing many other new products.

Dr. Smith received his B.A. in 1951 from Tarkio College, Tarkio, Missouri, and his Ph.D. in physical chemistry from the University of Nebraska in 1955. He is married and has three daughters. He is active in church work and sports.

Hundreds of other young men with scientific and technical backgrounds are building successful careers at Standard Oil. Their work is helping to make important contributions to petroleum progress.

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SQUARE D COMPANY

NEW DEVELOPMENTS

(Continued from Page 31)

'Gas Light' for Brussels Fair

The combining of hydrogen and oxygen gases to produce electricity will be among the scientific marvels to **be demonstrated at the Brussels** World's Fair. A **special exhibit of** its fuel cell, which produces electrical energy directly from the chemical energy of gases, was assembled by National Carbon Company, here at its research laboratories where development work **on the** unique power source is continuing. Further improvements have been made in the efficiency of the fuel cell since its announcement last September, and more compact units are now being tested. By designing the hydrogen and oxygen electrodes, made of specially treated porous carbon, as concentric cylinders to nestle within each other, researchers **have** produced a fuel cell that will operate on **hydrogen** gas and the oxygen in the air, eliminating the need lor a source of pure oxygen. Although this method of operation is still far from commercial use, it is an important milestone in the development of the fuel cell into a commerical and industrial source of power.

FALLOUT

(Continued from Puge 21)

and only the calcium can be used in body metabolism. The strontium 90 remains in the bones for a long time, continually emitting beta rays. These beta **rays** are detrimental to the calcium of the bones and a series of complex biological processes result which are ultimately harmful to the organism in varying degrees.

The next question is what is considered the maximum doses of these radioactive materials that the body can handle. It should be pointed out that no dose is considered absolutely safe, regardless of how small it is. There are, however, certain levels of radiation that can be tolerated. Just what these levels are have not yet been determined, but Dr. Curtice L. Newcombe of the Navy Radiological Defense Laboratory in San Francisco has warned that 70,000,000 tons of radioactive material spread over the earth is a theoretical "safe" limit. He further estimated that about 50,000,000 tons have been released in United States tests to date, with no method for calculation of the number of tons that have been strewed aloft by Russian tests.

Forecasting the consequences of future weapon testing is difficult and uncertain for several reasons. These points of uncertainty are: (1) what the future testing pattern will be as well as the kind and location of the testing, (2) what the degree of non-uniformity of fallout in the atmosphere really is, (3) what the storage times in different parts of the atmosphere and in different geographical regions of **the** globe are, (4) how the fallout will behave under the different geological and biological conditions that exist around the world, (5) how the fallout will distribute itself in a human population, (6) whether a threshold for radiation damage exists or not, (7) and how to arrive at an acceptable maximum permissible concentration of radioactive isotopes in man. It should be noted that indefinitely continued testing at some constant rate does not necessarily mean an indefinitely continued rise in radiation levels, for at some level the rate of radioactive decay will equal the rate of production of radioactivity. This is known as an equilibrium level for the constant test rate.

In spite of the evidence that indicates that further nuclear weapon testing will constitute a definite hazard to our future generations, we must consider it as an alternative course of action.

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FLYING HIGH

(Continued from Page 13)

does quite a bit of meandering, traveling from Rio de Janeiro in the winter to Patagonia in the summer.

So a new factor has been added to weather forecasting. If this jet stream can be utilized effectively for long range forecasting it will be of great benefit to a great many people. Farmers would like to know months ahead about the weather; to cut down on cattle herds, for example, if pastures are going to dry up, or to arrange for irrigation for truck farms. **City** officials would appreciate specific warnings of severe snows that clog traffic and of long droughts that endanger water supplies. Industries would like to lay plans around advance knowledge of abnormal weather.

*(Continued on **Page** 36)*

FLYING HIGH

*(Continued from **Page** 34)*

The benefits **to** the airlines will be tremendous when this **Forecasting** is perfected. The planes will **be able to** cut down flying time by hours and cut fuel **COSS Up to** 30'/. Already there are some automatic **devices** being used **to** find the jet stream and to keep **the** plane in the swiftest flowing part of it. The jet **streams** are now being studied with sounding balloons **that** arc tracked by radar. Undoubtedly many other methods will soon be found to study the jet streams.

METALLURGY

(Continued from Page 15)

completely. The metal, hafnium, was able to absorb neutrons readily and still maintain its structural strength under neutron bombardment. Because hafnium was also a metallurgical unknown another intensive research and development program had to be started. The reactor used 32 hafnium rods for controlling the atom splitting, or fissioning process.

Each of some 20,000 individual welds was X-rayed to make sure the entire primary water system was impervious to leakage. Stainless steel has proved to be one of the workhorse materials of construction for atomic power plants because of its relative economy, high strength and corrosion resistance. Extremely pure water circulates under 2,000 pounds per square inch pressure at a rate of 18,000 gallons per minute through each of the four main coolant loops into heat exchangers. The temperature is 525°F. The large 18-inch main coolant valves, which are made of stainless steel with walls 3 inches thick, can take emergency overloads of 3,000 psi differential pressure.

Rear Admiral H. G. Rickover, Chief of Reactor Development for the U. S. Atomic Energy Commission, has stated, "It is a common belief that atomic power development is primarily the province of the nuclear physicist. Nothing could be farther from the truth. The main problem is with materials and equipment . . . that must conform to exacting standards. Practical atomic power cannot be achieved by routine methods. The whole level of engineering design, materials, inspection and training must be raised significantly above present levels."

A concentrated effort to increase the service temperature of metals has occurred during the past 10 years. However, efforts to exceed a service temperature of 1600°F have had small success. The need for materials that have an adequate service life above this temperature is accute and radically different techniques and concepts will be required if we are to break through this temperature barrier.

Cermets offer one possible solution. Cermets are a class of dispersion hardened materials that combine ceramics and metals and in which, by definition, *30%* by volume is the hard or dispersed phase. The ductility problems are severe when the percent of the hard phase is increased to such a level that strength requirements at high temperatures are met. It is often difficult, if not impossible, to form these cermets in a conventional manner. Recently there has been success in producing micronsize particles of pure aluminum oxide that are spherical in shape. A definite increase in ductility of cermet-like materials is observed when spherical particles are used as the hard phase within a metallic matrix. A large amount of scientific effort in the United States is being placed today on the study of the nature of ceramics. The real breakthrough in the science of materials will come with the development of ductile ceramics.

As we know them presently, ceramics have excellent high strength characteristics, but tend to suffer from the shortcomings of low fracture resistance and a highly brittle nature. Very long single crystals of magnesium oxide, tested experimentally by Dr. E. R. Parker at the University of California, at Berkeley, have shown up to 20% ductility.

Dr. John H. Holloman, Director of Metallurgy and Ceramics for the General Electric Company, recently stated that advancement in the age of metallurgy and a better utilization of metals will come about as there is developed an increased understanding of the kinetics of transformation and how it controls alloy structure. The development of polymers will play an important role in the future. Along with this, the control of the location of atoms will lead to a better understanding of the properties of materials. Dr. Holloman predicted that the next age of metallurgy will be the control of atomic structure and not microstructure and stated that of the total learning effort in the world of science only *4%* is in the field of metallurgy.

Within the past few years, very small crystals of tin and iron that can undergo as much as 10% strain without permanent set have been isolated. The crystals were perfect. Metals with strengths exceeding 1,000,000 psi are possible, although there is no reasonable probability, at present, of having enough such material and having it in such size that we can build machinery of it.

Metallurgical engineering places a great deal of emphasis on the properties of materials, rather than on the material itself. Specific materials may be in or out of fashion, but the significance of properties change slowly if at all.

Those engineers who have a firm foundation or understanding about the properties of materials will be better equipped to solve the problems of the future. There is no doubt that the engineering student of today will be called upon in the years ahead to solve problems that his professor could not even imagine.

The student of metallurgy has an expanding opportunity for research and **development** of new alloys and related materials. The frontiers of the science of metals and materials offer a real challenge.

HIGH VOLTAGE FINISHING

(Continued from Page 23)

The fact that automobile companies have not only shown interest in electrostatic spraying but have actually adopted it in some instances for the painting of car bodies, indicates that this process isn't necessarily limited to the painting of small production parts.

The Fiat Motor Car Corporation, in Italy, has adopted the system using the charged wire grid for applying the finish coat to the body of their cars. The body moves on a conveyer into the spray booth, at which time the guns are automatically turned on, the body is painted, and the guns turn off. The results have been excellent.

In this country, the Studebaker Corporation was one of the first to use electrostatic spraying. They adopted the same type of system as Fiat to apply primer-surfacer to their bodies in 1953. The company had decided that to improve the finish on their cars, a heavier foundation coat would be necessary. At the same time it was necessary to increase their production rate. It was found through the use of the electrostatic spray method that they not only attained their prime objectives, but achieved a saving of $1.8] per body in paint and labor. Studebaker increased their maximum production rate from 80 to 170 car bodies per hour. There was also a saving of almost 37,000 cubic feet per minute of ventilating air for the spray booths—amounting to a substantial heat savings.

After the primer-surfacer is baked dry in an oven, it is wet-sanded until it is smooth. In the sanding process as much as 11/2 mils in thickness is removed. The former method permitted an applictaion of only 1/2 to 2 mils in thickness, whereas electrostatic spraying provided a uniform thickness of from *21/4* to 3 mils. This additional film thickness permitted a thorough sanding without any danger of leaving "cut-thin" or bare spots. Due to the more uniform and heavier coating, six less sanders and four less putty men were needed.

To the user of this new method came advantages through its decreased material and labor costs, reduction of health and fire hazards to a minimum, and a resultant finished product of greater sales appeal. The consumer benefits by these many advantages in the use and possession of a product of superior quality, appearance, and durability, in addition to the possibility of a lower cost effected through the savings to the producer.

INDEX TO ADVERTISERS

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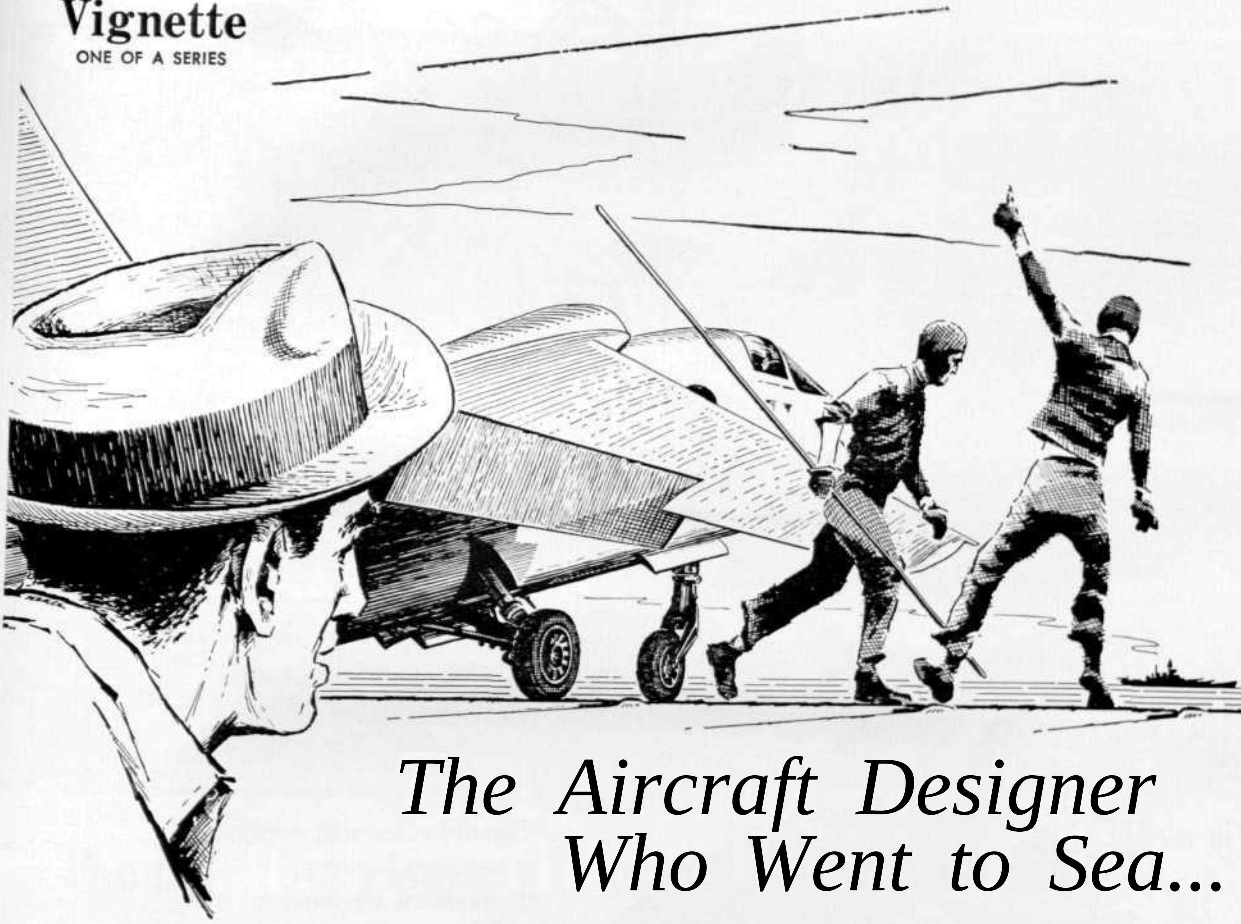
ONE OF A SERIES



The Aircraft Designer Who Went to Sea...

IT WAS A ROUTINE CRUISE for the *Bon Homme Richard.* But for Wayne Burch, it was a memorable climax to months of hard work. Aboard the carrier with the Chance Vought design specialist was the white-lacquered fighter he'd worked on so long.

Wayne had joined the Crusader dayfighter project in Preliminary Design, on alighting and arresting gear. He'd transposed his initial drawings into detail design and, later, he'd watched his gear pass jig and aircraft drop tests. At the Navy Test Center, the Crusader's gear absorbed maximum sink speeds and arresting tension, and Burch once more was there.

Now, Navy pilots on the *Bon Homme Richard* were taking the Crusader to sea, and Burch was going along. This time his assignment was simply to watch, and this time the Crusader was to be just part of the picture. Vought wanted him to experience carrier life and to see how his new weapon fitted in. For Wayne, whose sea log began and ended with one day's fishing from a 20-foot launch, it promised to be an eye-opening voyage.

For six days the designer shared quarters with Navy fighter pilots and had coffee with maintenance men. He studied aircraft spotting and catapulting, and he learned the sign language of the LSO (Landing Signal Officer). He marveled at the fingersnap timing of the Navy's deck handlers and at the *Bon Homme Richard's* mid-voyage refueling of two bobbing destroyers.

Wayne calls it "one of the most enjoyable weeks of my life" . . . and, as other sea-going Vought engineers have discovered, "one of the most profitable, too.

"Now I know the pilot's job, what maintenance wants . . . how really big the operation is.

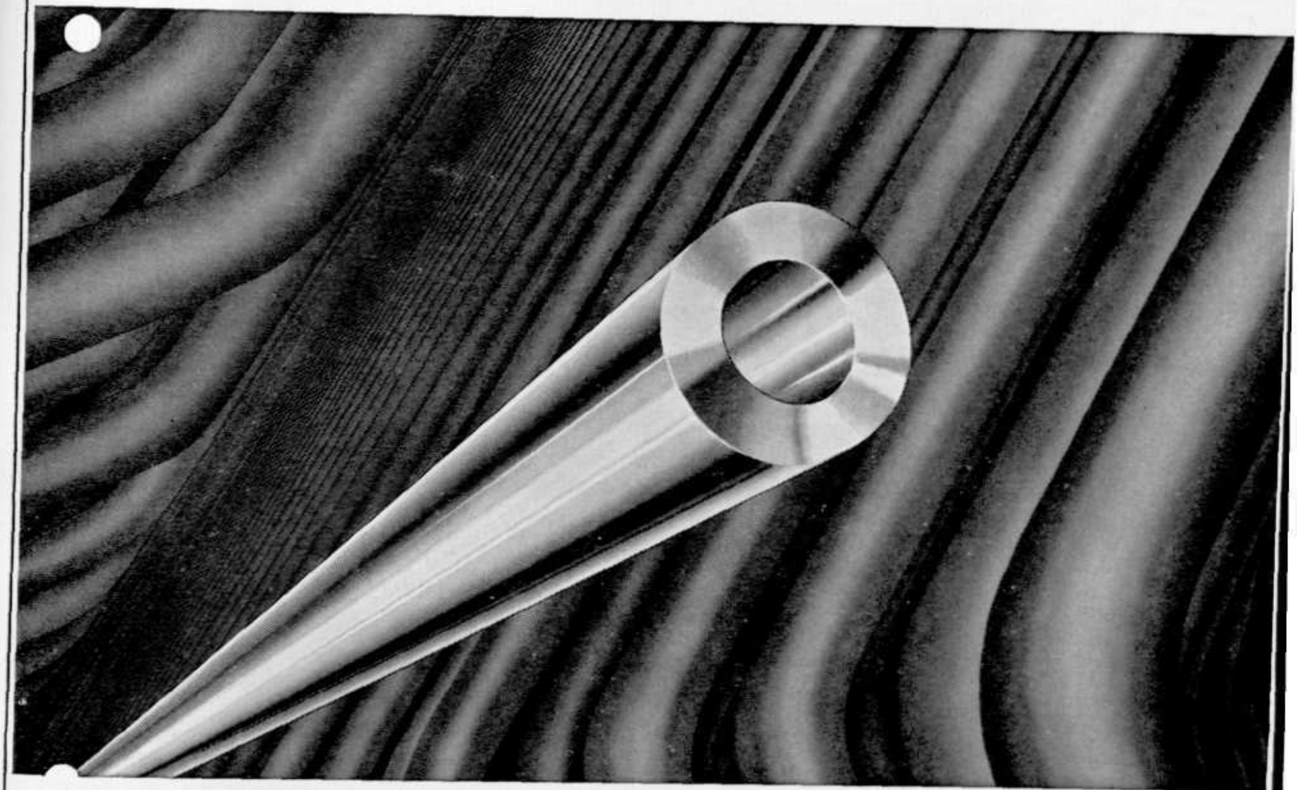
"It's something you don't get if you stick too close to design.

"I guess you'd call it *perspective."*

At Chance Vought the designer stays in touch with his product . . . Contact begins in development, extends through test and includes, when possible, a study by the designer of the tactical environment in which his weapon will serve.

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

Tear out this page for **YOUR STEEL NOTEBOOK...**



The hole that couldn't be made will be 20 miles long

THE Philadelphia Electric Company set out to build a revolutionary new power plant that would squeeze more energy out of fuel than ever before. This meant harnessing the highest combination of pressure and steam temperature ever achieved in a central station—5,000 psi. and 1,200° F.

The boiler superheater tubes that carry this steel will glow red hot 24 hours a day, year in, year out. If made from the alloy steels customarily used, the tube walls would have to be so thick that no mill could pierce it. So thick that heat transfer losses would be ruinous to boiler efficiency. A super alloy steel was needed, but no one had ever succeeded in piercing such steel into tubes without developing internal flaws.

Combustion Engineering Co., designers and builders of the boiler, gave the problem to Timken Company metallurgists. The problem was to make the steel with all the alloys in just the right balance to produce piercing quality steel.

Thru metallurgical research, they achieved the proper balance of alloy elements that made it possible to pierce 20 miles of seamless superheater tubes of the size shown above. It's another example of how Timken Company metallurgists solve tough steel problems.

WANT TO LEARN MORE ABOUT STEEL OR JOB OPPORTUNITIES?

For information about fine steel, send for "The Story of Timken Alloy Steel Quality". And for help in planning your future, write for "BETTER-ness and Your Career at the Timken Company". Just drop a card to The Timken Roller Bearing Company, Canton 6, Ohio.

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...on science and research

"In every field of science, advances in knowledge are forcing more and more specialization. As disciplines become narrower and their interactions harder to discern, communication among specialists becomes more difficult. At the same time, the relevance of political, economic, and social factors in the broad application of physics, chemistry, and mechanics to major practical problems is increasingly evident. Many such problems, unlike research, at the frontiers of the specialties, are too broad in their implications and too complex in detail to be solved by any expert working alone. The research team, uniting the diverse skills of many specialists, and using the best mathematical tools — theoretical and computational — is probably the most successful means of discovering realistic, timely, and original solutions to important problems of public welfare and security."

— F. R. *Collbohm, President*

Pump-turbine design is now the work . . . hydraulics/ the field ... of John Jandovitz, BSME graduate of College of City of New York, '52.

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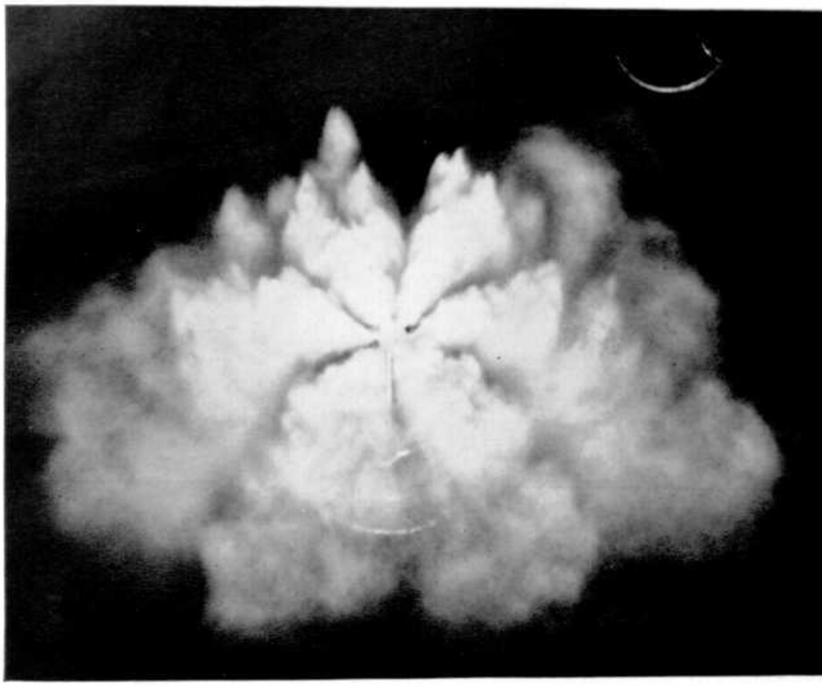
The Army's first operational rotor-tip propelled jet helicopter—built by Hiller.



The camera has caught the fuel spray pattern within the rear end of the ram-jet engine even though passing by at about 450 miles per hour.

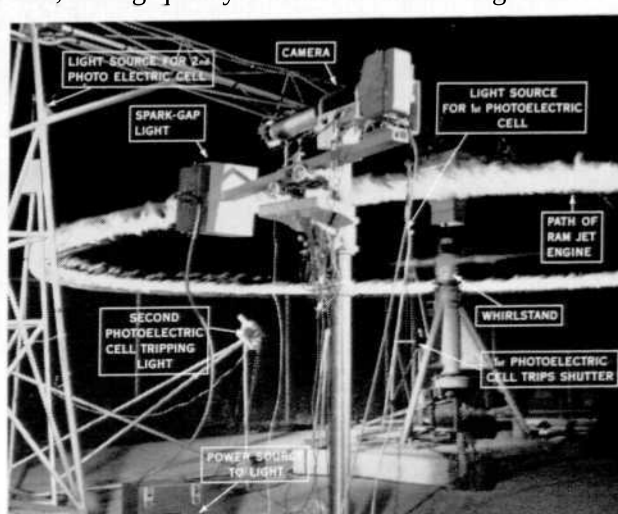
Project:
Inspect rotor tip jets for a whirlybird

Hiller Helicopters wanted facts on the fuel spray pattern of a ram-jet engine whirling at speeds up to 700 feet per second. Photography got the job.

WHEN HILLER HELICOPTERS of Palo Alto, Cal.—a pioneer in vertical take-off aircraft—developed a rotor-tip ram-jet engine, they knew the fuel spray would be subject to high air velocity and centrifugal force up to 1200 G's. Would the fuel spray be deflected outward and cause the jet to lose thrust? They wanted to know. So they set up the camera with its fast eye to catch what otherwise couldn't be seen. And they learned the right angle of air intake and nozzle to obtain the greatest power.

Using photography in research is an old story with Hiller—just as familiar as using it for improving public relations. It's an example of the way photography plays many important roles in modern-day industry.

In whatever work you do you will find that photography will play a part in improving products, aiding quality control and increasing sales.



This is all the human eye could have seen of the whirling ram-jet engine as camera takes its picture.

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One of a series*

Interview with General Electric's W. Scott Hill Manager — Engineering Recruiting

Qualities I Look For When Recruiting Engineers

Q. Mr. Hill, what can I do to gel the mott out of my job interviews?

A. You know, we have the same question. I would recommend that you have some information on what the company does and why you believe you have a contribution to make. Looking over company information in your placement office is helpful. Have in mind some of the things you would like to ask and try to anticipate questions that may refer to your specific interests.

Q. What information do you try to get during your interviews?

A. This is where we must fill in between the lines of the personnel forms. I try to find out why particular study programs have been followed, in order to learn basic motivations. I also try to find particular abilities in fields of science, or mathematics, or alternatively in the more practical courses, since these might not be apparent from personnel records. Throughout the interview we try to judge clarity of thinking since this also gives us some indication of ability and ultimate progress. One good way to judge a person, I find, is to ask myself: Would he be easy to work with and would I like to have him as my close associate?

Q. What part do first impressions play in your evaluation of people?

A. I think we all form a first impression when we meet anyone. Therefore, if a generally neat appearance is presented, I think it helps. It would indicate that you considered this important to yourself and had some pride in the way the interviewer might size you up.

Q. With only academic training as a background, how long will it be before I'll be handling responsible work?

A. Not long at all. If a man joins a training program, or is placed directly on an operating job, he gets assignments which let him work up to more responsible jobs. We are hiring people with definite consideration for their potential in either technical work or the management field, but their initial jobs will be important and responsible.

Q. How will the fact that I've had to work hard in my engineering studies, with no time for a lot of outside activities, affect my employment possibilities?

A. You're concerned, I'd guess, with all the talk of the quest for "well-rounded men." We do look for this characteristic, but being president of the student council isn't the only indication of this trait. Through talking with your professors, for example, we can determine who takes the active role in group projects and gets along well with other students in the class. This can be equally important in our judgment.

Q. How important are high scholastic grades in your decision to hire a man?

A. At G.E. we must have men who are technically competent. Your grades give us a pretty good indication of this and are also a measure of the way you have applied yourself. When we find someone whose grades are lower than might be expected from his other characteristics, we look into it to find out if there are circumstances which may have contributed.

Q. What consideration do you give work experience gained prior to graduation?

A. Often a man with summer work experience in his chosen academic field has a much better idea of what he wants to do. This helps us decide where he would be most likely to succeed or where he should start his career. Many students have had to work hard during college or summers, to support themselves. These men obviously have a motivating desire to become engineers that we find highly desirable.

Q. Do you feel that a man must know exactly what he wants to do when he is being interviewed?

A. No, I don't. It is helpful if he has thought enough about his interests to be able to discuss some general directions he is considering. For example, he might know whether he wants product engineering work, or the marketing of technical products, or the engineering associated with manufacturing. On G-E training programs, rotating assignments are designed to help men find out more about their true interests before they make their final choice.

Q. How do military commitments affect your recruiting?

A. Many young men today have military commitments when they graduate. We feel it is to their advantage and ours to accept employment after graduation and then fulfill their obligations. *We have a limited number of copies of a Department of Defense booklet describing, in detail, the many ways in which the latter can be done. Just write to Engineering Personnel, Bldg. 36, 5th Floor, General Electric Company, Schenectady 5, N. Y.* 958

*LOOK FOR other interviews discussing: • Advancement in Large Companies • Salary • Personal Development.

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