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JANUARY
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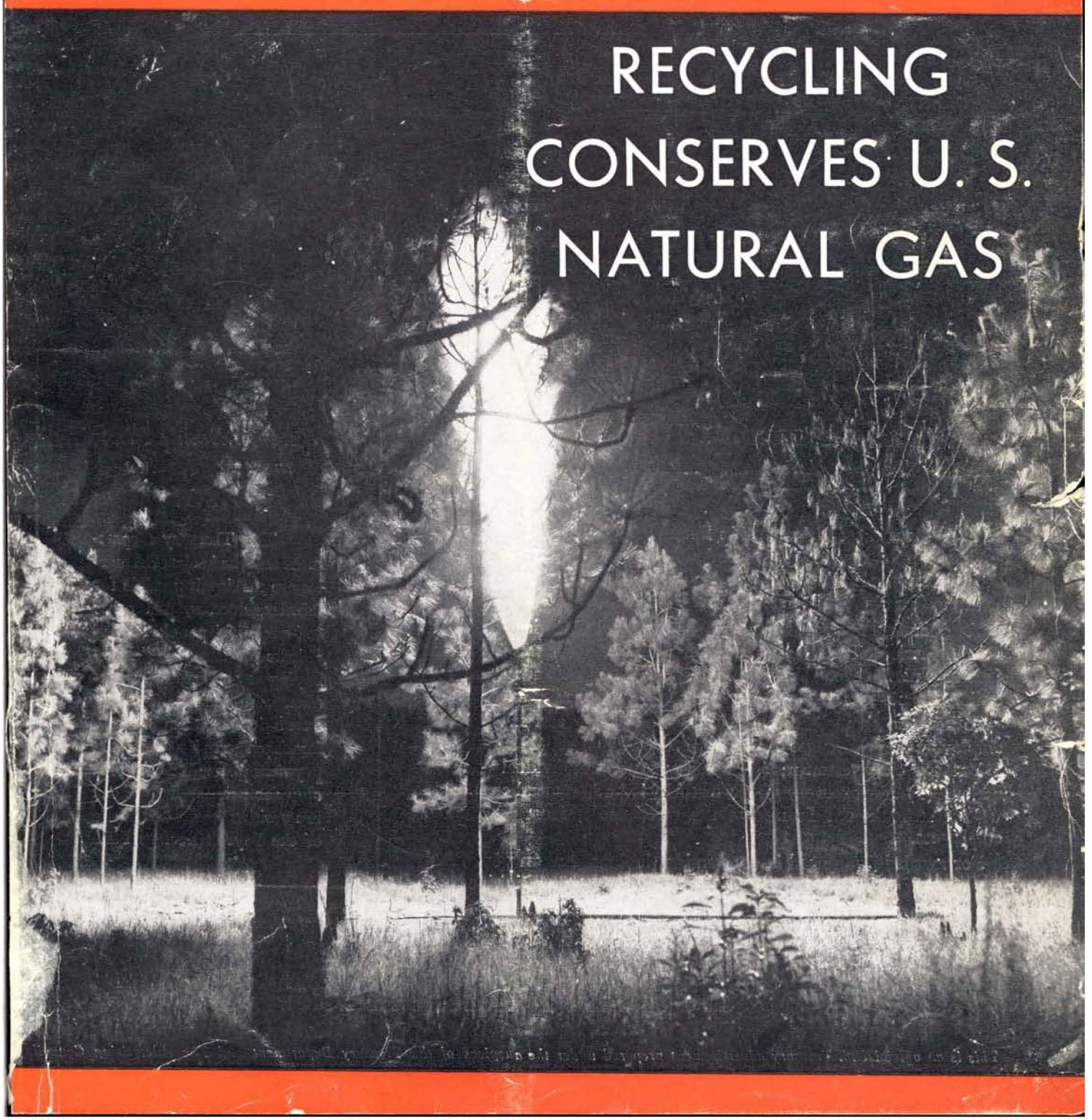

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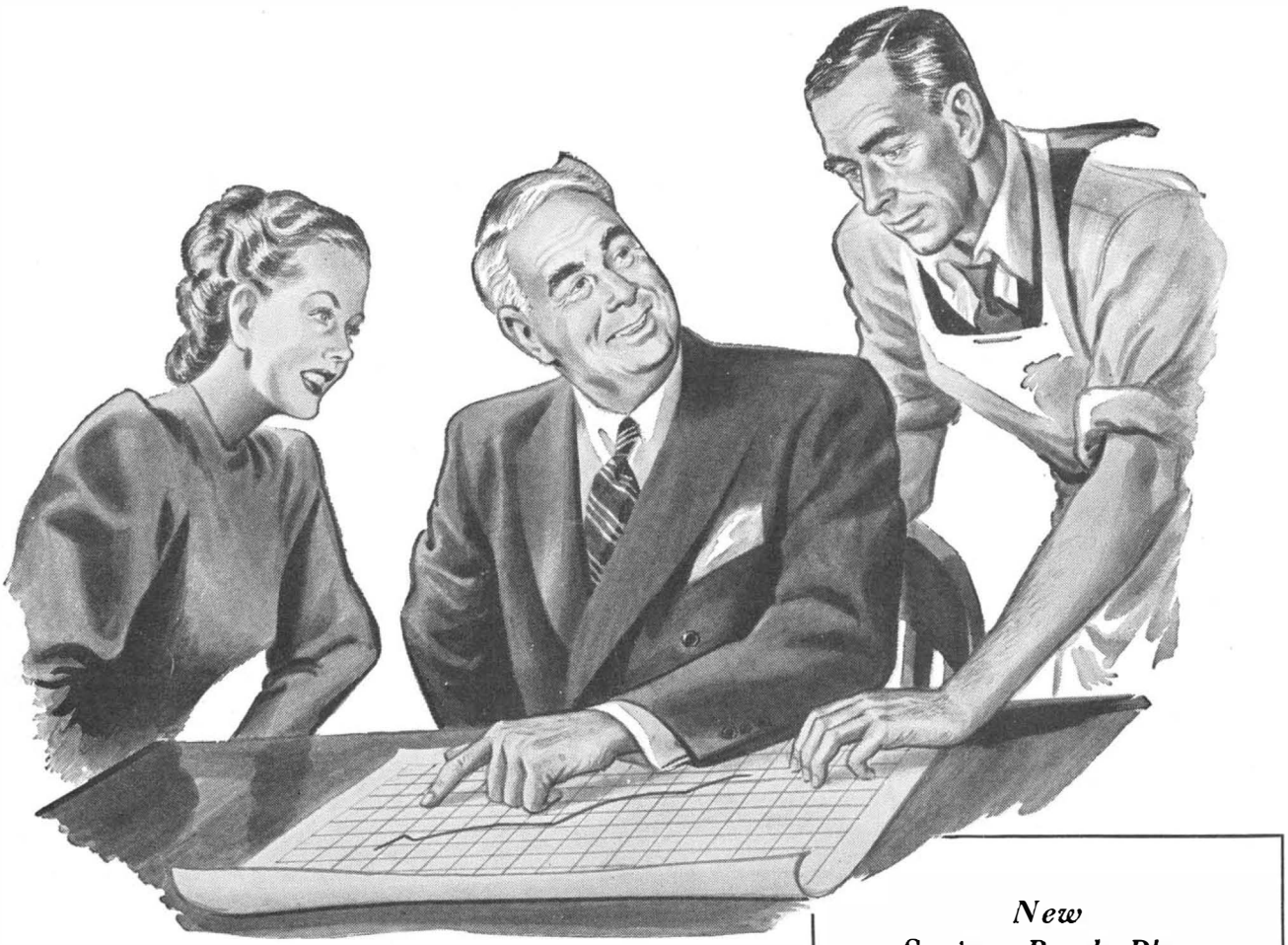

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Scientific American

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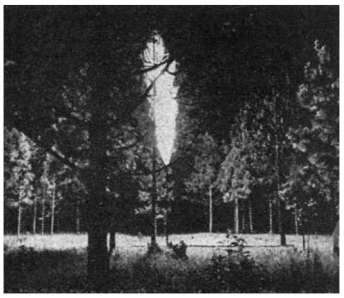

ON THE COVER: Natural gas being flared off in the field. Definite steps are now being taken to curb such waste. For story, see page 16.

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Scientific American

Founded 1845

In This Issue • January 1948

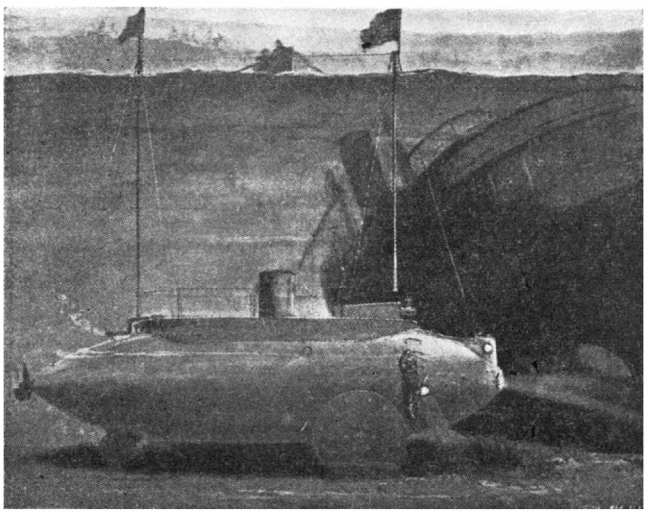
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of January, 1898)

NOBEL'S WILL — "The will of the late Alfred Nobel, the Swedish chemist, and expert in high explosives, who died at San Remo, Italy, on December 9, 1896, has been proved. The personalty is valued at $2,170,465. About half the estate goes to relatives and the remainder is invested, the interest to be divided annually into five prizes of about $10,000 each. Prizes one, two, and three are to be awarded to the persons making the most important discoveries in physics, chemistry, physiology or medicine."

SUBMARINE — "Our accompanying illustration shows the construction and operation of a submarine wrecking boat which has been designed to enable divers' quarters and the air-compressing plant, tools, winches, etc., to be placed at the bottom of the ocean in close proximity to a wreck. The many advantages of such a device, if it can be successfully



operated, are obvious, and the details of the design as worked out by Mr. Simon Lake, of Baltimore, Md., are certainly full of interest."

VOLTAIRE AND ROUSSEAU — "A commission that was nominated by M. Rambaud, opened the tombs in the Pantheon at Paris, December 18, and settled the question of the whereabout of the ashes of Voltaire and Rousseau. Both skeletons were found. Voltaire's skull had fallen into two pieces, which when placed together gave a striking presentment of his features. The skull of Rousseau showed no trace of a bullet wound, thus disapproving the widely entertained belief that he committed suicide by shooting himself in the head."

BROOKLYN BRIDGE — "The permission which has been granted by the trustees of the New York and Brooklyn Suspension Bridge to the Brooklyn trolley companies to run their cars across the structure has aroused opposition on various grounds, the most serious of which is that it is not strong enough to carry safely the increased loads which will be put upon it."

AROUND THE WORLD — "In less than a quarter of a century, the feat of touring the world in eighty days has passed out of the realm of fiction into that of fact, but we find ourselves within a few years of the day when the ordinary tourist can make the trip in less than half of eighty days. This will be possible just as soon as the Trans-Siberian railroad is completed, or early in the twentieth century. The Russian minister of communication, M. Chilkov, has stated that when the great railroad is opened the tour of the world can be completed in thirty-three days."

EARLY FLIGHT — "The fact that so many gifted scientists and engineers are engaged on the problem of artificial flight affords, in itself, a strong presumption that sooner or later a successful motor-driven flying machine will be an accomplished fact. We publish in the current issue a remarkable paper by Octave Chanute, the distinguished engineer and scientist, which gives the results of his own exhaustive experiments of the last few years to determine the principles of flight. The elements to be determined are as follows: The supporting power and resistance of the air; the motor, its character and energy; the instrument for obtaining propulsion; the form and kind of the apparatus; the extent of the sustaining surfaces; the material and texture of the apparatus; the maintenance of equilibrium; the guidance in any desired direction; the starting up under all conditions; the alighting safely anywhere."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of January, 1848)

SMITHSONIAN — "By accounts from Washington we learn that the Smithsonian Institute is in the course of erection, and that it is to be a large and elegant Gothic structure. We hope that the edifice will be an honor to America and a noble monument to the generous donor, who with prophetic eye looked down the stream of time and beheld Columbia as the centre of the civilized world."

BREECH LOADING — "A Swedish officer has invented a new kind of cannon, several pieces of which have been sent to Woolwich for trial. These guns are grooved like a rifle, and are not loaded at the mouth, but at the breech. The alleged advantages of these guns are that they are free from the danger of explosion, that the gunners are concealed while loading, and that the shot are thrown with greater accuracy of aim."

LIGHT FROM ELECTRICITY — "Mr. Staite, having decomposed water and produced light by it, through the agency of electricity, has been lecturing before the Philosophical Society of Sunderland, (Eng.) and has perfectly astonished the inhabitants of that place. The light which was of astonishing brilliance and beauty, was placed under an air-tight glass vase. When the gas was turned down it sufficiently lighted the spacious building, and bore the closest resemblance to the great orb of day of any light, it is said, ever exhibited."

ASTROGRAPHY — "Professor Nichol remarked in closing his lecture at Cambridge, Massachusetts, that if the sun could be made to assist in taking pictures of objects upon the earth, he could not see why a contrivance might not be fixed upon to daguerreotype his own picture. All that the astronomer would have to do would be to go to his study and use the microscope, and he could there examine all the different aspects of the sun."

RATTLESNAKE BITE — "A correspondent of the Philadelphia Inquirer states that tobacco applied to the wound made by a rattlesnake's bite, is an antidote to the deadly effects of its poison. Dr. Lee, of Hartford, Connecticut, states that he has treated a number of cases successfully at the South by application inwardly of alcoholic liquors."

AN ANNOUNCEMENT TO OUR READERS (II)

In the December issue this page carried an announcement of the forthcoming publication of a new Scientific American, under a new ownership and a new board of editors. The 103-year-old Scientific American is now to become a magazine of all the sciences, covering the physical, biological and social sciences as well as their more significant applications in medicine and engineering. The new Scientific American will be directed to the growing community of U. S. citizens who share a responsible interest in the advance and application of science.

The Scientific American has now entered the period of preparation which must precede the publication of any new magazine. This period will end with the appearance of the first issue of the new Scientific American in the spring. Until then, however, the Scientific American will continue regular publication without major change, reporting the practical applications of science in industry.

The December announcement to our readers also contained a brief description of the principles which will govern the editorial content of the new Scientific American. One fundamental principle is founded on the proposition that scientists, doctors and engineers today have an increasing concern that their work shall be more fully understood by their fellow citizens. It is accordingly expected that scientists, doctors and engineers will take an active part in the creation of the magazine's editorial content. The remainder of this page will be devoted to a closer examination of this assumption.

The Scientist and the Journalist

The editors of the new Scientific American believe that the men who are best qualified to write about science are scientists. They will therefore devote considerable effort to the solicitation of original writing from scientists. But since relatively few scientists have either the time or the inclination to write for an audience outside their own specialized fields, a large share of the writing which will appear in the new Scientific American must be undertaken by the editors, journalists who have had wide experience in the reporting of science. The editors recognize that the writing of science involves profound difficulties for both scientists and journalists. In the case of the scientist, the difficulties are largely those of clear communication at the non-technical level. For the journalist they are those of information and full understanding. The solution of the dilemma lies in the unique qualifications the scientist and journalist each bring to the task of science writing when they work together. This is what they will do in the new Scientific American.

The Role of the Scientist

The scientists whose work is reported in the new Scientific American will provide the substance of its articles. They will be the senior partners in their collaboration with the editors. They will not only furnish the facts, but also will share in the treatment of the facts. They will review the work of the editors for errors of omission as well as those of commission. They will, in short, take part in the development of each article from its conception to the time it goes to press.

The Role of the Journalist

The journalist's contribution to this collaboration is his command of the art of clear communication. The editors of the new Scientific American will write in plain English. They will use the vocabulary of the intelligent layman, which is the vocabulary of the scientist outside his own field. The journalist will also contribute the resources of modern graphic art to extend the power of words in expressing the ideas of science.

The End Product

The editors of the new Scientific American have often been asked: If your articles meet the scientist's standard of interest and accuracy, will they be understood by intelligent laymen? The answer states a fundamental conviction of the editors: There is no inherent mystery in the nature of scientific knowledge which prevents its communication to the interested, though uninformed, layman. Before the immense range of scientific knowledge all men, not excepting scientists, are laymen. In the new Scientific American, the scientific and the non-scientific layman will meet on the common ground of their interest in science.

Completely swathed in protective clothing a health physics inspector measures radiation intensity with a fish pole meter

Scientific American
JANUARY • 1948

RADIATION SAFETY: A NEW INDUSTRIAL PROBLEM

By Dr. Karl Z. Morgan
Director, Health Physics Department,
Clinton Laboratories
Oak Ridge, Tennessee

Elaborate Safety Measures Have Been Developed By the Health Physics Departments of Atomic Energy Plants to Protect Both the Workers and the General Public from Dangerous Radiations. These Protective Measures, Proved Successful in Small Scale Operations, Will Aid Greatly in Solving the Staggering Radiation Safety Problems of the Large Scale Atomic Energy Plants

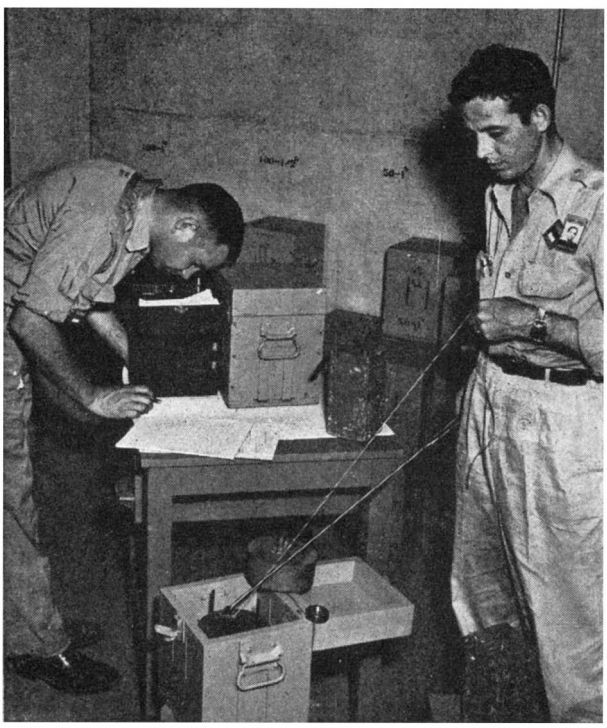
THE ATOMIC AGE began when Wilhelm Konrad von Roentgen discovered X-rays in 1895 and Antoine Henri Becquerel first observed the radioactivity of uranium in 1896. Almost from the beginning it was recognized that these developments could lead either to the unraveling of many problems on which man had labored for centuries, or, if unprecedented protective measures were not taken against these radiations, to suffering and death.

With the development of Einstein's theory, with the discovery of many particles of matter such as the electron, proton, neutron, positron and meson, and with the improvement in methods of accelerating these particles to high velocities, man began to realize the dream of the alchemist. He was able to change one element into another and could even convert mass to energy on a small scale.

It was only a few months after the discovery of X-rays that it was first found necessary to seek a cure for X-ray burns. Since then hundreds of persons have been injured and many have died as a result of the careless or improper use of this new form of energy. When the first atomic pile was set into operation on December 2, 1942, it was necessary to pause and consider whether it was wise to proceed with this important but dangerous development. It was estimated that if plans were carried out for the construction of the experimental pile at Oak Ridge and of the large production pile at Hanford, thousands of times as many curies* would be handled by the plutonium project workers as had been handled since the Curies discovered radium in 1898. The project directors reasoned that if radiation accidents were permitted to increase in proportion to the probable increase in radiation exposure, the sad experiences of the radium industry would be multiplied many thousand times.

HEALTH PHYSICS DEPARTMENTS — In an effort to find a solution to this problem, a department for the protection of the health of the plutonium project workers was established at the University of Chicago in the summer of 1942. From the start the principal duty of this department was understood to be "to make a study of radiation problems and to develop means for the protection of man from radiation ex-

*A quantity of radiation equal to that produced by one gram of radium.

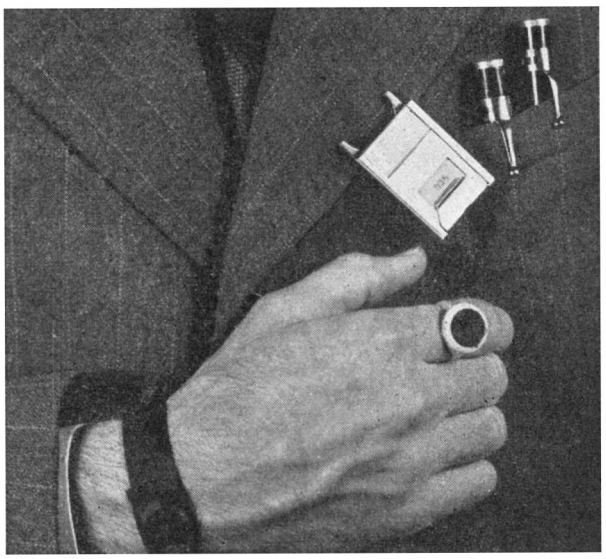


Vial of radioactive iodine is packed for shipment in a well shielded container. Worker in background checks the surface of another container for excessive radiation

posure." The leaders in this field have been physicists and physicians, but many chemists, engineers and men from other professions have also been trained to do the work.

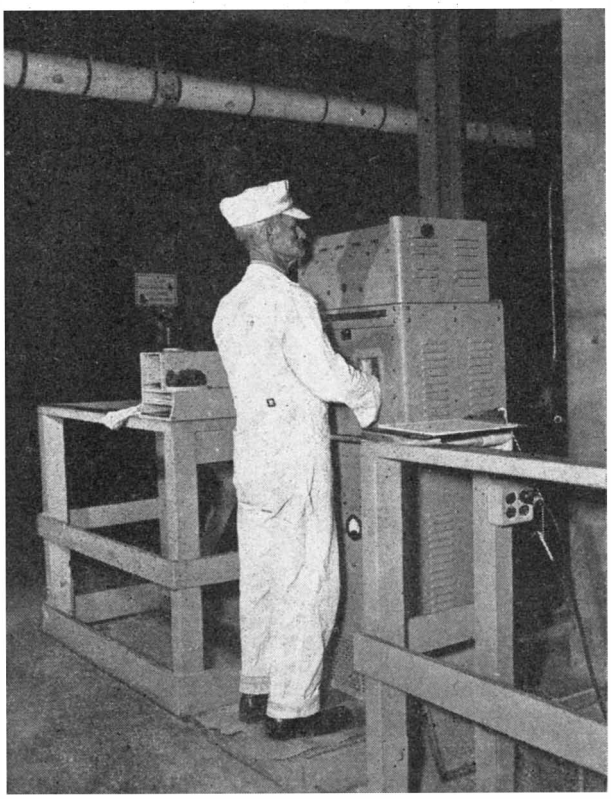
The radiation protection programs of Health Physics Departments at the University of Chicago, Oak Ridge's Clinton Laboratories, and Hanford are essentially the same, except for those problems dependent upon the scale of operations. Basically, the programs call for the following:

1. The development of new instruments and techniques for protection from radiation.
2. The calculation of safe tolerance levels of radiation exposure, the development of efficient shielding methods and the solution of radiation scattering problems.
3. Personnel monitoring, by which all persons exposed to radiations are provided with meters so that a record can be kept of the radiation exposure they receive. Thus a suitable warning can be given immediately when tolerance levels are reached.
4. Surveys of buildings, by which the various working areas are watched constantly to insure that working conditions are safe.
5. Off-area surveys of the air and water in the neighborhood of the plants to guarantee that the levels of contamination do not exceed appreciably the natural background levels of radiation that are always present.
6. Educational and consultation programs, by which everyone exposed to radiation in the laboratories and everyone using radioactive materials sent out from the plants is furnished with radiation protection information and learns how to follow all necessary protection measures.



Ion chambers in breast pocket and film meter on lapel are standard equipment. Small meters (note finger and wrist) may be worn on parts of the body especially subject to exposure

By standing on platform and placing his hands in the spaces provided the worker checks his hands and feet for possible contamination



In all of the plants, elaborate precautions are taken whenever radioactive isotopes must be handled. The isotopes themselves are moved with long tongs so that workers may remain as far as possible from the source of radiation. During periods of possible radiation exposure, a Health Physics Department supervisor maintains a constant watch on the radiation level with a hand instrument known affectionately as "Cutie Pie." At the same time a larger instrument, the Monitron, continuously measures the level of radiation, sounding an alarm if the eight-hour tolerance of radiation is reached. When a temporary radiation shield is needed, lead bricks are used.

Isotopes to be shipped to hospitals or laboratories are packed in specially designed lead pots. After each sample has been sealed in the shipping container, the Health Physics Department supervisor takes careful measurements to make certain that no radioactive contamination has gotten on the outside of the container. The entire container is then carefully examined for radiation leaks with a portable Geiger counter. The level of radiation intensity is further checked with an electroscope to see that the radiation penetrating the container does not exceed 15 milliroentgens per hour. This leaves a considerable margin of safety, since the level suggested by the United States shipping regulations is 200 milliroentgens per hour.

PERSONNEL MONITORING — Each person entering a restricted area on the plutonium project picks up a film meter and two ion chambers from his assigned rack. Two ion chambers are carried to minimize accidental errors of instrumentation. These three meters are carried by the worker during his normal duties and at the end of the shift are returned to the same rack. The ion chambers are examined immediately by Health Physics Department technicians. If *both* pocket chambers indicate a significant

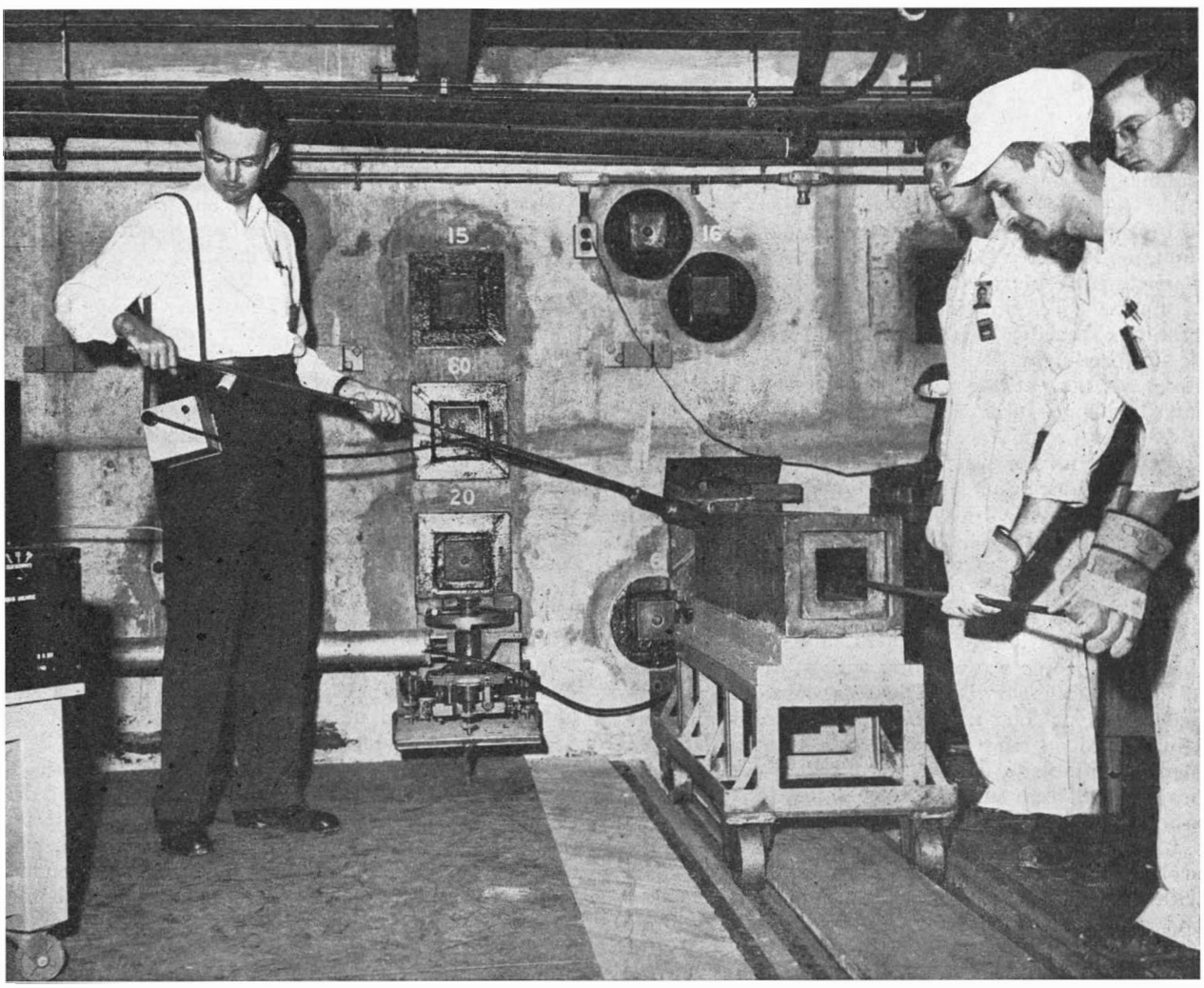
fraction of a day's tolerance exposure, the film meter is read and an investigation is made the following morning to make certain that no one has been exposed to excessive radiation.

The film meter contains ordinary dental X-ray film, part of which is covered by a cadmium shield. Measured by photometer, the blackening of the film under the cadmium shield is proportional to the gamma ray exposure. The blackening of the unshielded portion of the film is proportional to the exposure to beta particles or soft X-rays which are less penetrating. A special neutron film meter is worn by those who work with neutrons, and the proton recoil tracks are counted on this film after it is developed. The counting is done with the aid of a dark field microscope, and the density of the proton tracks is proportional to the neutron exposure.

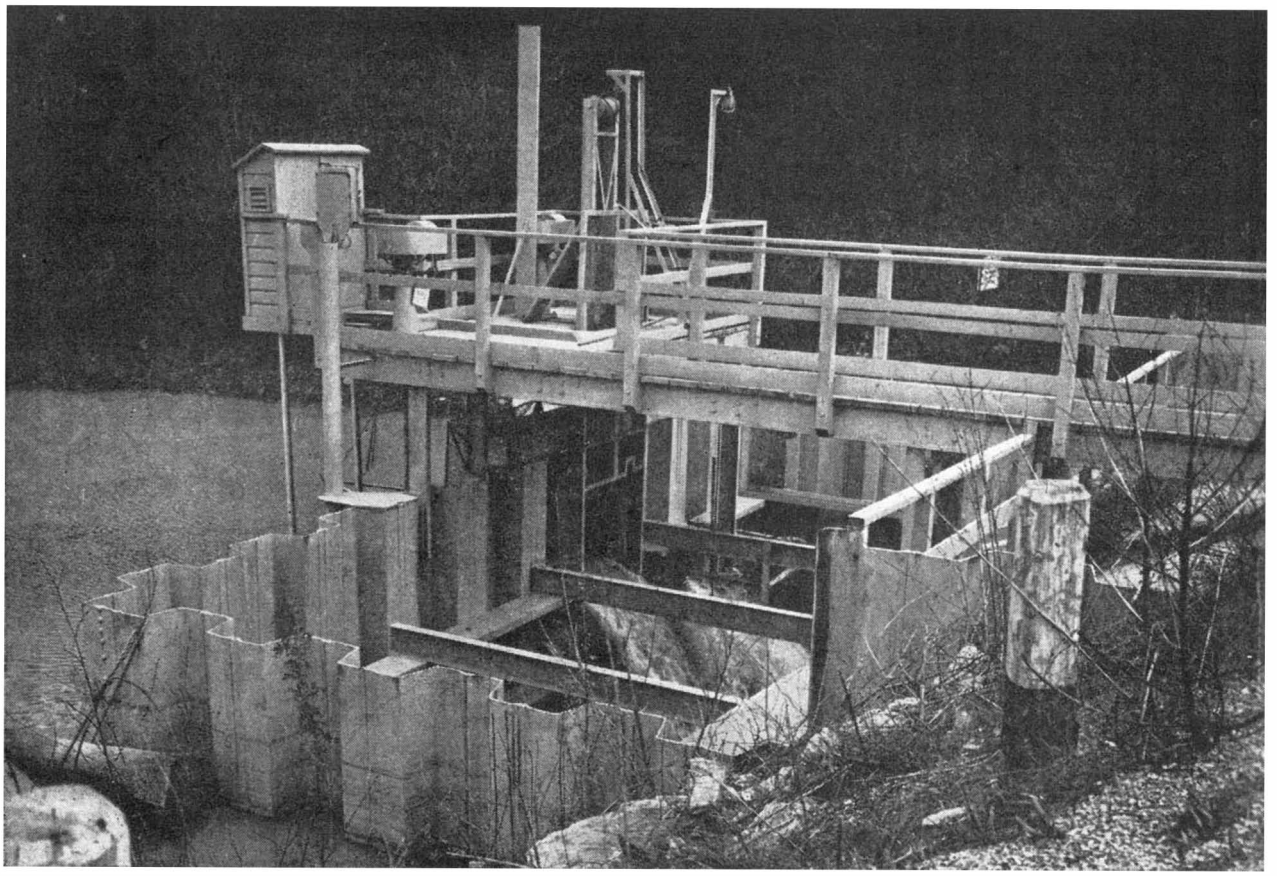
Perhaps one of the most unusual operations for health protection at an atomic energy plant is the decontamination laundry. All persons working in restricted areas wear protective clothing which must be washed regularly. The decontamination laundry uses conventional detergents to remove dirt, and a citric acid solution to remove radioactive isotopes. All garments are carefully checked with a Geiger counter for beta and gamma activity before they leave the laundry. Where necessary, other garments are checked for contamination by isotopes which emit alpha particles.

RADIOACTIVE WASTE DISPOSAL — All contaminated solid waste material from atomic energy plants is buried in guarded areas. Most of the liquid radioactive waste is stored in large tanks, although a small fraction is discharged into holding ponds and streams. Conditions in these ponds and streams are very closely controlled. For example, at White Oak Lake, a holding pond located about two miles from Clinton Laboratories, screens prevent fish from entering the restricted area. Instruments housed in a small building on the dam monitor the water continuously. Unusually high radiation standards are set by the Health Physics Department for water in the vicinity of Clinton Laboratories. It must be safe for continuous use either as drinking water or for swimming. Added to all this, the water leaving the holding pond is diluted by the Cinch River a hundred fold.

Instruments to measure radioactivity in the air are scattered around all buildings of the plutonium projects and the area surrounding them. In these, air is drawn through filter paper which surrounds a Geiger counter at the center of a large cylindrical



Operator (right) removes a radioactive isotope from the pile. Health physics inspector (left) monitors the job with a fish pole meter



The water contaminated by radioactive materials is held in ponds where instruments (in shed) monitor it continuously

lead shield. This filter removes some of the suspended radioactive contaminants from the air. The output of each Geiger counter operates a pen which keeps a written record of the air activity by marking a moving tape. The air activity, according to Health Physics Department requirements, must not exceed the order of normal background levels. Air always contains uranium, thorium, actinium, and their radioactive decay products. This, together with cosmic rays, composes the natural radiation background to which man is always subjected.

All these radiation safety precautions are expensive and require a great deal of effort and concern to everyone working on these plutonium projects. They have, however, paid great dividends. No one on any of these projects, as far as is known today, has been injured by radiation exposure. In fact, no one is believed to have averaged a radiation exposure that exceeds 10 per cent of the established tolerance level. This is a remarkable statement in view of the fact that these people are working with *millions* of curies of radioactive material. There is considerable evidence that as long as present standards are maintained, and as long as the Health Physics Departments continue to function properly, the plutonium projects will remain among the safest industrial operations in this country.

It should be pointed out that it has been no easy problem for the health physics programs to keep pace with the rapid expansion in the use of atomic energy and its products. Often new instruments had to be used in mass quantities when they were little better than experimental models. Today the reverse is true. Many instruments are available on the projects, and are badly needed elsewhere, but are not available due to the delays of declassification.

SHORTAGE OF MEN — There has always been a shortage of men with the proper interests, education and experience in health physics. Only time and great efforts can relieve this shortage. Health physics is demonstrating its necessity in a nation at peace, but should an atomic war come, thousands of men will be needed who have the proper training in this new profession. Some leaders in our country, having observed this problem, have taken preliminary steps to train an army of men to operate Geiger-Mueller counters and a few other health physics instruments. However, this leads our people only into a false sense of security. A man with the wrong instruments and with improper knowledge of how to use them or interpret the results will only complicate an emergency. A man with a scalpel, a stethoscope and a few weeks of training would not be a useful substitute for a doctor for the same reasons.

The great need is for more leading health physicists who have an understanding of the problems of decontamination; who know how to determine if the radiation levels are safe in a city water supply; who can state when certain areas should be evacuated after a city has become the target of an atomic bomb. Perhaps the best solution is to increase the educational efforts on the plutonium projects, and for more competent scientists to begin this training.

ONE THIRD OF WOOD

Editor's note: The following article will appear as part of Dr. Glesinger's book *The Coming Age of Wood,* to be published in the spring by Simon and Schuster, New York.

By Dr. Egon Glesinger
Director, Division of Forest Products,
United Nations Food and Agriculture Organization

Lignin, Companion of Cellulose as a Main Chemical Constituent of Wood, Resists Both Analysis and Utilization. New Laboratory Work, However, May Yet Make It a Valuable Raw Material. The First of Two Articles

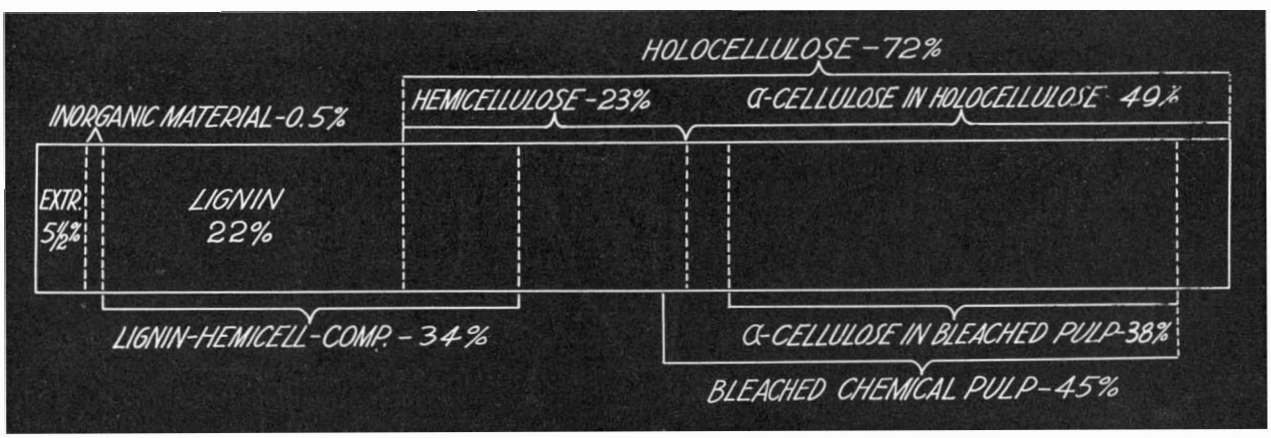
MUCH OF America's favorite ice-cream flavor comes not from the essence of a tropical bean, but from the lignin of Wisconsin spruce and fir, converted into synthetic vanilla. Given this diverting piece of information, the consumer has every right to ask: What is lignin? With that, he joins the company of some of the world's most distinguished scientists, who have been plagued for years by this same question. They know that lignin constitutes from 20 to 30 per cent of all wood, but have yet to determine its exact chemical structure and properties. Most wood chemists agree that lignin is a particularly rich substance and expect to find in it a major source for plastics and even synthetic gasoline. Yet, today, lignin is still nearly 100 per cent waste, and a nuisance besides.

Derived from *lignum,* the Latin word for wood, "lignin" means literally "wood substance." This designation might be challenged on the ground that there is about twice as much cellulose in wood as lignin. The name is justified, however, because it is lignin that differentiates trees from other cellulose plants, which have very little lignin in their structural make-up.

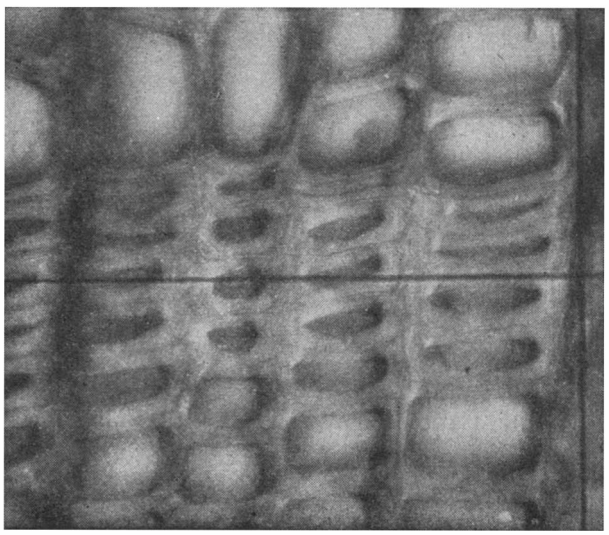
Without lignin, trees could never grow several hundred feet tall, stand up against storms, and support heavy loads of snow. Binding together parallel bundles of cellulose fibers, lignin acts as nature's plastic and gives wood its stiffness, impact strength and resilience. Its action might be compared to that of the cement that surrounds and binds the iron rods in reinforced concrete. Nature itself thus suggests that we take lignin and use it as a binder for making cellulose plastics. Unfortunately, this is more easily said than done. For the lignin commercially available today refuses to duplicate its performance in nature.

FOSSIL LIGNIN — Lignin is believed to have another, more fascinating assignment in nature. When trees die, they are attacked by various microbes. These microbes attack and destroy only the cellulose fibers of wood, leaving the lignin. If this was as true in prehistoric times as it is today, then coal is not just wood, as is generally believed, but lignin fossilized by the action of heat, pressure and time. Chemical analysis tends to confirm this theory. Lignin's carbon content of 70 per cent is closer to that of coal than of whole wood. Again, nature suggests that we look into lignin for the riches we have extracted from coal, starting with aspirin and running to xylol. But, again, the genie of lignin is confined to the test tube.

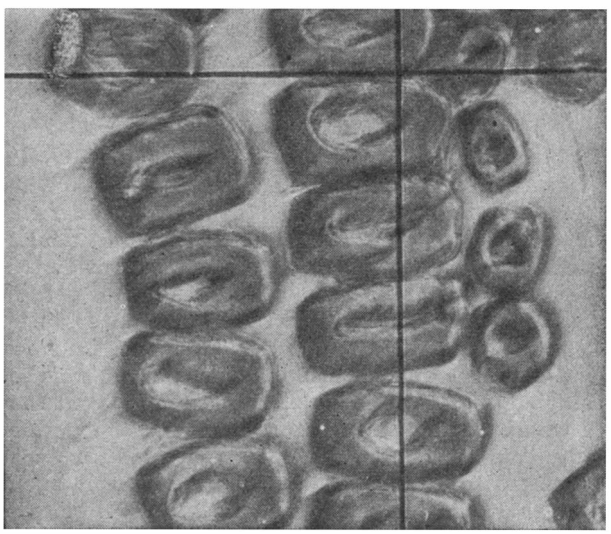
Our trouble comes not only from our ignorance about lignin, but also from the methods by which we extract it from wood. Unlike cellulose, which grows free and pure in the cotton boll, there is no such thing as free lignin in nature. Lignin is found only in close bond with cellulose. Chemists have never sepa-



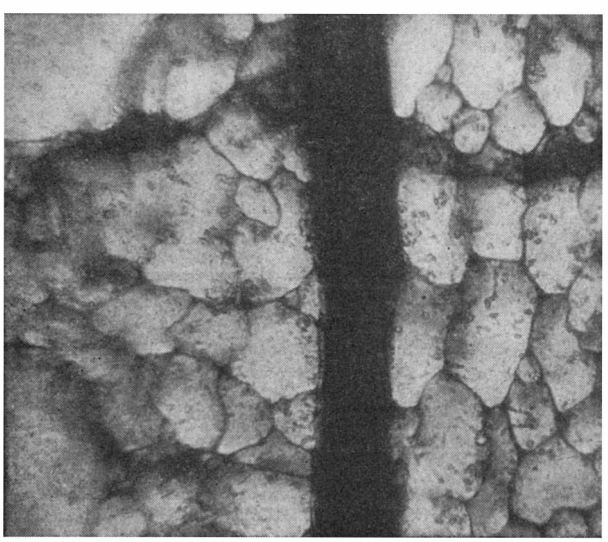
The chemical constituents of wood. Total cellulose, here defined as holocellulose, is broken down into low-grade hemicellulose and high-grade alpha cellulose. Lignin occurs naturally in chemical combination with hemicellulose to make up 34 per cent of wood. When it is separated from hemicellulose it makes up 22 per cent



Magnified cross section of wood



Cellulose fibers of wood with lignin removed



Lignin structure of wood with cellulose removed

rated it from cellulose with its natural qualities intact. Just what these qualities are, they are not sure either, although they have made some careful deductions. It is pretty clear that natural lignin is colorless, possibly transparent. Its action in holding wood together indicates that it is stable, unaffected by moisture and normal temperatures, and elastic. Unhappily, lignin is very much degraded by the industrial pulping and wood-sugar processes.

The divorce of lignin from cellulose was first accomplished on an industrial scale by a Swede, C. E. Ekman, who started the manufacture of chemical wood pulp in 1870. The wood pulp yielded by his sulfite process was, of course, the cellulose content of wood. The lignin, which was extracted at the rate of twelve hundred pounds per ton of wood pulp, was of interest only as a constituent of the waste liquors. This interest, in turn, arose from the public outcry that the infant chemical pulp industry find something better to do with its waste liquors than pollute the streams.

Waste-liquor research has since made progress. In the wood sugars, which constitute one third of the solids in waste liquors, it has found a valuable enough product to justify the expense in plant and fuel required to boil off the nine parts of water in which each part of waste-liquor solids is dissolved. The lignin that emerges from this process, as the remaining two thirds of the waste-liquor solids, however, is a discouraging, sticky brown powder. It shows little or no sign of chemical life or reactivity. Repeated failures to bring it to life have forced many wood industrialists to conclude that the best thing the scientists can do with lignin is find a cheap way to get rid of it. Research continues, however, on more constructive lines, and today scientists are cheered by indications that it is getting warm.

"BURN IT" — Meanwhile, the most practical solution the research directors of pulp companies are able to submit to the front office is to let lignin supply the fuel required for the pulping process. There is much to recommend this arrangement. It takes about half a ton of anthracite coal or its equivalent to manufacture a ton of chemical pulp. With a fuel value of 10,500 B.T.U. per pound, lignin is almost 50 per cent more efficient than whole wood and has about 75 per cent of the efficiency of hard coal. Nothing could be more logical than to use the nonfibrous and coal-like portion of wood as the source of the heat, power and steam required to extract wood's cellulose and convert it into fiber products.

The economies achieved by using lignin fuel account in large part for the recent spectacular advance of the sulfate pulping process. During the past fifteen years, it has doubled its share in the world output of chemical pulp and has dislodged the sulfite—or acid—pulping process from first place in North America. Using an alkaline instead of an acid, the sulfate process yields a waste liquor from which the lignin is more readily recovered. By burning lignin in their boilers, sulfate mills achieved an immediate reduction in coal consumption from 1000 to 300 pounds per ton of cellulose. Recent improvements have made the sulfate process completely self-sustaining in its energy requirements. The nascent wood-sugar industry has begun to make similar use of its lignin, although with regret, because its lignin shows definitely better

promise than does that of the pulp processes.

Sulfite factories, on the other hand, continue to buy practically all of their fuel and to discharge their lignin into the streams, even when they process and concentrate the waste liquors for the recovery of sugar. They hold that it would cost far more to clean their pipe lines and evaporators of the deposits formed by the lignin associations peculiar to the sulfite process than to buy all the coal they need and forget about lignin. The sulfite industry, accordingly, throws away some six million tons of lignin each year.

The annual heat requirements of the world's chemical pulp industries are the equivalent of eight million tons of anthracite. This fuel bill could be eliminated entirely by proper use of waste liquors. If this were done, lignin would yield every day a respectable total energy output equal to twelve times the total generating capacity of Grand Coulee and Bonneville dams. Use as fuel, however, confers very little value on lignin. With a coal price of $6 per ton, lignin fuel is worth from $2 to $4, compared to the earnings of $30 to $100 of its senior partner, cellulose. The best that can be said for lignin as fuel is that it is better to burn it than to dump it into rivers.

Compared to these two equally poor alternatives, the possibilities of lignin when chemically converted read like a tale by H. G. Wells. Lignin as fuel is not worth even a fifth of a cent a pound. The cheapest bulk chemicals, on the other hand, bring in ten cents a pound; fifty cents is not unusual, and in the field of pharmaceutics and cosmetics—the Hollywood of chemistry—prices are quoted in dollars.

IT TAKES MORE THAN FLAVOR — Synthetic vanillin is a perfect example of the high-grade products and prices lignin might yield. Obtained by treating waste sulfite liquors with an alkali, vanillin sells for $3 a pound. Unfortunately, one day's operation by United States sulfite pulp mills produces enough waste-liquor lignin to cover the nation's vanilla consumption for a full year. And since the remaining 2000 million human beings consume substantially less vanillin in toto than America's 140 million sweet-tooths, vanillin can never be more than a drop from the waste-liquor bucket.

Though it still has a long way to go, lignin's commercial career does not begin and end with vanillin. Wartime scarcity of other materials in Germany and Sweden, for example, brought about the use of considerable amounts of waste liquors in the manufacture of soap. The product did not make the grade as bath or toilet soap, but it was completely satisfactory for laundry use and helped these nations to reduce their consumption of fats and oils in soap to one third.

Excellent qualities as a tanning agent have found lignin another market in the leather industry. Penetrating the cosmetics industry, lignin is an ingredient in some hand lotions and scalp tonics. It serves also in several well-known bactericides and fire extinguishers.

Advantage is taken of lignin's natural plastic properties by using it as a rubber extender, a road binder and as an admixture to phenolic resins. A concoction of lignin and concrete is the basis for a number of new building materials and panels.

As a constituent of natural humus, the biggest single deficiency in agricultural soils, lignin shows great promise as a fertilizer. Enriched with elemental phosphorous and nitrogen, lignin promotes the formation of topsoil and thus might be used to extend farming to poor soils in heavily forested countries.

These applications of lignin either involve trifling quantities or, where they call for heavy tonnages, confer no higher value on lignin than its use as fuel. Moreover, none of them expresses lignin's great potential value as a chemical raw material. This remains the objective of the research now moving forward in almost all forest-product laboratories.

A forest in Vancouver. When its trees are used for pulp, nearly a third of the wealth of such forest land is wasted by the loss of lignin.

WHERE DOES POWDER METALLURGY STAND TODAY?

The Present State of a New Technology Introduced To Industry in the Thirties Is Reviewed

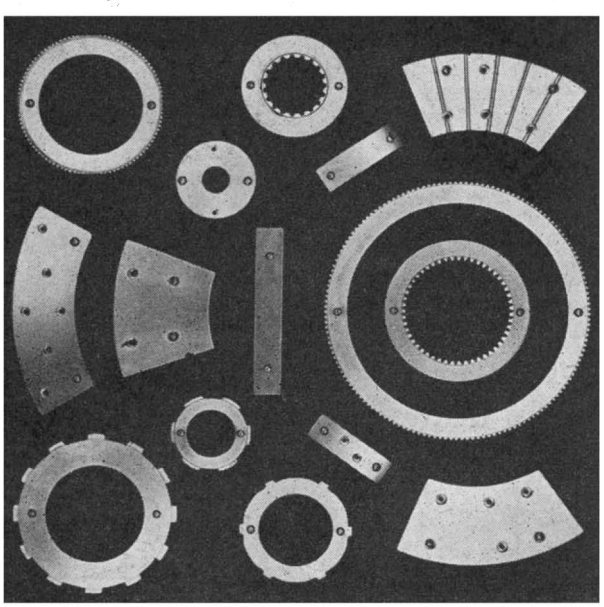
By H. R. Clauser
Associate Editor, MATERIALS & METHODS

ALTHOUGH the powder metallurgy process has been available to industry on a reasonably large scale for almost ten years now, industry is still somewhat confused as to just where this method of producing metal parts fits into the production picture. Even the metal powder producers and powder parts fabricators themselves are somewhat uncertain of their present and future status.

Probably the main reason for all this uncertainty is that powder metallurgy is still a relatively young process. Not young in the sense that it was just recently invented, because metal powders have been used for a number of centuries. But young in an engineering and commercial way. It has only been the last ten or fifteen years that powder metallurgy has been developed to the point where it can be used efficiently for more than just a few items. During the war powder metallurgy expanded and got a landslide of publicity. It was labeled a new and revolutionary process that had an extremely bright future. But that early publicity is now gone; the process must now support itself on its real merits and somehow find its place in the industrial production picture.

Some of the more outspoken and enthusiastic supporters of powder metallurgy have been inclined to talk of it as a cure-all, while detractors of the process have sometimes said that it is good for nothing. Of course neither of these extreme opinions is correct. Powder metallurgy is an engineering method of producing certain metal parts, and like all metalworking processes it has a definite set of capabilities and limitations which defines its range of usefulness in industry. So let's see what the process is, what its good and bad points are, what it can be used for and what some of the latest developments are.

Clutch parts formed by the powder metallurgy technique

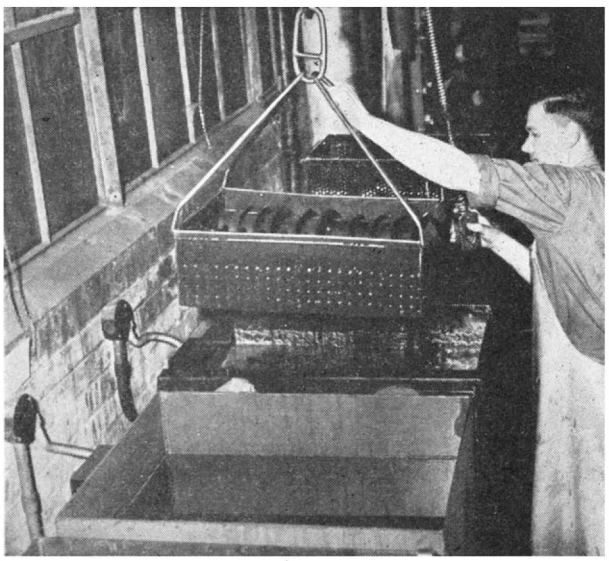


THE PROCESS — The manufacture of a part by powder metallurgy methods involves three major steps. First, the metal powder or powders are pressed in a mold or die to form a weak, "green" briquette that has approximately the final shape. The pressure of the press varies from 5 to over 100 tons per square inch. This press size is an important factor in limiting the size of parts possible.

After pressing, the briquette is sintered to bring it up to service strength by heating it to some temperature below the melting point of the powders. Sintering causes the solid particles of powder to bond together by atomic forces. The heating is usually done in an atmosphere or vacuum furnace.

Finally the sintered part is re-sized or coined to final exact dimensions. This is another pressing operation in which the part is formed in a die of suitable size by pressure. Where special properties are required, such as in the case of "oil-less" bearings, the part is impregnated with oil before the final re-sizing operation.

Powder metallurgy is primarily a small parts production method. High production rates can be attained by using automatic machinery. Outputs ranging up to 1800 pieces per hour are not uncommon



Porous bearings made from powdered metal being removed from the oil-impregnation bath

and in some cases it has been as high as several thousand per hour. Rather close dimensional tolerances can be held, even under high production conditions. On large work tolerances of about ±0.002 inch can be held, while on small parts they may be as low as ±0.001 inch. With special jobs tolerances of ±0.0005 inch are possible. The method involves fewer total operations than many other forming methods and can sometimes be more economical because of such things as low labor costs, high-speed production, elimination of machining and finishing costs and very little raw material waste. Also tooling costs are relatively low and set-up for production is fast.

On the other hand, the cost of metal powders is high and their availability is often a problem; the cost of dies for the pressing operations is also high. The size and form of products is limited. They must be relatively simple in shape, and their size is restricted by available presses. Parts around four square inches in section are generally the maximum. However bearings as large as 18 inches in diameter have been made. The strength, impact and elongation properties are not as good as those obtained in cast and wrought materials. And finally there are a number of design limitations that must be observed. Such things are sharp corners, large and abrupt changes in thickness and uneven cross sections must be avoided.

APPLICATIONS OF THE PROCESS — The applications or uses of powder metallurgy fall into two main groups: (1) It is used for parts which are difficult or impossible to make by any other method; and (2) It is used for making conventional parts which can be made by other metal forming methods such as machining, casting, automatic screw machine and forging.

In the past, and still at present, the principal applications of powder metallurgy are in the first group. For example, refractory metals like tungsten and molybdenum, because of their high melting points cannot be produced efficiently by other means. By powder metallurgy methods, solid bars of these metals are obtained. They can then be further shaped to final forms by swaging or rolling or drawn into wire for a variety of uses.

Combinations of metal powders to produce products retaining the characteristics of each of the component metals are also possible by powder metallurgy. The best known example of this is cemented carbides. Here a small amount of cobalt is used with tungsten carbide powder to give an extremely hard, relatively strong product. Cemented carbides are used for cutting tools and dies, and for wear and corrosion resistant parts.

Pórous bearings are probably the best known products made of metal powders. They are one of a number of products that take advantage of the uniform and conttrolled porosity present in metal powder parts. The bearings are impregnated with oil, usually sufficient to last the lifetime of the part. Metallic filters of powdered metals are another application that make use of this controlled porosity.

Magnetic cores used in all telephones and radios are a powder metallurgy product. They are formed with metal powders, each particle of which is coated with an insulating material. Cores of this nature could be made by no other process. For the electrical industry many types of current collector brushes and electrical contacts are made by powder metallurgy. Welding electrodes and small magnets can also be

Powder metal weighing and blending room is carefully air conditioned to avoid contaminating the hydroscopic materials

made of metal powders. And metallic friction materials composed of non-metallic ingredients in a metallic matrix are being used in clutch plates and brake bands to improve wear life under severe operating conditions.

During the war powder metallurgy was used in a number of instances to produce parts ordinarily made by such methods as casting or automatic machining techniques. In some cases the results were so promising that powder metallurgy replaced the conventional method and many predicted that it would take over many of the jobs now being done by other methods. However, in general there has been some disappointment in the lack of progress being made in this new direction of large volume production of small parts such as gears, cams, bushings and the like. In spite of the attractive advantages such as high rates of production, low metal loss and elimination of machining costs, indications are that present and future progress into this competitive field will depend largely on a number of other factors. One of the most important of these is the raw material problem. It is principally a problem of getting high-quality metal powders at a reasonably low cost.

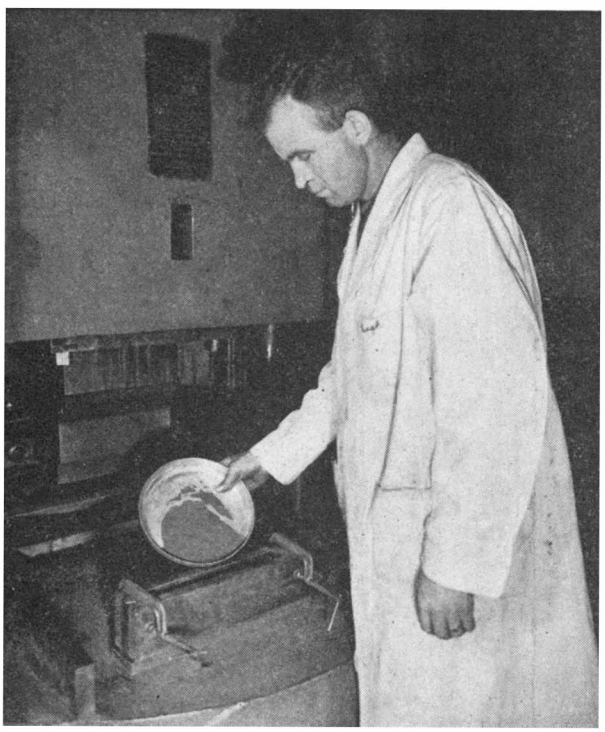
PRODUCTION OF METAL POWDERS — At present most of the metal powders used on a large scale are made by either atomization, electrodeposition or by chemical methods. In the atomization method the solid metal is melted and then shot through a small nozzle orifice. A stream of compressed air, steam or an inert gas striking the molten metal as it comes out of the nozzle breaks it up into fine particles. The particles are collected by ordinary dust collectors and are then ready for use. Atomization is used for making low-melting point metal powders such as lead, zinc, copper, aluminum and their alloys. The powders obtained are irregular in shape, have good density and are usually quite uniform in size.

The electrodeposition method is the same as that used in electroplating of metals, except that the conditions are reversed. In electroplating a hard, tenacious layer of metal is formed on the part serving as the electrode; in producing metal powder, however, a loose, brittle deposit is formed on the anode. This powdery deposit can be further ground or crushed to smaller particles. The particles are usually dendritic in shape and since they are of low specific gravity usually require heat treatment before molding. The common powdered metals made by this process include tin, silver, copper, zinc and iron.

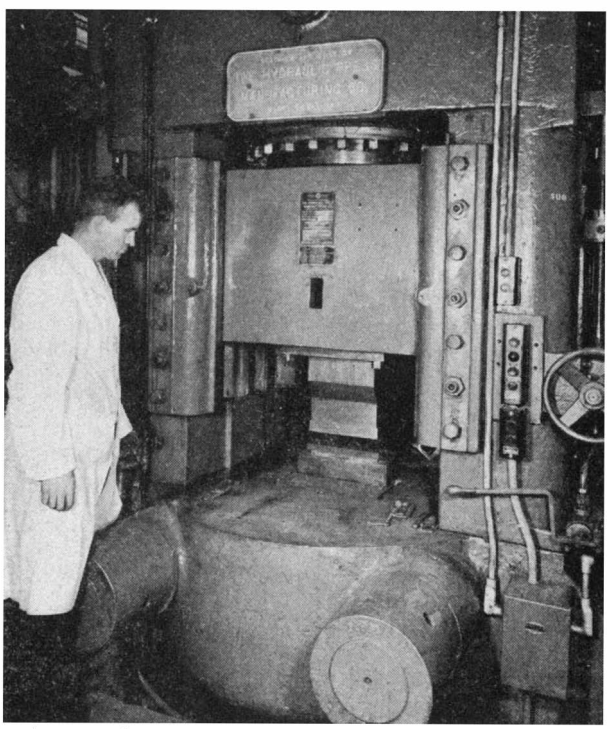
The chemical methods in which metal oxides or salts are reduced by gases, account for the largest amount of powders used by the powder metallurgy industry today. The oxide of the metal is most generally used. It is a very flexible process and a wide range of characteristics and properties are possible. Among the metal powders made in this way are iron, copper, nickel, cobalt, molybdenum and tungsten.

The carbonyl process should also be mentioned, because it gives some of the purest and finest metal powders. The process depends upon the decomposition of metal carbonyls which are produced by passing carbon monoxide over the spongy metal at proper temperatures and pressures. When the carbonyl decomposes, the metal powder is precipitated. Iron and nickel powders with superior properties are made in this way.

Practically all metals can be made in powder form by one of the processes described above or by one of a number of less common methods. However, the methods are still too costly and it will be necessary



A carefully measured quantity of tungsten carbide powder is poured into the die to make a carbide machining tool



Filled with tungsten carbide powder, the die is placed in the press where the "green" briquette will be formed

to develop ways and means of producing powders cheaply either by these established methods or by new processes.

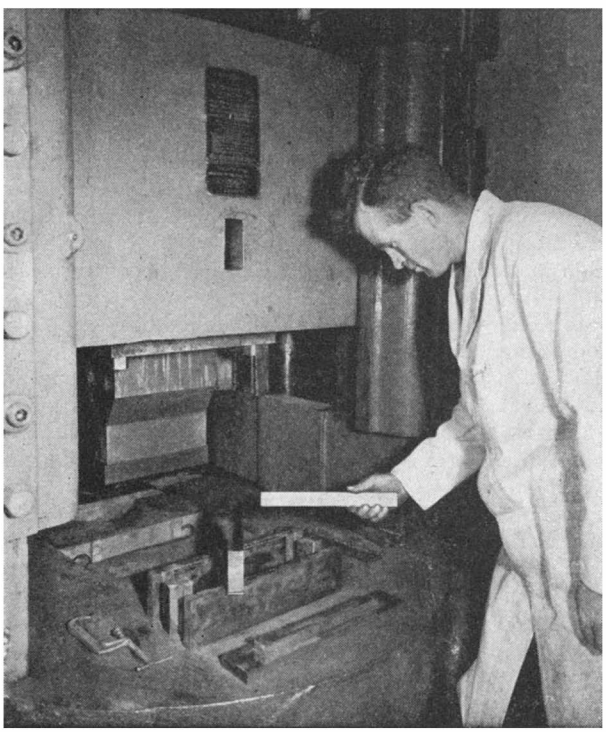
LOW-COST HIGH-QUALITY POWDER NEEDED — Before powder metallurgy can seriously compete with other metal forming methods on a large scale, cheap high-quality iron powder must be made available.

In the past much of our iron powder has been imported from Sweden and also some from Germany. Many fabricators are still importing their powder from Sweden. In fact, until recently the Swedish process had been the only commercial method of making iron powder at relatively low cost.

During the past few years domestic production capacity of iron powders has been increased by the development and use of several new production methods. Reports are that our domestic capacity is now between 10,000 and 12,000 tons per year. But at present this capacity is not being fully used.

The price of iron powders ranges all the way from seven and eight cents for Swedish low-grade sponge iron to over $1.00 a pound for the higher grades. Although domestic producers are now almost meeting the price of low-grade imported iron powders, the problem of bringing down the cost of the high-grade iron powders still remains. There is much talk about how this might be done. The two things most often mentioned are standardizing on a fewer number of different grades, and increasing the use of iron powwers and thereby increase the volume of production.

ALLOY POWDERS — The low properties—strength, elongation and impact—of metal powders as compared to those obtainable in cast and wrought metals is another factor that is hindering the rapid growth of powder metallurgy. Recent developments in alloy powders may do much towards eliminating this disadvantage.



The carbide briquette coming from the hydraulic press must now be sintered to bring it up too full service strength

In early methods of making alloy powder parts, the separate constituents of the alloy desired were combined by solid diffusion during the actual production of the part. The latest method is to use "pre-alloyed" powders. These are powders consisting of two or more elements made in alloy form before being fabricated into parts. Copper alloys, such as brass, have been pre-alloyed commercially for quite a number of years by means of the atomization method.

By using various newly developed processes a large number of alloy powders can now be produced by disintegration of the alloy material when it is in its molten form.

These alloy powders reduce the sintering time over that necessary for diffusion sintering. Also they usually have improved mechanical properties. The full affect that the development of these pre-alloyed powders will have on the powder metallurgy industry is still not known. However, it is generally believed that they will expand the use of the process.

Another possible means of improving the properties of powder metallurgy parts is by use of hot-pressing methods. Experiments have indicated that when metal powders are pressed in a heated instead of cold condition high density parts having comparatively high strengths are possible. Also, the pressing pressures required are much lower than those required for cold-pressing. The manufacture of large metal powder parts has been limited because very large, expensive pressing equipment is required. If hot-pressing lives up to its early promises, parts much larger than those now possible will come within range of the powder metallurgy process.

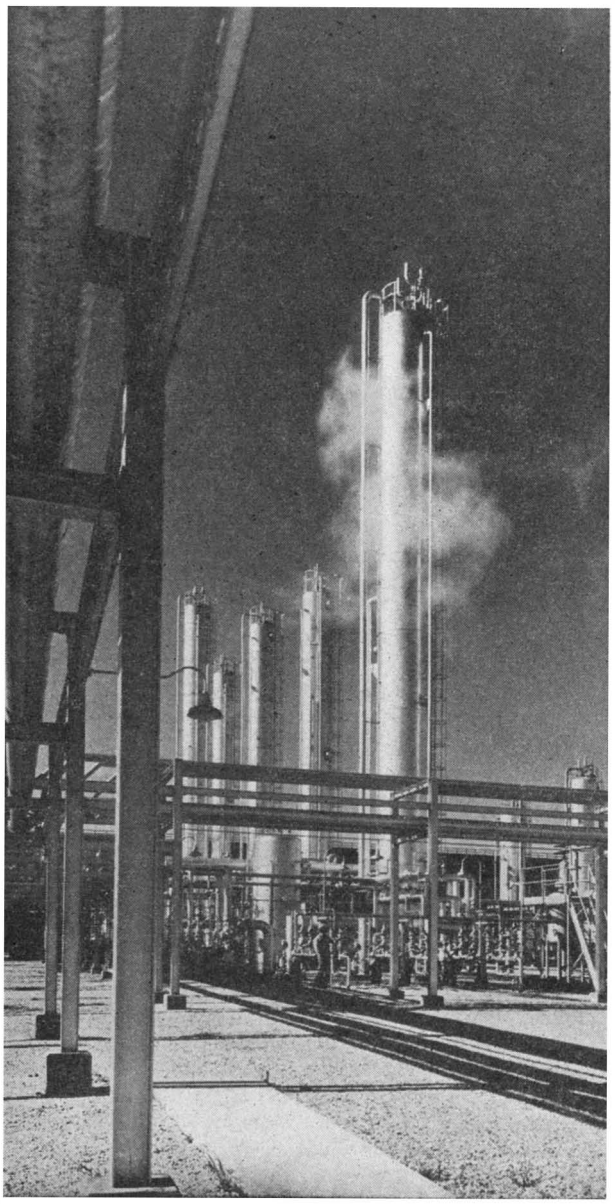
Hot-pressing should also aid the expansion of alloy powder parts. Many pre-alloyed powder materials require very high pressures when cold-pressed to attain their optimum properties. However, hot-pressing in many cases results in satisfactory properties at reduced pressures. Before hot-pressing can be used extensively on a commercial basis a number of problems—such as preventing oxidation during heating and eliminating excessive die wear—must be solved.

And finally, the future of powder metallurgy depends, to a considerable degree, upon the attitude of industry. In the past, many manufacturers have depended largely upon independent powder parts fabricators, because they have felt that the process is too complicated or that the cost of equipment is too high. Thus, metal powder parts have usually cost far more than they would have, had they been made right in the manufacturer's own plant. To take full advantage of powder metallurgy, industry must treat it as a metal parts production method just as it does die casting, forging or stamping. Actually, the cost of powder metallurgy equipment is no higher than that for most other production forming methods, nor is the process more complicated. So in time, when more of industry gets better acquainted with powder metallurgy's capabilities, and puts it in the production line like automatic screw machines and other metal forming machinery, we can expect to see powder metallurgy become a full-fledged production method.

RECYCLING CONSERVES U. S. NATURAL GAS

Valuable Hydrocarbon Fractions Formerly Wasted Are Pumped Back into the Ground

By Neil Uptegrove



In this cluster of fractionators the desired light cuts are separated from the gas condensate

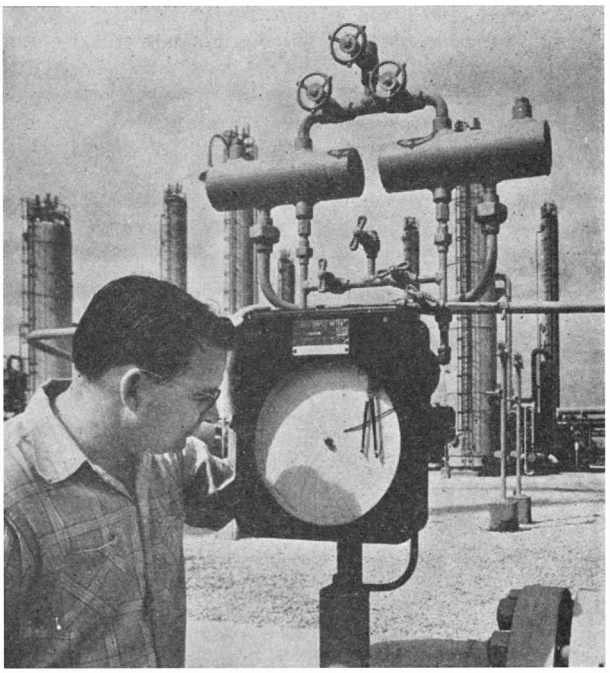
NATURAL GAS, the principal by-product of the petroleum industry, has generally been considered the worthless nuisance of the oilfields. Small quantities of natural gas have been used as fuel in oil-producing regions, but there have been few other markets of commercial significance for it. Most natural gas has simply been burned as it came out of the ground. This has not only wasted precious hydrocarbon fractions, but has also exhausted oilfields by reducing the underground pressure necessary to keep petroleum flowing to the wells.

In recent years the petroleum industry has become increasingly conscious of the fact that lost natural gas is lost wealth. Natural gas fractions, moreover, have become an essential adjunct to petroleum in the production of high-octane gasoline. The latest development has been that natural gas alone can be synthesized into gasoline by the Fischer-Tropsch process. These new uses require improved methods of producing and conserving natural gas. One such method which merits close attention is known as recycling.

Recycling, in brief, is a process whereby natural gas is tapped from high-pressure wells, the desired fractions (at present butane, propane and pentane) removed and the remaining gas pumped back into the ground. This final step 1) keeps the underground pressure, and therefore the productivity, of the field high and 2) conserves the remaining gas, still a rich store of hydrocarbons for the future.

In fields where gas alone is produced, recycling accomplishes another important end. This aspect of the process depends upon an unusual property of certain gases discovered by Kuenen in 1892. Kuenen found that whereas most gases condense into liquids when they are compressed, natural gas condenses when its pressure is decreased. He called this phenomenon "retrograde condensation." The traditional practice of the oilfields, in which natural gas escapes freely from the wells, causes many gas fractions to condense underground as the pressure falls. And because their high surface tension cleaves them to grains of sand, there they remain.

If the underground pressure is kept high enough to prevent condensation, however, these otherwise lost hydrocarbons can be removed in their gaseous state. This, the principal objective of recycling, makes possible the recovery of more than 70 per cent of the



This gage records the pressure of the residue gas as it is forced back into the ground

total reserve in a natural gas field. Since previous practice recovered no fractions that had condensed underground, recycling becomes a powerful agent for increased production as well as for conservation.

TWO SETS OF WELLS — Recycling requires two complete sets of gas wells. Production wells remove wet gas (i.e., gas containing all fractions) from gas-bearing strata. Injection wells pump the stripped gas back. The success of recyling depends largely on the proper placement of both. This requires a painstakingly accurate estimate of the size and shape of a gas field's underground reservoir. The most successful method of obtaining such an estimate to date has been through the use of the oil pool analyzer, a model of the field built from data supplied by geologists. When the model is filled with a conducting solution, the path of electric current through the solution is similar to the flow of gas through underground strata. This method has done much to make sure that injection wells are placed to spread the stripped gas uniformly, forcing the maximum quantity of wet gas into the production wells. Without such estimates, injection wells might be so badly placed that the stripped gas will travel in narrow channels and leave much wet gas behind.

Since an effective recycling operation must take in an entire gas field, it frequently requires close coöperation among companies who own various parts of the field. In fact, if a recycling operation is not run as a unit, it will fail as a unit. In sinking production and injection wells, property lines must be forgotten.

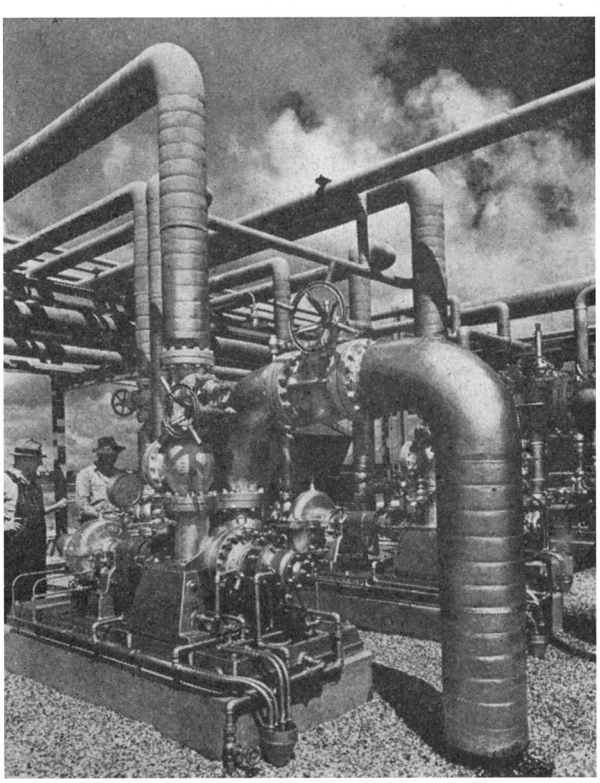
Such coöperation among companies on a recycling project can be far more difficult than it would appear. The legal problems encountered when several companies with various interests try to "unitize" a gas field can be enormous. Before any unity of effort can be obtained such questions as which company is to be the principal operator, how engineering decisions are to be made and how royalties are to be divided must be answered to the satisfaction of everyone concerned. In past years the difficulties encountered in the course of settling such problems have been the principal obstacle to starting a recycling program at all. But as the need for recycling has become more apparent, petroleum companies have participated in a trend toward a great community of effort.

An important stimulus for this trend has been the fact that the oil-producing states have begun to realize the value of recycling. Led by Louisiana, several states have already passed legislation requiring that retrograde condensate fields be operated by recycling. Other legislation has also prohibited the indiscriminate waste of natural gas.

The principle of recycling was first applied on a large scale in Texas in 1938. At first the wet gas from production wells was processed simply by retrograde condensation, i.e., the condensate was collected when wet gas from the wells was allowed to expand in closed chambers. Later a second type of separating plant came into use in which the wet gas was cooled to increase the efficiency of condensation. A third method, and now the most common, employs high-pressure absorption to extract condensate. This latter method yields more condensate than the others and has the additional advantage of requiring less horsepower for the compressors which force the stripped gas into injection wells.

RECYCLING AT ERATH — An outstanding example of a coöperative recycling project is the Erath Recycling Operation in Vermillion Parish of south central Louisiana. The first wells in this field were

Gas condensate is brought up from the reservoir by this pumping unit



drilled by the Texas Company in 1940, revealing that there was no significant accumulation of petroleum below 8000 feet. There was, however, a large quantity of natural gas and condensates from it. It was then decided to unitize the entire Erath field, build a plant to separate condensates from the gas and recycle the stripped gas.

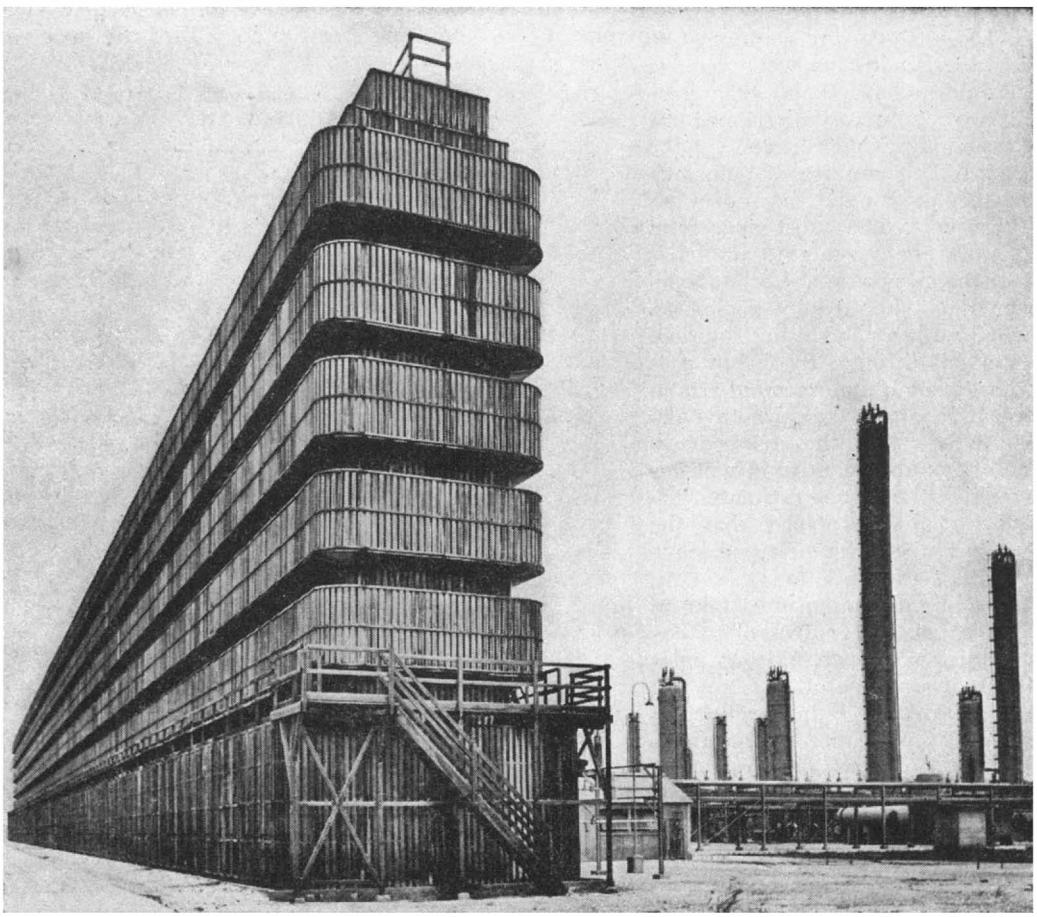
The Texas Company then proposed a plan for the coördinated development of the field in which the interest of each owner or leaseholder would be based on the relative value of hydrocarbons beneath each tract. The agreement was approved by 44 owners, some 400 leaseholders and royalty owners and by the Louisiana Department of Conservation.

Up to this point 11 wells had been drilled at Erath. After the field had been unitized, the total was brought up to 31 production wells and 12 injection wells. These wells made possible a production of 220,000,000 cubic feet of wet gas per day. The output of the plant which processed the gas for its desired fractions was approximately 16,000 barrels a day. After 11,000,000 cubic feet had been diverted as fuel to operate the Erath plant, some 197,000,000 cubic feet remained daily to be pumped back into the field through the injection wells.

GAS BEARING STRATA — There are 19 strata at Erath which bear gas and condensate, ranging in depth from 8100 to 11,970 feet. Pressures in the strata run from 3939 to 6245 pounds per square inch. The temperatures vary between 180 and 219 degrees F. When the gas is tapped from the production wells, it is under a pressure of 2500 pounds per square inch and at a temperature of 130 degrees. Its temperature lowered to 100 degrees in cooling towers, it proceeds to reducing regulators where the pressure is decreased to 1850 pounds per square inch. This drop in pressure lowers the temperature of the gas still more to 90 degrees. The wet gas then passes through separators which remove its cargo of condensate. Finally the condensate is fractionated by conventional methods of distillation.

When the gas leaves the separators, considerable care is taken to prevent fractions which condense under moderate pressure from going to the compressors. Suction scrubbers and high-pressure absorbers remove those fractions which have passed the separators. In the compressors, the pressure of the gas is raised again to 4600 pounds per square inch in one stage and is piped to the injection wells. Sixteen compressors of 800 horsepower each compress the stripped gas at Erath.

The recycling plant at Erath is the largest of its kind to be built to date. Its 16,000-barrel daily output of light hydrocarbon fractions, although it is only an insignificant part of the total production in Louisiana alone, is more than twice as large as the amount which could be produced by any other method. In these days of shrinking U. S. petroleum reserves, recycling offers real hope that the petroleum industry can increase the production of existing natural gas fields and open new fields which are closed to other methods of exploitation.



An atmospheric water cooling tower. In this tower vast quantities of water are chilled for use in the refining of the separated fractions

THE PILOT PLANT'S VALUE TO INDUSTRY

Editor's note: An enlarged version of the following article will appear in Mr. Killeffer's book *Methods of Industrial Research,* to be published in January by the Reinhold Publishing Corporation, New York.

By D. H. Killeffer
Chemical Engineer

If Properly Equipped, Staffed and Operated, The Pilot Plant Can Point the Way to Bring A New Industrial Process Safely Across the Gap of Uncertainty Existing Between the Laboratory Stage and Full-Scale Production

INDUSTRY generally can profit by adopting the chemical industry's pilot plant to guide its progress. Faced with serious difficulties in translating theoretical possibilities and laboratory experiments into going manufacture, the chemical industry invented the semi-works or pilot plant to "make your mistakes on a small scale so that your profits can be on a large one," as Baekeland put it. Or in the words of Kettering, the pilot plant is "a bridge across the shirt-losing gap" between laboratory experiment and plant production. The chemical industry had to develop something of the kind for its own survival since only in the most remote case can chemical processes be economically enlarged from test tube to tank directly without serious trouble. Chemical reactions differ inherently from mechanical operations that can be multiplied simply by installing more machines of the same kind. Two machines make twice as many cigarettes as one, but to attempt to jump from a bare chemical idea or experiment directly to full-scale production is to court almost certain failure from the mis-function of little things (and others not so little). The cost of interruptions, spoiled goods and wasted time thus entailed can readily smother an otherwise promising development.

To avoid these casualties which have plagued it whenever progress is rapid and development general, the chemical industry has devised and adopted the technique of the pilot plant, capable of small-scale operation under close control, as a means of exploring new territory. This valuable tool, now well developed, could be profitably adopted by other branches of industry to carry out their explorations and to promote their progress.

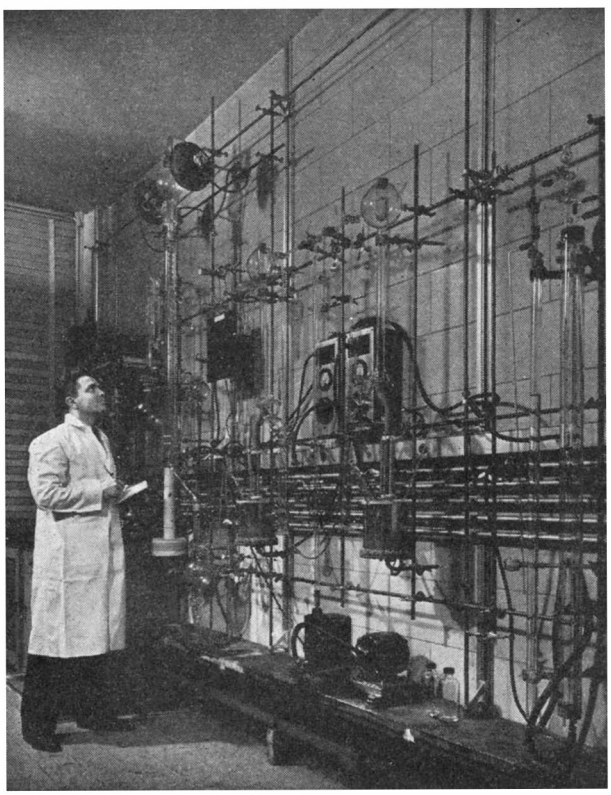
COMMON MEETING GROUND — In a very real sense the pilot plant is the halfway house of the chemical industry, for all the different phases of the industry meet here. Here the research chemist puts his reactions to their first test of production, but on a scale that avoids bankruptcy if they fail and undue danger if they run wild. Here the plant operating department, looking for improvements, can subject processes to the closest scrutiny and they can vary operating conditions without interrupting regular production. By operating processes in the pilot plant on a scale large enough to give meaning to the measurements taken from them, the engineering department can determine most, if not all, of the facts required to arrive at an efficient design for the full-scale production plant. Pilot plant operation can readily supply sufficient quantities of a new product, or a new modification of an old one, for distribution by the sales department to prospective users. This can yield a dependable estimate of market possibilities, covering quality, quantity and price of the product. All of these data, assembled and correlated, give management a penetrating analysis of the situation on which to base its decisions.

The pilot plant can, when properly used, safeguard the judgments of all concerned in the success of any enterprise. At the same time it provides a reasonable and practical meeting ground, more logical than the usual conference room, for settling differences between departments and for forming policies for the future. Here every aspect of each problem can be studied with great care and here the interchange of ideas and points of view between the several groups constituting the company's staff can take place on the common ground of determined facts.

An instrument so potent for the good of an organization must of necessity be handled with skill and understanding if all its possibilities are to be realized. The pilot plant can yield abundantly if it is (1) amply equipped, (2) staffed by capable persons and (3) well understood by all departments of the company. A genius might possibly be able to produce results from a pilot plant whose equipment is drawn entirely from the junk pile of the maintenance department's final discards. But a genius could get along without a pilot plant at all! Since pilot plants

must be run by average to excellent research workers to give day to day good performance and not by geniuses to perform miracles, both equipment and personnel of the pilot plant must be adequate.

PILOT PLANT SET-UP — Necessarily the details of the pilot plant are determined by the general nature of its problems. The pilot plants of a glass works, a petroleum refinery, a textile mill and a dyestuff plant are totally different from each other except in their basic elements. For instance, each would need space enough to set up miniature duplicates of the principal units of equipment of the parent plant and room beyond that to allow these units to be moved about into various combinations. Furthermore, each unit as set up for work must be so situated that every part of it can be reached for measurements, alteration, cleaning, repair and any other purpose that the operator may be able to imagine. The working space of the pilot plant must be heated and ventilated adequately for its purposes and must be provided with all the services of the plant itself: water, sewer, steam, electricity, fuel gas, vacuum, air pressure and any others available. Every reasonable and some unreasonable safety devices must be at hand. The equipment of the pilot plant must include as a minimum an adequate set of mechanical tools for setting up and dismantling any or all of its equipment, and every type of measuring (and preferably automatically recording) device and instrument that may reasonably bear on its problems. Finally some provision must be made for the assembly and recording of data, at least a desk in a separate room where records can be kept and calculations made.



This laboratory-scale molecular still will have to undergo many modifications in the pilot plant stage before it can be applied successfully to full-scale production

Synthetic resins are molded into drinking tumblers in the press of this plastics pilot plant

Beyond these basic items, the pilot plant ordinarily duplicates the operating plant in miniature. Size is the most obvious difference, but in addition to that, the essential flexibility of the pilot plant requires a generous use of tees, unions, and flanged connections on each unit and plenty of thermometer wells and other connections for gages and meters of various kinds. Equipment should be mounted on dollys or casters to be easily moved about as needed. Large, heavy items—hydraulic presses, jacketed pressure vessels, furnaces and other cumbersome major pieces —can be permanently mounted on solid foundations, depending for flexibility on bringing up lighter items to be connected into the various systems required. Mechanical industries can profitably set aside a single production line for pilot purposes or build one especially.

PERSONNEL REQUIREMENTS — The personnel of the pilot plant staff is even more important than its physical equipment. The prime necessity is to provide a skeleton staff of one or more persons as may be required to be permanently attached to the pilot plant. This staff must be experienced in as many aspects of the company's business as possible

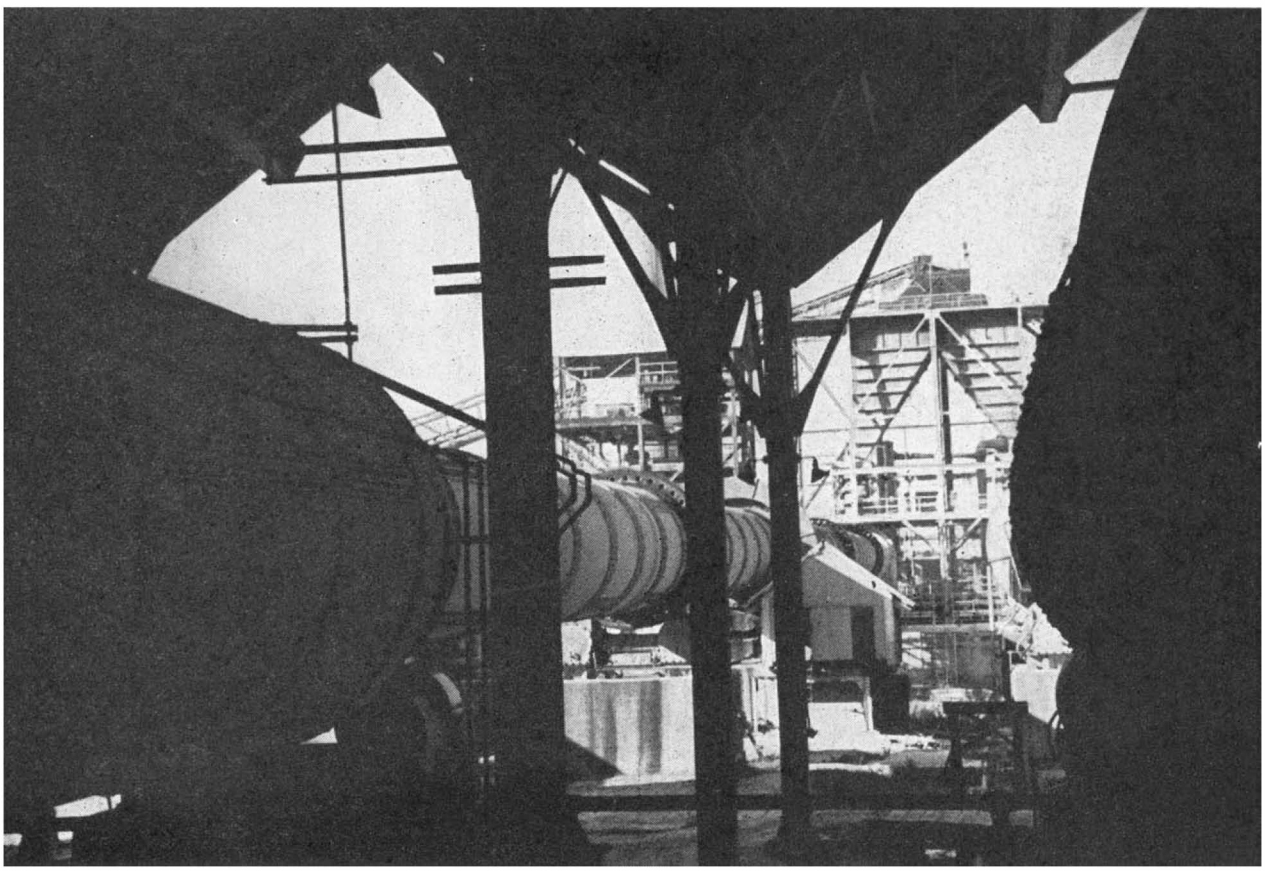
and certainly the director of the work must be thoroughly familiar with the points of view of research, production, sales and management. His inclination to go off the deep end in a research sense must be tempered by his desire in an operating sense to produce results as fast as needed; his salesman's optimism must be mixed with a generous share of management's conservatism. This individual must be so independent of each of these several divisions that none of them dominates him and that his thinking is not incompatible with any of them. Obviously such a person is impossible to find; but at least he is the one that should be sought, and the compromise person that is finally selected should be given a position as far as possible independent of each of the groups that will be his best customers—the company's department heads.

Having installed a minimum permanent staff in the well-equipped pilot plant, the next question is: How shall it function to best advantage? Necessarily someone from each of the other departments of the company interested in a particular problem must be available to solve it himself or with the assistance of others. When the pilot plant research approaches a point where some department other than its originator should be interested or should prepare to take over, then an appropriate person from that department should be available on loan. It is a mistake for any man whose primary interest is in some other department of the company to become permanently attached to the pilot staff. It is equally wrong not to send men from other departments into the pilot plant at reasonable intervals because each man can contribute to its effectiveness and each can learn something from it. M. C. Whitaker once emphasized the difference in men about the plant thus: "A man who is essentially a plant man is liable to be a nuisance in a research laboratory; and on the other hand, a man with research inclinations is a hazard to any production process." Yet these two types of men can safely and effectively meet in the pilot plant. Here the research-minded man can experiment to his heart's content without interfering with the regular progress of raw material into the main production line, and of finished goods out of it to customers. The production man for his part can watch in operation equipment more substantial than the glassware of the laboratory; he can also see a certain orderly progress of affairs that can be influenced and adjusted with a wrench and a screw driver instead of a glass blower's lamp and a piece of rubber tubing.

SALESMEN FAMILIARIZED — Here, too, the salesman can acquire some acquaintance with, and respect for, the processes and equipment that give him a product to sell. He can even operate the process himself without fear of drawing down the management's Jovian lightnings should something fail to go just right. This familiarity with his own product and a nodding acquaintance with the problems of others in supplying it have never yet been known to mar a salesman's effectiveness.

Finally the pilot plant provides an effective initi-

In the design of large installations such as this alkali works the pilot plant becomes an economic necessity

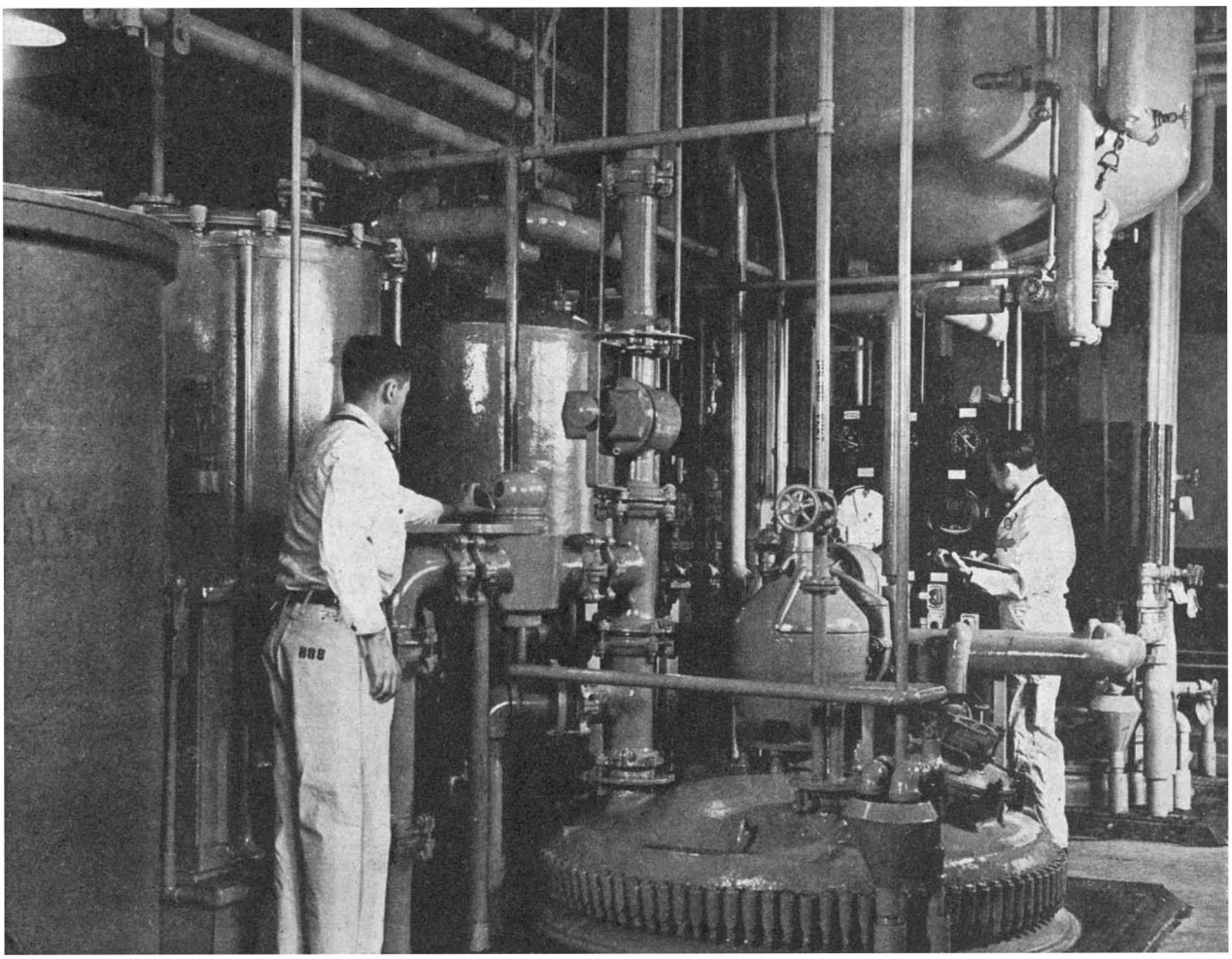


ation for any person entering a company with the expectation of assuming some responsibility for its affairs at once or later. The pilot plant's very nature makes this function simple and easy as well as time-saving and effective. Visitors are always problems in an operating plant and neophytes who are not definitely training to become operators must be classed as visitors whatever may be their histories and expectations. The operating force can seldom shut down an operation just to show a visitor how it works and certainly a shut-down cannot be timed to suit the visitor's whims. On the other hand, a trainee in the pilot plant can be given, under careful supervision, useful work to do in connection with its operation, and so earn his salt while learning.

No research and no development can be considered complete until it has survived the test of at least pilot plant operation. Here the research man continues to foster and cherish his offspring, but here he must transfer it by degrees to other's care. The stay of a process in the pilot plant may be considered to correspond to the period of adolescence in children. In infancy, the research man has complete control in every respect, but in the pilot plant his infant must be put through a process of growing up, of passing from the secure dependence of the research laboratory to the hazardous maturity of operation. It undergoes tremendous enlargement, but at the same time the new process is acquiring a purpose only dimly imagined in the laboratory.

Normal routine would require that the research man (or one chosen from the group if several have participated in the investigation) leave the laboratory and take his brain-child into the pilot plant. Here appropriate steps put the new process into operation. The staff of the pilot plant participates with the researcher in this, and as the work develops, representatives of the engineering department are called in to help things along. At a later stage a designated person from the sales department and another from the operating department may be called in to contribute to the development. Naturally, the sales department has no particular interest in the development of a totally internal process which will not affect the products for sale. Nor will the production department show serious interest in a totally new product until the sales department reports some actual or potential interest in it from the company's customers. Thus the burden of proof continues to rest at the point of origin, the research department, until some probable value of the development has been demonstrated. All of this consumes considerable time, but it also makes important opportunities to study the new process, to determine

A full-scale organic synthesis. To vary the arrangement of such equipment after it had been set into operation would be virtually impossible



its operating characteristics and to make enough of the product to develop some interest in it from potential customers and others than its parents in the research laboratory. The bugs in the process revealed by engineering and production, and those in the product found by sales and customers are gradually cleared out.

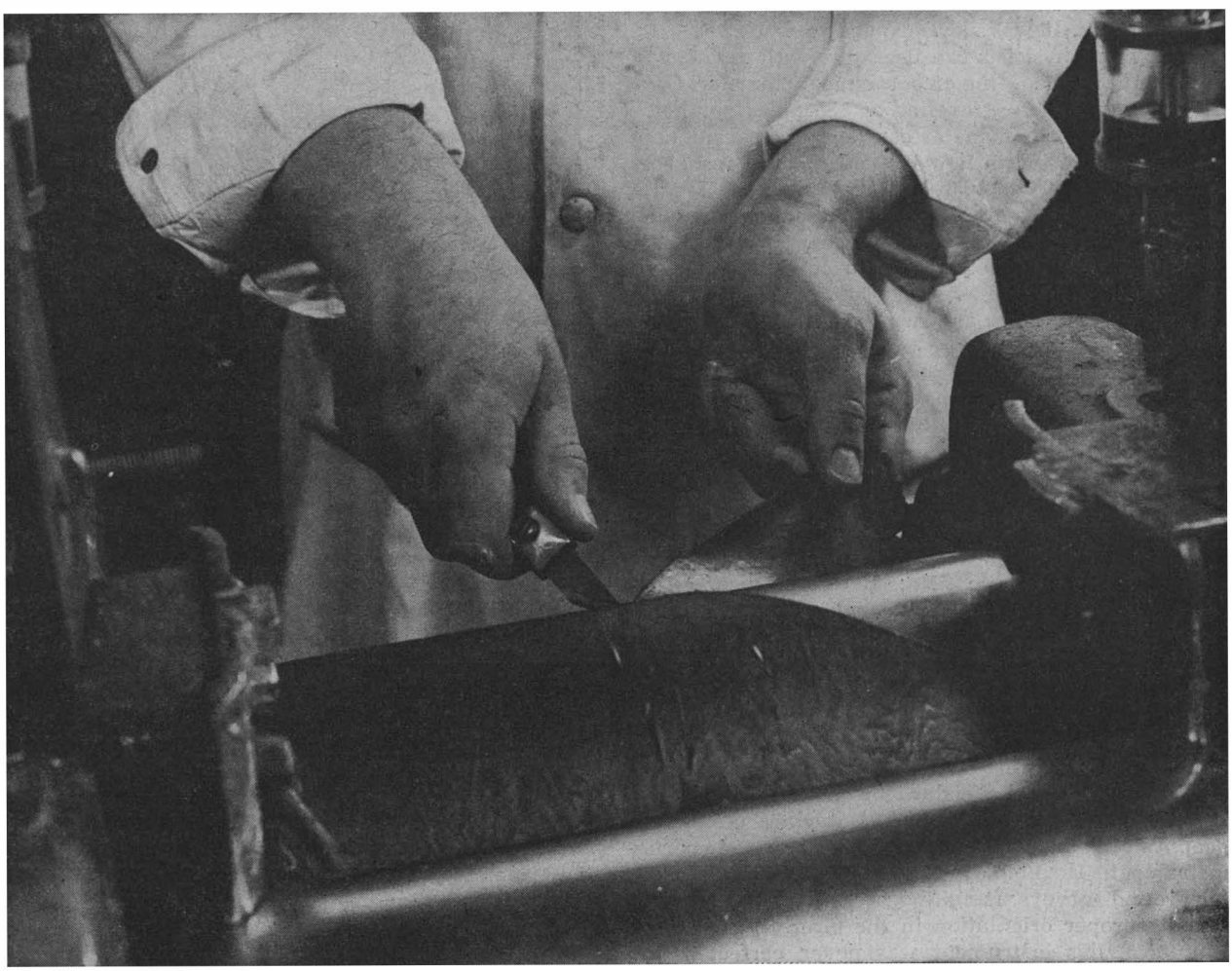
SMALL-SCALE BLUNDERS — Obviously blunders made in development are far less serious in their effects on the pilot plant scale than if they had happened in a production plant. But that in no wise excuses the temporary or permanent members of the pilot plant staff if they simply blunder ahead thoughtlessly without a careful plan. Far too often the research man abandons his brains at the door of the pilot plant, and because he understands that it is the place to make mistakes, proceeds to make every reasonable error and some utterly unreasonable ones. The plant man and the engineer do the same thing, and the pilot plant operator is the victim of them all.

Troubles sometimes arise because the value and function of the pilot plant are not understood by outsiders or by those temporarily on its staff. Too often the pilot plant is thought of as being an extension of the other fellow's territory reaching out toward one's own, when actually it is an independent entity between the two, belonging to neither and to both.

Design of pilot plant processes which will function adequately is an important study in itself. Unfortunately too little attention has been paid to it, presumably on the assumption that the good sense of all concerned will arrive at a reasonable and effective compromise and that such a compromise will be the thing desired. It may or may not be. The mere fact that it is a compromise does not guarantee its value. Furthermore, the fact is repeatedly made evident that failure can happen quite as readily between laboratory and pilot plant as between that and the full-scale plant. And it is not impossible for a process to succeed in the full scale plant when it has previously failed in both laboratory and pilot plant.

The basic problem of the pilot plant process thus is: to enlarge the laboratory experiments, to shrink the plant operation and to give the intermediate stage some logical and evaluable relation to each. This is by no means easy, but when thoughtfully achieved, it provides vital information on which all members of the policy-forming group of a company can base thought decisions. The practice of the chemical industry certainly points the way for others to follow in the use of this invaluable tool of management and growth.

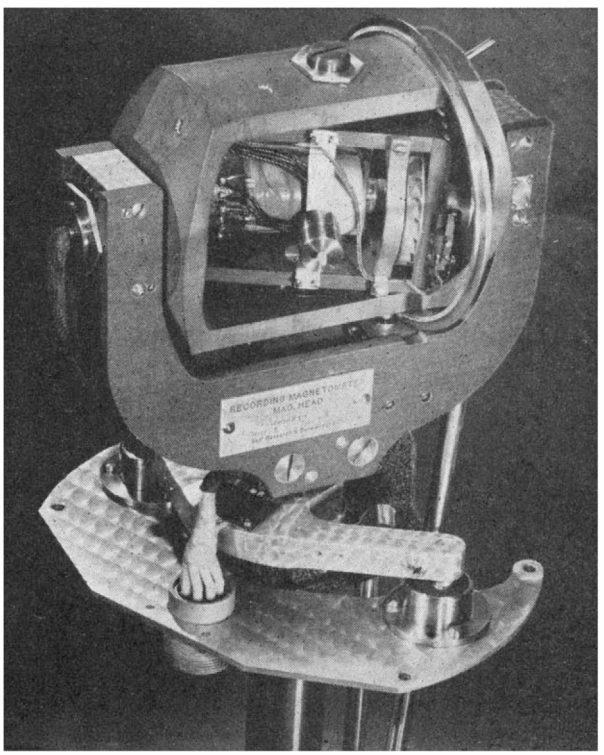
Small batches of rubber are processed on this pilot plant machine, duplicating in miniature the full-scale operation



PROSPECTING FROM THE AIR

The Airborne Magnetometer, Perfected During the War to Detect Submarines, Has Now Mapped Variations in the Earth's Magnetic Field Over 250,000 Square Miles. Its Purpose: to Reveal Hidden Formations Containing Minerals and Oil

By Homer Jensen and Eugene F. Peterson
Aero Service Corporation



A coil of wire with a special ferrous alloy core is the heart of this magnetometer sensing element

UNTIL recently geophysicists who needed information about the earth's magnetic field in a particular locality sent out survey parties with a magnetometer. Frequently the party had to hack its way through the bush to collect the necessary data. If the area were not too large nor the terrain too difficult, it might obtain a sufficient number of readings in two years. It was slow, expensive work.

Today geophysicists can use a dramatic refinement of this old method—the *airborne* magnetometer. Carried by an airplane traveling at 125 miles per hour, the airborne magnetometer can deliver accurate data to those interested in new oil and mineral resources at a rate of 1000 to 10,000 square miles per month.

Used as a geophysical instrument, the magnetometer is as old as the lodestone. A magnetic compass is itself a simple magnetometer, for it reacts to large bodies of certain ores. As long ago as the 17th century crude compasses and magnetic dip needles were used in the search for ore bodies in Sweden.

The magnetometer is fundamentally an instrument to measure variations in the earth's magnetic field. If the earth were a perfectly homogeneous sphere, its field would range without discontinuity from a minimum at the equator to a maximum at the poles. But the structure and composition of the earth's crust are widely varied, and the variations are reflected in discontinuities of the magnetic field. Accurate measurement of this magnetic field, therefore, yields data which can be interpreted by geologists and geophysicists as guideposts to mineral deposits and geologic structures possibly containing oil.

LITTLE MORE THAN A COMPASS — The magnetometer used by ground survey parties is little more than a compass—a device of magnetized bars rigged with special weights for greater sensitivity. In 1936 it was reported that A. Logachev, a Russian geophysicist, had experimented with an airborne instrument. He employed equipment already used for ground surveys, mounting it on gimbals to maintain its proper orientation in the aircraft. So far as is known, this instrument was never perfected for practical aerial use. Dr. E. A. Eckhardt of the Gulf Research and Development Company, who pioneered in the development of a high-sensitivity instrument in this country, states that the sensitivity of the Russian device was of the order of a rather coarse 1000 gammas.

The gamma is a geophysical unit of magnetic intensity, one gamma being equal to 10^{-5} Oersted. The extremely small quantity involved can be seen in the fact that the earth's magnetic field in the latitude of the U. S. has an intensity of about 50,000 gammas. An automobile at 100 feet gives a signal of two or three gammas. The effect of magnetic bodies varies roughly as the inverse cube of the distance from the body to the detector.

The magnetometer finally became an electronic

device capable of measuring magnetic fields down to the last gamma only in the last few years. Today's instrument, developed and perfected during the war, greatly improved the magnetometer's sensitivity and gave it wings. In flight, the magnetometer registers a continuous profile of magnetic intensity, recording the generalized pattern of an area rather than the scattered point information collected by ground surveys. At its usual mapping altitude (300 to 1500 feet) the airborne magnetometer is remote from local magnetic disturbances which tend to produce false contours.

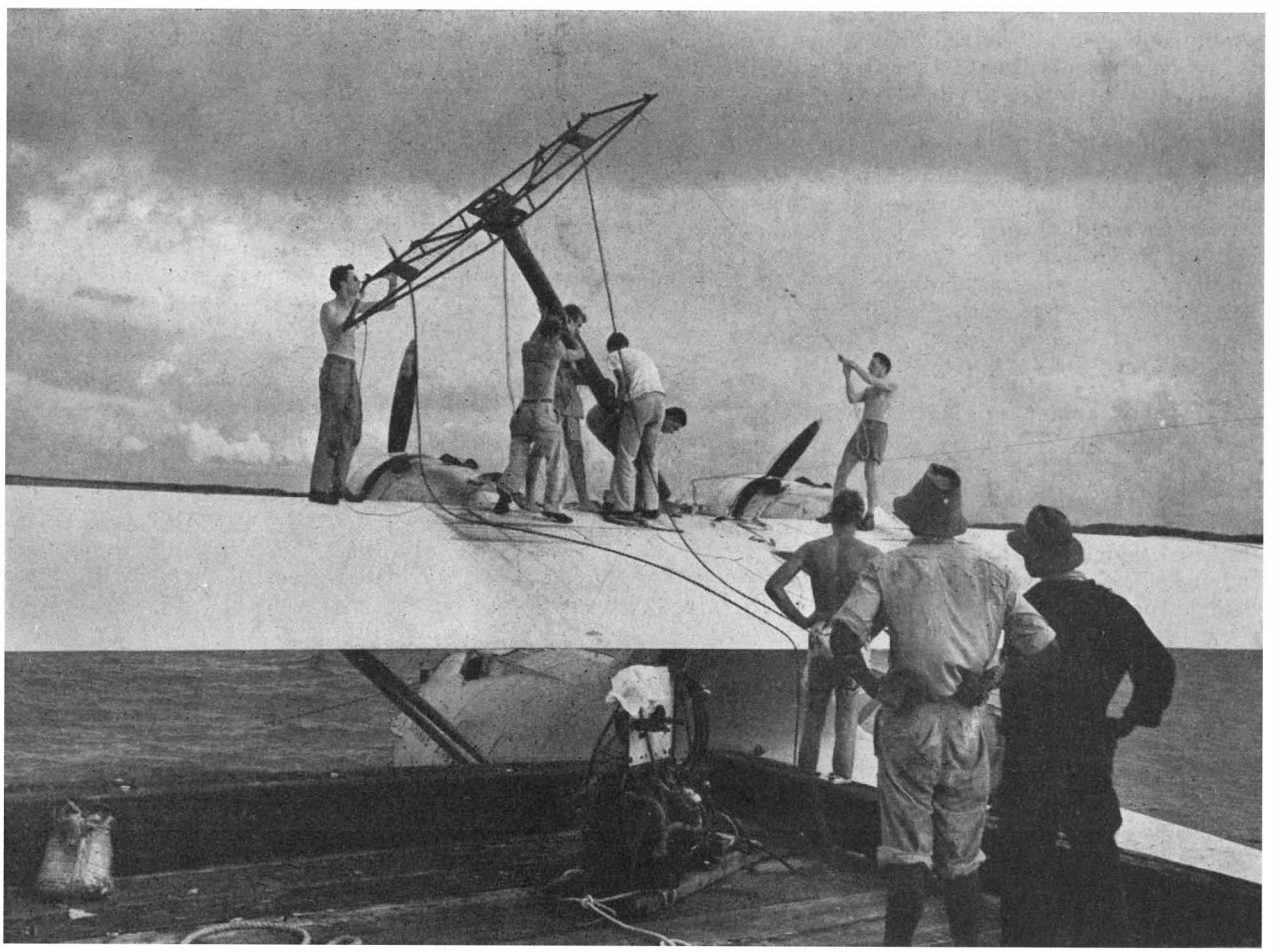
More than a quarter of a million square miles have been mapped by the airborne magnetometer since its first preliminary runs in 1941. It has performed in the Arctic cold at Point Barrow, Alaska and in the heat and humidity of Venezuela. Its operating techniques are now well established.

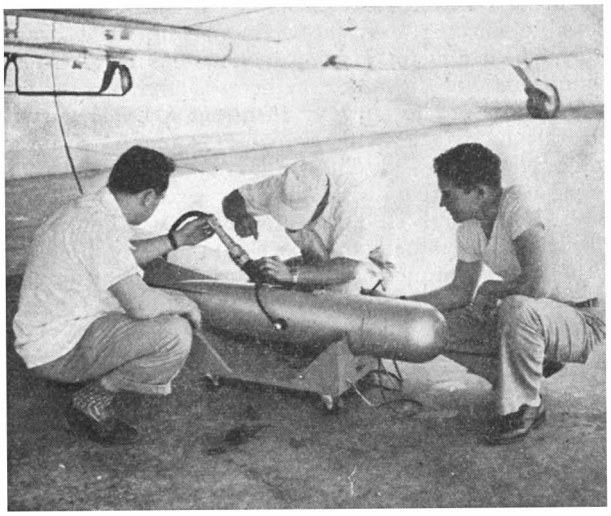
BAHAMAS SURVEY — A recent survey of the Bahamas area, uniquely complex in its problems, is a good example of how the magnetometer is employed. The Aero Service Corporation of Philadelphia, working for a group of five major oil companies, began the survey in May of 1947 and completed it last month. The problem in this largest of all magnetometer studies was to map an area of 80,000 square miles, of which 90 per cent was shoal water. There were few land points to correlate the magnetometer readings, but these were marked by old and inaccurate charts. Accurate reference by astronomical means was impossible because extreme anomalies in local gravity made it difficult to keep instruments level. These conditions were a large handicap to the precise requirements of the survey: to direct a DC-3 survey aircraft on a grid with two-mile squares within a tolerance of 150 feet. The magnetic records had then to be correlated with an exact record of this flight path. Fortunately the Director of Naval Petroleum Reserves had taken an interest in this problem in 1946 and techniques had been worked out for an airborne magnetometer survey over the Gulf of Mexico. Experience there had proved that the Shoran type of radio navigation was a precise and practical instrument for this purpose.

All the positioning of the Bahamas survey was done by Shoran. From a small number of points which had been related by Shoran to the North American Geodetic Grid, a network of geodetic positions was established for the whole area. Shoran stations were set up near previously established points and their positions accurately determined by conventional surveying. The position of marker boats could then be determined from these stations. The actual position of the magnetometer plane could thus be determined continuously through Shoran, from key geodetic positions.

Two ships 30 miles apart, provided continuous tri-

Erecting a Shoran antenna aboard a flying boat that functioned as a mark-ship during part of the survey





Repairing the sensing element of the magnetometer. The element is housed in a plastics "bird" which trails 100 feet below the plane in flight

angulation for the plane over an area of about 2400 square miles. When one area was completed, one marker ship moved into a new position and became a new station. The survey plane then referred to this new pair of points. The process continued until the whole area was covered.

It is interesting to note that like Shoran, developed by the Army Air Forces for precision bombing, the airborne magnetometer also had a wartime role, in locating submarines. The Bahamas survey plane carried a Shoran transmitter and receiver which operated an indicator to direct the pilot along a rigid flight path. The pilots reported it to be similar to flying an instrument landing system localizer all day long. The question of the plane's altitude presented its own complication. As the weather data available did not permit accurate setting of a barometric altimeter, modified radio altimeter was used to record the altitude continuously. All three elements of the plane's position—one vertical and two horizontal—were thus established. These were in turn correlated with data recorded by the magnetometer.

SUSPENDED FROM PLANE — The magnetometer used in the Bahamas oil survey, built by the Gulf Research and Development Company, was carried in a plastic "bird" suspended by a cable 100 feet below the survey plane. The cable also functioned as an electrical connection between the detector element and the plane's electronic equipment. The detecting element, or flux-gate, of the magnetometer is a coil of wire with a special ferrous alloy core. Its magnetic condition is investigated one thousand times a second by means of an alternating current from the plane. The output signal, proportional to the magnetic field in the locality, travels through the cable to a system of amplifiers in the plane and is fed into a recording mechanism. The recorder keeps a continuous account of the variations of the magnetic field transmitted from the magnetometer detector element.

In oil surveys the recorder traces are broad and sweeping, since oil-bearing rock is non-magnetic and the source of magnetic discontinuity remote from the detector. In mining surveys, the traces are irregular, small and steep, since the magnetic material is nearer the surface and the discontinuities more apparent. As an analogy, the magnetic contours of oil surveys are similar in appearance to the topographical contours of gently rolling country, whereas the magnetic contours over mineralized areas will resemble the topographic contours of hilly, chopped-up terrain.

If the Bahamas survey had been made principally over land, where there is enough distinctive terrain, the mapping would have been done with photographic reference instead of with Shoran. The position of the plane would have been recorded by a continuous strip camera. This camera, gyro-stabilized for greater accuracy, provides an unbroken record of the flight path on a single roll of 35 mm film. The film roll, which is 400 feet in length, records a flight path width of 700 feet over a length of 400 miles. This flight path photo-record is then correlated with the altimeter records and magnetic intensity profiles, as in the case of the Shoran records.

MAGNETOMETER APPLICATIONS WIDENING — The airborne magnetometer is coming into much wider application as an instrument of geophysical exploration. While it is no wonder tool, it has established certain definite advantages for rapid reconnaissance of large areas. In the case of highly magnetic ore bodies such as magnetite and ilmenite, the magnetic intensity maps may say, in effect, "Dig here!" In general, however, the airborne magnetometer's greatest value is in the elimination of unpromising areas and the isolation of points worthy of more exhaustive inspection by surface geology and the use of the gravimeter, seismograph and other instruments.

The great speed and accuracy of the airborne magnetometer was summed up by James R. Balsley, Jr. of the Geological Survey, U. S. Department of the Interior, in his report, "The Airborne Magnetometer." Balsley said that in two months, "A four-man crew made a survey of 3170 miles in the Adirondacks with flight lines usually a quarter-mile apart, a total of 11,300 miles of traverse. The cost of an equivalent survey with the dip needle would be 17 times as great and would have required 27 six-month seasons with a four-man crew—about 80 times the period required for the airborne survey. In addition, the ground survey would have been considerably less detailed and accurate."

Large areas now have been mapped with the airborne magnetometer. The U. S. Navy has mapped the Naval Petroleum Reserve No. 4 in Alaska, some sections of our Gulf Coast, the Aleutian volcanoes and submarine trench. It is reported that the Navy will employ the magnetometer to survey Bikini as well. The U. S. Geological Survey has mapped sections of Northern Michigan, Utah, Wyoming, Pennsylvania, Minnesota, Maryland and New York. Commercial surveys include sections of Canada, some states of the Middle West, and Southwest, the Bahamas area and parts of Venezuela and Colombia.

The sum of this work is a great body of accurate magnetic data never before available to geologists or geophysicists. From it will come a new insight into the value of magnetic instruments in oil and mineral exploration and new applications for this highly mobile new tool.

SCIENTIFIC AMERICAN'S Industrial Digest

NAVIGATION COMPUTER

Electronic Device Automatically Guides Plane in Any Weather

A NEW ELECTRONIC navigator for aircraft will in effect broaden the nation's air lanes at least 10 fold at each flight level, and at the same time make possible split-second timing of schedules under nearly any condition of wind or visibility. This device, called the B-D Computer will not only make it possible to handle more traffic safely, but also will permit greater speeds and eliminate landing delays due to "stacking." Since the automatic instrument makes the proper compensations for wind variables during flight, timing between air ports can be precise. Both the pilot and ground crew will know by pre-determined schedule exactly when each plane will land.

The B-D Computer will prevent crowding of the airways particularly during instrument-flying weather by placing planes flying the same route on various parallel tracks. While planes can be landed safely at 15-minute intervals today, the new instrument will make it possible for the planes to come in within a few minutes of each other.

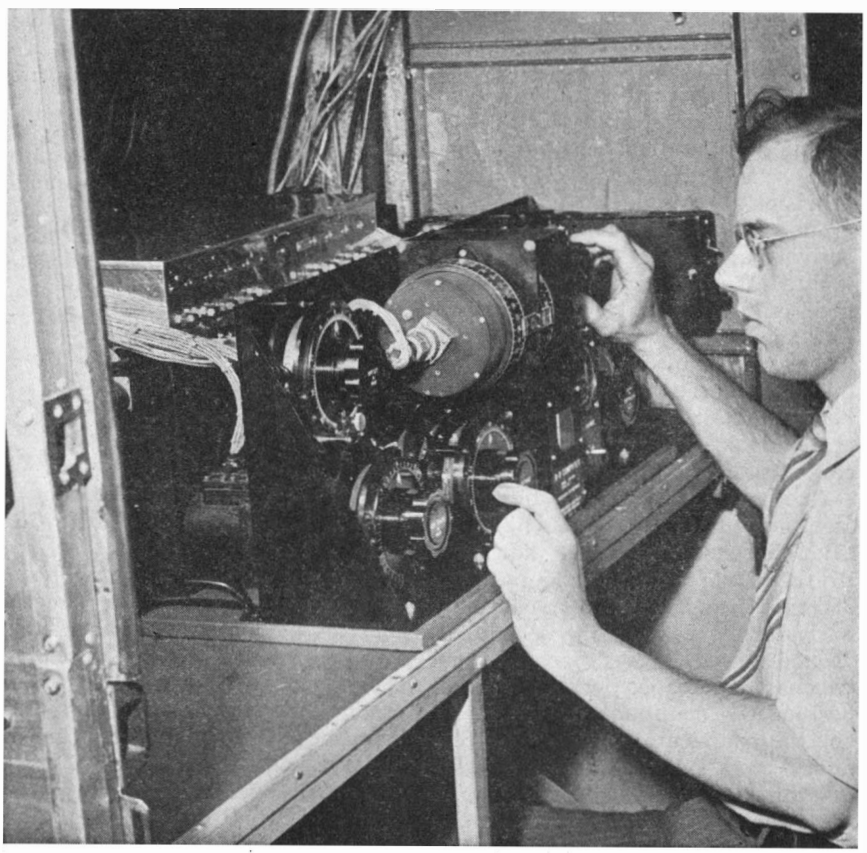
This instrument, developed by the Minneapolis-Honeywell Regulator Company, derives its name from the information supplied it by radio signals, namely the *bearing* of the plane from a ground radio station of known position, and the *distance* of the plane from this same point.

Under present methods of radio navigation only a very limited number of aircraft can fly the 'same route at the same time. The B-D Computer contains an "off course" control which will increase this limit by at least 10 times. Instead of each plane flying directly "down the beam," pilots will be able to set in an "off course" calibration on either side of the beam. Thus, radio ground control might schedule one plane down the center track of the airways beacon system, another plane five miles to the right of the center track and another five miles to the left. All could safely fly the same route at the same time. When given flight directions the pilot need only turn a dial to the designated number of miles off course and the plane will automatically hold that track until it arrives at its destination. The instrument takes into consideration and compensates for head, tail or cross winds and other factors.

Designed to make use of recently developed means of aircraft radio transmission, the computer takes signals from ground stations and relays them through the regular automatic approach coupler of the auto-pilot. This coupler is the device currently used for automatic landing. The signals are then routed to the autopilot to fly the plane automatically on the course set for the plane.

The computer receives signals from two different radio transmitters. One of these signals is received from the ODR (omni-directional range) transmitter and gives the direction of the plane in flight from the radio ground station. The other signal is picked up from the DME (distance measuring equipment) transmitter and it gives the distance of the plane from this same location. The present range of DME is limited to 100 miles. In flight, the off-track deviation is shown to the pilot on the regular cross pointer (blind landing) instrument, which is calibrated to read with the same sensitivity as when on automatic landing beams at 10 miles out from the air strip.

In preparation for a B-D navigated flight the pilot draws a straight line from his point of departure to point of destination on a regular air map and then draws a line measuring the perpendicular distance from his flight course to the location of the transmitting stations. He also measures the distance from the intersection of the two lines previously drawn to his destination, which is



The B-D Computer being tested by a Civil Aeronautics Administration engineer

called the on-track distance, and further measures the course angle with respect to north. This gives him three different figures, two of which are in miles and the third in degrees. The pilot sets up the computer by setting the appropriate dials to these numbers, and then turns on the autopilot. This also turns on the computer. He tunes in the radio stations providing the necessary information and is ready for take-off. The computer now is receiving two kinds of information, one a bearing signal from the omni-directional range and the other a signal from the distance measuring equipment.

In flight, the cross pointer instrument is switched to the navigation computer so that the meter now gives the flyer off-track information, while a separate dial gives distance to destination. He can either fly manually by watching the cross pointer needle as he does now on instrument approach landings, or he can switch to automatic control, so that the computer will fly the plane through the automatic pilot.

It is possible to provide the necessary settings in pre-set form so that all of the data for a routine flight covering long distance travel can be set in before take-off. The change from one ground reference station to another can then be made automatically as the flight proceeds.

It is also possible to add an automatic estimated time of arrival dial which can serve as guidance to the pilot in making good his assigned time schedules. This dial will not only tell the pilot when he will get to his destination if he holds his present airspeed, but also will enable him to adjust throttles to insure scheduled arrival. A further provision of this device will enable ground control to change assigned arrival time while the plane is in flight. In such an instance, the pilot need only set a dial which will tell him the airspeed required to meet his new schedule. The device takes into consideration such factors as head and tail winds, since the operation is based solely on geographical position.

Another attractive possibility in facilitating the keeping of schedules, is an off-schedule distance indicator. In this case the schedule position of the plane is computed continuously on the basis of the scheduled ground speed. The difference between schedule position and actual position is continuously indicated on the horizontal needle of the pilot's cross pointer instrument, so that the pilot can adjust speed manually to maintain his assigned schedule. It is intended that the off-schedule distance information will also be applied to an airspeed control system, operating through autopilot and throttle control, to keep the airplane automatically on schedule.

PIERCING HOLES

On Stamping Press Is Aid To Interchangeability

INTERCHANGEABILITY of parts is an essential factor in keeping today's assembly costs down, and the use of mass-produced precision stampings is one way to achieve interchangeability. A rapidly growing practice which extends these advantages is the piercing of holes on stamping presses, simultaneous with the stamping operation, rather than drilling or punching the holes.

Interchangeability is often difficult to achieve when many holes in a single complicated shaped piece have to be drilled or punched individually. The new technique permits the piercing of such holes, with diameters less than the thickness of the blank or with tolerances under 0.001 inch, at the same time as blanking and before forming. The holes may be round or shaped, and vary in size from 1/32 inch to several inches in diameter, in many instances the diameter of the holes being only a fraction of the thickness of the metal pierced. In some cases as many as 400 holes are being pierced in a single, comparatively small stamping.

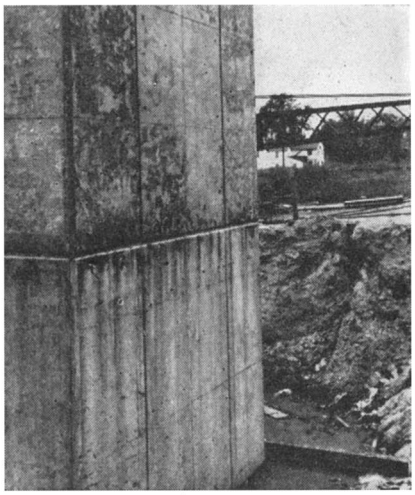
All types of metals used by stampers can be pierced successfully on stamping presses using tools and dies of proper design. Outstanding product applications to date include brass carburetor disks, pure nickel spinnerettes, brass ignition tubes, steel railway car hopper plates, heavy-wall aluminum tubing, copper end plates for motor rotors, and so on.—*F.P.P.*

BEVELING CONCRETE

With Rubber Strips Gives Smooth Finish, Cuts Building Costs

A NEW METHOD of forming bevels and decorative grooves on concrete surfaces by means of rubber strips attached to the forms—instead of conventional wood strips—is said to produce a smooth finish free of blemishes. The rubber strips can be re-used many times, resulting in lower construction costs.

These strips, developed by the United States Rubber Company, will be produced in various shapes and sizes for bevels and also decorative treatment. They are attached to the form with a waterproof adhesive, and can be removed easily from the mortar without chipping.



Rubber strips attached to the forms produced these grooves and bevels

RADIANT BASEBOARDS

Prove Their Advantages in University Tests

WARMER floors for basementless houses without resort to experimental types of heating, and better distributed, cleaner, and inconspicuous hot water heat for all homes were forecast recently by Professor Warren S. Harris of the University of Illinois.

Speaking of tests with "radiant baseboards" in the Institute of Boiler and Radiator Manufacturers' research home at the university, Professor Harris said that this system has proved a way to provide warmer floors, and that it gives much less difference between floor and ceiling temperatures, is convenient in being both inconspicuous and in not interfering with furniture placement, and is outstanding in cleanliness.

The radiant baseboard, a hollow cast-iron baseboard, placed at the bottom of the outside walls in a room, is painted to match the wood trim at the base of the other walls. Hot water in the baseboard is supplied from a conventional home heating boiler through concealed pipes.

By concentrating heating effect along the base of the coldest wall, the radiant baseboard produces warm floors. "This attribute is most important for basementless houses in which cold floors are particularly prevalent," Professor Harris said.

Comparing radiant baseboards

with conventional small tube radiators, on the basis of tests thus far conducted, the heating engineer said:

"Drafts were not experienced with either radiant baseboards or small-tube radiators.

"Radiant baseboards produced warmer floors and cooler ceilings than did the small-tube radiators, a characteristic which makes them adaptable to basementless houses.

"From the 60-inch level to the floor, the inside surfaces of the wall along which the radiant baseboard was installed were warmer than the room air at the 30-inch level of the thermostat, whereas these surfaces were cooler than the room air when the small-tube radiators were used.

"The radiant baseboard was clean in operation.

"The radiant baseboard blended with the wood trim of the room in appearance, and did not interfere with placement of furniture in the room."

ANTI-FRICTION BEARINGS

With Cartridge-Type Housings Facilitate Reconversion

When machines and other equipment are redesigned for assignment to new tasks, it often is necessary to locate shafts where ordinary hangars or pillow blocks would be difficult to mount.

Anti-friction bearings in cartridge-type housings are solving the problem. Some housings are made to be force fits in plain holes which may be drilled in a machine frame or any structural member. Others have double plate flanges with holes provided for fastening screws. Still others have threaded extension housings so arranged that if turned on a fitting steel shaft the bearing housings may be positioned for shaft alinement, or if the rods are turned the housings may be backed away and so act as take-up units for belts or chains.—*E.L.C.*

EMBOSSING THERMOPLASTICS

By Four-Step Process Is Quick and Simple

Embossing acrylic and other thermoplastics by a recently developed method depends for its success upon a new casting material called Ceramite. Both Ceramite and the associated technique were developed by the Furane Plastics and Chemical Company. Only four steps are involved in this embossing process:

1. A clay model, or equivalent, is prepared with the design that is to be embossed on the thermoplastic sheet.

2. Ceramite is poured over this model and allowed to set for about 30 minutes before it is removed from the model.

3. The Ceramite casting is cured for several hours at room temperature.

4. A warmed thermoplastic sheet, backed with a rubber pad, is placed over the Ceramite casting and pressed firmly against it. The pad acts to force the plastics into every detail of the design.—*C.A.B.*

"IMPOSSIBLE" MACHINING

Of Alloy Casting Is Done With Cemented Carbide Tool

Considered practically "un-machinable," castings of Ni-Hard—an alloyed, heat treated white iron with a Brinell hardness ranging from 550 to 700—are generally finished to shape by grinding.

Ni-Hard, however, can be machined with tools of cemented carbide. The Ni-Hard six inch mine pump casing shown in the accompanying illustration is being finished on a boring mill at the plant of Barrett-Haentjens and Company with Carboloy Grade 44A tools. Rough cuts as heavy as .075 inch are made with a feed of .020 inch, on a 20 inch bore of the six inch pump casing, using a speed of 5¼ revolutions per minute, which is equivalent to a 27½ foot per minute cutting speed. Finishing cuts are made with a .015 inch depth of cut and a .020 inch feed. Speeds of approximately 16 feet per minute are used on such special cuts as turning a 45 degree angle on the face of a casing, or boring the inside diameter of the Ni-Hard "wearing plates."

Machining these casings requires 16 hours with Barrett-Haentjens' carbide setup, compared with about twice this time for grinding.

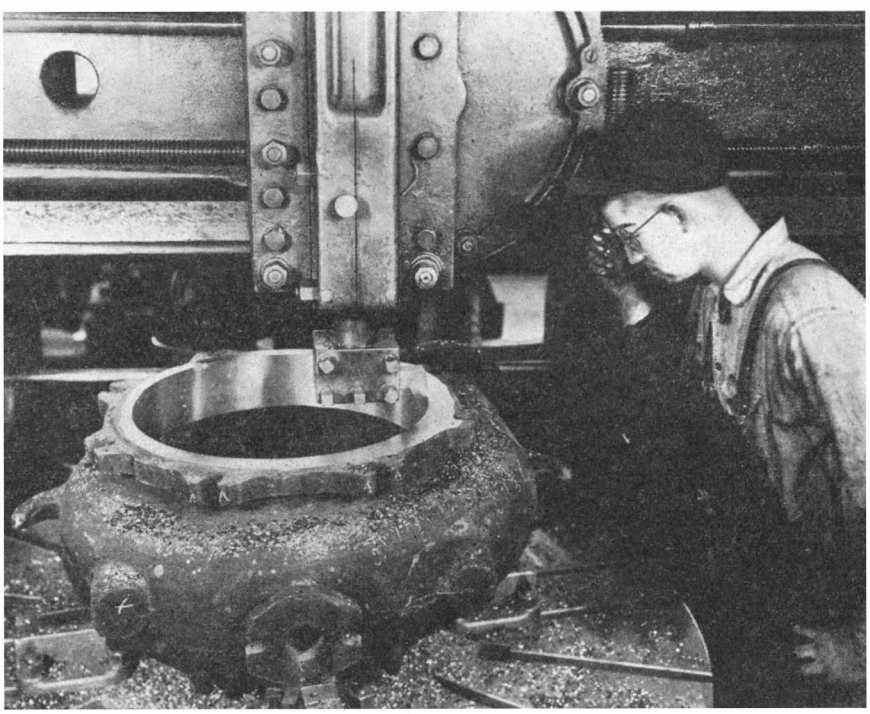
NATION'S COAL RESERVES

Can Last 1500 Years, Says Bituminous Expert

Coal reserves in this country are so enormous that they can supply all this nation's requirements for the next 1500 years, Dr. Harold J. Rose, vice president and director of research for Bituminous Coal Research, Inc., stated recently. This applies to requirements for heat, light, power, transportation and the smelting of metals, all liquid and gaseous fuels, and most synthetic chemicals, at the present rate of consumption, with allowance for conversion efficiencies, he said.

"The world has spent more of its mineral wealth in the last 40 years than in all preceding history," he continued. "Production has been particularly great in the United States, so that we already are a 'have-not' nation, or are rapidly becoming one, with respect to many important minerals."

The outstanding bright spot in this serious situation is the enor-



Rough cuts as heavy as .075 inch can be made

mous coal supply, amounting to about one half the world's known reserves, according to Mr. Rose, who went on to say: "Coal has been, and will continue to be, this country's most important mineral resource, and the foundation of its expanding industrial production. Technical developments have been so rapid that coal can now be used to produce almost any type of solid, liquid, or gaseous fuel or synthetic chemical product."

In contrast to the large coal reserves, Dr. Rose continued, the proved reserves of petroleum and natural gas in this country would last only 8½ years if they could be produced and used fast enough to supply their present markets, and to take over all present coal uses at the same Btu efficiency.

These facts are causing a great increase in the support being given to coal research, he pointed out, by the coal industry itself, by federal and state governments, by the petroleum, gas and chemical industries, and by equipment manufacturers. Expenditures on research and engineering development work closely related to coal are $15,000,000 or more annually, in this country, with large additional expenditures in England and other countries.

TABLE-TOP TUBE MODEL

Simulates Electrons, Tube Elements on Grand Scale To Test New Designs

A VACUUM tube model constructed on a highly magnified scale is aiding engineers to develop more powerful, more efficient vacuum tubes by reducing the tube-design testing period from three or more months to a single day. This model electronic tube is a rubber-topped table where rolling bronze balls about the size of BB shot play the rôle of electrons speeding from one end of a tube to the other.

"By using this grand-scale model, we can produce approximate replicas of most kinds of electronic tubes," explains R. O. McIntosh, electronics engineer of the Westinghouse Research Laboratories, where the model is being employed. "We can check the internal design of a tube in one day, whereas former mathematical trial and error methods of testing consumed about three months to do the same job.

"Even to change the design of a single tube part used to require a whole day. Now it can be done in five minutes."

To test a tube design, research men stretch a thin piece of rubber —measuring only a few hundredths of an inch in thickness—over an area about the size of a small dining room table. The electrons are simulated by the small bronze balls which weigh only 1/14 ounce apiece.

"The 'electrical' push and pull necessary to propel these over-sized 'electrons' is provided by creating hills and valleys in the rubber surface of the table," Mr. McIntosh explains.

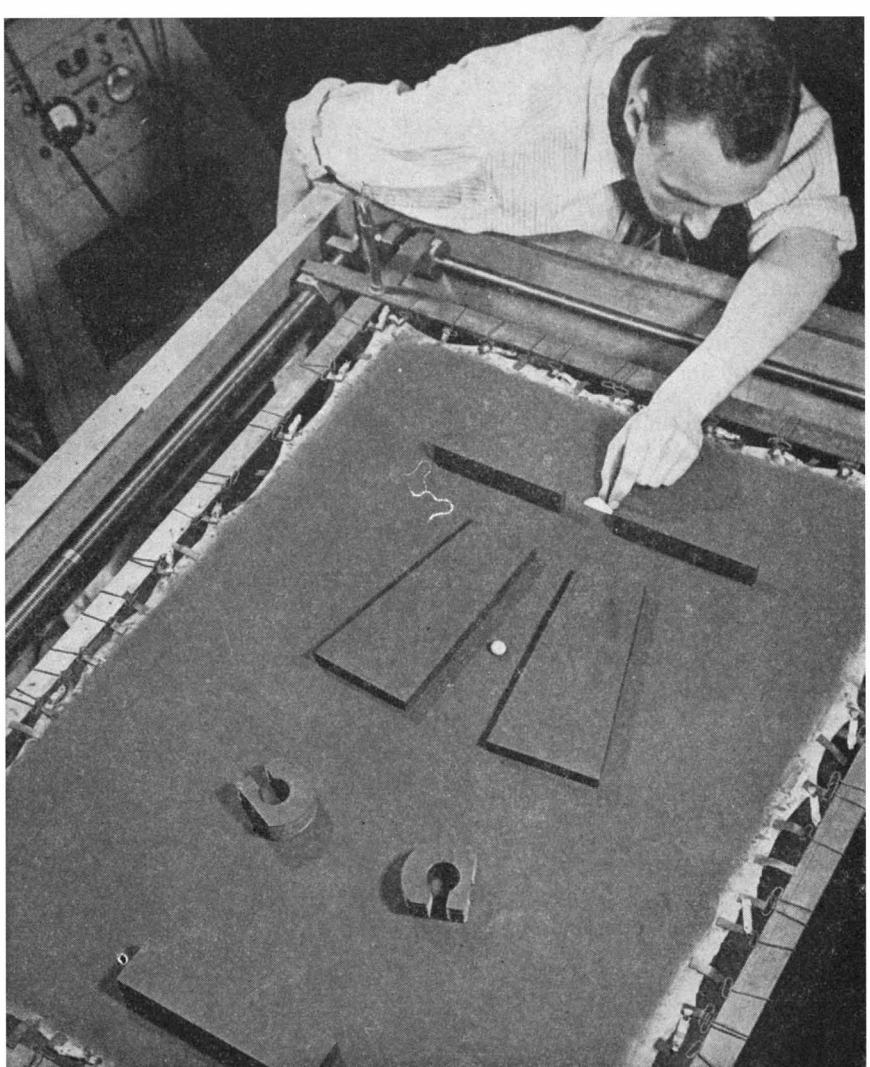
"Real electrons are repulsed by negative charges and attracted by positive charges. On the table, attractive forces are represented by the downward slope of a hill and the upward slope acts as a repulsive force. By proper arrangement of hills and valleys we can steer the ball, speeding it up or slowing it down. Then by measuring the time it takes for the ball to roll from one part of the table to another, we can calculate the speed of actual electrons in such a tube. This tells us the voltage needed for this part of the tube."

The table model can also reveal how far apart the tube elements should be spaced and what their shape would be. By actually reproducing in wooden blocks various shapes and sizes of electrodes—round, pointed or square it is possible to learn which arrangements gives the greatest output of electrons, and delivers them to the most useful place.

IDLE WELDING MACHINE

Saves Time and Money In Coach Seat Fabrication

AN EXCELLENT way—believe it or not—to cut production costs on some jobs today is to buy machine tools which have so much productive capacity that they stand idle most of the time. A few years ago, such an idea—applied to a medium



Slight hills and valleys in the thin rubber sheet simulate electrostatic attraction and repulsion as the white "electron" speeds from the "cathode" (at the man's hand) to the "plate" (lower left corner). This table-top model is aiding research engineers develop more efficient vacuum tubes of all types

sized company with relatively limited production runs—would have been called ridiculous. The Heywood-Wakefield Company, however, has an excellent example to prove its practicality.

Heywood-Wakefield makes, among other things, coach seats for buses, railroads and so on. These seats are supported on the aisle side by stainless steel pedestals formed from 18 gage sheet stainless. These were formerly fabricated by gas welding the seam that forms the oval. It took 10 minutes, roughly, to complete one of these welds. This was followed by grinding.

Some time ago, however, after discussing the problem with Progressive Welder Company, the fabricator re-designed the pedestals slightly and installed a Progressive seam welder to fabricate them. The machine, Heywood-Wakefield knew, had a production capacity far in excess of anything they could use. It could turn out in an hour what it took a gas welder a week to weld up.

As a result, the welder operates only two weeks out of every eight or nine. But after the first few weeks of operation, the machine had already paid for itself—largely because it doesn't cost anything to run a machine when it stands idle (six or seven weeks idle out of every two months in this case). Since then, the machine has been saving enough to regularly pay the wages of 10 additional workers on other jobs.

The machine is equipped with a special moving fixture, also designed by Progressive, which carries the pedestals through between the welder wheels. The fixture has a collapsible copper mandrel which serves to hold and locate the pedestal during welding, the collapsible construction permitting quick removal of the finished parts. Seam welding has also practically eliminated all grinding at the welds, while avoiding destruction of stainless steel qualities—something difficult to do when gas welding.

The welder is so designed that if the occasion arises, the wheels can be removed and the machine used for either press or spot welding of other parts.

PLASTICS GAS PIPE

Extruded Tubing Replaces Steel In Home Installations

EXTRUDED plastics tubing is replacing steel gas pipe in home installations where it conducts fuel gas from the gas main to the customer's meter.

The one-inch cellulose acetate butyrate tubing used for this purpose has several advantages over steel pipe: it is readily available, whereas steel has been in short or unstable supply for years; it is light in weight and easily handled; fewer men are needed to install it than are required for conventional pipe; shipping and installing costs are lower; it can be bent on the job and requires little equipment for joining; and it resists deterioration in most soils. Tests made by the Southern California Gas Company revealed that these pipes could be used almost everywhere, except where they might come in contact with refinery gases and other products of oil refining. They are laid only in mild soils, not in rocky ground (since rocks could pinch the tubing together when the excavation was filled and tamped) and are placed at the standard depth of eighteen inches.

Joining this pipe is simple. The two ends of the one-inch outside diameter pipe, made from Tennessee Eastman Company's Tenite, are coated with a solvent cement and joined. A sleeve of one-inch inside-diameter tubing, similarly coated on the inside, is then slipped over the joint, and the three pieces are "welded" together at once. Cement is colored for easy visual inspection of the joint.

Joints are covered with grease, two wraps of cellulose acetate sheet, and one of kraft paper. This makes a suitable shield for mild soils, and does away with the time and bulky equipment necessary for preparing the hot asphalt shields which are used on steel-pipe joints.

Gradual bends in the flexible tubing are easily accomplished on the job. Right-angle bends are made in accordance with company rules with pre-fabricated right-angle sections sleeve-jointed to the tubing.

Joints at the "service T," where the plastics pipe meets the steel gas main, and at the "riser," where a copper tube joins the pipe to carry gas into the house, are made with Dresser fittings—pre-assembled iron joints in the shape of hollow dumbbells. A gas-tight assembly is made by tightening the ends of the Dresser fitting, which contains rubber glands in either end, around the Tenite pipe, metal T or riser.

To make a connection, a standard metal T is welded, crossbar down, to the steel main. (If a mechanical service T instead of a welding T is used, welding is not required—meaning one less man on the installation crew.) The leg of the T which is at right angles to the main is assembled with the Dresser fitting, as is the end of the plastics gas pipe. A similar fitting is used on the other end of the Tenite pipe, and a copper tube completes the connection to the meter.

Joining two lengths of plastics gas pipe

The main is tapped by means of a special tool inserted through the vertical crossbar of the T. Afterwards, the top end of the T is plugged, and gas flows from the main up through the T, into the Tenite pipe, and to the customer's meter.

Tenite pipes and joints are made to stand up under a maximum safety pressure of thirty pounds per square inch, although in tests they are said to have withstood far higher pressures.

Thus far, Southern California Gas Company has made about 500 installations (about 40,000 feet of plastics tubing). For the time being, the plastic tubing will be used only for domestic standard services which involve just one size of tubing and fittings.

BRIGHT BARREL FINISHING

Achieves Great Cost Reductions In Small Parts Production

SOME OF the more recent forms of barrel finishing (for example, Roto-Finishing, developed by Sturgis Products Company) have not only resulted in brighter-honed parts than can normally be produced in bulk at high production rates, but also in cost reductions in the neighborhood of 90 per cent in some cases.

One manufacturer of fishing reels has applied the process to several different types of parts, with the following specific cost savings (to show the range): A stainless steel plate that originally cost 23.1 cents per hundred to buff, is now barrel-finished for 21.0 cents, with a saving of 9 per cent in finishing costs. Again, a brass bushing, formerly buffed on a wheel, originally cost 34.1 cents per hundred to buff. With the barrel-finishing process, the cost has

dropped to 1.3 cents per hundred, a saving of 96 per cent. And, finally, a brass stamping that previously cost $1.41 per hundred to buff, now entails only 3.9 cents per hundred, a saving here of 97 per cent.—*F.P.P.*

SUGAR DERIVATIVE

May Become Ingredient Of Resistant Varnishes

RESEARCH now under way at the United States Department of Agriculture's Eastern Regional Research Laboratory may prove the merit of allyl sucrose, a chemical derivative of ordinary sugar as a varnish resin.

Over two years ago, the Laboratory developed allyl starch, similar except that the raw material is starch instead of sugar, which dissolves in standard varnish solvents. Applied to surfaces of wood, paper, or metal, the varnish leaves a smooth, high-gloss coating which is resistant to solvents, acids, alkalies and hot oils. Cured at 175 degrees Fahrenheit, for a short time, the coatings are thereafter resistant to temperatures up to 400 degrees, Fahrenheit.

An experimental run made with sugar at that time looked promising, so its possibilities are now being further explored. An early drawback was the necessity of distilling the allyl sucrose under high vacuum in order to get a clean product; that has been solved, and now only a water wash is necessary.

Allyl sucrose has all the virtues of allyl starch, and an additional one as well: It is more compatible with varnish solvents. Raw materials for its synthesis are cheap enough so that the resin may eventually compete with ordinary varnish resins.—*H.C.E.J.*

ALUMINUM WIRING

Performs Well, Is Becoming Generally Accepted

INSULATED aluminum electrical wire has advanced beyond the experimental stage to become a permanent product of the electrical industry, according to H. H. Weber, of the wire and cable department of United States Rubber Company.

Aluminum wire was frequently employed as a substitute for copper during the severe copper shortage of World War II. Its performance has been so satisfactory, says Mr. Weber, that it is winning permanent acceptance in electrical circles.

Insulated aluminum wire has been used considerably in airplanes, where its lighter weight increased the range and payload of planes. Now United States Rubber Company is making large quantities for homes, factories and other buildings.

"Aluminum is in plentiful supply and economical to produce," said Mr. Weber. "Deposits are to be found in most of the earth's crust. A shovelful of common clay may contain as much as a pound of aluminum. Aluminum has the highest electrical conductivity of any metal on a pound-for-pound basis. It has high strength and good resistance to the elements. The fact that aluminum wires and cables are being used in large quantities in aircraft, where safety and reliability are paramount, is a strong indication of their suitability for rugged, reliable service. The lighter aluminum wire permits a substantial reduction in the weight of planes. This application puts the wire to a severe test, with repeated cycles of heat, cold, moisture and vibration."

Through intensified research the United States Rubber Company in co-operation with aluminum producers has developed new techniques and materials for soldering and insulating aluminum, Mr. Weber explained. He pointed out further that Underwriters Laboratories recently approved aluminum conductors for homes and industrial buildings, and they have been recognized for many years by the National Electrical Code.

WHIRLING TESTER

Pilots and Instruments Subjected To High Accelerations

POWERED by an electric drive system, a new machine now being built by the Navy will subject aircraft pilots and instruments to high accelerations, equivalent to those experienced in actual flying. The new accelerator will provide radial accelerations up to 1290 feet per second per second, or 40 times the acceleration of gravity. The rotating system, developed by the General Electric Company, will be driven directly by a vertical motor rated 4000 horsepower and capable of developing a maximum torque of 1,700,000 foot pounds.

Acceleration patterns of aircraft in flight maneuvers will be simulated by the drive, which utilizes an amplidyne exciter in combination with an electronic control system, which in turn will be responsive to a program control. Emergency stopping will be accomplished by dynamic braking, the machine being brought to a final halt by pneumatically-operated friction brakes.

HOLE DRILLING "CANNON"

Fires Punch Through Steel Rail To Reduce Boring Time

WORKERS who tend the 135 miles of railway track in the Ford Motor Company's Rouge plant now are equipped with a "cannon" that will shoot holes in steel rails. Called a velocity power-rail punch by the Mine Safety Appliance Company which manufactures it, this 45-pound, portable industrial firearm is loaded by placing the cartridge behind a punch of desired diameter. The firing pin is then attached and the "cannon" fired by a tap with a light hammer.

The explosive force drives the punch through the steel rail, leaving a clean, perfectly round hole. This eliminates the time-consuming job of drilling holes in rails when laying track.

Firing a cartridge slightly larger than .45 caliber, the punch is capable of shooting holes up to one and one-half inches in diameter in three-quarter inch steel.

PLASTICS ON CANS

Improves Appearance, Permits Re-sealing Containers

TWO examples of plastics' use in the can field offered by the American Can Company indicate that synthetics may be of considerable value in improving both appearance and performance.

The first improvement involves the use of a thermoplastic seal to replace solder on the side seam of cans. The advantage of this change is that containers sealed up the side with plastics may be fully decorated around the outer wall by lithograph. The half-inch wide strip of solder on soldered cans cannot be overprinted.

The second improvement is a new type closure which can be re-sealed after the can has been opened. The moisture-proof seal is achieved by an interrupted thread-type cover having a ring gasket located inside the indented outer edge of the cover where it fits over the top of the can body. This gasket, which helps to lock the cover tightly in place, is made of paper impregnated with a wax and a thermoplastic resin. The re-seal can was specially developed for American Home Foods, Inc.

New Products

FUEL SYSTEM CLEANER

Gums, Tars Are Dissolved and Burned with the Fuel

A NEW TYPE of liquid fuel system cleaner is designed to dissolve and eliminate formations of gums, tars and other dangerous binders that are directly responsible for a large percentage of power stoppage and maintenance expense. This cleaner reforms all soluble hydrocarbon binders into a liquid which burns with the fuel, while rendering free all insolubles into a colloidal suspension. Applied either as a reconditioner or as a preventive simply by pouring into the fuel tank, it functions equally as well with oil, gasoline, kerosene or fuel oil systems. This includes every type of engine, power unit or fuel burner.

This product, called Tank Kleen by its manufacturer, the Celco Corporation, is claimed to be harmless to metal. It eliminates condensation and moisture from the fuel system, prevents freezing of lines in cars during the winter and improves starting summer and winter and aids in freeing sticky valves and cleaning carburetors without removing them. In the shop it does a fast and thorough job of reclaiming clogged metal parts and carbonized fittings.

BATTERY TESTER

Hearing Aid Cells Checked Under Full Load for More Accuracy

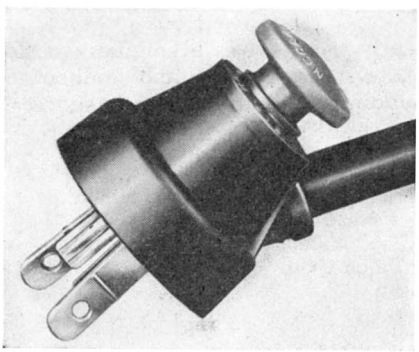
COMPACT and reliable, a new battery tester was designed for checking hearing aid batteries. The device was developed by International Instruments, Inc. in close collaboration with the hearing aid industry. It is designed to test hearing aid batteries of all types and it is claimed that it is the only hearing aid battery tester on the market which checks batteries under full operating conditions for greater accuracy. The compact design of the tester is made possible through the use of the one inch miniature precision movement and the scales are clear and easily read. The unit is housed in a plastics case and is supplied with a leather carrying case.

Tester checks all hearing aid batteries

LOCKING PLUG

Touch on Plunger Fixes Prongs Firmly in Receptacle

FITTING any standard power outlet, a new plug locks firmly in the receptacle at the touch of a finger. Pressure on the plunger attached to a sliding wedge forces the prongs of the plug against the contacts of the outlet locking the plug and forming positive contact even in a badly worn receptacle. The plug is unlocked merely by pulling out the plunger. This device, marketed by Neoline, Inc., as the Neolock "105" Locking Plug, is approved by the Underwriters' Laboratories and can be easily installed on all types of electrical appliances.



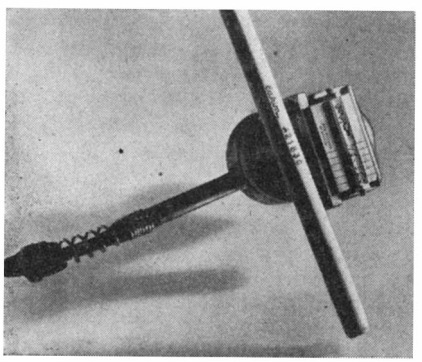
Pressing the plunger locks the plug

ELECTRIC BRANDER

Wood or Leather Permanently Marked by High-Speed Iron

ELECTRICALLY heated, a brander is intended for high speed burn-marking of trademarks, signatures, special designs, lettering and so forth on either flat or round surfaces of all types of wood and leather products. Designed primarily for use in an arbor press, bench press or drill press, the unit can also be used effectively by hand when desired.

The interchangeable type used in this high-speed branding iron, a product of New Method Steel Stamps, Inc., is of a special bronze alloy for quick heating and the lettering or design is burned into the wood or leather the instant contact is made. A dovetail clamp holds the interchangeable type rigidly in place. There is a ½ inch round hardened steel shank on the back of the heating element for fitting the unit into a press. The heater works from any 110-volt socket. The heating element itself is so cast into the head of the brander as to be integral with the unit. It is claimed that this method of construction permits the heater to stand a lot of abuse without failure.



Brander's heater operates on 110-volts

A wide variety of designs and styles of lettering can be furnished with the basic heating element and type holder.

ELECTRONIC AMPLIDYNE

Maintains Pre-Set Speed Regardless Of the Load Condition

CONSISTING of a high-gain balanced D.C. electronic amplifier and a motor amplidyne, a new control unit is useful in many types of motor control where precise regulation of current, voltage, and speed is necessary.

Designed for use as a regulated adjustable-voltage power supply for D.C. motors up to one and one half horsepower, and as a regulated exciter for larger adjustable-voltage drives up to 200 horsepower, the new electronic amplidyne has an output of 1½ kilowatts, 250 volts. It is arranged for use on either a 220- or 440-volt, 3-phase, 60-cycle power supply.

The electronic amplidyne makes possible a speed range of 20 to 1 or greater. It maintains speed closely at any setting, regardless of load conditions. It assures smooth, rapid acceleration, and reduces starting shock on the driven machine by means of current limit control of acceleration and stalled current.

Quick stopping without undue stress to motor or driven load is provided

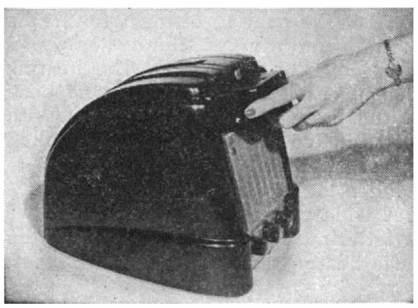
by suicide braking utilizing current limited regeneration. The equipment satisfactorily maintains speed on overhauling loads where the motor is required to absorb power and act as a brake during part of the loading cycle. It is readily adaptable to programming and processing control.

Design features of the unit produced by the General Electric Company, include a completely balanced amplifier which is insensitive to line voltage changes; an industrial electronic amplifier with hinged panel which provides easy access to all parts and connections; a circuit which is easily adjusted for various operating conditions; and a locking device which maintains settings once the circuit has been adjusted. Double end ventilation is provided.

WIRE RECORDER

New Machine Coils Recording Wire In Small Magazine

A NEW wire recording device eliminates handling of the wire with a wire cartridge which can be plugged in. The cartridge records 30 minutes of speech or music on half a mile of stainless steel-brass wire and may be played



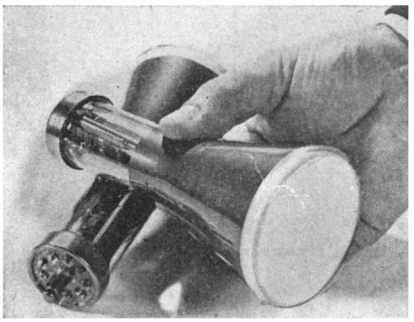
Wire magazine is easily plugged in

back immediately without rewinding. This latter feature is made possible by the fact that the cartridge contains two lengths of permanent wire, wound on four spools. The wires wind, unwind and rewind themselves. Another feature of the recorder, manufactured by RCA-Victor, is a timing device calibrated in minutes which permits the user to determine the exact location of recordings on the wire. Without requiring a separate operation to "clean" previous material off the wire, the recorder automatically erases previous sounds as a new recording is being made.

MIDGET RAY TUBE

Suited For Use in Television Servicing Equipment

SAID to provide improved electron-optical characteristics, particularly at the screen edge, a new cathode ray tube has a flat face, and short over-all length. Designed for oscilloscope use, the tube has improved cross-talk characteristics between deflection-plate pairs, and is well suited to the require-



Tube's over-all length is 6⅛ inches

ments of unusually small, light-weight service equipment needed in television installation and maintenance work, according to the manufacturer, the North American Philips Company, Inc. Length of the tube, designated type 3QP1, is only 6⅛ inches and face diameter is 2¾ inches. The tube utilizes P1 (green) phosphor, and has electrostatic focus and deflection.

GROUP TELEPHONE

Device Does Not Require The Use of Headsets

MAKING possible group telephone conversations without the use of conventional extra headsets, a device recently developed quickly converts a standard French telephone into a microphone and loud speaker. Called the Jordaphone, the new device consists of a small console and a microphone. When the user wishes to change his telephone to a group conversation instrument, he places it in a recess in top of the console. Several people may then speak into the microphone and return conversation is heard on the speaker.

The Jordaphone, manufactured by the Jordanoff Corporation, is not directly connected with the telephone line. Telephone conversations are carried on through it by way of the magnetic fields surrounding the transmitting and receiving ends of the standard instrument. Impulses from the telephone receiver are picked up by a coil in the

The device permits the entire group to take an active part in the conversation

console and amplified. The voice of the user speaking into the microphone is cut off from the amplifier so that only his natural voice is heard.

Power for the device is supplied from a regular electric outlet. Its total weight is 80 pounds.

INTERVAL TIMER

Accurate Measurements Down to Less than A Microsecond

AN INTERVAL timer for accurate time measurement will measure intervals in steps of 0.625 microsecond. The instrument, manufactured by the Potter Instrument Company, will register directly intervals up to one second. Longer periods can be recorded by using an

Timer indicates by neon glow lamps

external counter to record the number of times the cycle is repeated.

Originally designed to meet the requirements of projectile velocity measurements, the prototypes of this unit, called Model 450, are currently in use in many government proving grounds.

The interval timer is actuated by positive pulses which can be easily derived from detectors such as photoelectric equipment and closing contacts. The time base included in the instrument consists of a 1.6 Megacycle crystal oscillator. The oscillator, electronic switch and counter decades are made up as individual units which plug into the chassis. Indication is by means of neon indicator glow lamps.

GLASS GLOBULES

Replacing Sand in Plaster Mix Cuts Weight Two-Thirds

WEIGHING only 12 pounds per cubic foot as compared with sand's weight of 85 pounds per cubic foot, a new light-weight building material, formed of little glass globules, is "popped" by intense heat from raw perlite ore, and is ideally suited, as one of its uses, to replace the sand in plaster. In the construction of an ordinary seven-room house, with its 700 square yards of plaster, this material, product of Dant and Russell, would cut the weight of the plaster from 21,000 pounds to 7000 pounds, an elimination of seven tons of useless weight.

Besides this reduction in weight, plaster containing this material, known

as Dantore, resists the checking and cracking of plaster common in houses which have settled even slightly. The little glass globules and the gypsum are more flexible in adjustment to the stresses of settling. In addition to its light weight and greater flexibility on walls, it also offers a considerable degree of insulation against heat, cold and noise.

AUTOMATIC DISINTEGRATOR

Broken Taps or Drills Are Removed Without Damage To Casting

ELECTRODES are used in an automatic disintegrator as the vehicles to remove taps, drills, studs, reamers and so forth from die sections or castings of hardened steel, brass, bronze or almost any other alloy. This is accomplished without heating or distortion of the casting or machined part. Once adjusted, the disintegrator will complete its operation without any further attention, and one man can keep four or five disintegrators going. Broken number two taps up to one inch in diameter are easily removed. An ordinary ½ inch tap is disintegrated in seven or eight minutes. Electrodes several feet in length are available for deep holes. This disintegrator, manufactured by the Ansaldi Tool and Engineering Company, is of the revolving head type which can be swiveled to any angle or compound angle. It can be used horizontally, up-side-down, to a height of seven feet or close to the floor. The standard unit is equipped with casters, but a model is also available for use on a bench and another model is adaptable to drill press operation.

DEMOUNTABLE BATTERY

Unit Is Easily Disassembled Into Its Components

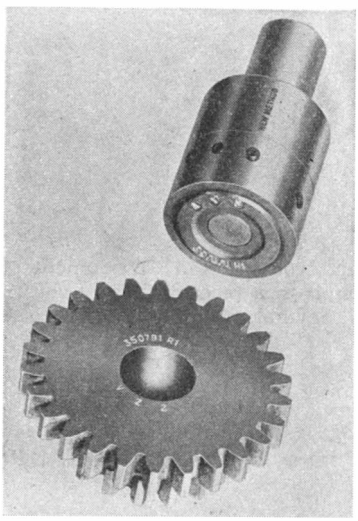
FULLY demountable, a new automobile battery can be taken apart, repaired and reassembled in 15 minutes with an ordinary pair of pliers. Known as the NuForm Demountable Battery, it contains no hidden sealed parts and it can be completely disassembled into its components. The box, the covers for the cells, the posts, terminals and connecting links are designed for long and dependable service. Other parts can be quickly replaced. Another feature of the battery, manufactured by Associated Battery Assemblers, is the cushioned suspension of the plates from the covers of the cells. This prevents injury from shock and vibration which often occurs when plates rest on the bottom of the battery. It is also claimed that the unconventional design and construction of this battery eliminates leakage, corrosion and sulfation around the terminals.

Cut-away view of battery shows cushioned suspension of plates from cell covers

ANNULAR MARKER

Permits Stamping of Standard and Variable Data Simultaneously

EMPLOYING a combination of a solid stamp and interchangeable type, a new stamping device for annular marking permits stamping parts like gears, bushings and sleeves around the radii with such standard information as the part number and/or a trade mark, together with additional variable data such as a heat treat code, the date or a batch number, all in the same marking operation. In addition to lending itself to fast, accurate hand stamping, the new marker also has a press mounting adaptor permitting it to be used on practically all types of presses (including manual presses) for machine stamping.



The marker may be used as hand stamp or adapted to many types of presses

The new marker, product of New Method Steel Stamps, Inc., consists of a mounting adaptor, and a bushing stamp carrying the standard information which is mortised to take interchangeable characters for the variable data, all held together by set screws. The set screws that hold the bushing stamp in place engage a V-groove in the adaptor arbor. Each interchangeable stamp has a flat ground on one side. The set screws bear on these flats, thus insuring perfect radial alinement no matter what size bushing is used for the solid stamp.

PLASTICS CLAMP SUPPORTS

Unaffected by Atmospheric Conditions, Will Not Corrode or Sweat

FOR MOUNTING wires, cables, tubes, pipes and so on, newly designed plastics clamp supports have high impact and tensile strengths. The plastics is an excellent insulator, which insures against short circuits when used in electrical installations, and the edges of the clamps are rounded, eliminating the possibility of cutting wire or tubing. The tough yet flexible plastics can withstand temperature changes between — 78 and + 180 degrees, Fahrenheit, and, unaffected by atmospheric conditions, they will not sweat or corrode. Produced by Holub Industries, Inc., they are available in 16 stock sizes ranging from 1/8 to 1 1/4 inch, in 1/16 inch variations.

Available in 16 stock sizes

FIRE-RESISTANT PAINT

Decorative Surfacing Will Not Sustain a Flame

FIRE-RESISTANT paint developed for the Navy is now available for commercial and domestic use. Ready-mixed and self-sealing, the paint is applied in the conventional manner, and one coat covers wallpaper, plaster, composition, concrete, wood and so forth. The dried paint has a fine-textured flat finish and can be easily washed. Called Fire Stop by its manufacturer, Plicote, Inc., the paint reaches maximum fire resistance two weeks after it is applied. It is available in a wide range of colors.

ALL-WELDED SOLENOID

Small, With Great Strength And High Efficiency

FOR USE where powerful pull is needed in a small space, such as in appliances, pinball machines, safety devices, trip mechanisms and vending machines, a new all-welded solenoid develops a maximum pull of .26 pounds in a half-inch stroke, operating on 110 volts, 60 cycles.

An L-shaped mounting bracket permits horizontal or vertical mounting of the solenoid, which is produced by the General Electric Company. Frame and bracket are welded together for long life. Frame laminations are of silicon

steel, making possible more pull per watt input, and high efficiency is achieved by welding these laminations together. Welding reduces eddy current losses, since the welds are outside the magnetic flux path.

The removable coil, sealed inside a plastic housing, is paper layer wound, heat treated to remove moisture and impregnated with a plastic. It is highly resistant to shock, splashing water and oil.

Plunger laminations of silicon steel are welded. A new type of pole shader, brazed into place, provides maximum quietness at a lower watt consumption.

TENSION METER

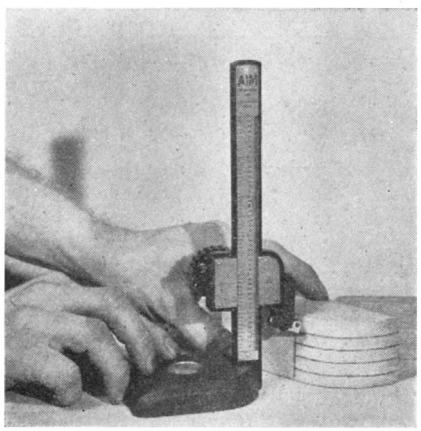
Check on Thread Strain Speeds Manufacturing Processes

STRAIN on threadlike materials can be measured quickly by a new tension meter, thereby preventing breaks and speeding manufacturing processes using such materials. The meter, developed by Dr. Erwin J. Saxl of the Saxl Instrument Company, gives a reading of thread tension on a dial. It may be used to measure the tension of threads in all types of textile machinery, such as those used in warping, quilling, throwing and spinning of all types of yarns. In non-textile production, it may be applied to the winding of ammeter coils, elastic rubber threads, cords for tires, wire for incandescent lamps and the uniform manufacture of helical grids in radio tubes.

VERNIER HEIGHT GAGE

Features Low Cost and Simple Operation

FOR GENERAL shop and production work and for model making, a new low-cost vernier height gage has a stainless steel scale measuring in hundredths of an inch from zero to six inches and in fractions by sixty-fourths. A metric scale is also available, as is a choice of cast iron or aluminum base. The slide, which has a hardened steel scriber, is easily adjusted by a large plastics knob. The accessories which may be obtained with this gage, manufactured by the Aim Instrument Corporation, includes a depth reading bar and indicator adapter, an adjustable go-no-go gage for production work, and a pencil lead holder which will be of especial interest to the pattern maker.



Height gage in use with lead holder

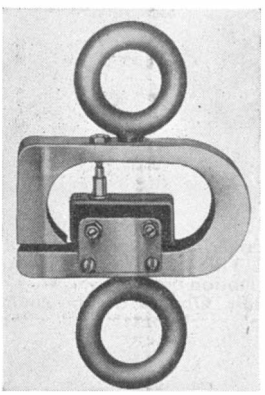
SAFETY SCALE

Weighs Accurately and Warns of Overload

WEIGHING loads up to 10,000 pounds, a versatile "monitor" flashes a caution signal, rings a bell, and cuts out the hoist motor on chain or cable hoist, and overhead cranes in case of overload.

Made of special alloy tool steel, this new device, called the Dyna-Switch, can be attached between overhead rail and hoist, or between hoist chain and hook in a few minutes. On cranes it is placed directly on the hook.

After a great many stress cycles in tests, it is claimed that the device always returns to true zero. It withstands accidental overloads far in excess of the limit called for by hoist or crane without affecting calibration.



Rings a bell, flashes a light or cuts off the motor when hoist is overloaded

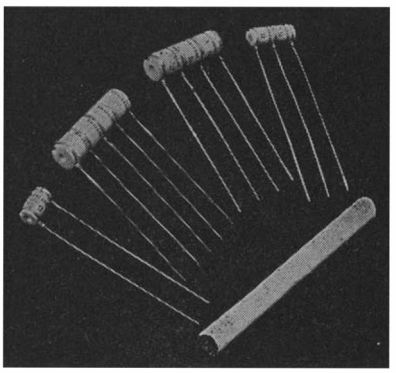
The Dyna-Switch, product of W. C. Dillon and Company, is made in the basic model, with motor cut-off; visual model, with red caution lamp; and weight model, in seven types—from 0 to 100 pounds, to 0 to 10,000 pounds, with indicators showing 1 to 100 pound divisions.

The switch is 7⅞ inches from top to bottom of eye bolts and weighs 3¼ pounds. The switch is a Burgess Micro-Switch type.

MINIATURE RESISTORS

In Four Sizes, Feature Close Tolerance

FOR SMALL electronic equipment where space is at a premium, a new line of miniature resistors are said to be both dependable and accurate. Produced in four sizes ranging from 150,000 to 550,000 ohms, the units have a tolerance of 1 per cent, and closer tolerances can be furnished on special order. These Akra-Ohm Precision Resistors, as they are called by the producer, the Shallcross Manufacturing Company, are equipped with two-inch tinned copper leads, and the units are sufficiently light and small, that they can be suspended from their leads for mounting. Windings are non-inductive, and a special impregnation permitting operation under highly humid conditions, is available.



Resistors have tolerance of 1 per cent

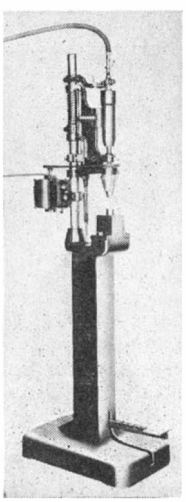
PNEUMATIC RIVETER

Combines Hammer Action With Rotation

WITH interchangeable heads of four capacities, a pneumatic riveting machine which combines hammer action with rotation can be applied to assembly of parts made of metal, plastics, porcelain, fiber, wood and so on. The interchangeable heads of the machine, product of the Schlack Manufacturing Company, are available for rivet capacities to 3/32, 5/32, 1/4 and 5/16 inch base based on soft steel. It mounts a motor-driven spindle for peening tools to form round, oval or flat heads; to peen shafts, pins, studs; or to flare small tubes and connectors.

The spindle is carried in a spring-supported frame, sliding on a vertical column that is equipped with a foot pedal to bring the tool, called Pneu-Spin, down on the work. Above the spindle head is a pneumatic hammer

The pneumatic hammer is able to strike from 4000 to 6000 blows per minute with a quarter inch stroke to the rotating tool



that imparts 4000 to 6000 blows per minute with a 1/4 inch stroke to the rotating tool from a 75 to 80 pound air supply. Force and frequency are adjustable at the valve. Work is supported by an aluminum pressure pad attachment carrying a spring-backed pad. The pad foreruns the peening tool to hold work rigidly against rivet set or fixture. A positive stop assures uniform rivet heads and is adaptable to the assembly of moving parts. Vertical spindle movement is through 2 1/2 inches with vertical adjustment through 4 1/2 inches, and the throat measures 4 1/2 inches. The overall height is 65 inches, the anvil height 40 inches.

HANDY PAINT SPRAYER

Operates by Foot Pump, Needs No Cleaning After Job

PARTICULARLY well suited to small scale touch-up paint jobs, a portable paint spraying unit operates by means

Paint supplied in disposable containers

of a foot pump. The paint for the sprayer is supplied in disposable containers, so there need be no cleaning up after a job, or when changing colors. The unit, manufactured by Cesco Products, Inc., is supplied complete with spray gun, foot pump, six feet of air hose and an accumulator tank.

NEW CEMENTED CARBIDE

Hard Titanium Compound Resists Great Heat

A NEW cemented carbide composition, the same type of hard compound widely used in cutting tools and wear-resistant parts, has been developed which retains its strength and resistance to corrosion at high temperatures. The new composition, called Grade K138 by Kennametal, Inc., withstands temperatures that destroy conventional carbides and cast alloys; resists thermal shock better than ceramics; and has a specific gravity about a third that of tungsten carbide, and two thirds that of steel. Pieces of this composition have been heated to 2100 degrees F. for 48 hours without loss of strength. Neither does it change appreciably when heated to 1800 degrees F. and quenched in water. Air cooling from the same high temperature leaves no effect other than initial discoloration of the surface.

The new carbide's properties suggest many practical uses. Resistance to oxidation and hot gases, together with abrasion resistance due to high hardness, make it suitable for high temperature structures such as furnace parts and guides for hot rolled metal. Its light weight and strength are advantageous for rotating parts exposed to high temperatures. The new heat-resistant material consists essentially of titanium carbide with cobalt as the bonding element. The titanium carbide has heretofore been used only as a minor ingredient of cutting tool alloys.

HUMIDITY DETECTOR

Sensitive Element Is Film Changed By Moisture Content of Air

A NEW humidity detector utilizes a thin film which is unusually sensitive to changes in the moisture content of the air. Variations in moisture similarly alter the electrical resistance of the film, making possible direct meter readings of humidity. Such readings are of

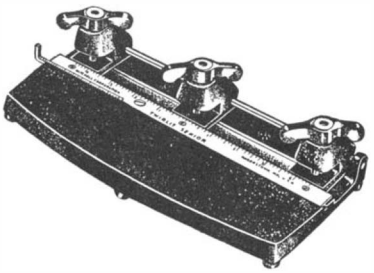
considerable importance in many manufacturing processes.

The detecting element, manufactured by the American Instrument Company responds to changes in humidity in less than a second. It will record variations in relative humidity of 0.1 per cent. Changes in barometric pressure do not affect its accuracy. In various applications, it may be used to indicate or record humidity, or to control processes influenced by humidity.

PAPER DRILL

Cuts Holes in Up to 200 Sheets Of Paper in One Operation

HAVING a capacity of 200 sheets (one half inch) per operation, a new hand operated paper drill is designed for



Multiple-hole paper drill

drilling holes in magazines, records, reports, loose-leaf sheets and so on. Manufactured by Mitchell Corporation, Twirlit drills are available in both single- and multiple-hole models.

TELEVISION RECORDING CAMERA

Motion Picture Is Made Directly From Monitoring Tube

SAID to be the first of its kind, a new camera produces motion pictures directly from the face of the monitoring picture tube in a television broadcasting station. The camera which takes pictures at the rate of 24 frames a second, was developed by Eastman Kodak Company in coöperation with the National Broadcasting Company studio at station WNBT and the Allen B. DuMont studio at station WABD. Main uses of the new camera in television broadcasting will be:

1. To enable the recorded programs to be reused by the sponsor for institutional public relations and advertising.
2. To record transmitted shows for billing requirements.
3. To record all "live" programs that go out on the air. This use, for example, will be important for legal purposes.

Another possible major use, still in the experimental stage, is in a television "film network." The new camera photographs the monitor tube in the broadcasting studio. This tube shows everything that is transmitted and is used by the station to keep constant supervision of the program.

If a film network proves feasible,

the camera would photograph television programs by recording them as shown on the monitor tube. These film records of "live" programs could then be re-broadcast by stations in other cities. This would supplement the present limited and expensive television networks using coaxial cables and radio relays.

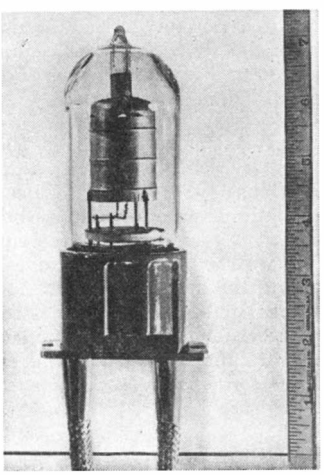
Basic camera design features of the camera include a 1200-foot film magazine that permits continuous recording of a half-hour program; separate, synchronous motor drives for the shutter and film-moving mechanisms; a coated f/1.6 lens of two-inch focal length.

The double-chamber magazine is a self-contained unit housing both the unexposed and the exposed film. It may be readily removed from the camera. Light-locks allow changing of loaded magazines in a lighted room.

HIGH-ALTITUDE TUBE

Air Forces Sponsor Development For Use In Guided Missiles

DESIGNED for service at altitudes higher than 60,000 feet, a new type of high-voltage vacuum tube has been developed under the sponsorship of the Air Material Command of the Army Air Forces. The principal application of the tube will be in the control circuits of guided missiles. The most important feature of the tube is a base made like a glass bottle stopper. This construction



The tube base and socket construction eliminates flash-over at the terminals

excludes all air which, at high altitudes, can cause arcing at the terminals.

The tube socket is the exact counterpart of the tube, with its angle of taper large enough to keep air from being trapped when the tube is plugged in. This design keeps the air exit open until the bottom of the tube reaches the bottom of the socket.

The socket is made of a bonded glass-mica composition which will not carbonize in an electrical breakdown. The original tube, manufactured by the Amperex Electronic Corporation, is a high vacuum, half wave rectifier rated at 14,000 volts peak inverse. Although rated only 14,000 volts peak, this tube-socket combination will handle voltages to 35,000 volts peak.

The new design is applicable to all types of high voltage vacuum tubes which may be subjected to similar high-altitude conditions. When used in areas which are strongly radioactive, tubes of this type will not break down externally due to ionizing action.

HIGH-SPEED RELAY

Features an Operating Time of One-Millionth Second

ASSEMBLED in a standard metal radio tube container, a new high-speed D.C. relay is said to have an operating time of one millionth of a second. The unit, called a Millisec Relay, is made by Stevens-Arnold, Inc., in one size, single-pole double-throw, for use with resistive loads, and is equipped with a shielded coil for those applications where shielding is desired between the coil and contacts. The contacts are rated at 110 volts, D.C., one-half ampere.

PHENOLIC TUBULAR CAPACITORS

Molded Plastics Condensers Operate In High Heat, Moisture, Shock

MOLDED phenolic tubular capacitors feature rugged construction and high heat- and moisture-resistance. They are conservatively rated for operations under temperatures ranging from —40 degrees to +85 degrees C., and generally speaking, they are slightly smaller than paper condensers of comparable ratings. The phenolic-sealed construction of these capacitors, manufactured by the Sprague Electric Company, makes possible dependable operation under severe conditions of heat, moisture or mechanical stress. They are available in all popular capacities in 200, 400, 600, 1000 and 1600 volt types.

The Editors Recommend

Best Sellers in Science and Technology

GUIDE TO THE LITERATURE OF MATHEMATICS AND PHYSICS — ***By Nathan Greer Parke III.*** A guide for self-directed education in both mathematics and physics. The major part is a classified list of books in each sub-class of both subjects and in related engineering subjects. **$5.10**

ANCIENT PLANTS AND THE WORLD THEY LIVED IN — ***By Henry N. Andrews, Jr.*** The science of the past evolution of plants told for readers with a serious interest in pure science. **$4.60**

HANDBOOK OF CHEMISTRY — ***By N. A. Lange.*** Sixth edition of a well-known handbook of chemical information, reset and greatly corrected. A useful and convenient volume. **$7.15**

HIGH FREQUENCY INDUCTION HEATING — ***By Frank W. Curtis.*** Answers many questions concerning induction heating and its utility in industrial processes. Thoroughly practical in scope. **$3.10**

MUSICAL ACOUSTICS — ***By Charles Culver.*** Textbook for college students majoring in music, and essentially physics throughout. Covers all important phases of acoustics of music. **$3.10**

PLASTICS — ***By J. H. DuBois.*** Third edition, again revised and enlarged, with two four-color plates. This is an important book on the whole general subject of plastics, plus much brand new material on synthetic rubber, manufacturing processes, and plastics moldings. **$5.10**

NORTON'S STAR ATLAS AND TELESCOPIC HANDBOOK — ***By Norton and Inglis.*** Tenth edition of a standard work, with main charts redrawn for epoch of 1950. Standby for amateurs past the cradle roll. **$5.35**

THE MEANING OF RELATIVITY — ***By Albert Einstein.*** Second edition with added chapter describing advances since publication of first edition some 25 years ago. Requires knowledge of advanced mathematics and physics; not a popular exposition. **$2.10**

THE SCIENTISTS SPEAK — ***Edited by Warren Weaver.*** A review of recent advances in all of the sciences and a wide-ranging discussion of the meaning of science in the modern world. This book brings together the 79 "science talks" by 81 distinguished scientists which were broadcast at the intermission of the New York Philharmonic Symphony Sunday afternoon concerts in the 1945-46 and 1946-47 seasons. **$3.85**

RADIANT HEATING — ***By T. Napier Adlam.*** Complete information for engineers, architects, and contractors on design, installation, and control of hot water, steam, warm air, and electric radiant heating systems. **$6.10**

SLIDE RULE SIMPLIFIED — ***By C. O. Harris.*** How to use a slide rule, without any of the mystification that often surrounds this important tool of the engineer. Excellent illustrations make everything clear. **$4.10** including a slide rule; for book alone. **$2.85**

MACHINERY'S HANDBOOK — ***13th Edition.*** "Bible of the mechanical industry." 1911 pages of latest standards, data, and information required daily in shop and drafting room. **$6.10**

PROCEDURES IN EXPERIMENTAL PHYSICS— ***By John Strong, Ph.D.*** A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **$7.45**

EXPERIMENTAL SPECTROSCOPY — ***By Ralph A. Sawyer.*** Covers theory and types of spectroscopes and spectographs, mounting and use of gratings, determination of wavelengths, infra-red spectroscopy, spectrochemical analysis, and so on. Somewhat elementary, but requires knowledge of physics and some physical optics. **$5.10**

THE EINSTEIN THEORY OF RELATIVITY — ***By L. R. and H. C. Lieber.*** An intermediate book from which engineers and the like can get close to an understanding of relativity. Partly in language but largely in mathematics of college grade, mainly calculus. **$3.10**

HEAT PUMPS — ***By Sporn, Ambrose, and Baumeister.*** Presents the basic facts on the design, operation, installation, and maintenance of heat pumps for either heating or cooling in domestic and industrial applications. **$3.85**

PRINCIPLES OF PHYSICS, VOL. III—OPTICS — ***By Francis Weston Sears.*** One of the most modern works on physical optics available today. At college level, it covers the subject with emphasis on physical principles rather than practical applications. **$5.10**

IF YOU MUST GAMBLE—***By Maurice Lenihan.*** Statistical safety, as practiced by insurance companies, applied to bridge, dice, roulette, horses and so on. No guarantee of successful "systems," but sound advice lightly handled. **$2.10**

EXPERIMENTAL PLASTICS AND SYNTHETIC RESINS — ***By G. F. D'Alelio.*** Explicit directions for making most of the well-known plastics and resins, using a minimum of laboratory equipment Many of the processes can be translated directly into industrial applications. **$3.10**

FUNDAMENTALS OF OPTICAL ENGINEERING — ***By Donald H. Jacobs.*** This work starts out at the very beginning, is mainly non-mathematical, and is probably the best suited of all existing books as an introduction to optical design. Author is a physicist at Bureau of Standards. **$5.60**

THE HOME FREEZER HANDBOOK—***By Gerald J. Stout.*** Detailed instructions for building and operating home freezers, large and small, that are low in first cost and economical to run. Section on preparation of foods for freezing. **$4.10**

INDUCTION HEATING — ***By Osborn, Brace, Johnson, Cable, and Eagan.*** Principles and theory, practical applications of motor-generator and high-frequency induction heating, circuits and frequency generation, and comparisons of heat-treating methods. **$3.10**

AN OIL BURNER HANDBOOK—***By L. J. Whelan.*** How oil burners work, how to get the greatest efficiency from them, how to conserve fuel, and what to do about troubles, are all told here in simple, understandable language—for home owners or technicians. **$2.50**

(The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted. All prices subject to change without notice. Books listed are offered for retail sale only, not to the trade.)

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CURRENT BULLETIN BRIEFS

Conducted by K. M. CANAVAN

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

LITHCOTE. In eight pages this catalog describes and illustrates this protective coating and lining process for steel and other metals, which is applicable to many types of storage and transportation equipment. A wide range of uses is described, and the results of laboratory tests are given. *Lithgow Corporation, 333 West 40th Place, Chicago 9, Illinois.—Gratis.*

SEAM WELDERS. In eight pages this bulletin presents information on standard and special seam welders which are available in three sizes—light, medium and heavy duty. Each size is also available in three types—circular, longitudinal and universal. Typical applications are shown. Request Bulletin 803. *Progressive Welder Company, 3050 East Outer Drive, Detroit 12, Michigan.—Gratis.*

COMBUSTION SYSTEMS AND BURNERS is a 12-page booklet outlining the basic principles of gas-fired combustion systems. The function of four types of burners—atmospheric, immersion, low pressure and high pressure—are presented, and sectional drawings and charts of types of burner-equipment illustrate the text. *Surface Combustion Corporation, Technical News Bureau, Toledo 1, Ohio.—Gratis.*

PRECISION BALL BEARINGS is a 20-page catalog which lists and describes the various types of ball bearings, giving milimeter equivalents, bearing specifications and bearing equivalents as well as a comprehensive chart explaining the standard AFBMA bearing numbering code A pictorial section shows precision ball bearing methods. Request Catalog 2001. *Jack and Heintz Precision Industries, Inc., Cleveland 1, Ohio.—Gratis.*

PINES BENDERS. Outlining various innovations in bending machines, this 18-page catalog illustrates machines which are designed to speed up the production of bends in pipe, bars, tubes and extruded shapes. Typical applications of these machines as used in the metal furniture, refrigeration, processing equipment, bicycle, aircraft and automotive industries are shown. *Pines Engineering Company, 601 Walnut Street, Aurora, Illinois.—Gratis.*

THE ARCHITECTURE OF BROADCASTING TRANSMITTER BUILDINGS is Issue No. 9 of the Western Electric *Oscillator.* The information contained in this 68-page booklet has been compiled with the aid of network engineering executives and leading architects. It covers such subjects as site selection, layout of buildings, construction methods, and de-

signs for modern transmitter buildings. Many typical buildings and installations are shown. *Western Electric Company, 195 Broadway, New York 7, New York. —Gratis.*

OUTLINE OF LECTURES ON ADVANCED RADIO SERVICING. This 32-page booklet contains many helpful facts taken from a manual of 30 lectures on radio servicing. Included are pointers on location of store, advertising, how to obtain business, rates and charges, as well as the necessary equipment for locating faults and so on. *Supreme Publications, Nine South Kedzie Avenue, Chicago 12, Illinois.—10 cents.*

CONTINUOUS SOLVENT EXTRACTION PROCESS. Providing detailed information on the handling of soybeans, cottonseed, flaxseed, peanuts, corn germ and castor beans, this 20-page bulletin describes and illustrates the equipment available for the extraction process and analyzes its economies. Request Bulletin 13B6757. *Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin.—Gratis.*

THE INSIDE STORY. In 44 pages this booklet, in interesting cartoon style, tells the story of how the Yale compact door closer operates. *The Yale and Towne Manufacturing Company, Public Relations Department, Chrysler Building, New York 17, New York.—Gratis.*

HIGH INTENSITY RUNWAY LIGHTING. In 12 pages this bulletin contains descriptions of the use, installation and ratings of this type of equipment which is being distributed by the General Electric Company's Apparatus Division. Request Bulletin GEA 4931. *American Gas Accumulator Company, 1027 Newark Avenue, Elizabeth 3, New Jersey.—Gratis.*

ANNEALING IN STANDARD RATED FURNACES. Defining various annealing and related processes for both ferrous and nonferrous metals, this four-page bulletin also describes both direct fired and prepared atmosphere furnaces—discussing the advantages of each. Request Bulletin SC-135. *Surface Combustion Corporation, Technical News Bureau, Toledo 1, Ohio.—Gratis.*

X-RAY DIFFRACTION CAMERA FOR MICRO-TECHNIQUES is a four-page reprint which outlines the construction and application of this camera which is especially adapted to fiber analysis. Sample diffraction patterns are shown for unstretched and stretched polyethylene. *North American Philips Company, Inc., 100 East 42nd Street, New York 17, New York.—Gratis.*

WATCHMAN—WHAT WOULD YOU DO? This 12-page booklet, illustrated with instructive cartoons, is useful as an aid to plant managements in training watchmen in the proper procedure when fire is discovered. Stressing eight important fundamentals, it includes the operation of extinguishers, calling the fire department, checking sprinkler valves and starting fire pumps. *Associated Factory Mutual Fire Insurance Companies, 184 High Street, Boston 10, Massachusetts.—Gratis.*

Books

THE BOOK DEPARTMENT of Scientific American is conducted, with the cooperation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S. All remittances are to be made in U. S. funds. Prices given are subject to change without notice.

APPLIED CHEMISTRY

By Sherman R. Wilson and Mary R. Mullins

ONE of the by-products of the intensive development of chemistry during the war is the necessity it has created for revision and amplification of text books. Students are particularly avid to learn something about all the late developments that have received major attention in the news following the lifting of wartime censorship. This new edition of the high school chemistry text of Wilson and Mullins sets out to accomplish just that. Sometimes it finds the going a little tough in its efforts to explain the more abstruse developments to an audience of beginners in chemistry (to whom the book is definitely directed) but on the whole it does an effective job. (714 pages, 5½ by 8½ inches, copiously illustrated.)—$2.50 postpaid.—*D.H.K.*

FLIGHT ENGINEERS MANUAL

By Charles A. Zweng

THE DUTIES of a flight engineer on the airways are as important as those of the pilot, and require perhaps greater knowledge. The book, written as a help to the passing of the Flight Engineer's Certificate examination is clear, accurate, comprehensive, up to date. It contains a wealth of information concisely presented on aircraft and engine operation with special attention to the Constellation, the DC-4 and the Boeing Stratoliner. (416 pages, 10½ by 6¾ inches, illustrated.)—$4.10 postpaid.—*A.K.*

INVENTIONS AND THEIR MANAGEMENT

By Alf K. Berle, S.B., and L. Sprague De Camp, M.S.

MILLIONS of dollars of lost profits, thousands of hours of frustration, hundreds of law suits, could be saved if inventors would take the time and trouble to get clear ideas about the complexities of protecting, marketing and developing their inventions. This book does not tell the whole story; only a first class patent lawyer can do that for the inventor. But in the hands of any individual inventor or in the engineering library of any large manufacturing company this book can give concise answers to some of the most perplexing problems of the inventor. (742 pages, 5½ by 8½ inches, about 100 illustrations.)—$6.10 postpaid.—*E.L.C.*

NEW WEAPONS FOR AIR WARFARE

Edited by Joseph C. Boyce

ANOTHER in the series, "Science in World War II," this volume deals specifically with the development and production of (1) Radar fire control equipment; (2) Proximity fuses for rotating projectiles; (3) Proximity fuses for rockets, bombs and mortars; and (4) Guided missiles. The book, edited by a former special assistant to the chairman of the National Defense Research Committee, is written in easily understood not-too-technical language, making it a work of very decided interest to the layman. (292 pages, 5½ by 8½ inches, illustrated.)—$4.10 postpaid.—*N.H.U.*

THE REACH OF THE MIND

By J. B. Rhine

READERS wishing a summarizing account of the status of Professor Rhine's 17 years of research on extra-sensory perception—telepathy and clairvoyance (both free from time and space limitations), precognition and psychokinesis, the action of the mind on objects—will find it rounded up in this new book, though the frequent use of symbols like PK, DT, QD, and psi is wearisome. It surprises everyone to discover how much evidence there is for extra-sensory perception. Some scientists have become convinced, physicists are found the most objective, and many psychologists who are personally convinced are noncommittal due to reasons of expediency. Despite the convincing evidence as Rhine presents it (with a little impatience), science's lack of a stampede to full acceptance has the same stabilizing effect that an opposition bench has on a government party in

power. Most interesting parts of the book are the later chapters discussing in detail the consequences, philosophical, ethical and everyday-practical (everybody's mind an open book, but you've still a chance to reform) that would follow if we could get voluntary control of what actually is a feeble, undependable, seldom useful agency. People said we'd never get control of atomic energy. (234 pages, 5½ by 8¼ inches, 17 illustrations.)—$3.60 postpaid.—*A.G.I.*

THEY TAMED THE SKY

By Douglas J. Ingells

THIS IS an accurate, straightforward, well-written account of the research and engineering that created our military aircraft, its armament, engines and equipment. The story of our fighting pilots is known to everybody. Here is the story of Wright Field, of the patient engineers and test pilots who paved the way for giving the combat pilots their tools. The book is the result of careful research, and it does not exaggerate. Perhaps it is all the more dramatic on that account when it tells what happens to a man deprived of oxygen in the stratosphere, of the tremendous hazards of the test pilot, of the wonders of jet propulsion, of what can be done in huge wind tunnels, of the marvels of radar, of the way jet planes and rockets shrink space. (268 pages, 5½ by 8 inches, illustrated.)—$3.60 postpaid.—*A.K.*

COMMERCIAL FERTILIZERS

By Gilbeart H. Collings

THE FOURTH edition of this valuable text book brings the subject of fertilizers and related matters quite up to date. Copious illustrations, including a number in color, add greatly to the value of this authoritative work, both to the student and to others interested in the production and application of fertilizers. An extensive bibliography and an excellent index complete an excellent book. (522 pages, 6 by 9 inches, illustrated.)—$4.60 postpaid.—*D.H.K.*

PRIMER FOR HOME BUILDERS

Edited by Allan Carpenter and Norman Guess, and the Editors of Popular Mechanics

THIS tome should reduce somewhat the probability of the inexperienced home-seeker suffering a complete catastrophe at the hands of the builder or real estate salesman. Pointing out the many pitfalls threatening home builders and buyers, this highly readable book covers, among many others, such vital details as how to plan the house; what materials should go into the house; what the architect and contractor do; and, in the case of an older house, what danger signals to heed if one is to avoid ending up with a hopeless termite trap. Of special interest is the section dealing with the more important legal aspects of building or buying. Here, these usually confusing issues are reduced to simple English, with their full significance dragged out into the open. A "must" for the novice, this book can teach even the experienced house-hunter a thing or two. (171 pages, 8½ by 5½ inches, illustrated.)—$2.60 postpaid.—*N.H.U.*

Because of increased production costs of books, publishers' retail prices today are subject to constant change. It may be necessary, therefore, for our Book Department to advise book purchasers of increased costs, even when orders sent are based on current quotations.

The Editor

AN INTRODUCTION TO METALLURGY

By Joseph Newton
Second Edition

AN EXTRA-COMMENDABLE aspect of this second edition of a commendable textbook on metallurgy is its inclusion of references (although necessarily too brief) to nuclear fission and its products. It also contains an expanded discussion of pyrometallurgy and a new section on powder metallurgy. It might well have also added a section to identify and date personalities mentioned in the text (*e.g.*, Bain, Bessemer, Gibbs, Thum) and thus give some little historical perspective to a technology which Professor Newton (of the University of Idaho) notes "still makes use of some rule-of-thumb methods, and still finds it necessary to employ artisans to do work which cannot be learned from scientific textbooks." (645 pages, 6¼ by 9¼ inches, illustrations.)—$5.60 postpaid.—*M.W.*

THE WORKS OF THE MIND

Edited by R. B. Heywood

TWELVE lectures, by an artist, sculptor, architect, musician, statesman, legislator, administrator, scientist, mathematician, historian, philosopher, who discuss the creative processes by which they work—at least some do. Others wander more or less hither and yon. (246 pages, 5¾ by 8½ inches, unillustrated.)—$4.10 postpaid.—*A.G.I.*

SMALL WONDER
The Story of Colloids

By Gessner G. Hawley

THIS book is written in such a clear and simple style that at the start it seems intended for a popular audience. But as the reader progresses he finds that it is an intensely serious work, sufficient for the needs of all who must deal with colloids in any other respect than to design equipment, or to make scientific studies. Thus we have a book which is clear enough to be understood by any high school or college student, but is deep enough to meet the needs of public works officials, foods company executives, purchasing agents and others who must deal responsibly with

colloidal equipments and processes although rarely understanding them. The book would be excellent as a text for teaching. In the modern movement to make more science clear to more people this book deserves an important place. (230 pages, 8¾ by 6 inches, illustrations, charts, and drawings.)—$3.60 postpaid.—*E.L.C.*

BASIC ELECTRONIC ELECTRICITY

By James R. Cameron

FROM the fundamentals of electric charges through the structure of matter and a discussion of voltage and current, this solid yet somewhat simplified text carries the reader along to vacuum tubes and their applications in various fields. The text is remarkably clear in its exposition, and it is to be regretted that the numerous drawings are very poorly executed. (320 pages, 5 by 8 inches, about 200 illustrations.)—$5.10 postpaid.—*A.P.P.*

THE CHEMICAL COMPOSITION OF FOODS

By R. A. McCance and E. M. Widdowson

SECOND American edition of an English work on the composition of foods, prepared primarily for the guidance of the dietitian, the important content of this book is given in tables which show composition in grams or milligrams per hundred grams or cubic centimeters, or in grams or milligrams per ounce, of a great variety of common foods. Recipes are given for a number of prepared foods whose compositions are included in the tables. The book is obviously English both in the selection and naming of the foods included, but neither this nor its English peculiarities of spelling and choice of words will prevent the earnest seeker for information from finding it. Rather, these oddities natural to its English origin will merely annoy American users of the book. (156 pages, 5½ by 8 inches.)—$3.85 postpaid.—*D.H.K.*

MUSIC IN RELATION TO EMPLOYEE ATTITUDES, PIECEWORK PRODUCTION, AND INDUSTRIAL ACCIDENTS

By Henry Clay Smith

THIS paper-bound monography is the result of a 12-week study of 1000 factory employees. Dr. Smith (of Hamilton College) succinctly concludes: "Music during working hours will generally improve production where repetetive work is common. Properly administered in such situations, it not only will increase production but will also provide widespread employee satisfaction. . . . Although music, on the average, had no influence on the accident rate, the relation of music to accidents was not entirely clear in the present study." (59 pages, paper covers, 6 by 9 inches, tables and charts.)—$1.85 postpaid.—*M.W.*

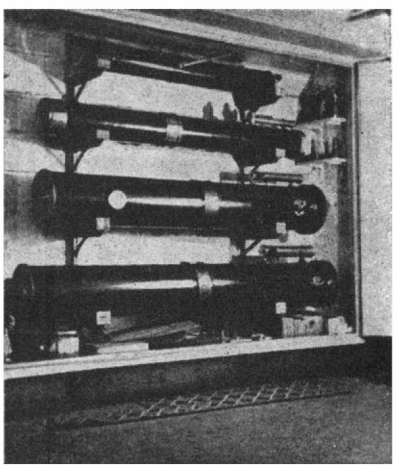
BUG BITES HARD

And This is What Resulted

"THIS," writes an Omaha amateur telescope maker, "is what happens when the bug gets out of the 'A.T.M.' book and bites you really hard."

The top one is five inches in diameter—small and easily portable.

The next one is six inches in diameter—customary size for the beginner's first telescope, magnifying 100 diameters. The lower two are ten inches in diameter but differ in length for special uses. These can be carried out of doors



Tubes of four telescopes

and attached to a fixed mounting and pointed anywhere in the sky.

Why did this man make four telescopes? For the same reason that a fisherman may own nine rods and eleven reels.

Below are three telescopes made by a physician in Haven, Minnesota. First

Many make three to six

he made the center one, six inches diameter. Next the one at the right: same diameter but shorter—better for faint stars and nebulae. Third he built the nearer one, 9¼ inches in diameter magnifying 200 diameters.

Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American Books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

Two of Porter's sketches, Figures 1 and 2, "were made," he writes, in the optical shop in Pasadena while the 40″ glass plug, weighing 450 pounds, was being removed from the 200″ mirror. It was a delicate operation, as the plug was cemented into the large mirror with plaster of Paris. The men are shown digging out the plaster. Figure 2 shows the face side."

Time out to gasp. Is that workman a housewrecker recklessly wielding a crowbar on the finished, figured, completed mirror? So Porter was asked and answered, "The 'crowbar' was a rod of steel only about ¼″ in diameter, and the technique was simply digging out the plaster little by little, the clearance between the mirror and plug being about ⅜″. The last segment was undug at the top, so that when this finally broke away the plug just dropped onto a bed of powdered plaster underneath."

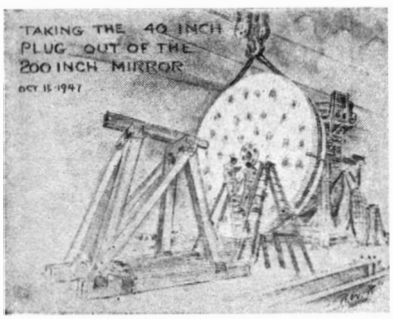


Figure 1: Hole enters plug

"In the first sketch," Porter continues, "the mirror is shown as it hung from a strap from the 50-ton crane above. At the left is a massive supporting frame for a heavy horizontal timber with its end turned cylindrical (10″ diameter) to fit a corresponding hole in the rear of the glass plug. When the glass plug was freed the crane advanced the mirror until the wooden plug entered the hole. Then the mirror was lowered slightly until the plug was loose and free, and was moved away from the plug, leaving it resting on the timber's end.

"It is interesting to remember how the glass plug was inserted, years ago. It was rested on a cake of ice and, as the ice melted, the glass settled slowly, safely, into the 40″ hole."

Since two pictures take the place of 20,000 words few words are needed to describe the clean, workmanlike brass-bronze telescope eyepiece focus control shown in Figures 3 and 4, designed and made by Philetus Allen, 1 John Street, Glens Falls, New York.

1 is the eyepiece.
2 is its standard 1¼″ tubing.
3 is the adapter tubing.
4 is the housing.
5 is the hand control.
6 is its spindle.
7 is the worm.
8 is the worm rack.
9 is an adapting plate to fit tube.
10 is the tube.
11 is a washer fitted inside tube.
12 is a ring nut.
13 is a band.
14 represents face of worm rack.
15 represents a section of the bottom, the keyway, and rack.

Your scribe has manipulated this focus control, which works as smoothly as a turtle's neck. Allen adds: "The worm rack, 8, was made by threading the inside of a length of brass tubing, 12 threads per inch, and then cutting a ¼″ section from this and soldering it to the adapter tube. The worm is of polished steel. Everything can be made on a lathe except the keyway and slot for the worm, which are shaper jobs."

Precisely in which details British and American standard astronomical eyepiece shells differ having long been something of a mystery, H. E. Dall, 166 Stockingstone Road, Luton, England, a co-author of "A.T.M.A.," was invited to contribute a note and kindly sent Figure 5. "This," he writes, "is a typical medium-power eyepiece of British standard thread type as used most commonly here. Advantages of the screwed mounting are: easier to remove or insert without shaking the telescope; doesn't get stiff with lack of grease; and better for attaching cameras, spectroscopes and Barlow lenses.

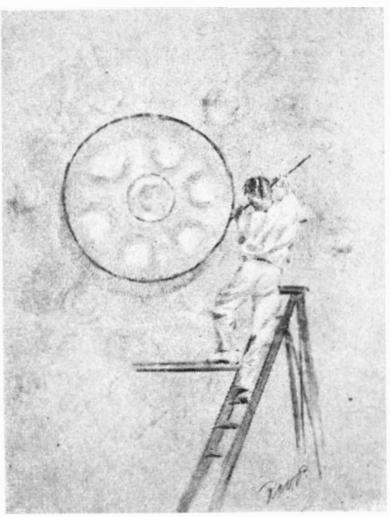


Figure 2: Mining out plaster

"Generally, however," he comments, "the British product has too long a thread. Whenever I make them I try to confine the thread to one complete turn only. This is adequate for such a coarse pitch screw and is very quick to remove or attach.

"In my drawing," Dall continues, "a Huygenian eyepiece is shown, this being by far the most common astro eyepiece used in this country. It seems that the Ramsden type is more favored by Americans. The Huygenian gives no color fringes outfield, as does the Ramsden. Dust on the field lens is not visible, especially to near-sighted folk. The eye clearance is greater. The somewhat higher spherical aberration is not troublesome until applied to short focus

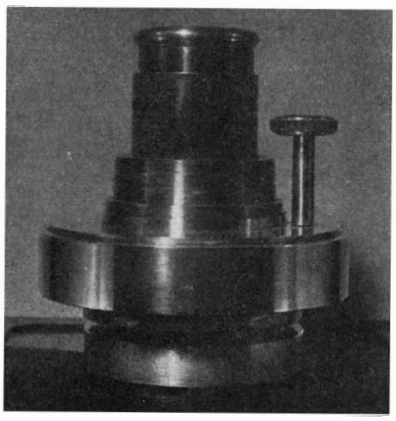


Figure 3, Allen focus control

mirrors, *f*/7 or shorter. The advanced amateur will prefer the orthoscopic type to either, though for *f*/15 refractors there is no gain except greater eye clearance."

THOUGH the winter winds of the 9272-foot Pic du Midi in the central French Pyrenees violently shiver its outer shell, or carapace, (Figure 6), the telescope just within will remain always in a dead calm. This telescope at the famous French observatory is to be a 59", *f*/5 Newtonian-Cassegrainian. It is described in *L'Astronomie* (Paris) and will be something to watch. A translation:

"The principal original feature of the 150-centimeter reflector will be the fact that it is not to be sheltered in a dome. For this there are two reasons," says Director Baillaud. "The main one, the one that decided us, is that the air movements that exist in a dome in the neighborhood of the dome slot are an important cause of image troubles. The second in practical order is that we have not found a place on the top of the peak to build a big enough dome to house our reflector. The instrument will not be in the open air, even then; it will be sheltered by a sheath, a carapace, which will conform to all its outlines and follow along in all its movements without touching any part. This carapace will absorb the force of the winds. The axes round which the carapace will turn will be concentric with the axes which turn the telescope. The two polar axes will rest on piers so independent of each other that the

vibrations of the carapace cannot be transmitted to the telescope by the earth.

"This altogether new design, which will seem very bold considering the severe climatic conditions on the Pic du Midi, was conceived in the course

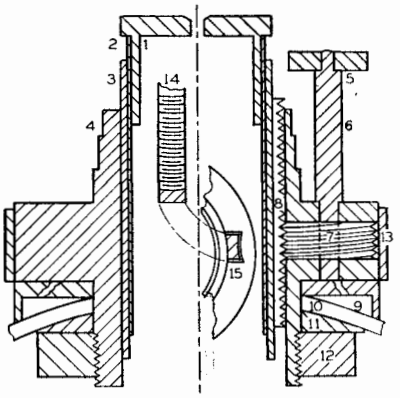


Figure 4: Focus control detail

of conservations between Monsieurs Lyot, Carmichel, Gentile, and myself," Dr. Baillaud continues. "The fact is, we believe that it will involve no complications and that it will not cost more than a dome. To us it seems to be the coming solution for reflectors larger than about 60" in diameter."

The men named as behind this daring design, a moving carapace unlike the fixed one which surrounds the tower telescope on Mt. Wilson, are the ablest practical optical scientists in France. Dr. Couder is astronomer at the Observatory of Paris and, with Dr. André Danjon, is co-author of the book "Lunettes et Télescopes ("Reflectors and Refractors") a sort of advanced Bell which should be translated into English. Dr. Lyot is famous for his inven-

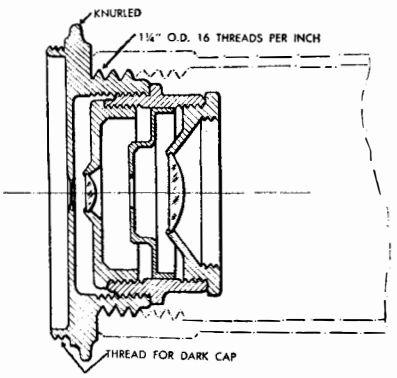


Figure 5: British eyepiece mount

tion, design, construction and use of the Lyot coronagraph by which solar eclipses can be made artificially at any time.

The three-meter shell or carapace enclosing the telescope will contain a little inner coop where the astronomers can observe at the Cassegrainian focus and another coop for the Newtonian focus, also ladders, the finder and a 19½" refracting telescope. Access to these coops will be by trap doors. The

coops will be air-controlled to a comfortable temperature but the air in the interior of the tube and in contact with the mirror will be held artificially at an even lower temperature than that of the air outside, in order to produce a stratification of the air which should tend to diminish its circulation within.

One other new feature of the Pic du Midi telescope is to seal the tube at the skyward end with a plane-parallel glass window to break up air currents. A somewhat similar proposal, though with a different object, has reached this magazine from S. L. Walkden, father of the Richest-field telescope, London. "I have speculated on trying the following. For a 6" Newtonian prepare a thin, say 3/16", plano-plano plate of finest low-dispersion optical glass and surface workmanship and place this in the main tube an inch or two farther out than the flat. Attach the diagonal to this and it becomes a supporting plate having no spider diffraction. Film-coat the two surfaces of the glass to minimize light losses."

MULTIPLYING the number of telescope makers by the number of mirrors made by each, and again by the coefficient of human carelessness *Kc*, we find that x plumbers have been called to y homes to clean abrasive gunk from z

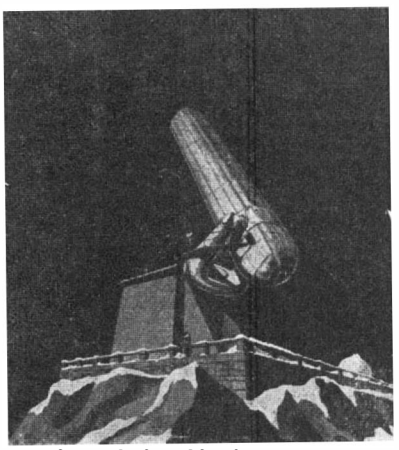


Figure 6: Its skin doesn't touch

drain traps; while n carloads of only half-used Carbo have been wasted. Some thrifty mirror makers keep a deep pail under their washing spigot at all times and all grit from whatever source ultimately reaches its bottom and stays there unless the water is unnecessarily stirred up.

After a few mirrors have been made this catch-all, now half full of gunk, is taken to a flowing brook and stirred until the milk (glass fragments) and finder grit have floated downstream. A surprising amount of clean coarse Carbo will be found in the bottom—enough to hog out the next mirror.

To re-grade this mixture probably would not pay. Moreover, this would require more equipment and skill than may at first seem called for. At least, the manufacturers of abrasive grains have long sought ideal ways to grade their product but found only approximations.