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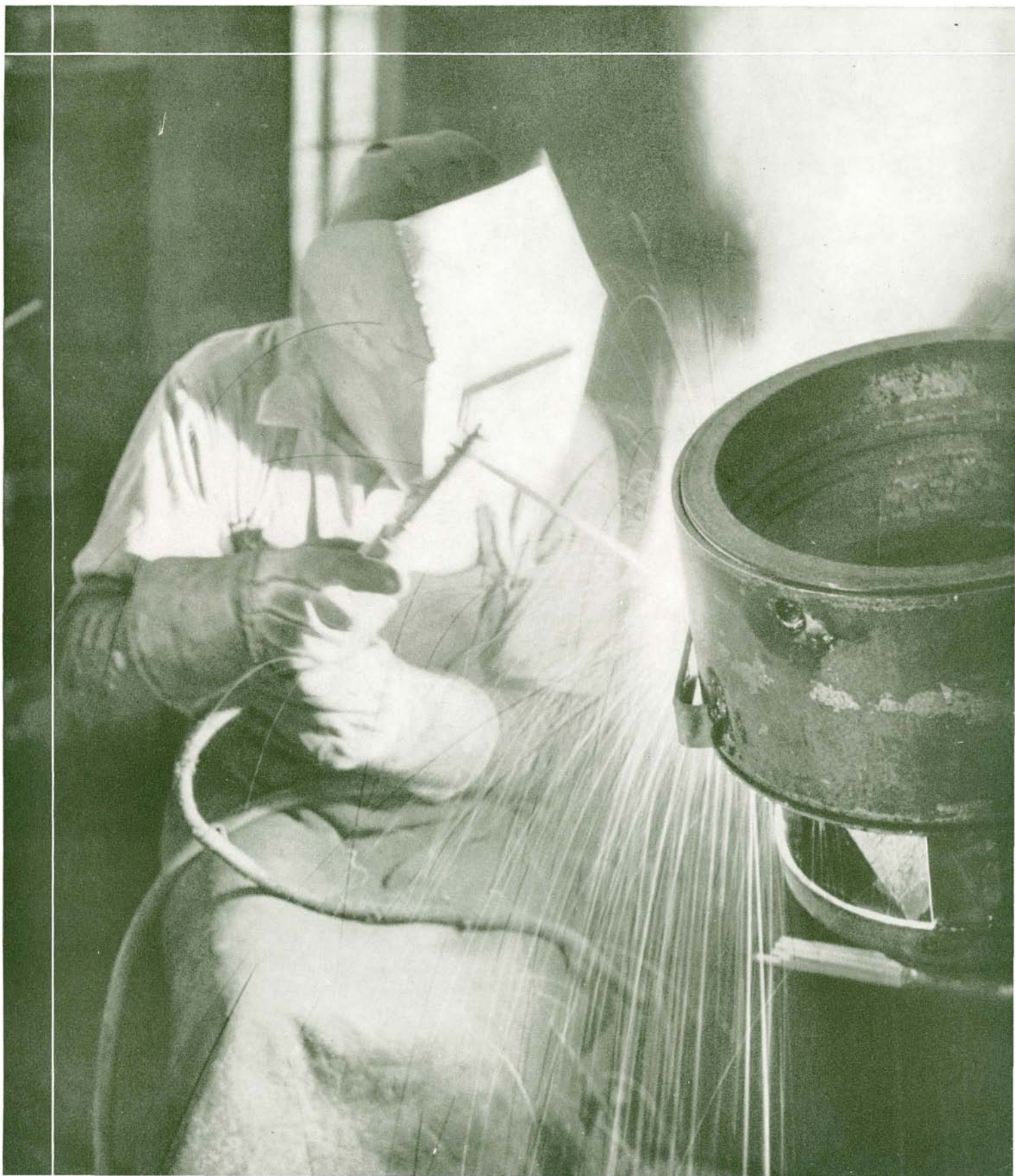

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SYNTHETIC RESINS have in very recent years developed a sizable and important industry. In spite of that fact, the literature on the subject has been slow in coming. Here at last is a two-volume set which totals over 1600 pages of information on all phases of chemistry relating to these new products. Types of synthetic resins, their uses, chemistry, and manufacture are fully covered. An indispensable set for the advanced chemist.—Both Vols. $20.00 postpaid.

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By RAY W. SHERMAN

DRIVERS of cars are egotists. Each thinks he knows how to drive better than the other fellow. Each would learn much, however, through a quick reading of this 150-page book which deals with all phases of good driving and safety on the road. It does not recommend fast driving but it indicates that speed, of itself, is not dangerous, and sets forth ways and means to inject a greater amount of safety into the ever-faster driving of our time. Captain Edward V. Rickenbacker has written an introduction in which he says: "I believe it is the obligation of every car driver and owner to become acquainted with this book. . . ."—$1.15 postpaid.

Unsolved Problems of Science

By A. W. HASLETT, *Cambridge Univ., England*

IT IS the author's claim, and it is probably true, that the unsolved puzzles of science are fully as intriguing as the things science has definitely settled. His book covers these unsolved puzzles in the sciences of cosmology, geology, meteorology, anthropology, biology, physics, and mathematics. The style of writing is excellent, the author's scientific information is broad and accurate. He seems to be as fully aware of the important researches in science on this side of the Atlantic as the other. One of the best books we have seen on current advances in science.—$2.15 postpaid.

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By GEORGE LETCHWORTH ENGLISH

Now that the mineral collecting hobby is spreading so rapidly we are beginning to see some good books and magazines about it. This book is aimed specifically at the amateur collector and it tells him how to go about collecting—what to do and what not to do. With this information is combined a general elementary treatise on crystallography and mineralogy—all prepared by an author who has been an outstanding mineral collector and a scientist as well as lifelong collector. A really practical book, with 257 illustrations and 307 pages of text.—$2.65 postpaid.

Why We Don't Like People

By DONALD A. LAIRD

IT MATTERS little how much you know, how good-looking you are, how much money you have, if you are out of tune with the people and things about you. If you are "maladjusted"—a social or business misfit—you can't go far in this world. The author has purposely written this volume in non-technical language so that the layman who has never had guidance in analyzing his own failures and shortcomings will find this book interesting and helpful.—$2.65 postpaid.

Handbook for the Amateur Lapidary

By J. HARRY HOWARD

HERE at last is something of a real book on a subject concerning which there have been little more than pamphlets, and mighty few of these. One of these was the one dollar sketch, "The Working of Semi-Precious Stones," by the same author, who also wrote, in Scientific American, March, 1932, an article on amateur lapidary work or gem polishing. Howard's newest book now provides practical instruction in all kinds of gem cutting for the beginner and for the advanced amateur. Its accent is on the practical, for this is a real shop book that tells not merely a lot of generalities about lapidary work but actually how to do it, how to set up the rig to do it with, and even where to get the parts of that rig. Lapidary work was much of a trade secret till Howard bored in, learned the methods and, by means of his books, turned the secrets into a fascinating hobby for everybody.—$2.15 postpaid.

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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COVER

WELDING is becoming of vastly increasing importance to industrial operations throughout the world. Our cover photograph shows just one of the many applications that are discussed in complete detail in the article starting on page 244.

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50 Years Ago in . . .

Scientific American

(Condensed From Issues of May, 1886)

PANAMA CANAL—"When M. De Lesseps and his party inspected the Panama Canal, in February, they were accompanied by Mr. John Bigelow, as the representative of the New York Chamber of Commerce. Mr. Bigelow states that it is impossible to say what the final cost of the work will be, or when it can be completed. Mr. Bigelow regards the canal as an undoubted possibility if sufficient funds be provided, but he ventures no opinion as to whether they will be, or what sum or what amount of time would be necessary to complete the work."

DEEP FOUNDATION—"The location of the Hawkesbury River railroad bridge near Sidney, Australia is one that demanded extraordinary work, not in regard to the superstructure, but in relation to the foundations for the piers. The total height from the bottom of the piers to the rails will be 227 feet. Sinking piers to such a great depth has never been attempted, even in this age of wonderful engineering. Like most of the methods of American engineers, the chief characteristic of these plans, as now contemplated, is simplicity. The outer tube of the caisson is oblong in plan, being 20 feet wide by 48 feet long.

Within the outer tube are placed, at equal distances apart, three cylinders or dredging tubes, 8 feet in diameter. The lower part of these tubes is extended to meet the cutting edge. The space between these tubes will be filled with concrete as the cylinder sinks. After the cylinder has reached a solid resting place, the three inner dredging tubes will also be filled with cement, thus making a pier of solid cement from the bottom to the water level."

GAS TANKS—"The famous South Metropolitan Station gas holder, of London, 214 feet in diameter, over 150 feet high, and 5,500,000 cubic feet capacity, long held its position as the largest in the world. It has now been eclipsed by a pair of holders erected recently at the Birmingham (Eng.) Corporation Gas Works. Each of these is contained in a tank 240 feet in diameter, is said to be 150 feet high, and to hold 6,400,000 cubic feet."

SAW—"A saw without teeth, that will cut a steel rail in two minutes, is in operation at the Central Hudson shops, in Greenbush, N. Y. The disk is made of Bessemer steel, and runs at a very high rate of speed. While in operation a band of fire encircles the saw, and the many sparks flying from the revolving disk resemble a display of pyrotechnics. A small stream of water cools the saw while in motion. By this plan one saw will cut nearly 3000 rails before it is worn out."

STAMPS—"Mr. Patrick Chalmers, of Wimbledon, has issued a pamphlet claiming that his father, James Chalmers, bookseller, Dundee, was the inventor, in the month of August, 1834, of the adhesive postage stamp."

SPANISH WARSHIPS—"The Spanish Government have contracted with Messrs. Yarrow & Co., of Poplar, for the construction of two first-class torpedo boats of the *Falke* type. The speed in fighting trim, carrying 17 tons on board, is guaranteed to be 23 knots, and when running light 25 knots, or about 26¼ and 28½ miles per hour."

HEALTH—"The great question of the day is not this operation or that, not ovariotomy or lithotomy, or a hip joint amputation, which have reflected so much glory upon American medicine, but preventive medicine, the hygiene of our persons, our dwellings, our streets, in a word, our surroundings, whatever or wherever they may be, whether in city, town, hamlet, or country, and the establishment of efficient town and state boards of health."

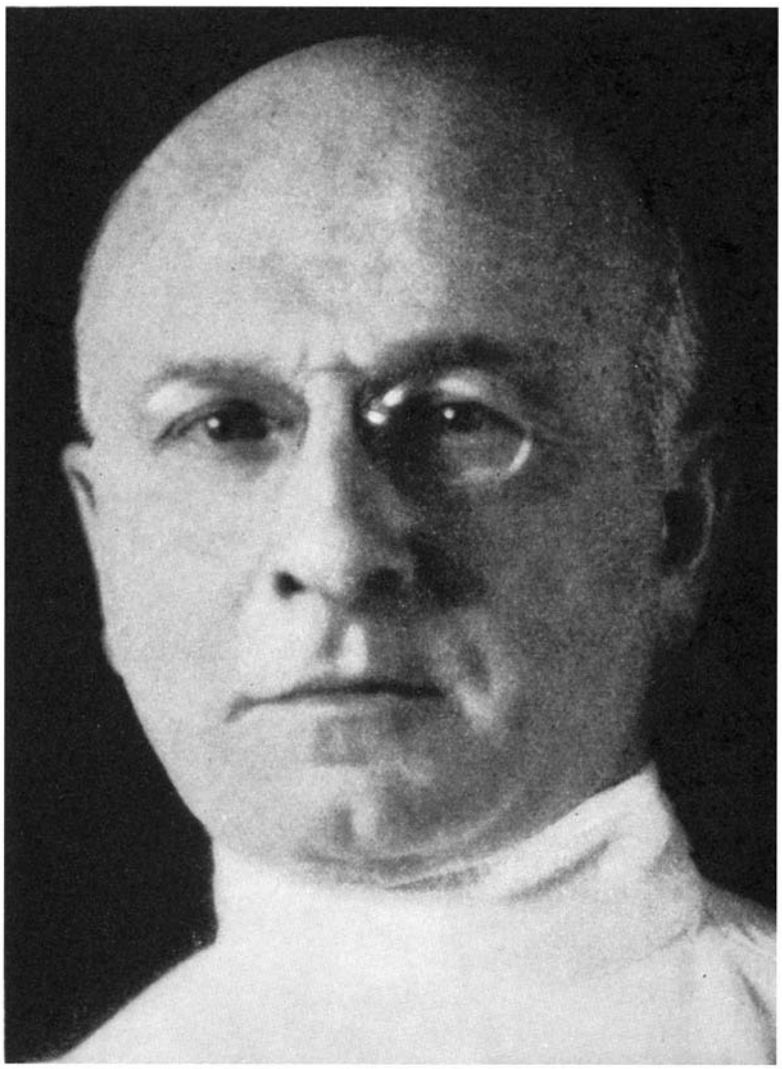
"AMERICA'S" CUP—"The yacht *Atlantic* was successfully launched on May 1. The new clipper has been built after the designs of Captain Philip Ellsworth by a syndicate of yachtsmen composed of prominent members of the Atlantic Yacht Club. The purpose of her existence is the defense of the *America's* cup, for which the British cutter *Galatea* is now the avowed competitor."

GUN MOUNTS—"Captain W. H. Bixby, Corps of Engineers, U. S. Army, proposes to replace the present slowly built, difficultly moved, difficultly releveled masonry foundations for heavy guns behind earthen parapets by rapidly constructed, easily moved, easily releveled wrought iron foundations, to rest on cross girders or sleepers embedded in the earth of the *terre-plein*, and provided with a front parapet anchorage sufficient to resist all direct recoil."

ELECTRIC WORKS—"The remarkable inventions of Mr. Charles F. Brush have been made available and remunerative by the Brush Electric Company, who are the sole owners of all his patents. This combination of inventive genius and business sagacity has, within the last decade, done much to revolutionize the artificial illumination of the world, and built up a business in whose various branches more than $25,000,000 are now invested. The entire area occupied by the buildings is about seven acres. In the main shop are manufactured the dynamos, arc lamps, and indeed all other apparatus requiring the use of machinery. The heavier machines, such as the planers, drill presses, lathes, some of them being very ponderous, are all placed on solid stone foundations."

TELESCOPES—"A long article is contributed to *Ciel et Terre*, in which the writer maintains that the real inventor of the telescope was John Lippershey, a spectacle maker at Middleburg (Netherlands), who was born in Wesel, Germany. James Metius, who, according to Descartes, has been regarded as the inventor, wrote on the 17th of October, 1608, to the Provinces of Holland, stating that he, *as well as* the spectacle maker of Middleburg, was manufacturing the instrument that brings objects near."

Personalities in Science



DR. ALEXIS CARREL

STRETCHED along several blocks of Manhattan's eastern waterfront is a semi-isolated string of low buildings whose corridors smell of antiseptics. Here, near the heart of a great community, yet strangely detached from its noise and too vibrant atmosphere, a corps of white-coated biologists of plain appearance and simple manner works day by day on some of the more fundamental problems of biology and medicine—problems often of the kind which cause unintelligent men and women to throw down their newspapers in disgust and ask what earthly good could come of such absurd experiments.

But the Rockefeller Institute for Medical Research does not explain. It does not need publicity, and is beholden only to the fact that it knows what it is doing. All its energies are turned, instead, to the prosecution of its work. Later on, the outcome of the "absurd" experiments, trickling down through to physicians, will doubtless touch that same man and woman's lives in some vital, practical way, and if that happens, perhaps it is enough. In science, one advance cannot be pursued with much hope of success until previous "log jams" are unsnarled. The Rockefeller Institute's business is to unsnarl log jams.

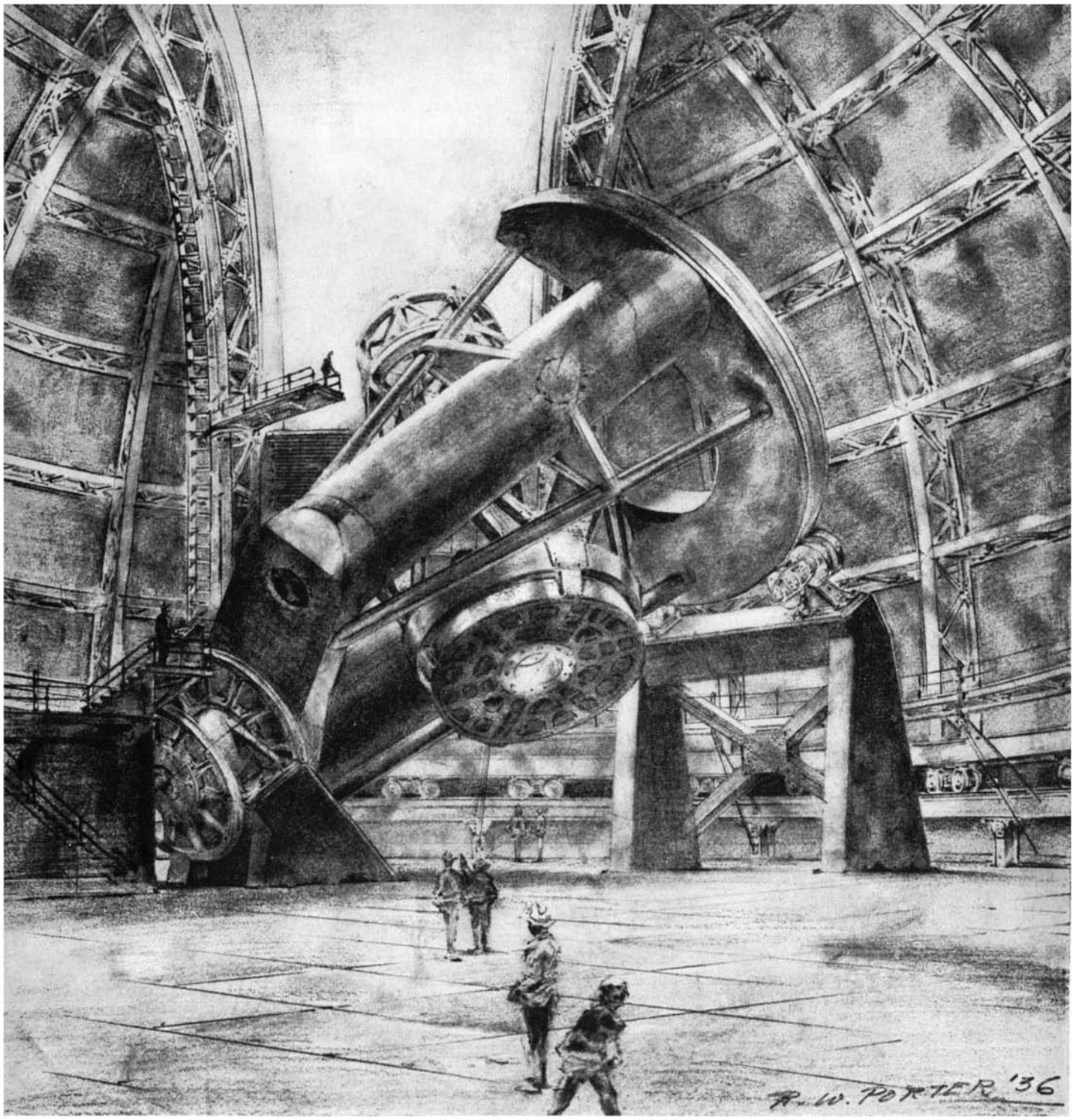
Among the scientists at "The Institute," none is so very widely known, so frequently discussed, none has become such a tradition in the outside world, as a stocky, brachycephalic Frenchman, Dr. Alexis Carrel, whose age will shortly be 63. Yet seldom is Dr. Carrel seen in public life. His work is done in quiet and modest simplicity. In "American Men of Science," the special who's who of the scientific world, Dr. Carrel's life work is summarized in a mere 7½ modest lines—less than many a lesser man—for he wrote the summary himself. He states his special interests in science simply as "experimental surgery; biology." Each of these covers a vast territory.

"Chicken hearts—isn't he the scientist who has kept a chicken's heart alive for ten years?" This is what the average man most quickly links with Dr. Carrel. But the truth is that Dr. Carrel has kept a chicken heart not only alive but beating in a glass tube of nutrient solution, and constantly growing, for 24 years, 3 months. That small, famous portion of chicken giblets seems to be well on its way to immortality, both in a literary and literal sense.

But such experiments are more—far more—than an interesting stunt; they throw significant light on two big problems, one purely scientific, the other purely practical. The biggest, likewise the most fascinating, problem of biological science is to answer that baffling question, "What is life?," also its corollary, "Is life a purely physical and chemical phenomenon or is it something more (vitalism)?" Secondly, the practical, immediate problem of human beings growing old. Just what is growing old, anyway? More facts must be learned before we can fully answer this question, but Dr. Carrel has done this much: by introducing different chemicals into those bits of tissue of which he has several which are junior to the one aged 24 years, he found not only how tissues grow old, but evidence that indicates that if tissues were kept cleansed of waste, they would never grow old.

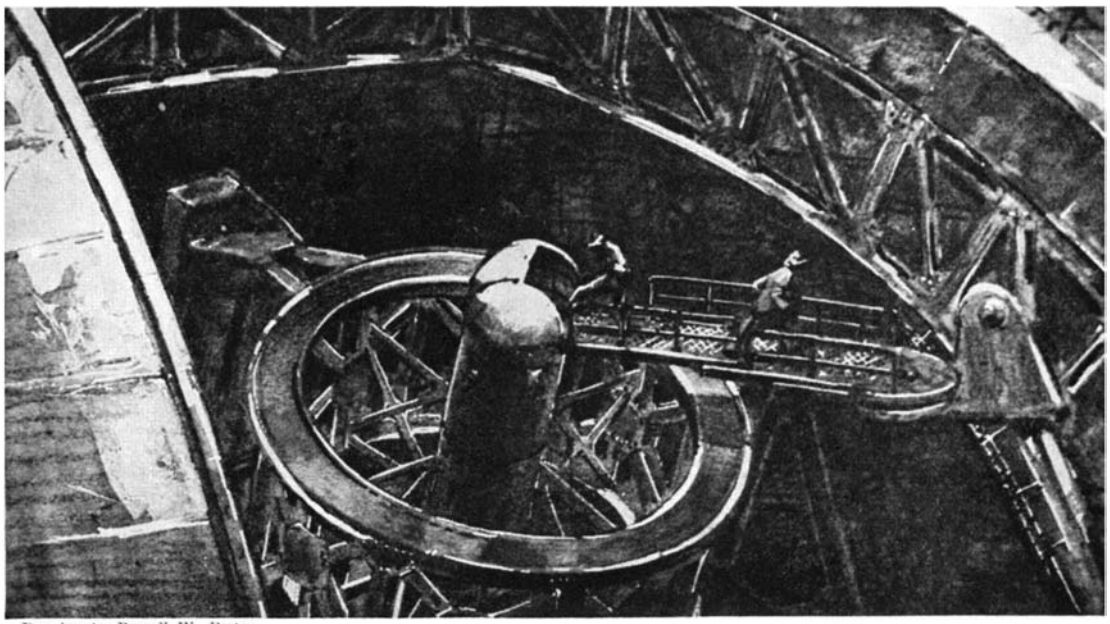
In 1912 Dr. Carrel received the Nobel Prize for Medicine in recognition of his technique for growing tissues outside of the body. His researches point to the future possibility of transplanting live organs from one organism to another. As we do not die all over at the same instant, some organs outliving others by minutes or hours, and the skin sometimes by still longer, organs may some day be transplanted from persons who have died in part to living persons who require new ones.

Researches like these dig deep into the very foundations of things. They are basic. And they sometimes change history.



TENTATIVE SKETCH OF THE 200-INCH TELESCOPE

THE above sketch, made by R. W. Porter after the latest engineering designs under consideration, gives the best idea now available of the probable appearance of the 200-inch telescope. A one tenth scale steel model of this type, built in the Instrument Shop of the California Institute, is nearly ready for rigorous tests for flexure, torsion, and so on. Bearing tests are already under way. The telescope tube will be more than 20 feet in diameter and 60 feet long, stiff enough to carry an observer at the upper end without flexure. As the total weight of the moving parts will be about 425 tons, the perfection demanded of the bearings, driving mechanism and all controls and auxiliary apparatus is obvious. The telescope will be suitable for many classes of work. Probably its chief use will be for the study of the faint extra-galactic nebulae and the spectroscopic investigation, with the highest dispersion, of the brighter stars of our own galaxy.—*George E. Hale.*



Drawing by Russell W. Porter

Changing observers at the primary focus of the 200-inch telescope

THE 200-INCH TELESCOPE

Observatory Design . . . A New Astrophysical Observatory . . . The Great Reflector . . . Auxiliary Devices . . . Purpose of the New Observatory

By GEORGE E. HALE

Honorary Director, the Mount Wilson Observatory of the Carnegie Institution of Washington. Chairman of the Observatory Council of the California Institute of Technology

IT was an oppressive August evening at Rochester in 1892, and a group of us had flocked out on the sidewalk, to escape the hot rooms of the hotel. A prominent figure in the company was Alvin G. Clark, who still carried on his father's well-known optical shop at Cambridgeport. He was telling of a recent experience, to which I listened intently. A plan for a large refracting telescope in Southern California had failed for lack of funds. However, the excellent 40-inch disks of optical glass, ordered for this purpose from Mantois some years before, had been completed and were then in Clark's shop. Did anyone know of a purchaser?

I had come down to the American Association meeting from the Adirondacks, where my wife and I were spending a short vacation. Fly-fishing for trout, though a favorite sport, had not been entirely free from dreams of a large telescope, which I needed to pursue my plans for solar research. We had visited the Lick Observatory two years before, and I was still under the spell of the great 36-inch refractor, first dimly seen reaching toward the heavens in a huge dome lit only by the comparison spark of Keeler's spectroscope, with which he was engaged in his classical researches on the radial motions of the planetary nebulae.

I had been offered the use of the Lick telescope at that time for the development of the spectroheliograph, which I had begun at my small spectroscopic laboratory and observatory at Kenwood (Chicago) in the previous year. But the installation of a 12-inch refractor at Kenwood seemed the wiser plan, and with this the spectroheliograph was completed and brought into daily use for the photography of the solar prominences and the calcium flocculi early in 1892.

AFTER hearing Clark's story I lost little time in returning to Chicago, where I combed the financial district in vain. However, a suggestion by Mr. Charles Hutchinson, a trustee of the nascent University of Chicago, led to a visit by President Harper and myself to Mr. Charles T. Yerkes, who promised to give the 40-inch objective, subsequently a Warner & Swasey mounting, and finally a building at Lake Geneva for the Yerkes Observatory. As one of the comparatively few surviving members of the first faculty of the University, I look back upon this experience with pleasure, in spite of the troublesome task of raising the funds for site, equipment, and maintenance.

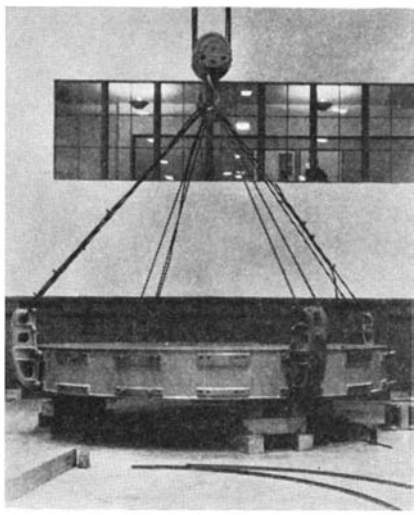
This task was essentially completed in 1902, when a new possibility presented itself. The Carnegie Institution of Washington, established in that year, considered several projects in astronomy. One of these was an astrophysical observatory, for which a committee of three (Lewis Boss, Campbell, and the writer), selected a provisional site on Mount Wilson, near Pasadena. As a special gift, expected by the trustees for this purpose, did not then materialize, I began some inexpensive experiments on the mountain in the winter of 1903-04, with instruments borrowed from the Yerkes Observatory. The results led the trustees to appropriate 10,000 dollars for a continuation of the work. A few months later further funds became available and the original project was provided for.

How to design an observatory, whether large or small, is a many-sided problem. I had encountered it in elementary

form as a boy, when I began my first amateur work in chemistry, physics, microscopy, photography, spectroscopy, and astronomy. Each of these subjects delighted me, and I have found all of them of use in later life. Concentrating my attention when about 15 on spectroscopes and telescopes, I used my other tools and instruments, many of them home-made, as auxiliaries. The value of bringing fixed and sharply defined celestial images into the laboratory, for study with the most powerful spectroscopes I could obtain, was obvious, though this method had been little used. For certain kinds of work, however, a moving equatorial telescope, with photographic or spectroscopic apparatus attached, was more desirable. Both schemes were tested at Kenwood, and from this experience the Yerkes Observatory was designed.

THE conditions at Lake Geneva and Mount Wilson were nevertheless very unlike. The Yerkes Observatory sprang from a lucky chance, which in considerable degree determined its character. Its chief instrument must be the 40-inch refractor, admirably adapted for some types of solar and stellar research, but not suitable for others. It could not be too far from the University of Chicago, though many other possible sites within the same radius were studied before Lake Geneva, Wisconsin, was selected. Its building must be a single one, of rather ornate construction, to meet the wishes of the donor. As for its miscellaneous instrumental equipment, nearly all had to be built in our own shops, except the useful nucleus supplied from the Kenwood Observatory. The reader might be amused if I were to recount the many expedients by which small gifts were obtained. A typical instance of necessary economy was the purchase of the large portrait lenses (old Voightländer type), embodied in the Rumford spectroheliograph, from a pawnshop in St. Louis!

The staff was necessarily organized slowly, as small gifts were secured here and there for salaries. Its character was defined by the possibilities of our instruments and resources, rather than by the needs of a homogeneous and well-ordered plan of research. But we never failed to get the best men obtainable, as those who recall its composition will agree.

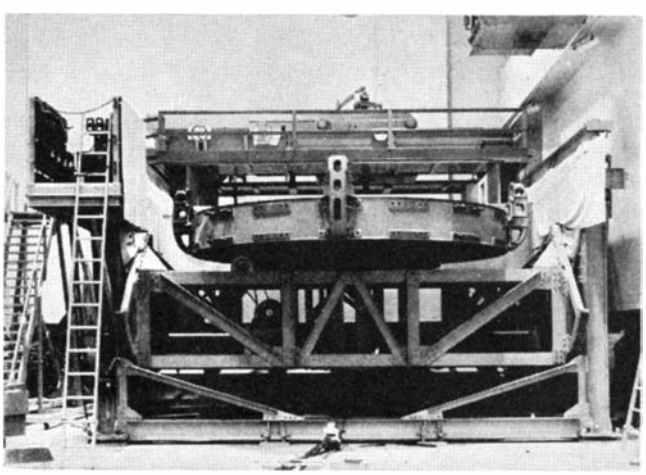


The base or turn-table on which the disk will be ground, polished, figured and tested, ready to be lifted to the spindle of machine shown below

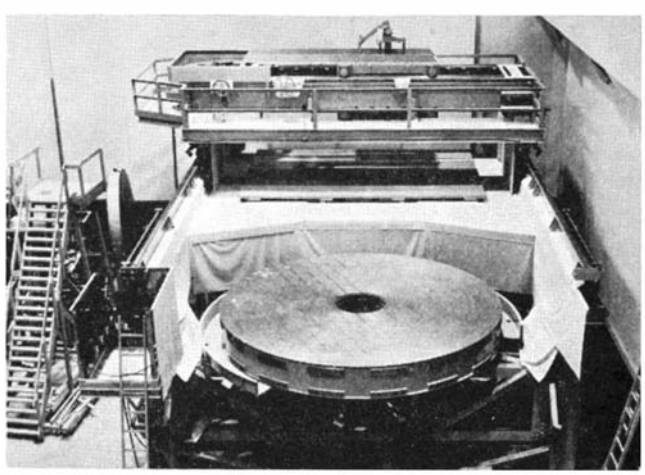
Mount Wilson offered a very different condition of affairs. The site was selected after an extensive survey in California, Arizona, and Australia, made by one of the most experienced double-star observers at the Lick Observatory. The late Professor Hussey, whose admirable report on this survey may be found in an early publication of the Carnegie Institution of Washington, knew good seeing when he found it. The initial scheme of research, worked out in a homogeneous way after 15 years of planning and investigation at the Kenwood and Yerkes Observatories, involved a physical and astronomical study of stellar evolution, giving special attention to the sun as the only star near enough to be analyzed in detail. Instead of doing what we might with a single large refractor, the various telescopes were designed to meet the observational needs in view. Novel difficulties of many kinds must be overcome, partly because of the choice of a rugged mountain, accessible only by narrow trails, and partly because of the uncertainties involved in the use of new types of instruments, such as large coelostat telescopes suitable for long exposures on the sun. Various papers in the *Astrophysical Journal* tell how these problems were solved.

Of course, as is almost invariably the case, the financial problem was the most serious, at least for nearly a year. Afterwards it disappeared for some time, until it was revived in a still more serious sense when it became necessary to find more than half a million dollars to mount and house the 100-inch mirror provided for by Mr. Hooker of Los Angeles. Later the generosity of Mr. Carnegie came to the rescue, and this telescope has proved to be the most powerful instrument of its kind.

AFTER I had felt forced by repeated illness to resign the directorship at Mount Wilson, some isolated place for continued research became necessary as my health gradually improved. I began work in a crude wooden hut on the grounds near my house, and succeeded in developing the first promising spectrohelioscope. As soon as I was able to perfect this instrument under the better conditions afforded by my solar laboratory (about the size of the old Kenwood Observatory), erected for me on the edge of the Huntington estate, I realized its new possibilities. Hence the designs of spectrohelioscopes published in Scientific American and the improved standard form described in the *Astrophysical Journal*. This comprises a complete small solar observatory, and is in daily use by amateurs and professionals in many parts of the world. It is mentioned here because it illustrates some of the possibilities of



The table shown in the illustration at the top, in place on the large machine in which the mirror will be made



The working mechanism of the machine, run off, showing the turn-table (ultimately to be the base of the telescope)

small special instruments for productive research.

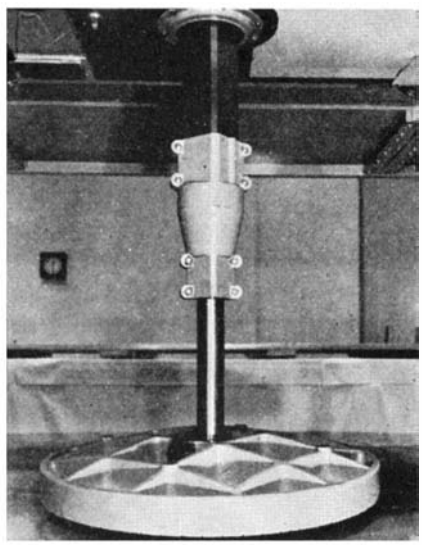
In 1927 I was asked by the editor of *Harper's Magazine* to contribute an astronomical article. "The Possibilities of Large Telescopes" seemed an attractive subject, so I described some possibilities suggested by the Mount Wilson experience. A proof of this paper, sent to Dr. Wickliffe Rose, then President of the General Education Board, led within a few weeks to a gift to the California Institute of Technology for a 200-inch telescope and a complete astrophysical observatory, with laboratories, shops, and auxiliary equipment.

Although I had been a trustee of the California Institute for many years, I was still a member of the Mount Wilson staff, and had not the faintest idea of establishing a new observatory for the Institute when I wrote to Dr. Rose. I had hoped that the 200-inch, if it could be obtained, would be given to the Carnegie Institution for the use of the Mount Wilson Observatory, but Dr. Rose thought otherwise. The Carnegie Institution and the California Institute had worked in co-operation for years, but it could not be denied that the needs of the graduate school of the Institute, combined with the facilities offered by its very able staff and its physical and chemical laboratories, offered new and promising possibilities. However, if another observatory was to be provided, a special problem of organization and design was evidently called for.

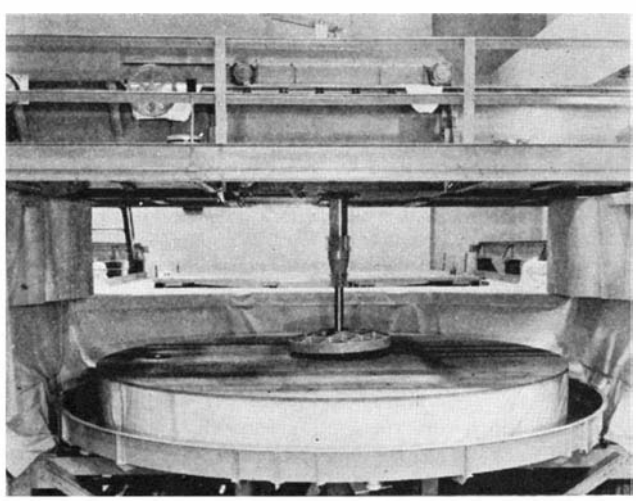
The Mount Wilson Observatory, with its three solar telescopes, its 60-inch reflector, its 100-inch reflector, and several other major instruments on Mount Wilson, aided by its laboratories, computing division, and shops in Pasadena, was at the height of its efficiency, and any solution adopted evidently should not interfere with its future researches. The equipment of the new observatory must therefore be designed so as to supplement, rather than to duplicate, the astronomical and physical instruments and other facilities already available, and a closely co-operative scheme of research must be devised.

The solution was simple, and I prepared a general outline in New York as soon as I found that the desired co-operation between the two institutions could be arranged. Dr. Adams, my successor as director at Mount Wilson, felt that a better site could be found under present conditions for the 200-inch telescope, and a search lasting several years has recently resulted in the selection of Palomar Mountain, in San Diego County. The headquarters of the staff will be in Pasadena, in touch with the California Institute and the Mount Wilson offices and laboratories. An astrophysical laboratory on the grounds of the Institute will provide space for this staff, with such laboratories as will adequately supplement those already available. Near at hand, also on the Institute campus, are the necessary instrument and optical shops. These are also equipped so as to supplement the corresponding shops of the Mount Wilson Observatory, which are still as busy as when they were erected in 1904.

The 200-inch telescope is being designed so as to reach all parts of the heavens seen from our latitude, and will be provided with a variety of auxiliary apparatus. Several types of mounting have been studied, and investigations are still in progress on the final model. A satisfactory type of tube has been designed and rigorously tested in the form of a one tenth scale model, and attention is now centered on the kind of bearings best adapted to support the north end of the (yoke) polar axis. The ratio of focal length to aperture decided upon is $f/3.3$, to permit the faintest and most remote extra-galactic nebulae to be photographed. Thus the principal focal length will be about 55 feet. The great size and stiffness of the tube will permit an observer to be carried in a cartridge-shaped chamber, mounted at the center of the tube at the principal focus. Such a house, affording ample space for the observer, will obstruct only a very small fraction of the total light falling on the 200-inch mirror—no more than a Newtonian mirror would do. Electrical controls within easy reach will permit the observer to move the telescope at will and to observe celestial objects visually or photographically, with spectrographs, or with such instruments as photo-electric cells. The small field of good definition given by an $f/3.3$ mirror will be adequately increased by a correcting lens designed by Dr. Frank E. Ross.



Close-up detail of the high-speed spindle and 48-inch grinding tool



The high-speed spindle attachment and 48-inch grinding tool attached to the 200-inch grinding machine

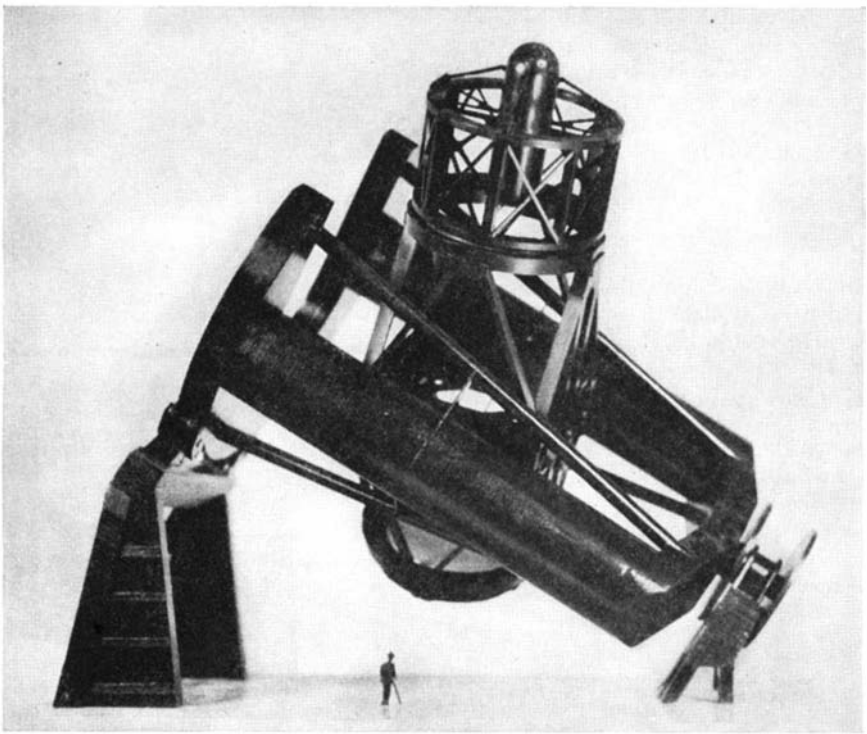
Convex mirrors, to transform the telescope instantly into the Cassegrain or coudé form, will be mounted below the principal focus. One of these, when turned into position by an electric motor, will give a large and well-defined star field below the perforated 200-inch mirror, where direct photographs or spectrograms can be taken.

A special attachment, to be used for the first time with the 200-inch telescope, will be a pair of cradles parallel to the polar axis, hung on opposite sides of the (hollow) declination axis, and so geared that they will hold any instrument in a vertical plane as the polar axis revolves when following a star. Thus a long and powerful spectrograph, or such a delicate device as the most sensitive radiometer, can be employed to excellent advantage on any part of the sky. The converging beam will be sent to the slit or radiometer vane after reflection from a 45 degree plane mirror at the center of the tube and a totally reflecting prism mounted before the slit or vane.

ANOTHER Cassegrain mirror, in conjunction with a plane mirror, will form a star image in a fixed position south of the hollow polar axis. Here it can be analyzed by several powerful spectrographs, mounted on a massive pier in a constant temperature chamber.

An agreement has just been made with the Westinghouse Electric and Manufacturing Company to build the 200-inch telescope mounting at their Philadelphia plant, after its design has been completed at the California Institute.

Because of the low coefficient of expansion of fused silica, a long and seri-



A simple little wooden model, incomplete in several respects, of the mounting for the 200-inch mirror. It is being studied by the Engineering Committee

ous effort was made by the General Electric Company to manufacture large mirror disks of this substance. Dr. Elihu Thomson and his associate, Mr. Ellis, undertook many ingenious experiments, which I have briefly outlined in the *Astrophysical Journal.* In spite of the extreme difficulties encountered, they were successful up to a certain point, but a 200-inch disk proved to be unattainable.

Fortunately we could turn to the unique resources of the Corning Glass Works, where a new form of Pyrex, especially adapted for our needs, was developed by the research staff under the general supervision of Dr. Arthur L. Day. An excellent 120-inch disk, which has been partially ground in our optical shop, was soon produced, and a 200-inch disk is now practically ready for shipment to Pasadena. We are greatly indebted to Dr. Day and the Corning Glass Works and especially to Dr. Hostetter and Dr. McCauley for their skilful work.

A 120-inch grinding machine, and a large one for the 200-inch disk, have been designed and built in our shops. The base of the tube for the 200-inch telescope, built after our designs by the Baldwin Works in Philadelphia and the Babcock and Wilcox plant in Barberton, Ohio, has recently arrived at our optical shop. Approximately 20 feet in diameter and four feet deep, and weighing about 19 tons, it will serve as the turn-table of the 200-inch grinding machine. Within it the 200-inch Pyrex disk will lie on its special support system during the long process of grinding, polishing, figuring, and testing.

In addition to a series of spectrographs, from those giving the very low dispersion serving for radial velocity measures of the extra-galactic nebulae to the large and powerful instruments required for the adequate analysis of the bright stars of our own galaxy, much other auxiliary apparatus is needed. But before speaking of some of this apparatus, two other methods of increasing the efficiency of the 200-inch reflector should be mentioned.

The first of these is the process of aluminizing telescope mirrors, first developed on a large scale by Dr. John Strong of the California Institute. Aluminum mirror surfaces, deposited electrically in a high vacuum, have many advantages over silver. They do not require burnishing, and thus are free from the diffuse light produced on silver by the rouge on the burnishing pad. This is admirably shown by the much greater clearness with which such objects as the companion of Sirius can be seen. Their coefficient of reflection is high over a long range of wavelength, especially in the ultra-violet. This results in an increase of about 50 percent in total reflecting power. Examples of the gain thus obtainable are shown in Wright's photographs of the ultra-violet spectra of planetary nebulae and the large extension of the Ring Nebula in Lyra photographed by Duncan with the 100-inch telescope. Equally important is the fact that they do not tarnish like silver, an advantage best appreciated in the case of large telescopes (the 200-inch mirror, though lightened by its ribbed back, weighs nearly 20 tons).

The small field of sharp definition of telescope mirrors having focal ratios ranging from $f/5$ to $f/3.3$ is well known. An extensive study of this problem, now being made for us by Dr. Ross of the Yerkes Observatory, has greatly improved the efficiency of several large reflectors, and will be still more important in the case of the 200-inch telescope. Dr. Ross has already computed many types of "zero" correcting lenses, which are mounted near the principal focus of the large mirror. Some of them are described in various papers published in the *Astrophysical Journal.*

In order to photograph the spectra of the faintest nebulae, lenses of very short focal length are used in the cameras of special spectrographs. Dr. W. B. Rayton, of the Bausch and Lomb Optical Company, succeeded in designing a lens having an equivalent focus of 32 mm. and a relative aperture of $f/0.59$. This high-speed lens, when used by Mr. Humason with the 100-inch telescope, cut down the exposure time for a twelfth magnitude star from two hours to ten minutes, using two prisms. It is with this lens that the radial velocities of the very remote nebulae have been photographed, leading Dr. Hubble to the determination of the linear relationship between their velocity and distance ("the expansion of the universe").

THE Rayton lens is designed on the type of a 4 mm. microscope objective. Recently Mr. R. J. Bracey, of the British Scientific Instrument Research Association, has designed for us an immersion objective of the extraordinary ratio of $f/0.36$. This lens, made by Beck, should be decidedly faster than the Rayton lens. It gives sharp spectra over an adequate range of wavelength, the focus being on the plane surface of the rear lens of the system, with which the film of the photographic plate is kept in optical contact by a special immersion fluid.

Other auxiliary instruments of great sensitivity and usefulness have been designed for us, including the photo-electric amplifier of Dr. Albert E. Whitford, already applied with great success by Dr. Joel Stebbins on Mount Wilson. With the 100-inch reflector the limiting distance at which a candle could be detected by this amplifier is 3000 miles, assuming no absorption in the atmosphere beyond one mile. Important improvements of the radiometer have been made by Dr. Sinclair Smith, and Dr. Charles G. Abbot, who has already succeeded in measuring the energy curves given by the spectra of several stars at the coudé focus of the 100-inch telescope.

In a more complete account of the above work given in the *Astrophysical Journal* (September 1935) I have added a description of a search for the best

(*Please turn to page* 293)

OUR POINT OF VIEW

Industry and Employment

PERHAPS the most significant point yet brought out in connection with the question of technological unemployment is the fact that, although the population increased 62 percent from 1899 to 1929, the number of gainfully employed persons rose 69 percent. In this particular period, marking the rapid mechanization of American industry, more workers were required, in proportion to population, than ever before. During that period, the national income rose from a mean average per worker of 547 dollars in 1899 to 1719 dollars in 1929, the income per worker rising 215 percent in dollars, or 48 percent in purchasing power. Thus the question of technological unemployment becomes merely an academic one. It is all a matter of viewpoint. Each new machine, or set of machines for a particular process, does necessitate a temporary period of adjustment, but by the long view is seen to add new employment.

In a new book "Machinery, Unemployment, and Purchasing Power," by the National Industrial Conference Board, the economics of the machine are once more elucidated in a fact-finding study that withstands a most searching analysis. To the figures quoted above, others equally as pertinent may be added. There is, for example, the unquestioned fact that in the 50 years ending in 1929, 18 new industries came into being and accounted for an 18 percent increase in total employment. Manufacturing as a whole employed 29 percent of the working population as against 21 percent 50 years earlier. No more definite proof that machines make jobs could be adduced.

The status of the trade, transportation, and service industries has also shown vast improvement. These three absorbed only 10 percent of the workers in 1879 but 29 percent in 1929. Domestic help jumped from 10 to 13 percent. Yet machines innumerable have been developed to "compete with" human labor in all these fields.

As a Parthian shot, the Board's study dispels the delusion that present unemployment is permanent, a point on which there is a continual babble of uninformed argument. Industrial production in June, 1935, stood at 71 percent of the 1929 average, yet employment was 76 percent.

Despite facts and figures, however, the country will probably continue to be treated to the spectacle of spell-binders urging audiences to smash machines or perpetrate some other equally foolish act. "Because of the machine" they have already urged reduction of working hours to a ridiculous point. What would have been the status of American industry today—indeed, of the American worker—had such misguided zealots fought their fight and had their way at the birth of the now enormous electrical industry just 50 years ago!

Japanese Example

COLDS are so often of an epidemic nature, and are so common to all seasons of the year, that it would be greatly to the advantage of our country to adopt a certain Japanese custom which has been recommended by Dr. John E. Loveland, a Middletown, Connecticut, physician.

The Japanese, instead of shaking hands, bow deeply and often several times when they meet socially. In a room full of Japanese this habit shows itself to be a gracious, cordial address, fully as friendly as our hand shake.

We may well imitate the Japanese in their forms of politeness, for they have a reputation of being among the most polite people in the world.

In our country a person with a cold contaminates his hands by his handkerchief and then, in shaking hands, inoculates other hands. If a public enemy wanted to start an epidemic of colds in a city, he could accomplish his purpose effectively by hiring a person with a cold to go about shaking hands with as many persons as possible.

In Copenhagen, in a large laboratory, the staff and guests are instructed not to shake hands.

If we could do away with this uncleanly and infectious habit in our country we would probably prevent much discomfort and loss of time from colds, and by preventing epidemics we would lessen loss of life among infants and old people. Pneumonia usually is ushered in by a cold.

The embarrassment of refusing a handshake can be avoided by substituting a more kindly tone of voice and more of a smile and bow.

If a group of our leading people such as our college professors, judges, and doctors—especially the doctors—would start the hygienic bow agoing they would be public benefactors.

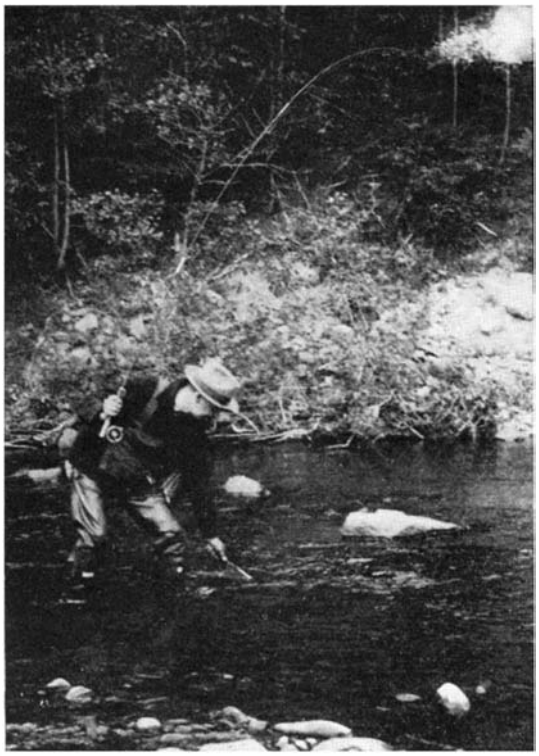
Placards could be used in places of congregation, requesting the omission of hand infection. With very little effort we could break up the unnecessary passing around of the bad that is temporarily in us. What misguided cordiality it is to distribute disease under the disguise of a friendly hand-grasp. Many of us realize this fact but feel that we must continue to follow the conventional method of greeting because it is conventional. But it is a conventionality which arose before the age of science, and in our era it is essentially unscientific.

American Practice

SHORTLY after the war, at a time when America had already outstripped the world in paved highway construction, we read with amusement one British writer's reason for the high power of American cars. Their high power, in contrast to contemporary European practice of building low power cars, was necessary, said the commentator, to negotiate roads of our wild and undeveloped hinterland! Europeans are now beginning to understand the real reason, and are rapidly adopting American practice. The change is coming about because of the new high-speed highways being built on the Continent.

In Germany and Italy, particularly, have great highway construction programs been carried out; and in our last issue was published a short item on Europe's Highway No. 1, which is eventually to link London with India and South Africa. On highways such as this, where there is no speed limit, old-style engines burned themselves out and fell apart after an hour or so of hard running. And there is no question as to hard running, for the German highways have two lanes, each to accommodate four cars abreast; and both these and the Italian Autostrada are toll roads having no grade crossings. The result is that the old type European engines are being re-designed along American lines, with particular attention to bearing pressures, methods of lubrication, and safety factors. Designing engineers everywhere are receptive to American ideas. They seem especially interested in the use of aluminum cylinders and in latest American combustion chamber design.

As the user of more cars than all the rest of the world combined, America has been the proving ground of highway and automobile practice. It is to be hoped that other nations, in drawing on our experience, will also observe and heed the warning of our vast number of automobile accidents. They can draw many lessons therefrom, if they will.



Do Hatchery

SOME people think that hatchery trout are as far removed from a real trout as a Caspar Milquetoast is from Mussolini. They deem them nothing but caricatures of the fish that once filled our clean, cold streams and lakes. They judge them helpless, unfit, over-fat, tasteless, pampered degenerates raised at great expense and turned loose to perish unless some deluded angler catches them first as a substitute for real fish.

If these contentions are accurate, then the fishermen of our land are in a bad way indeed, for no other way is left to provide fishing at home except to release these same hatchery-reared trout.

It has been said time and time again that trout are just incidental to the outing; that the real joy of fishing lies in the blue sky overhead, in the bits of bird song, and in the play of sunlight and shadow on the riffles. All very nice—*but* show us a man who does not feel ever so much more appreciative and soothed if the trout are there and rising and if his creel sags a little heavier as the hours pass!

Full creels today, however, would indeed be rare if it were not for the restocking of trout waters by states, government, and sportsmen's clubs everywhere. Each year there is a cry for more and larger fish and each year sees our streams whipped harder. It is no wonder that, with the demand for an ever-increasing output, our fish-rearing establishments have not had much time to see if they were turning out the best sort of trout possible. Trout rearing at its best is a gamble and all too often the fish culturist is too busy being thankful for any kind of output to do much worrying about any shocking differences between the appearance and behavior of his pets and the wild fish they are intended to replace.

Fortunately, there has been so much learned about the feeding and care of trout that it is no longer necessary to turn out ludicrous imitations of the genuine article. It is possible to raise trout at hatcheries in no way inferior as to shape, color, and vigor to the typical wild fish. I do not say that this is being done everywhere, but it is possible where environment and diet are correct.

Such an improvement in hatchery trout is the result of years of experimenting not only by the United States Bureau of Fisheries but by other agencies. For example, the Bureau of Fisheries in 1925 turned over a trout hatchery at Pittsford, Vermont, to be devoted entirely to research in trout culture. The business of this hatchery is to make the fishermen of the country more agreeable people to live with by finding means to provide them with bigger and better trout at less expense. Thus, studies in the diagnosis and control of fish diseases, elaborate feeding tests, selected breeding work, and a program of stream improvement and related studies of trout stream production have all played a part in the task of restoring our overworked trout waters to a semblance of their former status.

THE starting food usually used at the Pittsford hatchery is finely ground beef heart or liver. Heart, lungs, liver, and spleen of swine, sheep, or cattle are time-honored hatchery foods. Fish is also used extensively in some situations. At Pittsford various dried products, when mixed with finely ground liver, make the trout grow faster. Dried foods successfully used have been fish meal, meat meal, dried buttermilk, clam-head meal and others. Salmon egg meal makes the fish grow faster and gives better color than the others. The food bill is always the chief item on the list of hatchery expenditures. Dried foods must never be used alone; some fresh meat is required to keep the fish in condition.

The present article, however, considers only the results of some experiments designed to find out whether the trout produced in the course of the work would be worth anything as game fish.

The first test involved 100 marked brook trout liberated in August of their second summer in an excellent trout stream adjoining the hatchery. The primary object of the experiment was to see if the fish were capable of finding their own food soon after planting or if there would be a gradual period of adjustment to a new environment. Their behavior as sporting fish was, of course, of equal importance.

It was planned to give the fish approximately 24 hours' liberty and then to commence taking a daily sample of ten fish with rod and reel until all, or as many as possible, of the fish were recaptured.

On the day following liberation the first assault was made on the planted

Weighing food to be fed to trout at the Pittsford, Vermont, hatchery

trout. As I approached the brook I admit having felt a bit excited, for I was intensely interested in seeing whether those trout would respond to flies in true game-fish fashion. There was not long to wait! In the fast current of the first liberation pool a trout hit the gray hackle with force and accuracy, and from the rise until he twisted on the shore he did his best to undo his fatal mistake. An angler who found fault with that battle for freedom would be a hard person to please. As I went about the business of preserving the stomach in a bottle of formalin for future study, and setting down the data as to the place of capture and so on, I found myself wondering if this well-behaved fish was the exception, but before the daily sample had been taken all doubts had vanished. Those hatchery fish needed no

Trout 'Go Wild?'

Restocking is the Trout Fisherman's Only Hope for the Future . . . Proper Methods . . . Results of Hatchery Experiments . . . "It Can Be Done"

By RUSSELL F. LORD
In charge, U. S. Experimental Trout Hatchery, Pittsford, Vt.

one to apologize for them in any respect.

The brook itself was low and clear and it was soon found that as much care was necessary in approaching pools as in any ordinary fishing. A sudden movement on the shore would send the fish darting for cover as if they had spent all their lives in avoiding mysterious shadows on the edge of their watery world. When they decided to take a fly they struck hard and acted as trout should act. Due to a diet designed to bring out the colors, they were as brilliantly marked as the ordinary wild fish. And, incidentally, the flavor of the specimens was not to be adversely criticized!

Not only were these fish proving to be on the alert for food, but they were actively competing with the trout already present in the stream. For example: On one cast the angler hooked and landed not one fish, but two! A wild rainbow and one of the newly-planted brook trout had both struck the moving flies and of the two fish the brook trout was more firmly hooked. Rainbow trout have a habit of getting under way like lightning once they decide on something tempting, but the hatchery-reared brook trout was equally alert.

THE stomach of the brook trout showed an interesting assortment of food. The posterior end still contained remains of the last hatchery meal, while the anterior end contained 13 freshly taken caddis worms and a few mayfly nymphs. This did not look as if the pampered hand-raised trout had been very much handicapped by its former confinement.

Fishing continued until 82 of the 100 brook trout were recaptured and every moment of it was real fishing. The trout responded when it pleased them to do so and before the final score could be tallied the anglers were forced to resort to a variety of lures. The fish definitely did not "come easy."

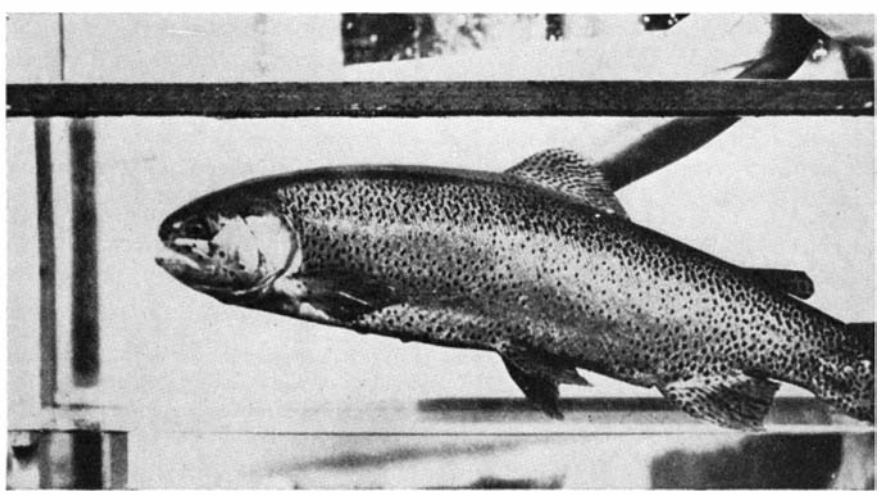
Every stomach was preserved and contents analyzed. If it is assumed that hatchery trout must gradually learn to forage for themselves because of their new environment, we might expect to find a steadily-increasing number of food organisms in the stomachs as time passed. Such was not the case. Nothing resembling a daily increase in the amount of food was observed. The only conclusion possible, therefore, is that hatchery environment had little deleterious effect on the ability of the fish to forage for themselves on short notice. In fact, the average number of insects per stomach was very close to that found by another investigator who examined the stomachs of a large sample of wild trout from New York State waters.

It is not surprising that hatchery fish can take up the business of foraging. One has only to observe a pond of fish during the summer when the midges are active or a hatch of mayflies is on in a nearby stream. I have seen fish jumping in the Pittsford ponds so steadily that dozens of them were in the air at once, and they kept it up as long as the insects were active. At other times the fish in the ponds have been observed working over the bottom gravel, picking it up in their mouths and ejecting it with force. This winnowing process allowed the heavier gravel to sink while the midge larvæ, which represented the gold of the mining activities, were snapped up before they settled to the bottom. Often too, when fingerlings are being transferred to outdoor pools, the first pailful of transplanted fish can be seen reveling in their freedom and jumping for low-flying midges before the second pailful of young fish has been brought from the hatchery. From my observations it seems that a trout on being liberated is as pleased as a small boy quietly raiding the ice-cream freezer on a school picnic. Everything is his; lots more of his favorite food and nobody to curtail any little whim!

THE general conclusion is that the anglers of our country need no longer feel too downcast over the passing of typically wild trout. Hatcheries can, if they follow the right methods, rear trout capable of taking care of themselves on being planted and that will be pleasing to the anglers as game fish. This can not be done, however, by holding fish in an unsuitable environment and feeding them the first thing that comes handy. Not all hatchery-reared fish can be expected to meet the requirements. The hatchery environment should approach as closely as possible the waters to be stocked. Over-fed trout reared in relatively warm, crowded pools can not any more be expected to make good in a cold, swift stream than a soft city man can be expected to duplicate the feats of his northwood's guide. In short, our trout fishing near home is entirely up to the hatcheries, and it is up to the hatcheries to see to it that the fish put out are something worth the expense of rearing and the effort of catching. The bright spot is . . . *it can be done.*

●

Sportsmen can do much to promote better fishing in their localities by urging scientific methods in their own hatcheries. More emphasis should be placed on better fish than on quantity production.—The Editor.



That's a *real* trout. Note for comparison the man's arm helping this nine-pound hatchery-reared mamma rainbow trout to look pretty for the photographer

Cut Weight—Cut Cost

Welding's Rapidly Growing Importance . . . Used for Production, Patching, Repairs . . . Saves Weight and Thus Modifies Design Practice

By PHILIP H. SMITH

WELDING is revolutionizing production technique. Within the past half dozen years it has graduated from primarily a tool of repair to a foremost tool of production.

In almost every enterprise which involves joining of metal, welding has been introduced because it permits faster, cheaper, and better work, and produces a stronger and lighter product.

It is welding to which we owe the low-priced automobile without squeaks and rattles, the streamlined train, the railroad track without the clickety-click at rail joints which makes for passenger discomfort and maintenance expense, and airplanes which fly to the Orient on schedule.

Welding can be made to serve several purposes, although it is strictly a process for joining metals. It can be used for fabrication, for repair of broken or worn parts, and for hard-surfacing parts in new equipment or machinery which have become worn in use. A major, indirect achievement is reduction of product weight. Welding strikes at the weight problem from several angles and in so doing it creates new standards. It does away with bolts, rivets, and re-inforcing sections in joining metal pieces. Elimination of rivet holes makes for greater strength, hence smaller sections can be used. Welding also makes possible the use of high strength steels in place of castings. This means the elimination of useless re-inforcing metal as well as a lightening of the product itself by virtue of using a stronger material.

Flame welding, as an efficient mender-of-metals, quickly repairs broken machine parts of all kinds

IF you search through books to find out why welding has suddenly become so important, you will get little satisfaction. Welding is not a new art. Gas welding goes back nearly 40 years; resistance welding has been known for 50 years; the first patent on the carbon arc was issued about 50 years ago, and one on the metallic arc followed immediately. Current achievements cannot be explained by a simple recitation of discoveries, because they really stem from a series of minor developments.

Welding is a primary tool of industry today because a few pioneering souls kept everlastingly pushing it. Scientific American prophesied a great future for it some 15 years ago—despite the terrific fight that was being waged against it—but it takes a long time to overcome industry's resistance to the new. It requires pressure and in this case the "push-over" was given by the depression. Manufacturers seeking greater economies in fabrication found welding ready to be used and coincidental developments made it much more practical and dependable than ever before.

Welding metallurgy, practice, and equipment have all been improved. It has been learned, for example, that metals can be made more weldable by adding small amounts of other metals to the base metal, or to the electrode, or to both. A case in point is the addition of columbium or titanium to stainless steel to reduce the formation of carbides and to give welds which will not corrode. Copper, long regarded as difficult to weld electrically, is now being handled very easily by the "long-arc" process. Advances in equipment cover an even wider range. Multi-flame torches have reduced costs and increased speeds in oxy-acetylene welding, while electric welding machines have been made largely automatic in operation so that high speeds can be maintained and good welds produced with a minimum of worker fatigue.

One of the most ingenious equipment developments in arc welding is the coated electrode. It is well known that certain metals oxidize readily at high temperatures, and the formation of oxides is apt to result in imperfect welds. To get around this risk, the electrode is covered with a flux coating which fuses along with the wire. The flux protects the metal while going through the arc and covers the deposited metal to exclude practically all oxides and nitrides while the metal is solidifying. Such coatings contain a substance to help maintain a steady arc, the stabilizer usually being titanium dioxide.

Today a manufacturer has at his disposal a number of different welding processes to meet the varied requirements of material and design. These types are: gas, electric arc, flash, resistance, atomic hydrogen, and thermit; a brief description of them will aid in a later portrayal of achievement.

GAS welding burns acetylene and oxygen to supply the necessary heat for fusion. Recently it was discovered that an excess acetylene or carburizing flame has a marked advantage in the welding of plain carbon steels because it increases speed and efficiency. Its paramount use is for welding overland pipe lines and industrial pipe.

Arc welding employs either a carbon or metallic electrode. When the carbon electrode is used, additional metal is supplied by a filler rod as in acetylene welding; the metallic electrode itself melts down in the heat of the arc to supply the weld metal. Metallic electrodes differ in composition depending upon the kind of metal to be welded, and the various metallic ingredients are introduced to the deposit either from the rod or the coating.

Flash welding likewise employs an arc. Pieces to be welded are placed close together and then separated to create an arc. When sufficiently heated, the pieces are brought together under pressure.

Resistance welding covers all types where resistance to the passage of an electric current generates localized heat. Under this classification come butt, spot, and projection welding. Butt welds are made by clamping work in close contact and letting the current flow until the joint is heated. Union is then made by applying a forging pressure. Spot welding is performed by placing two sheets of metal in contact between tapered electrodes and permitting a low voltage, high amperage current to pass through the circuit for a brief period to fuse the metal at the electrode points.

A PROJECTION weld is a modified spot weld. Here projections or buttons are raised on the sheet or plate at the points to be welded. When a current passes, the projections themselves act as electrodes and a series of welds are thus made in one operation.

Spot welding has two other forms which are important. One is seam or stitch welding; the other, shot welding. Seam welds resemble stitches in appearance because the weld is formed by a series of overlapping spots. The electrodes are fitted with rollers and the work is fed between them to effect a series of intermittent welds. Shot welding, sometimes called electro-percussion welding, calls for the passage of a low voltage, high amperage current between copper electrodes and through the plates to be welded, the electrodes pressing against the outer sides of the plates. This achieves an intense, quick heat which does not penetrate to the outer faces of the metal where it would reduce the noncorrosive properties. Momentary high surges of power are obtained without high kilowatt demand by means of a condenser or an inductive winding which constitutes a potential reservoir. This reservoir fills and overflows with each shot.

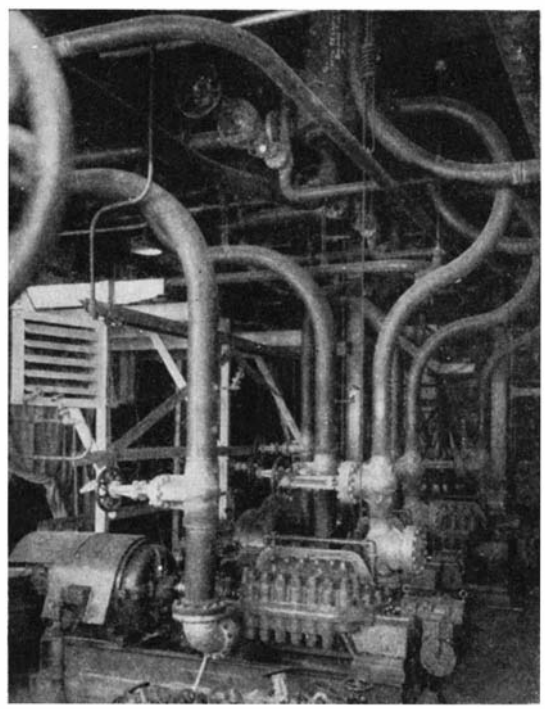
Atomic hydrogen welding is relatively new. In effect, a stream of hydrogen is passed through an arc between tungsten electrodes. The molecular hydrogen breaks down into the atomic state with absorption of great heat. Upon leaving the influence of the arc, the hydrogen reverts to the molecular state, giving up its absorbed heat to the metal which it fuses. The hydrogen creates more heat while burning and also excludes air from contact with the weld.

Thermit welding utilizes the reaction between powdered aluminum and iron oxide at high temperature. A charge of these materials is ignited in a crucible and when the temperature rises above 2800 degrees Fahrenheit, the aluminum unites with the oxygen of the iron oxide to set free the iron at a high temperature. At this point the molten metal is allowed to flow around the joint to be welded, to melt it and then to solidify to form a homogeneous mass.

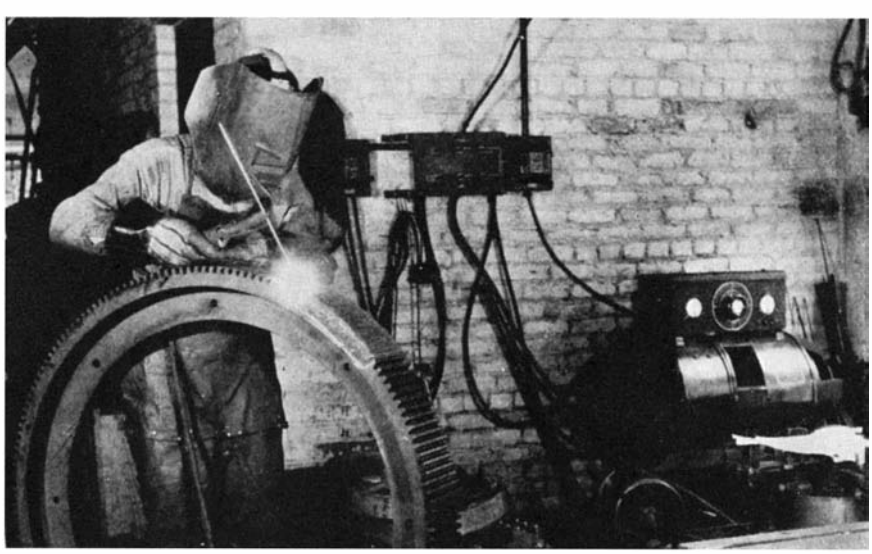
Industries which have to do with transportation afford the most striking examples of the use of these processes in fabrication. The automobile industry sets the pace. This can be attributed in part to the proverbial willingness of the automobile manufacturer to adopt anything which will bring about production economies, and in part to the fact that producers of moving mechanisms are most conscious of the importance of weight reduction.

A vast amount of development work had to precede the application of electric welding to mass production. Means had to be found to repeat the welding cycle automatically and control had to be established over pressures, heat, and timing. Welding had to be made a precision operation before it could be fully accepted. Now with that goal attained, electric welding has become a genuine tool of mass production.

Resistance welding is well suited for automobile manufacture because it affords the means for uniting forgings and stampings into strong, light, integral parts at a speed unequaled by most other processes. One of our lowest priced cars boasts more than 3200 welds, and to put them in requires more than 600 welding machines and over 1000 welding torches. Gas, flash, butt, spot, seam, and electric-arc welding are employed. The fuel tank, for example, is made in halves and united by seam welding. The seam runs 102 inches and is finished in 90 seconds. Rear radius rod brackets are welded to the axle housing at the rate of 55 inches per minute, while a vast number of sub-assemblies undergo similar speed treatment.



Arc welded piping and valves



Arc welding, too, is an important tool for repairs. Here a broken gear is being given an arc-welded filling of new metal in which new gear teeth will be cut

To list all welding operations would be tantamount to describing all assembly; enough to say that the car body emerges as a single metal unit without bolt or screw to hold it together—and later to let it fall apart. The saving in time, material, and weight conspires to produce a vehicle that is better and cheaper than its counterpart of a few years ago.

The saving of weight made possible by welding is of paramount importance in aircraft construction. High-strength alloy steels, welded together in lasting union, spell low weight, high performance, and maximum safety. The *China*

Clipper, which has mastered the Pacific, reveals exceptional use of welding as the following item will testify. The engine mounting comprises two circular brackets made of 18- and 12-gage chrome-molybdenum tubing, welded to form. It weighs but 74 pounds yet it supports an 800 horsepower engine weighing 2380 pounds, and takes the vibration without a whimper.

The railroads are a little behind the procession but are coming fast. Here again weight reduction is vital to operating efficiency. The railroads recognize that their come-back depends largely upon a modernization of equipment, leading to higher train speeds and increases in pay loads. Their steps to this end involve the use of high-strength alloy steels coupled with welding.

THE Burlington *Zephyr* is an example of welding progress. The bumper, engine bed, and bolster are formed from high-tensile-strength steel alloy plates arc-welded together. The Diesel engine-block is built up from welded steel plates. The body proper is constructed entirely of cold rolled stainless steel, shot welded. Stainless steel, substituted for ordinary steel, achieves an ultimate strength of 150,000 pounds per square inch as contrasted to 45,000. No weakening of the structure is occasioned by rivet holes, nor are there any rivet heads to offer resistance to the wind.

Having seen motor truck bodies lightened, the railroads have applied the idea to freight cars, finding that welded alloy steels permit a saving of 25 percent in weight of hopper cars. This new construction gains a payload increase of 10,000 pounds per car and a corresponding reduction in dead weight to be hauled back empty.

Railroads have made shop use of welding for many years. Locomotive frames, driving-wheel spokes and centers, rocker shafts, cross heads, guide yokes, and a great number of other parts are kept in repair with welding. A new technique is to build up worn hub liners by simply depositing the right kind of bearing metal, saving time and cost of disassembly and replacement.

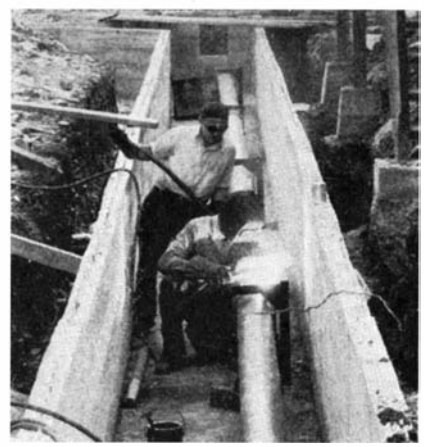
Rail maintenance is a big item in operating costs and is bound to increase under the hammering of higher speed trains. It is claimed that the railroads of the country repair 500,000 battered rail joints with oxy-acetylene welding every year and 400,000 with the electric arc. Now comes a scheme which promises to reduce this upkeep expense substantially.

The new idea calls for welding rail ends together to do away with the majority of joints. What we learned in school about the need for expansion joints between rails was all a mistake. Rails have been joined satisfactorily in lengths as great as 2600 feet, though the practice abroad where the method has been well tried out, is to limit lengths to about 400 feet. There is no warping or buckling of the rail and wear and tear is cut sharply. Some authorities say that maintenance can be reduced as much as 65 percent, and figuring rail upkeep at 300 dollars per mile per year, here is a potential saving of large proportions.

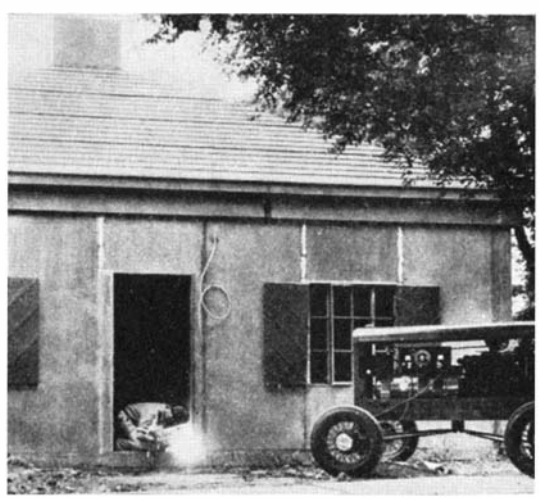
Reducing the weight of moving mechanisms is not confined to transportation. In the electrical industry a beginning has been made in replacing castings with fabricated structural steel, arc-welded, to save anywhere from 25 to 50 percent in weight. A typical example is a rotor for a synchronous motor, arc-welded from steel plates and rolled H-sections. A similar trend is observed in other industries where intricate shapes are cut with oxy-acetylene flame and then welded.

Welding has been pioneering in building construction for many years, but only now are real results appearing. The possibilities are very clearly revealed by the following comparison between welded and riveted types of construction:

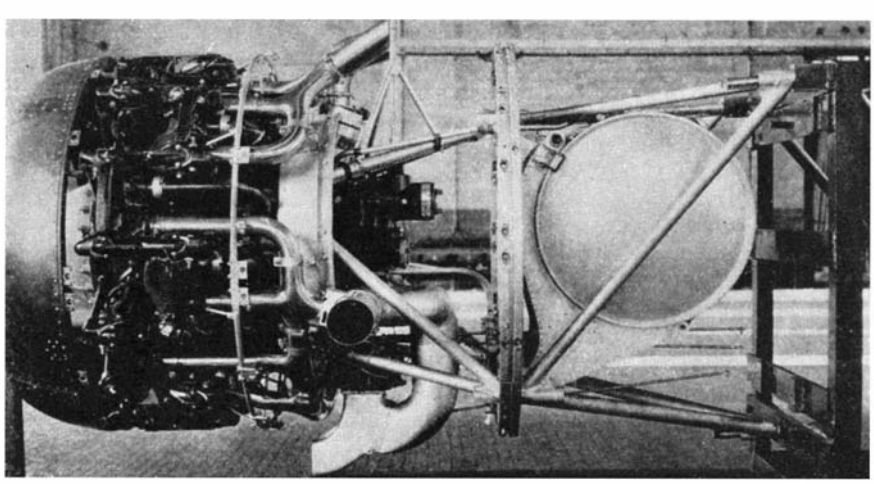
If we take a standard riveted beam,



Welding finds more and more uses in many phases of building operations and in engineering. Here the water main to a building is being joined permanently by the electric arc



Design of some of the newer, pre-fabricated houses is predicated on the use of welding of studs, braces, and the like. The design shown here is all steel and welded throughout



An engine of the *China Clipper* on its welded support. Weld strength is shown by weight of engine: 2380 pounds, and of the welded steel frame: 74 pounds

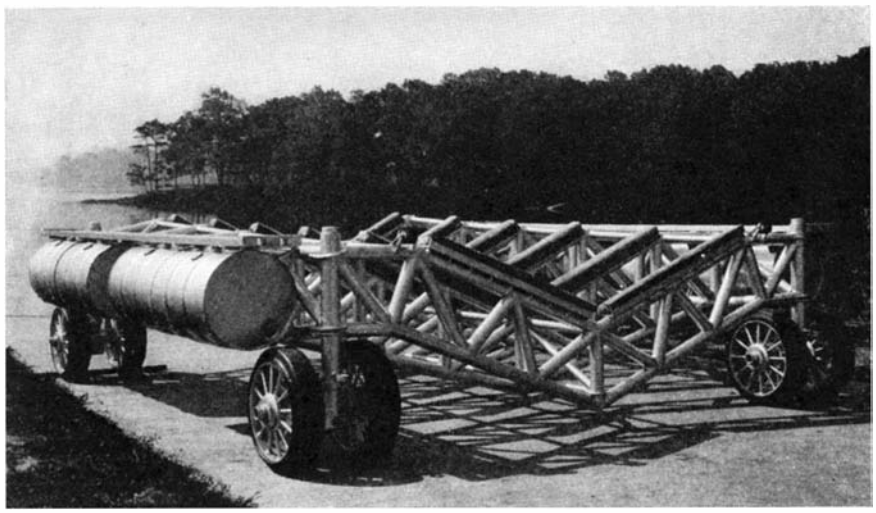
15 feet long, weighing 798 pounds, with an elastic limit of 55,000 pounds per square inch and ultimate load of 68,900 pounds, and switch to welding, the weight can be reduced to 785 pounds, yield point raised to 65,000 pounds and the ultimate load lifted to 77,200 pounds. If the beam is redesigned to make the most of welded construction, the weight can be reduced to 656 pounds, with the yield point holding at 65,000 and the ultimate load rising to 78,000 pounds. Generally speaking, welded construction can save from 15 to 30 percent in weight over the riveted form.

Probably the largest welded structure at the moment is the Sterling Memorial Library at Yale which soars 18 stories into the air. Under construction in Illi-

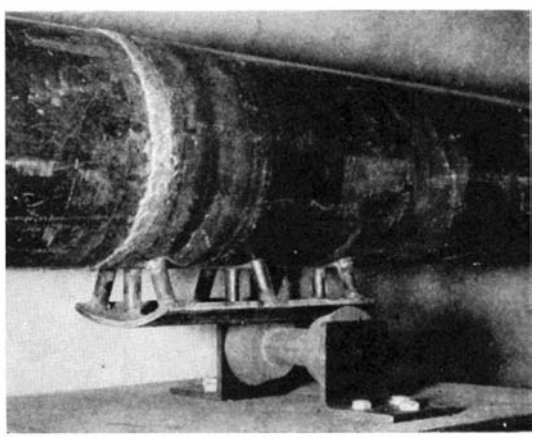
nois is a modern factory into which will go 2000 tons of welded structural steel and about 50,000 feet of weld. In residential building, notable work has been done in framing and now comes a welded house without frame.

This arc-welded structure, just announced, is made up of sheet steel panels: two sheets four by nine feet to a panel, with insulating material between. The panels are simply welded together and then sprayed with paint and white silica sand to give a plaster or stucco effect. Not a single nail nor a piece of wood is used. Such construction reduces the amount of material required, permits factory production of insulated panels, and speeds up erection on the site.

The qualities which make welding suitable for uniting structural steel are

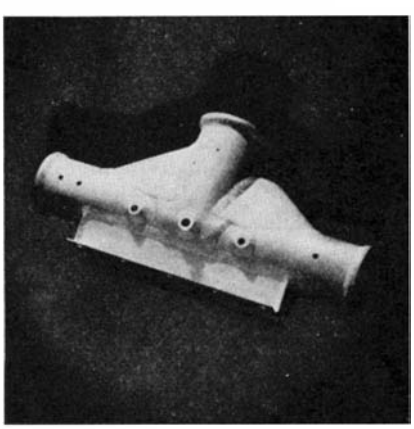


Unique "amphibian" landing truck for the *China Clipper*. Made of welded chrome-molybdenum steel tubing, this cradle is used to haul the giant plane ashore



An arc-welded butt joint and a welded steel roller support for a 14-inch steam pipe line

Welding does a production job. The strong, welded, airplane control socket shown below was made up of 18 pieces



those which recommend it for repair and construction of bridges. Pressed to find ways of maintaining bridges in the face of lower appropriations, one county highway department has adopted welding for all repairs of parts that have failed or suffered from corrosion. It has even gone so far as to salvage old bridges and re-form them to make new ones.

Among the many other uses of welding which have come to the fore in recent years, there should be mentioned the joining of pipe to make miles and miles of unbroken overland lines, and the installation of domestic and industrial piping of all types. The bulk of this work is being done with oxy-acetylene welding. Household refrigerators are full of welds today. Home and office furniture is being made of welded steel and even kitchen utensils are being fabricated with a welding process. Pressure vessels for industry and tanks for the storage and shipment of milk and chemicals are being fabricated from non-corrosive metals; this field has as yet hardly been touched.

In the field of industrial work, bronze welding is gaining rapidly as a means of repair. Practically all commercial metals can be so treated, the practice being one of depositing bronze from a welding rod, using the oxy-acetylene flame to melt the rod and to heat the base metal. Although the base metal is not melted and there is no fusion with the bronze, extraordinarily strong welds can be made.

Closely allied to this process is the bronze-surfacing of metal parts to improve their wearing qualities. Bronze-surfacing can be used on new wearing parts or to build up worn ones. When parts are subject to extreme abrasion as is common in mining, dredging, and drilling equipment, hard-surfacing can be effected by use of an alloy material. There are several such alloys now available; one is a chromium-manganese-iron; another is cobalt-chromium-tungsten; and the most recent to appear on the market is cast tungsten carbide, a material with near-diamond hardness. The carbide is crushed and screened and placed in a steel tube to form a welding rod. When the tube is melted by an oxy-acetylene flame the tungsten carbide is distributed evenly over the wearing surface and bonded by the steel from the tube. Hard-surfacing is in its infancy and destined to grow because of the dollar-and-cents saving.

With brass, bronze, aluminum, copper, and alloy steels now being welded successfully on a production basis, the manufacturer who would utilize the best that research has made available can no longer ignore welding as a tool of fabrication. The product may be tanks for industry, machine tools, or agricultural implements—it doesn't matter what—there is a strong probability that welding has something to offer.

MANY welding processes are now so automatic that operation is no more unpredictable than it is with the modern machine tool. This is true despite the fact that there remains a great deal of art in the technique of welding. Operation can be controlled and quality can be maintained, even at high rates of speed. Indeed, it is this high degree of control which makes speed and quality mutually inclusive.

The field for welding has only begun to open up, even though its basic principles *were* known a half century ago. We are now poised on the threshold of a new era. Welding, coupled with recent metallurgical developments, is about to transform the industrial world. And when its contribution is finally chalked up, perhaps the outstanding items will be the rejuvenation of the railroads and the unscrambling of the home building problem.

Photographs courtesy Climax Molybdenum Co., Hobart Bros., General Electric Co., and The Linde Air Products Co.

A Catastrophe That Did

Why the Billion-Ton Minor Planet which Recently Passed Closer to the Earth than Anything Ever Known to Astronomers did not Strike it . . . The Earth is Safe for a Long Time to Come

By HENRY NORRIS RUSSELL, Ph. D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society

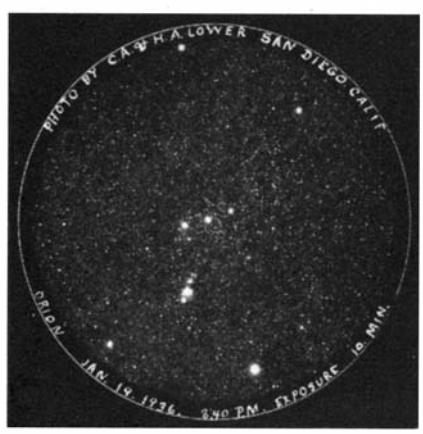
WITHIN the past month a discovery of unusual interest has been announced. On the 12th of February, Delporte, an assiduous and successful observer of asteroids, reported from the Belgian National Observatory at Uccle, near Brussels, the discovery of a faint object, of the 13th magnitude, in the constellation Leo, which showed a most unusual motion—south-westward at the rate of very nearly two degrees per day, which is eight or ten times the average rate for an asteroid near opposition.

Later observations—cabled to this country in answer to a request from Harvard—permitted the computation of a preliminary orbit, which showed that this body was receding from the earth, and rapidly growing fainter, and was in danger of getting lost. Fortunately, the weather cleared late that night, and a photograph showing the object was secured at the Harvard station at Oak Ridge by Whipple and Cunningham—the latter the computer of the orbit, who must have felt well repaid for the high-pressure work of calculation by this happy result. Since then, more observations have been secured at Harvard, Yerkes, and Lick—and doubtless also in Europe, though the mails which would bring them here have not yet arrived—and several computers have described orbits which agree well enough to make it evident that the newly-discovered body is moving in one of the most remarkable orbits known to astronomers thus far.

Figure 1, which is based on calculations by Mr. Herget and Miss Davis at Berkeley (the latest now at hand), shows the situation clearly. At perihelion, the orbit comes within 41 million miles of the sun—less than Mercury's greatest distance: at aphelion, the distance is slightly more than 300 million miles—more than halfway from the earth to Jupiter. The orbital eccentricity is 0.763, and the orbit resembles that of a comet, rather than a planet.

For this reason, the body has so far been called by the non-committal name of the "Delporte object." Van Biesbroeck, however, observing with the 40-inch Yerkes refractor on February 22, found that it appeared perfectly stellar, with no trace of hazy surrounding light—which is sufficient reason for classifying it as an asteroid. No other of the more than 1300 minor planets has so eccentric an orbit: but Hidalgo, discovered in 1920, runs it fairly close, with an eccentricity of 0.65.

Along with this high eccentricity goes a very low inclination, 1°25′. In consequence, the orbit passes very close to those of Venus, the earth, and Mars. In our diagram, the earth's orbit is supposed to be exactly on the plane of the paper. The other orbits come up through it at the points marked by cross-lines, and drop below again at the dotted cross-lines shown on the opposite sides.



A photograph of the constellation of Orion, taken by C. A. and H. A. Lower of San Diego, California, with a Schmidt telescope of the type described by Professor Russell in the number for July 1935. The telescope or camera has an aperture of 10 inches and a focal ratio of *f*/1 and its notable feature is the fact that, unlike telescopes with ordinary paraboloidal mirrors, it has a very wide undistorted field—up to 12 degrees in diameter. Built by H. A. Lower, such a telescope consists of a spherical mirror and at the upper end of the tube, a thin, irregularly curved, plano-concave lens whose function is to counterbalance the spherical aberration of the primary mirror. On examining the half-tone with a lens it is evident that various pairs of stars on the original have linked themselves together in the reproduction, but on the original negative the stars are everywhere tiny round sharp dots

The closest approach to the earth's orbit is at the point marked *A*, where the planet's orbit lies above the earth's, but by only 1/60 of the distance between either one and the sun—that is, no more than 1,500,000 miles.

This is the closest possible approach between the earth and the new asteroid—and it actually happened, very nearly if not exactly, on February 7th. When the planet was discovered, it was about eight million miles from us, and receding at the rate of a million and a quarter miles per day. By the end of February, it was 28 million miles away, and at the end of March it will be 80 million miles from the earth and twice as far from the sun.

ON the other side of the sun, as the planet comes in, its approach to the earth's orbit is not so close—about 2,200,000 miles—but still very much nearer than any other planet ever comes.

The approach to Venus' orbit, at the point marked *B*, is still closer—about 1,000,000 miles. The least distance from Mars is at *C*, and is slightly less.

A hypothetical inhabitant of this planet would therefore have remarkable opportunities of observing these three larger neighbors. The earth, at the recent close conjunction, would have appeared to him three fifths as large as the moon does to us—a conspicuous disk to eyes such as ours—nearly at the full phase as it approached, a half-moon when largest, changing rapidly into a crescent and shrinking as it receded. Venus, at a similar favorable opportunity, would look as big as the moon does to us, and Mars more than half as big. This little world would be a fine station for planetary observers!

They would have to be long-lived, though, to hope for many good chances. The planet's period is calculated as 2.55 years, or about 930 days. If it finds

Not Happen

the earth close by at a given return to the conjunction-point, next time the planet will be right away on the opposite side of its orbit. To get a really favorable approach, the earth, which moves 1,600,000 miles a day along its orbit, must return to this point within less than a day of the time when the planet reaches the corresponding place upon its path.

Among conjunctions, taken at random, therefore, not one in 500 will be as favorable as that which has just passed unobserved, and the average interval between them will be more than 1000 years. Venus moves faster and close approaches should therefore be somewhat rarer, while for Mars they may be a little more frequent.

PASSING from fancy to fact, we notice, conversely, that it may be as long before we dwellers upon earth may have another equally good chance to see the new planet. It must be a very small one. From the rough estimates of its brightness which are so far available, it appears that, if its reflecting power is similar to that of Mars or the moon, it is from half to three-quarters of a mile in diameter—a mere "mountain broke loose." Next year, when it is again in opposition, it will be near aphelion and it would appear like a star of the 22nd magnitude—beyond the power of even the greatest telescopes to reveal, even if we knew precisely when to look for it. When near perihelion it would, like Mercury, have a small angular distance from the sun, and would be very difficult to photograph. The only chance of finding it again would seem to be when it once more approaches one of the two favorable points at nearly the same time as the earth does. Unless it can be followed with large telescopes and very carefully observed, then it is lost in the distance even for them. It will not be possible to determine the period accurately enough to justify predictions over a long interval; and it may be a long time before it is observed again.

This strange little body sets one speculating. How has it been able to follow its orbit for millions of years without colliding with one of the planets which it so narrowly misses? In the short run, this offers no difficulty—a million miles is really fairly wide of even a planetary target. But in the long run, the inclination and eccentricity of its orbit will slowly change, as will those of the larger planets, owing to their mutual perturbations. A change of 1½° in the relative inclination of its orbit to the earth's would bring a chance of actual collision. We do not know, in default of laborious computations, how fast the planet's orbit plane will shift, but to change the plane of the ecliptic by 1½° takes about ten thousand years—so we and our immediate descendants appear to be safe. Even if the two orbit planes were, and remained, exactly coincident, there would probably be many years of grace before the crash. If, when the planet reached the point of intersection, the earth was as much as 10,000 miles ahead or behind, no harm would come of it. The actual danger zone (allowing for the oblique crossing) is about 12,000 miles in total width. Now the circumference of the earth's orbit is 600 million miles, so that there is only one chance in 50,000 of a collision. Fifty thousand revolutions of the asteroid would require about 125,000 years. Within a much shorter time, the perturbations of the orbit planes would abolish the dangerous grade crossing.

San Diego, 9 P.M., 10 seconds, *f*/1, Schmidt telescope. Lower and Lower

During the two billions or so of years since the solar system came into being, a good deal may have happened to this tiny planet. It has certainly never hit a larger planet—for in that case it wouldn't be here—but it may well have made a close approach to one of the planets, and been deviated by its attraction from a less sensational, and less dangerous orbit.

Despite these well-founded reasonings, a certain sense of insecurity remains. When we reflect that a projectile weighing perhaps a billion tons, and moving more than 20 miles a second, got by the earth, nearer than anything ever known before to astronomers, without being seen till it was well past, one starts thinking. Why it wasn't seen sooner is clear enough—it came from the region in the heavens close to the sun, and, when nearest, was in the region around the celestial pole, where planet-hunters do not work. If its orbit had intersected the earth's, and if it had come but a few hours earlier or later, we would have had no warning of the impending catastrophe. In any event, it would not have wrecked our planet, nor destroyed all life, or all civilization upon its surface, although it might have spread nation-wide devastation.

IF such a body should be observed at some fairly close approach, prior to the collision, and kept under watch till its orbit was precisely determined, it would be possible to predict the place, as well as the time, of the disaster, and one might imagine a systematic evacuation of half a continent to escape the peril. But the chance of such a thing is so excessively small that, from the actuarial standpoint, astronomers could not honestly ask for the endowment of an extensive "asteroid patrol" to forewarn us.—*Princeton University Observatory. March 4, 1936.*

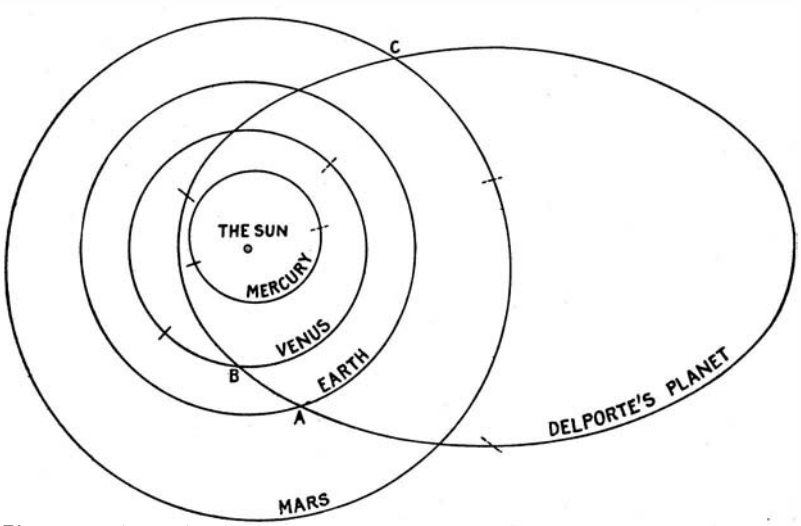


Figure 1: **The path of the recent visitor across the locality of the earth's orbit —though it is not exactly in the plane of the same orbit. See text for explanation**

SEEING IN

Made Possible by the Electron Lens . . . Focuses Electrons as Glass Lens Focuses Light . . . Useful for Secret Signalling . . . Image Fidelity

By VLADIMIR K. ZWORYKIN

Director, Electronics Research
RCA Manufacturing Company

Editor's Foreword: Seeing in the dark may be said to be one of the ends of research in electronics; in the accompanying article Dr. Zworykin tells briefly yet succinctly of the results that have been obtained. By the system described, it is possible to focus electrons that have been emitted from certain surfaces under the action of light, either visible or invisible. With such an electron lens it was only a step to the development of telescopes that can be used for seeing in the dark.

ELECTRON optics is a comparatively recent branch of the science of electronics, based on the similarity of electron paths through certain types of electric fields and those of light rays through ordinary lenses. This field of study shows that it is possible to shape electrodes in such a way that the electric field between them will act as an "electron lens," capable of focusing the electrons leaving a cathode into an image of that cathode. Such an "electron lens" is found to have properties almost identical with those of an ordinary glass lens. For example, the image must be in focus if it is to be sharp; the magnification is determined by the distance from the electron source or object to the lens and from the lens to the object; furthermore, the image will be inverted as is the case with an optical image. Just as the camera lens must be corrected if the image is to be free from distortion, so must the electron lens be corrected in order to obtain a perfect image.

Certain surfaces, such as cesiated silver, emit photo-electrons under the influence of radiation extending from the ultra-violet, through the visible, and well into the infra-red. If we could watch the electrons leaving such a surface when an infra-red image was projected on it, we would see close to the surface an "electron image" which is identical with our original projected image. However,

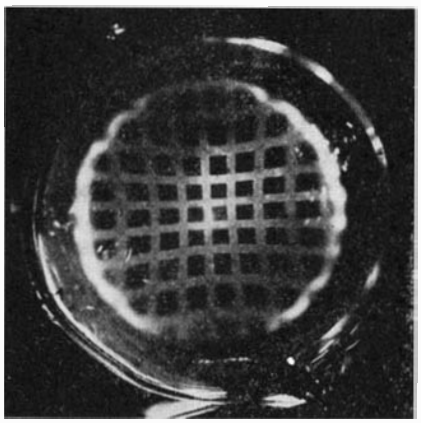
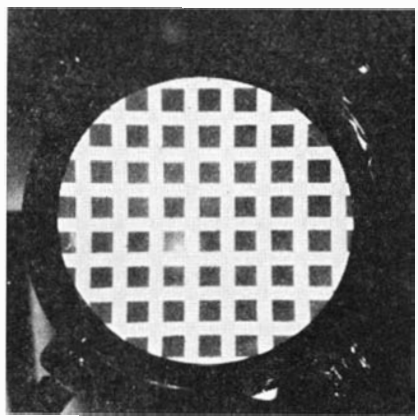


Figure 2: In this view of the image formed of a rectangular grid, distortion is present, but in *Figure 3,* at the right, this distortion is eliminated by the simple expedient of curving the infra-red sensitive cathode of the tube upon which the image of the object to be reproduced is thrown. Curved cathodes are shown in the drawings below



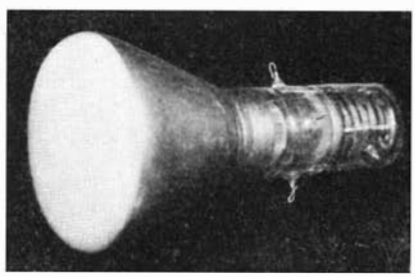


Figure 5: An image tube with nine-inch screen. Note the focusing rings

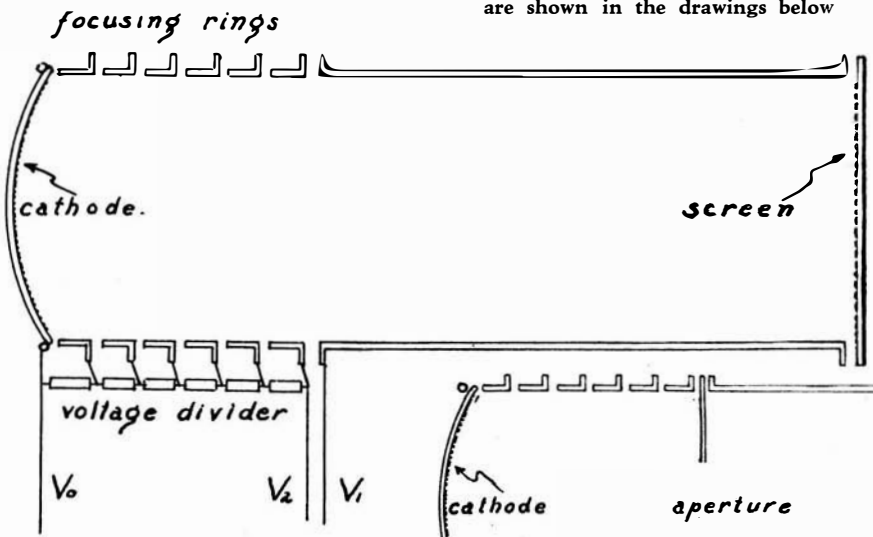


Figure 1 (above): A diagram of the electron lens system described, showing the curved cathode and the anode cylinder to which a high positive potential is applied. The focusing rings and the anode form the electron lens system which is adjusted by varying the potential applied to the rings at the point indicated by V_2

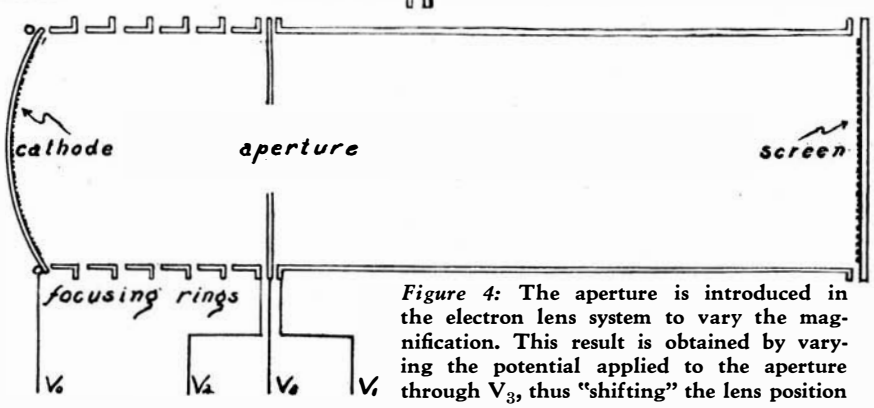


Figure 4: The aperture is introduced in the electron lens system to vary the magnification. This result is obtained by varying the potential applied to the aperture through V_3, thus "shifting" the lens position

THE DARK

these electrons move in all directions so that at a very short distance from the photoelectric surface, the electron image blurs into a random cloud which bears no resemblance to the original picture. At first sight, it seems impossible that these electrons can ever be reassembled into an image again, but at this point electron optics comes to our aid and makes possible the reconstruction of the image. This reconstructed image can then be made visible to the eye by directing it against a fluorescent screen.

The electron image tube makes use of an electron lens system to reassemble the electrons from the photo-electric cathode and to focus them onto a fluorescent screen which becomes luminous when bombarded by electrons. Figure 1 shows diagrammatically how this lens system is constructed. A high positive potential V_1 is supplied to the long anode cylinder to accelerate the electrons to a high velocity in order to produce fluorescence on the viewing screen. The anode, together with the focusing rings, form the "lens" system which can be adjusted by varying the potential V_2. This lens system will image a rectangular grid into an image such as is shown in Figure 2 on the opposite page.

In order to correct for the "pin cushion" distortion and curvature of the image field existing in Figure 2, the cathode is made curved as shown in the two diagrams, Figures 1 and 4. A photograph of the final corrected image obtained by this tube is shown in Figure 3.

Finally, in order to be able to vary the magnification of the lens system, an aperture is introduced between the anode cylinder and the focusing rings. Varying the potential V_3 of this aperture in effect "shifts" the position of the lens, causing a variation in magnification. Figure 4 illustrates this arrangement.

A typical image tube with nine-inch viewing screen is shown in Figure 5. An interesting use to which this type of tube may be put is exemplified in Figure 6. A large aperture lens is mounted so as to image the scene, towards which the telescope is pointed, onto the infra-red sensitive cathode of the tube. This image is in turn reproduced on the fluorescent screen of the image tube, thus enabling the observer to "see" by infra-red radiation. Such a device can be used to test haze and smoke penetration by infra-red, for secret signalling, and other obvious applications involving infra-red rays.

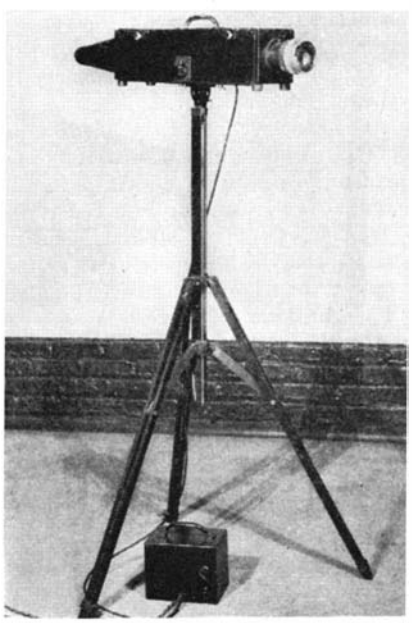


Figure 6: **A telescope for "seeing in the dark," described in the text**

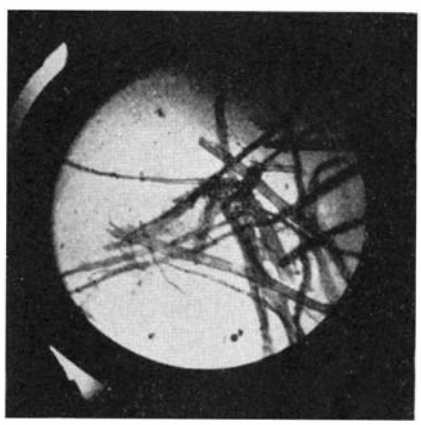


Figure 8: **A micro-specimen as seen with the set-up illustrated below**

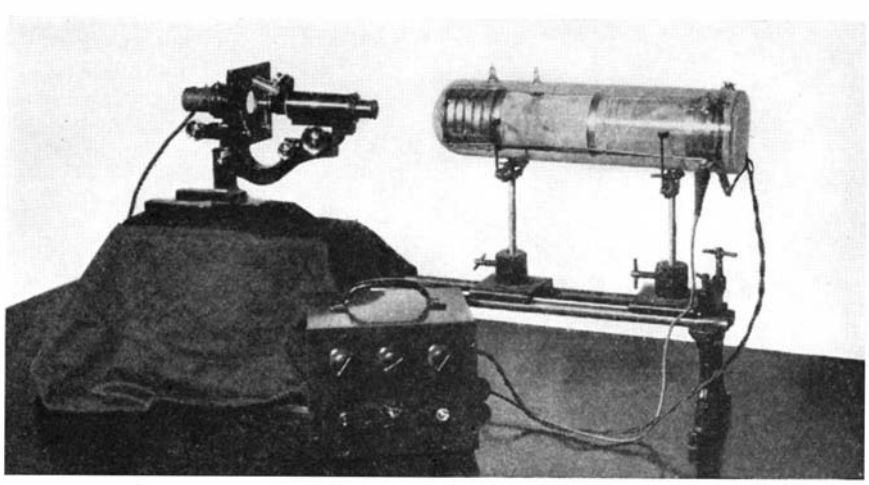


Figure 7: **A microscope set-up for infra-red microscopy**

ANOTHER use is in connection with infra-red microscopy. Figure 7 shows an image tube and microscope arranged for infra-red work. The visible image of a micro-specimen as produced on the fluorescent screen is shown in Figure 8.

The next two photographs (Figures 9 and 10) were made by photographing the fluorescent screen of an image tube while an infra-red picture was projected onto the cathode. They illustrate fairly well the resolution and fidelity of the image obtainable.

Figures 9 and 10: **Examples of infra-red pictures as reproduced on the screen of an electron image tube**

A Modern Port

Advance Port at Ocean for French City . . . Wharf Piers Unique . . . Built on Land, Floated, Sunk . . . Engineering Problems . . . Channel Dredge

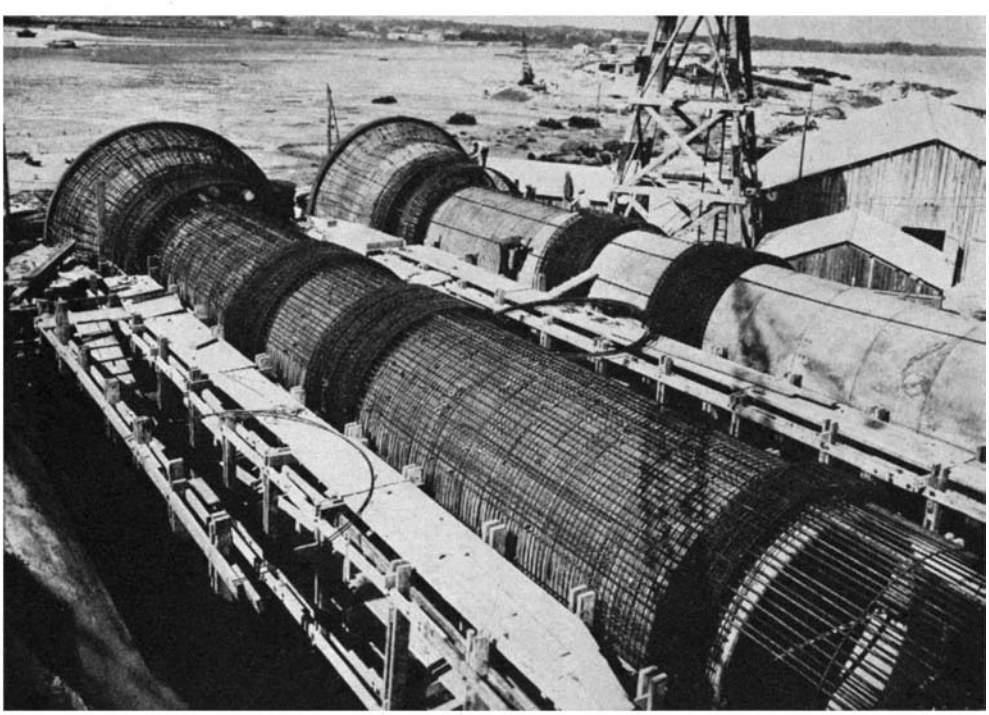
BORDEAUX, for many generations famous for its wine trade, stands forth today because it is the third largest of the seaports of France. Present interest in this historic city is especially justified because of certain engineering achievements recently wrought by the alert technicists of the Bordeaux Port Authority—accomplishments that have added greatly to Bordeaux' importance as a center of maritime commerce.

Bordeaux lies inland from the Atlantic Coast of France a distance of fully 62 miles, and is reached by way of the Gironde and the tributary Garonne River, on which the port is located. The run between the open sea and Bordeaux, quite apart from tidal considerations and currents, is at times hampered by fog or by other obscuring conditions of the atmosphere. Low visibility compels reduced speeds and may lead to mishaps of varying gravity. Until latterly, vessels carrying passengers and mail matter have used Bordeaux, itself, as the point of embarkation; and unfavorable weather has occasioned vexatious delays both in the time of arrival or in reaching the open waters of the ocean.

The demand for greater speed and the saving of time led the Port of Bordeaux Authority to call into being an advance port or landing place for Atlantic liners at a comparatively sheltered position just inside the mouth of the Gironde and close to the sea. This halting place for liners is linked by rail with Bordeaux; arriving passengers, mail, and express matter can be quickly transferred to trains and whisked off to Bordeaux no matter what may be the existing navigational difficulties on the water route. Conversely, outgoing travelers, mail matter, and so forth, can now leave Bordeaux hours later than previously and reach their waiting steamer at the advance port and be out at sea a short while afterwards. This makes it possible to save several hours, and is a great convenience to the traveler and of much value to the shipper. The Bordeaux Port Authority has spent approximately 11,000,000 dollars in providing the new accommodations.

THE advance landing place consists primarily of a wharf, 125 feet wide and 1041 feet long, that is connected with the neighboring shore by a jetty that has a length in excess of 1000 feet. The wharf carries a building in which there are commodious waiting rooms, baggage rooms, a restaurant, and other conveniences. The wharf is wide enough for four railway tracks for the accommodation of both passenger and freight trains; there are typically modern facilities for loading and unloading arriving and departing steamers. The connecting jetty carries two tracks and a broad roadway for motor vehicles plying between the landing place and the nearby mainland and the coastal towns. The terminal is far enough offshore to assure at low tide a depth of water alongside averaging more than 40 feet; because the estuary is occasionally swept by strong winds and sizeable waves, the landing place is equipped with hydraulic fenders that serve as buffers between the wharf and moored vessels, so that neither the craft nor the terminal structure shall be damaged by any surging movement.

The construction of the advance port presented difficulties. The landing place had to be set on an underpinning that would have its footing in a bed of firm clay underlying a stratum of sand, gravel, and shattered shells that has a vertical depth of from 20 feet to 30-odd feet—the area frequently being swept by sudden storms. It was manifest that pneumatic caissons could not safely and efficiently be used to get the sustaining piers down to the prescribed seating. That method would take too long and would be too grave a menace to the sand hogs laboring in the working chamber. After considerable experimenting and successive modifications, the chief engineer of the port authority developed unit piers or columns of a unique type that could be sunk into place quickly without employing pressure workers at all.



Two of the reinforced concrete cylinders in course of construction on shore and near the site of the advanced landing wharf for steamships. Compare with man on the center scaffold

Most of the piers that are carried deep into the waterbed took the initial form of cylindrical shells having a general diameter of 13 feet, a length of 87 feet, and flaring sections at one end about 25 feet in diameter. These cylinders, nearly 100 of them, were heavily reinforced concrete structures that were built on shore; launched from a broad-gage marine railway so that they

For Bordeaux

By R. G. SKERRETT

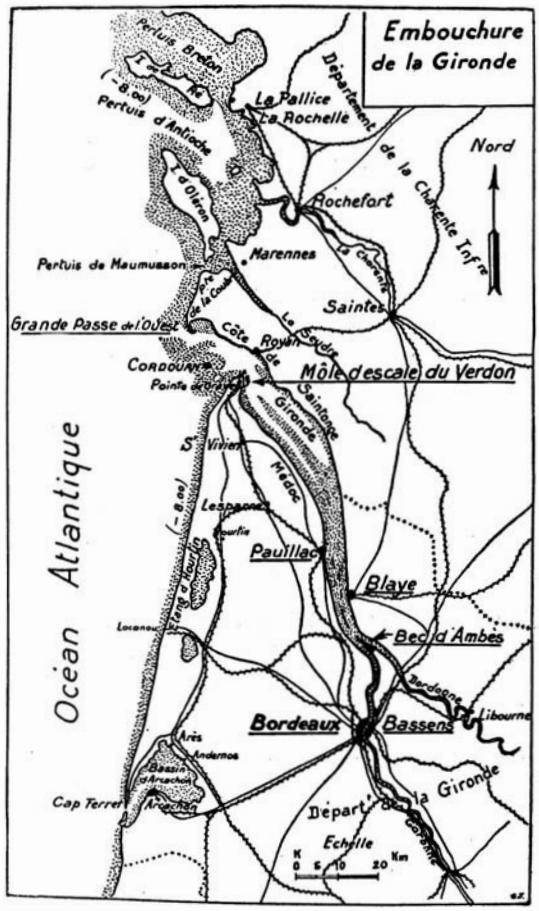
could be picked up, one by one, by a large floating derrick; and transported to their respective points of sinking at the terminal site. The derrick stood each cylinder upright with the flaring end downward and then set it on the bottom of the estuary. At that time each cylinder weighed about 290 tons; and its deadweight was counted upon to make it penetrate the water-bed as the material inside the lower chamber was excavated and transported to the surface.

THE excavating of the sand, gravel, and sea shells was done by a number of agitators arranged equidistant on a circle within each cylinder, the intake ends of these pneumatically operated contrivances lying a foot or two below the cutting edge of the flared bottom of the cylinder. Each agitator served the twofold function of stirring up the bottom material and of lifting it to the surface, and it was made up of tubing 10 inches in diameter in which was inserted axially a two-inch pipe that conveyed high-pressure air to its lower end and discharged the air through 30-odd small holes that pointed upward. Both the 10-inch tubing and the contained air pipe reached from the water-bed up to the working platform on top of the cylinder; the bottom edge of the agitator had long saw-like teeth to cut into and to break up the bottom materials.

When compressed air was discharged upward, it produced, in effect, an emulsion that was lighter than the enveloping water, and this unbalancing caused a strong inrush at the bottom of the agitator and a vigorous movement surfaceward — the current being strong enough to carry fair-sized rocks up and overboard at the discharge points of the six agitators.

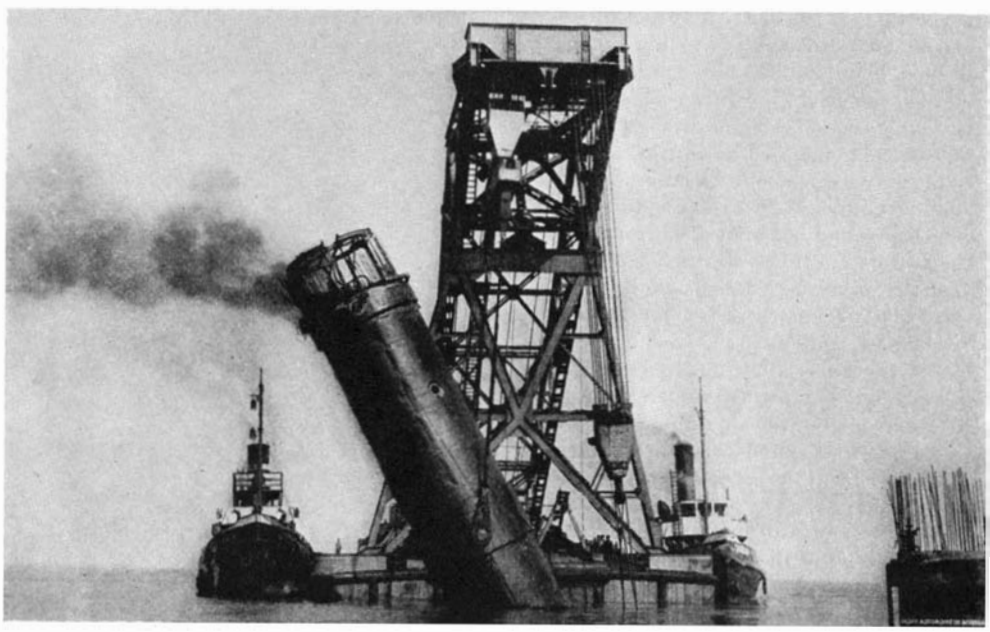
In the foregoing manner, the materials enveloped by the belled bottom of the cylinder were excavated and the cylinder settled deeper and deeper until it reached and penetrated a few inches into the basic stratum of firm clay. Then, with the cutting edge thus sealed so that external water could not enter the cylinder beneath the cutting edge, the agitators were used as pumps to lower the level of the water within the cylinder, and that operation caused the outlying water to act with a downward pressure, like a deadweight, great enough to force the cylinder two or three feet into the clay and to anchor it securely there. With that done, the flared bottom chamber was permanently sealed with concrete to produce a plug that would permit the complete unwatering of the interior of the cylinder, after which the cylinder was poured full of concrete to transform the shell into a monolithic column.

By following the procedure described, unit piers were launched, transported to their prescribed positions, and sunk to their final footholds in the sub-aqueous clay in the astonishingly short period of only two hours on an average. The pneumatic-caisson method would have taken much longer, would have been more costly, and would have been exposed to damaging if not destructive interruptions by abrupt changes of weather.

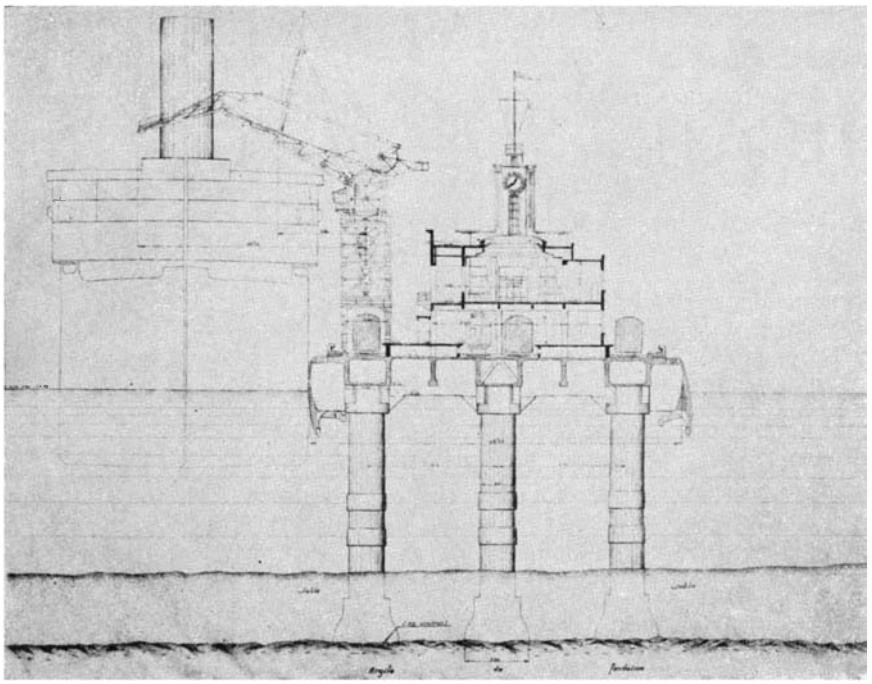


The mole, or advanced landing near Le Verdon, lies just inside the mouth of the Gironde

Having created the advance landing place near the mouth of the Gironde, the Bordeaux Port Authority had next to provide a channel to the sea that would be of ample size to meet increased traffic and the needs of the biggest of French liners that would make use of that base. The existing zigzag channel could not be altered to satisfy the requirements, and the only acceptable so-



One of the monster, 290-ton pier cylinders being swung upright by a powerful derrick preparatory to starting its journey downward deep into the sand and clay of the water-bed



Transverse section of advance port, with ship tied up. Note the buffers on the side of the wharf; also flared bottom ends of piers penetrating water-bed

lution of the problem was the excavating of an entirely new channel that would cut straight across a wide and far-flung sand bar that lies off the mouth of the Gironde. This meant that dredging would have to be done in the open and often boisterous ocean. To deal with the difficulties, it was necessary to design and build a sea-going dredge of exceptional characteristics and to equip her so that she could do her work without having her dredging apparatus damaged or herself injured in that exacting service.

THE craft built especially for the work is the suction dredge *Pierre-Lefort*. The vessel has Diesel-electric drive, can be completely controlled from a central station, and is capable of receiving and transporting to a point of discharge fully 2600 cubic yards of excavated material. The *Pierre-Lefort* has two large suction tubes or dredges fitted, one on each side of her, to trail as the craft advances. The bottom intake or suction end of each of these tubes is fan-shaped and is arranged to rest upon the bottom and to be dragged along as sand or sediment is drawn into it. Powerful electric pumps within the *Pierre-Lefort* suck up bottom material and water at the same time and deliver the mixture into cargo compartments where the solid matter remains after most of the water is diverted overboard. Gates in the bottom of the cargo compartments are opened when the loaded vessel has been moved to a deep water point for the discharge of the spoil.

Aside from her notably up-to-date equipment and method of propulsion and mechanical drive, the success of the *Pierre-Lefort* is, in the main, due to the unique flexibility of her suction pipes which are so devised that the suction ends can follow freely the contour of the water-bed, while the vessel pitches and rolls in a seaway without causing wrenching or harmful stresses either to the ship or to the attached and dragging suction pipes. Each suction pipe is long enough to do its work in water 65 feet deep. The pipes are each about 21½ inches in diameter and are secured to the vessel at their upper ends by revolving connections. Interposed in the steel pipes at suitable positions there are flexible joints, and the suction or lower end of each pipe is provided with a sturdy ball joint. This exceptional flexibility in her suction pipes has enabled *Pierre-Lefort* to do her work, day in and day out, in the open sea while waves were running that had a height of 11 feet and more—the dredge going steadily forward at a rate of two knots against a current that had a velocity of five knots. The ship was able to load and to discharge herself 15 times in the course of 24 hours. This included the time taken to run to a dumping point and to return to her place of dredging.

ALL told, the *Pierre-Lefort*, and an older modified steam dredge, have excavated the new channel by which the Gironde is now linked with the Atlantic. That channel is more than half a mile wide, 2½ miles long, and has a depth of not less than 30 feet at low tide. The cutting of that channel required the excavating of about 10,000,000 cubic yards of material. Both the building of the advance port and the dredging of the new channel have increased to a marked extent the advantages of Bordeaux for maritime trade; but from a technical point of view, what has been done there is of outstanding interest to the entire engineering world because of the ways in which natural difficulties have been mastered. Both undertakings have been under the direction of François Lévêque, chief engineer of the Port of Bordeaux Authority; each project was attacked in a practical way only after much preliminary study and experimentation.

The completed project bears witness to the thoroughness with which that study was made, as well as to the ingenuity displayed by the French engineers in performing an outstanding job under great difficulties.

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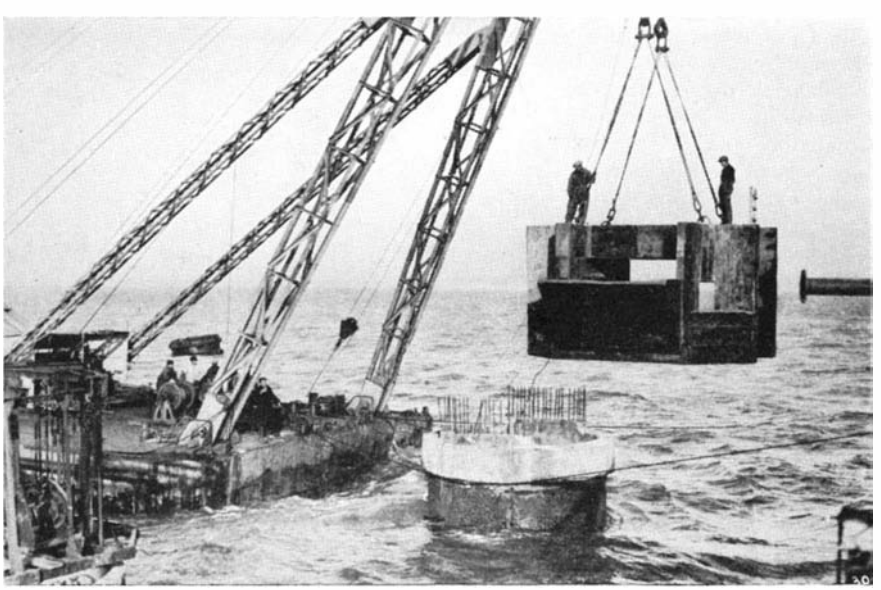
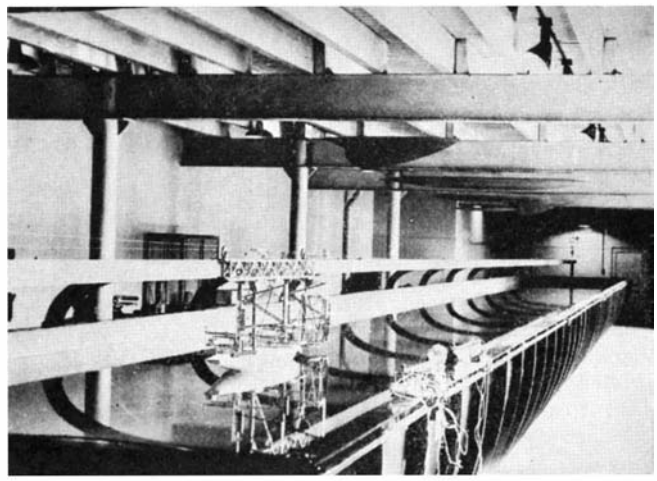
R. G. Skerrett, author of the preceding article, has written another, for early publication, on the enormous Fort Peck Dam project. It is an unusually interesting and lucid story of a significant engineering feat.—The Editor.



A seated cylinder—a steel-encased monolith—about to receive its concrete cap for the immediate support of the deck and superstructure of the advance port

Towing Tank

Tests Ship Scale Models



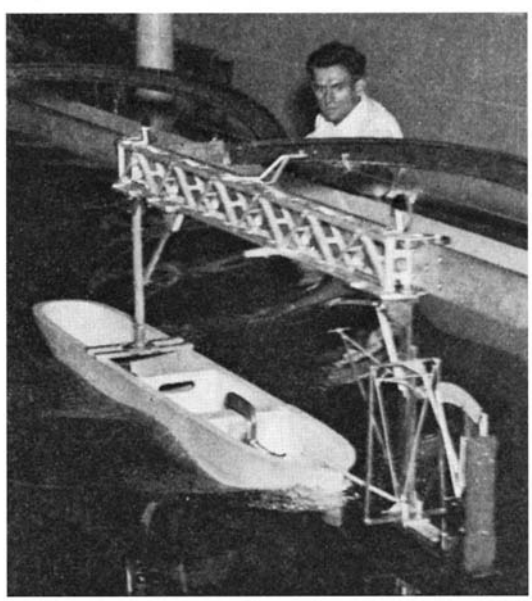
A general view of the towing tank described in the accompanying text

THERE has recently been put in full operation at Stevens Institute of Technology, Hoboken, New Jersey, an experimental towing tank, equipped to make accurate resistance measurements on ship models, and marking the culmination of four years of investigation by Professor Kenneth S. M. Davidson and other members of the Department of Mechanical Engineering.

What is of particular interest in this connection is the fact that testing will be done with small models whose advantages in the matter of cost and convenience are immediately apparent. In addition to fundamental research in the field of hydrodynamics, the tank is available for commercial testing.

The towing tank is 100 feet long, 9 feet wide, and 4.5 feet deep, of semicircular cross-section. It is built of ¼-inch copper-bearing steel plate set into cradles of three-inch channels. The whole structure is carried on two lines of 15-inch I-beams, which in turn are carried directly on specially built foundations in the cellar under the building. This precludes the possibility of building vibration being transmitted to the tank. It is set down slightly into the floor so that the top is at a convenient height for observation.

The towing carriage is drawn along a stainless-steel rail by an endless cable. The cable passes over a stepped pulley, directly connected to a gear box, which in turn is connected to both an alternating-current and a direct-current motor. The direct-current motor is for acceleration and reversing and the alternating-current drive is for constant speed towing.

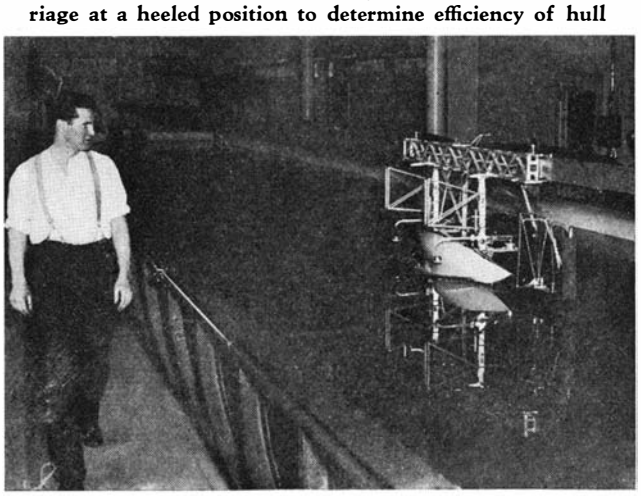


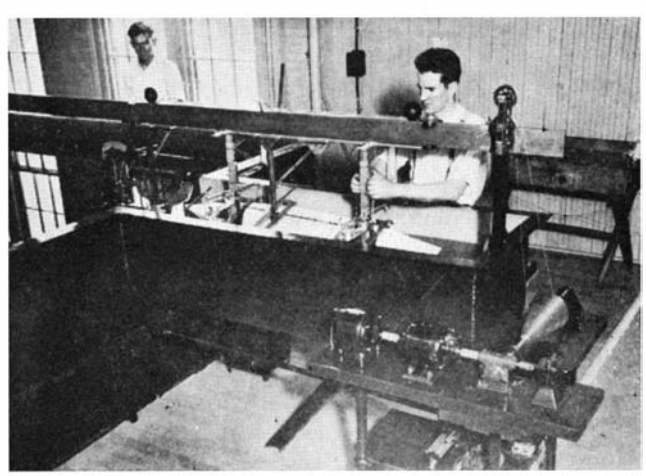
Testing a model of a Hog Island type of ship in the tank. Note bow waves and instruments

The measuring apparatus in general consists of a longitudinal dynamometer and two lateral dynamometers, all of which can be mounted on the carriage at once. In addition to measuring longitudinal resistances of ship models in the usual manner, combinations of both longitudinal and lateral forces can be obtained for sailing yacht models in various positions. These positions include heel angles up to 45 degrees and leeways up to 10 degrees. Measurements can be taken to determine the centers of lateral resistance. A large dynamometer for obtaining hull resistances of full-size yachts is also part of the equipment. Included in the auxiliary equipment is an apparatus for calibrating the dynamometers against dead weights.

It is believed that the Stevens tank is a valuable supplement to existing ship model towing equipment in this country. It is thought that the small tank will be of decided value in the hull design field of both sailing yachts and commercial vessels. This can easily be seen when one compares the cost of models. On a particular project several small models with suggested differences could be built and towed for the cost of one large model and its test. This would allow considerable latitude in trying hull changes.

Below: A scale model of a racing yacht is held by the carriage at a heeled position to determine efficiency of hull





Setting up the dynamometers on the towing carriage to measure longitudinal and lateral resistance of a yacht hull

THE MYSTERY OF THE

A Particle or Entity which May Turn Out to be a Nonentity . . . The Law of Conservation Apparently Fails . . . What Scientists are Wondering

By JEAN HARRINGTON

IF anyone ever compiled the Ten Commandments for science, the law of conservation of energy would surely be included among them. If ever there was a law within which nature seemed confined, it was the one which stated that energy may change its form, but it cannot be created nor destroyed.

Energy is the chameleon of science. It appears as heat, as light, as motion. It is stored chemically in the food we eat, the air we breathe, and the coal that keeps us warm. It sends the electric current humming along our telephone wires, and it annoys our neighbors via our radio loudspeaker. It is latent in all matter, for science has shown us that mass and energy are only two different forms of the same thing. Yet whatever its form, it remains intrinsically the same: the capacity to do work.

When we drive a car, the chemical energy of the gasoline is turned first into heat, and then into the mechanical energy which operates the pistons and turns the wheels. When we stop for a traffic light, the car's energy of motion is transformed back into heat in the brake bands, the tires, and the road.

Radiant energy of the sun is stored in growing plants by a chemical process known as photosynthesis. The eater, in turn, stores the supply in brain and muscle, ready to be put to use for mental or physical activity.

ENERGY changes such as these can be similarly analysed in many another cycle. Often the amounts going into each successive form can be exactly measured. The first scientist to suspect that these many different aspects of energy are equivalent was Benjamin Thompson, a British sympathiser who escaped from America during the Revolution. He became a military engineer for the Bavarian government, which bestowed upon him his familiar title of Count Rumford. Late in the 18th Century, he was supervising the task of boring cannon, when he noticed that the brass became hot and stayed hot as long as the process continued. He experimented with a crude calorimeter, and concluded that motion could be turned into an equivalent amount of heat. This observation inspired a series of experiments which culminated a half century later in the acceptance of the law of conservation of energy.

Today no one can say whether that law holds universally or not. The study of atoms has brought to light many cases where previously accepted laws and theories have seemed to fail. It is as if the atom assumed the privilege of misbehaving within its own tiny, private sphere. Not the least of its sins is its apparent disregard of the law of conservation of energy.

To understand the how and why of this atomic peculiarity, we must first know a little about radioactivity. There is a certain group of heavy elements—

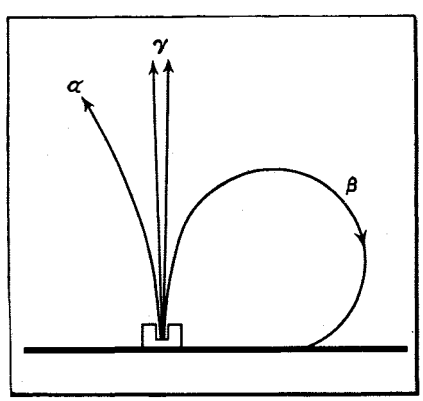


Figure 1: **A diagrammatic representation of the three types of rays emitted from radioactive elements**

uranium, thorium, and radium are typical examples—which are by nature unstable, and which are breaking down continually into lighter and more stable elements. The reason for this spontaneous disintegration is not thoroughly understood, but it has to do with unbalanced energy conditions within the nucleus of the atom. For the heavier elements, the nucleus contains so many protons and neutrons that the forces holding them together are ill-adjusted and easily upset. In such a case, the nucleus will try to rebalance and stabilize itself by emitting some kind of particle or radiation. A minute quantity of a radioactive element may take anywhere from a few minutes to a billion years to disintegrate, depending upon how easily its equilibrium is upset, and how great the forces a particle in the nucleus must overcome in order to escape.

A nucleus may choose one of three ways to throw off some of its excess internal energy, for there are three types of spontaneous emission. When these were discovered by Becquerel, back in 1896, scientists thought they were something new and mysterious in the way of radiations, and named them vaguely enough—alpha, beta, and gamma rays. But later investigation showed them to be old familiar friends, coming from a new and different source. The alpha rays proved to be streams of helium nuclei, massive particles with a positive charge of two. The beta rays turned out to be nothing but the well-known negative electrons, while the gamma rays were not particles at all but appeared to be similar in nature to light and X rays of a very short wavelength.

THERE is a very neat little diagram (Figure 1) which shows the differentiation of the three kinds of rays. Suppose we have a little piece of radium in an open metal container. If we put this in a strong magnetic field, the effect will be to sort out and separate the rays as they emerge. When an electrified particle encounters a magnetic field, a force is set up which tends to make the particle travel in a curve instead of a straight line. Now the alpha particle has a positive electric charge, so its path is bent in one direction; while the beta particle has a negative charge, and is sent off in the opposite direction. The reason its path is so much more curved is that it weighs so much less than the alpha particle, and hence responds more easily to the deflecting force. The gamma rays, being electrically neutral, are not affected at all by the magnetic field, and continue their straight line course.

Actually, this experiment could never be carried out, because the conditions for detecting the rays must be adapted for each of the three separately. Moreover, no single radio-element ever gives off all three radiations simultaneously. A nucleus may emit an alpha or a beta particle, but not both together, although gamma rays may accompany either particle.

In Figure 2 is a sketchy representation of a typical disintegration family—

NEUTRINO

part of the radium series. It shows how a nucleus breaks down in successive stages, by one way or another, until it reaches a stable form. Radium A, at the left of the diagram, emits an alpha particle and thereby becomes a new element known as Radium B. This in turn gives up an electron and becomes Radium C. The latter is a bit peculiar. Most of its atoms—more than 99 percent, in fact—emit beta particles and become atoms of Radium C′. A tiny, independent fraction, however, chooses another path and turns itself into C″ by shooting off alpha particles. The end product of both is the same thing, both C′ and C″ eventually becoming Radium D. This is a stable isotope of lead, and there is no further disintegration.

To be strictly accurate, we should mention still a fourth kind of radio-emission. When elements are made artificially radioactive, they sometimes emit positrons or positive electrons. But these need not concern us in our study of energy conservation. It is the beta rays which concern us most.

Now every atom of a given element is perfectly similar to every other atom of the same element. Each contains the same number of electrons revolving around the nucleus. Each contains the same number of protons and neutrons within the nucleus. And with each is associated a certain characteristic amount of energy. Thus, when a nucleus of one element loses an alpha or a beta particle, it changes itself thereby into the nucleus of a quite different element with a different characteristic energy. Each transmutation, then, *must involve the loss of a certain fixed amount of energy.*

The loss may be accounted for in several ways. In the first place, the very mass of the ejected particle represents a large amount of latent energy. The velocity, and hence the kinetic energy of the particle, accounts for an additional loss. If these two are not sufficient to make up the required energy difference of the two nuclei, a gamma ray may be thrown in to even things up. The gamma ray may possess varying amounts of energy, depending upon its frequency or wavelength.

We have now arrived at a point where we may state our problem, and the gist of it is this: Given two identical nuclei, each of which emits an identical particle, each thereby becoming identical nuclei of a different kind, the energy loss in both cases should be exactly the same. This is true for alpha emission, *but it does not always hold for beta emission.* At this crucial point, the law of conservation of energy apparently fails.

How do we know this is true? Returning to our two identical nuclei, we shall submit them to a test which should show whether or not the energy loss really differs in the two cases. The experiment, devised by Ellis in 1924, is similar in theory to the one sketched in the first diagram; but this method is practical, for it is designed to study only the beta rays (Figure 3). A tiny speck of, let us say, Radium B, is placed in a metal container, next to a heavy lead block which bears a photographic plate. The whole apparatus is placed in a vacuum box in a strong magnetic field. The rays passing through the slit are bent by the field, just as before, so that they fall on the plate, where each electron leaves its "photograph" as it falls.

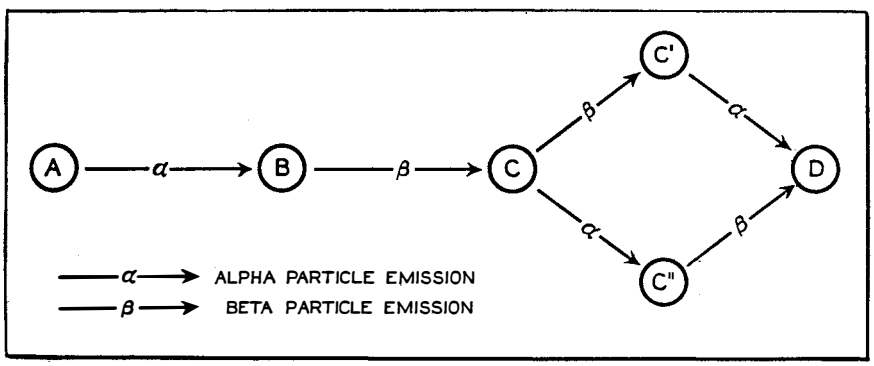


Figure 2: **A typical disintegration series. Part of the radium family, from Radium A to Radium D, which is an isotope of lead. Explained in the text**

Suppose for a moment we have just two nuclei of Radium B and two beta rays, *X* and *Y*. They have the same energy due to their intrinsic mass, and if they had the same velocity, they should be deflected the same amount by the magnetic field and land on the same spot on the film. The fact that they do not proves that they must have different energies of emission, and there are no gamma rays in this case to make up the difference. Yet both parent nuclei turn into identical nuclei of Radium C.

Of course we could never get two isolated particles such as *X* and *Y*. There are many thousands of them, but they behave in the same way, perhaps no two among them having the same velocity. The developed film (Figure 4) shows a wide spread of energies, ranging continuously from a maximum which corresponds to the exact difference in energy level between the two nuclei, down through 6 or 7 million electron volts.

Because this apparatus sorts out electrons of different energies, just as a prism sorts out light of different wavelengths, it is called a beta-ray spectrograph. Indeed, the developed plate looks very much like a spectrum of light.

UNFORTUNATELY, the experiment is complicated by the so-called secondary beta rays—electrons which do not originate inside the nucleus, but are knocked from their orbits outside the nucleus. These, however, can be fairly easily identified. Instead of having a wide range of unrelated velocities like the electrons from the nucleus, they fall into various speed groups, depending on which orbits they come from. Many of them land, therefore, on the same region of the photographic plate, leaving a band or spectrum "line" which is darker than the background, as at *A*, *B*, and *C* in Figure 4, and is easily distinguished.

But what of this continuous background? Why do the nuclei send forth electrons of such different speeds? And what becomes of the excess energy when the electron is traveling slower than it ought? That is just what the scientists are wondering. If part of that energy simply disappears, leaving no trace of its passing, then the conservation law is an empty formula. Naturally, the investigators are reluctant to let it go at that. And so there have been proposed a number of alibis which seek to absolve the atom from its asocial behavior.

The explanation which has aroused the most interest to date introduces a new particle, the neutrino, into the atomic family. Unfortunately, the neutrino, if it exists at all, is extremely shy and retiring. It has never been observed, and it has consistently evaded attempts to track it down. But if there really is such a particle, it will prove a godsend to the defenders of the energy conservation law.

The theory of the neutrino is simple enough on the surface. We have pointed out that the mass of the electron accounts for part of its energy. This is a by-product of Einstein's law that mass and energy are only two different forms of the same thing. When the electron is going too slowly to use up all the ex-

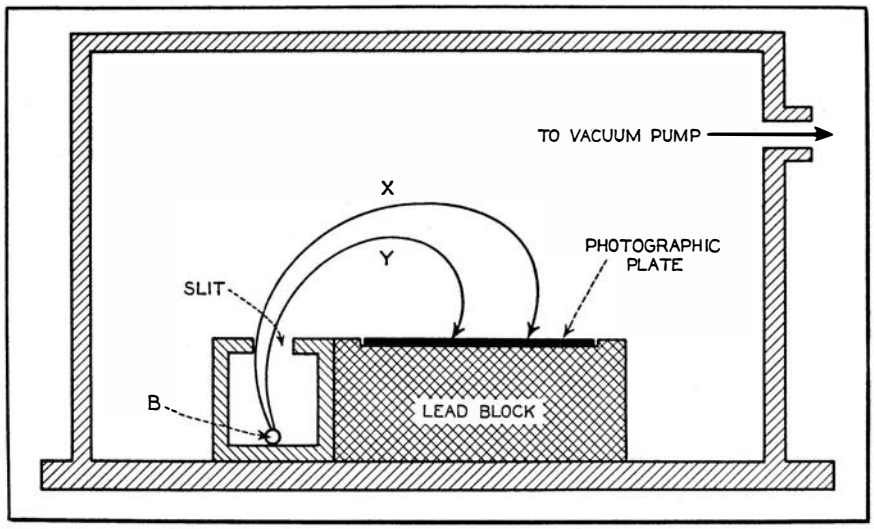


Figure 3: **A diagram showing how Ellis's magnetic beta ray spectrograph works**

cess energy within its parent nucleus, suppose that the nucleus also emits another particle, with just enough mass to make up the difference. If this particle, our neutrino, had any electric charge, it should be easily detected in a magnetic field. Since this is not true, we must assume that it has no charge, and is just a neutral mass like the neutron. On the other hand, if it were as heavy as the neutron, again it should be easily detected, because it would leave the nucleus so much lighter. As a matter of fact, scientists have made the startling assumption that the neutrino at rest has no mass at all!

THIS sounds absurd, of course, until we remember that a photon, or particle of light, has no detectable mass, but still has energy and can be converted into mass upon occasion. Moreover, there is another scientific law which has bearing here: the peculiar fact that the faster a body moves the heavier it is. This effect is so slight at ordinary speeds that it cannot be detected. A freight train going at a 50-mile-an-hour clip weighs only a tiny fraction of an ounce more than it does at rest. But bring a body up close to the speed of light—186,000 miles a second—and its mass increases very appreciably.

These particles shooting off from atoms come as close to the speed of light as anything we know of except light itself. So if our neutrino, starting out from nothing, and working up to a velocity of 100,000 miles a second, may acquire for itself a small but very important mass.

Since the velocity of the beta ray is a variable quantity, differing from atom to atom, naturally the neutrino must also be a variable. The two are complementary mates, the one making up the deficiencies of the other, and the energy of the two always coming to the constant total we need to save our conservation law.

Up to date no one has been successful in devising an experimental technique sensitive enough to catch the neutrino up to its tricks, if, indeed, there is one to catch. All we have on it now is circumstantial evidence. For instance, Dr. Kenneth Bainbridge of Harvard reported recently to the American Physical Society the discovery of certain pairs of isobars which, he claims, could not exist unless the neutrino also exists. Isobars are elements identical in weight but differing in chemical properties. That is, their atoms contain the same total number of protons and neutrons, but in different proportions. By a complex mathematical development, it has been apparently shown that pairs of isobars differing in atomic number by only one are a theoretical impossibility, unless a neutrino weighing more than zero is a factor in their creation. Dr. Bainbridge and his associates, using a mass spectrograph, a precision instrument for weighing atoms, have definitely isolated three such pairs. This is, of course, indirect evidence for the neutrino hypothesis, and it is not entirely above question.

The neutrino theory was first proposed by Pauli; since then the great Italian physicist Fermi has tried to put it on a mathematical basis which would conform to wave mechanics, the quantum theory, and all the other theories of the nucleus. Unfortunately, the neutrino has of late fallen into disfavor, principally because Fermi's mathematics predict the wrong results. In science, a theory may be logically possible, but if it is not mathematically sound, then alas for logic! The neutrino worked into so neat a case for the law of energy conservation that it is rather a pity to discard it. But it seems we must, at least for the time being, until someone puts it on a sounder mathematical basis, or, better yet, actually finds it.

Two German physicists, Beck and Sitte, have put forth an alternative theory, which likewise has its good points and its bad. Instead of a neutrino accompanying each beta particle, they suggest that a positron or positive electron is its chosen mate. Dirac has shown that electrons and positrons may be created in pairs out of other forms of energy, so there would be nothing strange in this. Instead of actually escaping from the nucleus, as the neutrino is supposed to do, the positron is immediately recaptured by the nuclear forces, and is thenceforth divorced from its partner electron.

This theory does not fit well, either, with the experimental facts, without some intricate and not thoroughly justified mathematical juggling. It has received less interest and attention from physicists than the more spectacular neutrino theory.

A third school of thought has attempted to show that the law of conservation of energy does not necessarily always hold true. We have mentioned before in another article the principle of probability, the underlying theory of wave mechanics, which has already reduced many of our physical laws to expressions of *average* rather than absolute behaviour. Perhaps energy conservation is also only an average condition.

It seems improbable, however, that the law should be broken only, so far as we know, by the beta rays. Such consistency in misbehavior is rather incompatible even with the law of probability.

I DO not claim to set myself up as a prophet of science, but I am willing to hazard a guess that none of these three theories will hold out much longer. Probably the ultimate solution of the beta ray mystery is still forthcoming, when some scientist or other thinks up a better idea; an idea perhaps just as understandable as any of these, but which will better fit the facts. And the rest of the scientific world will be left thinking, "I wonder why that didn't occur to us before?"

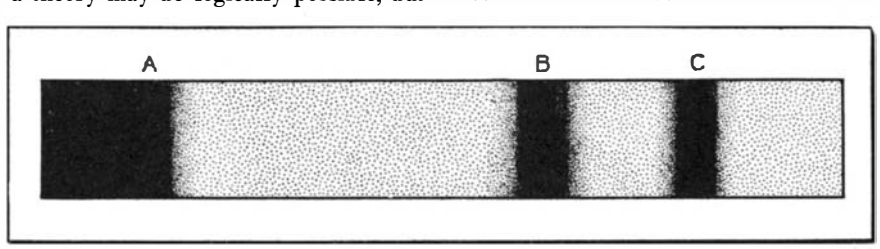
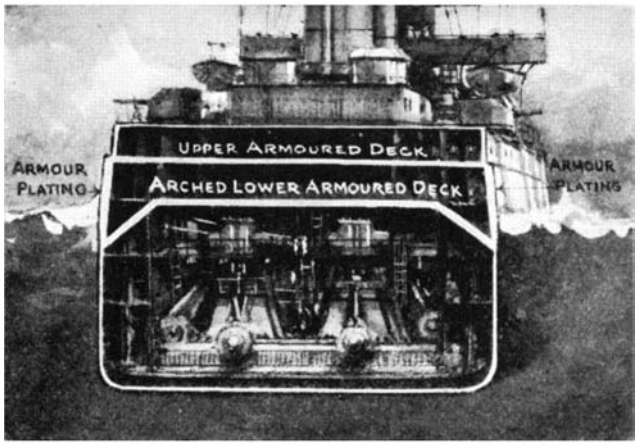
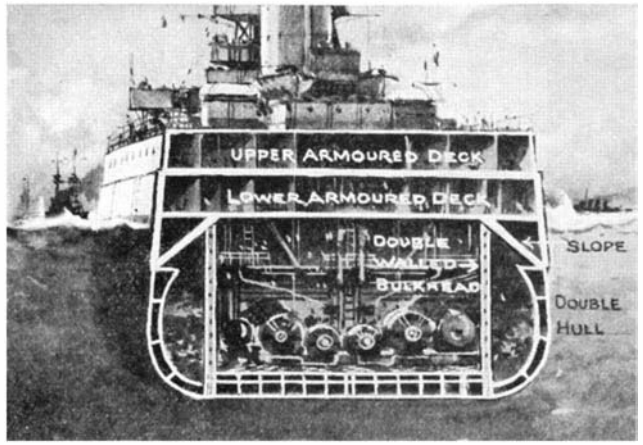


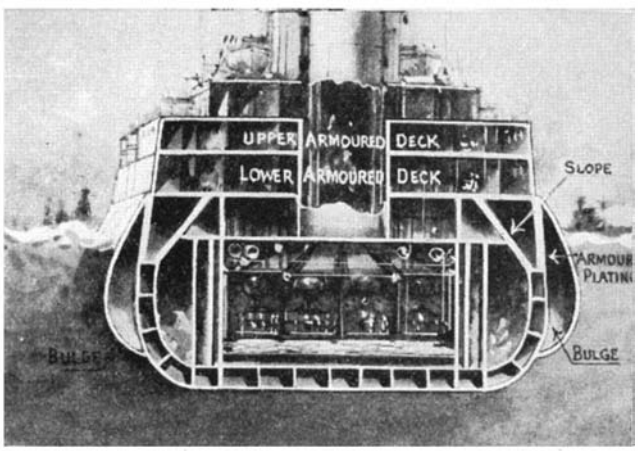
Figure 4: **A beta ray spectrum, showing a continuous background due to primary beta rays, and darker "lines" A, B and C, due to groups of secondary beta rays**



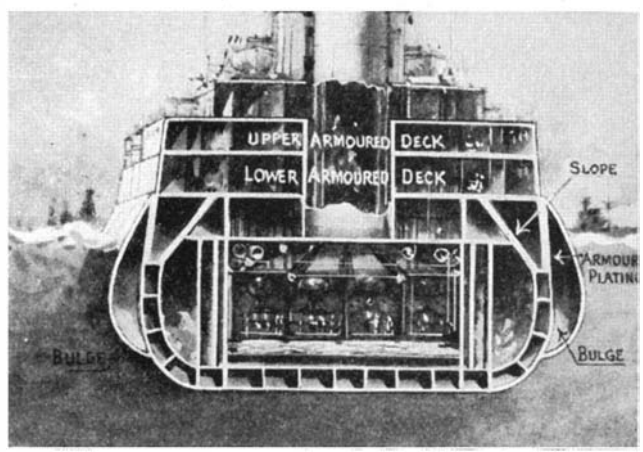
The "caisson" system worked out by Emile Bertin, the French naval designer. Intended as a defense against gunfire, it has been adapted for protection against air bombing. Modified, it is followed by all navies of the world



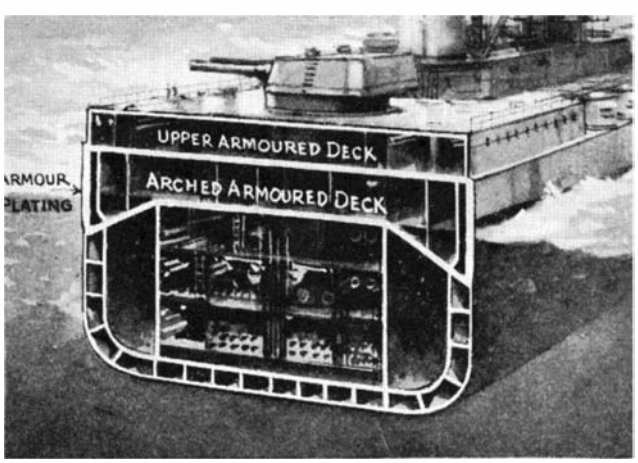
How the United States Navy does it. In this system, the slopes (*glacis* or *talus*) are thicker than the lower armored deck itself. The double hull and strong bulkheads provide protection against all kinds of underwater explosions



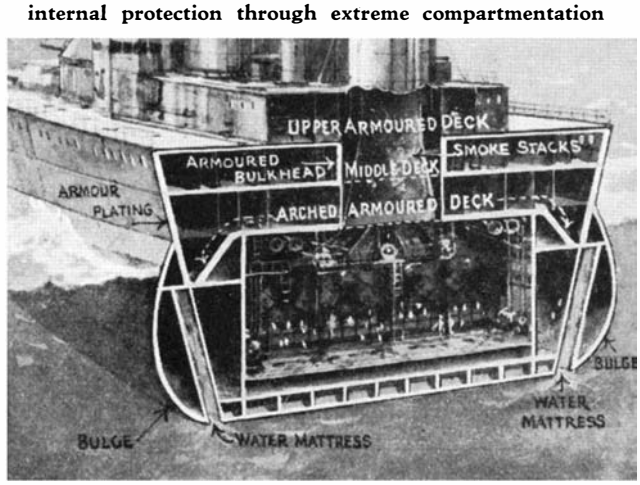
A pre-war type of armored ship, the French *Danton,* utilizing the Emile Bertin system of protection—a "caisson" within the hull—as a protection against torpedoes which can be launched from aircraft as well as water craft



The much-discussed "blisters," or bulges, which add a cushion to absorb the shock of underwater explosions. This section, of the British *Royal Sovereign,* shows good internal protection through extreme compartmentation



Armor protection of the French *Bretagne* which is still in commission. The main armor belt is 13½ feet wide; and there are two protective decks plus a complex system of interior bulkheads, all of which protect against torpedoes



The great battle-cruiser *Hood* of the British Navy, the armor and protection of which weighs 13,800 tons, or one third the vessel's load displacement. Note the liquid "mattresses" that are formed by the open-at-bottom bulges

THE CAPITAL SHIP'S STRUCTURAL DEFENSE

THAT the mightiest units of world navies of today are proof against surface, underwater, and air attacks is a hotly discussed question. Yet certain battleships are well-nigh invulnerable. Why this is possible can readily be imagined after a study of the extent to which compartmentation and armor plating are achieved in the capital ship sections shown above. While the hulls may appear thin, they are in reality quite heavy, the armor belts at the water-line being up to 16 inches in thickness. From drawings by C. E. Turner, through the courtesy of *The Illustrated London News.*

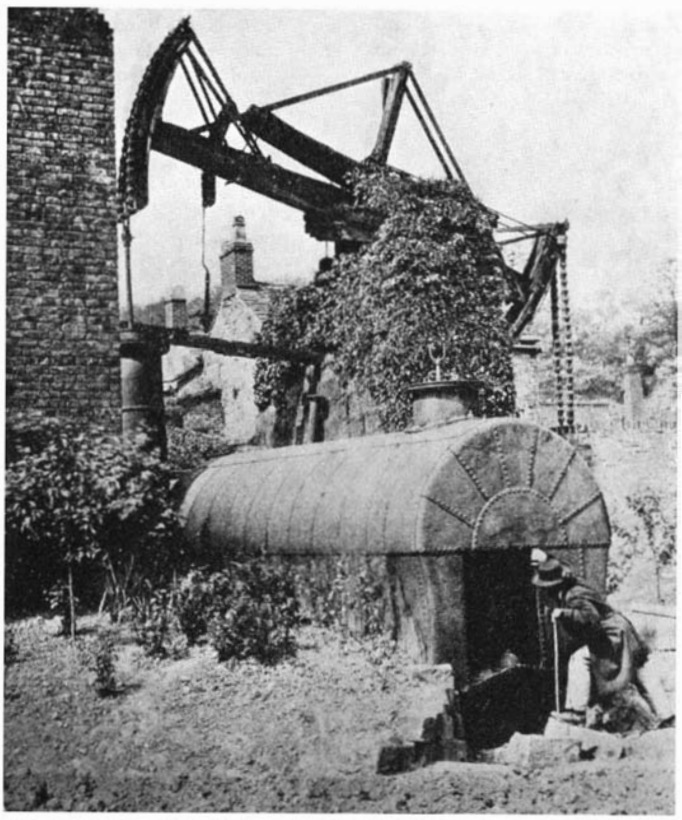
'Fairbottom Bobs'

Oldest Newcomen Engine . . . Salvaged, Shipped to America from England . . . Restored . . . Operating Once Again . . . A Mechanical Link with the Past

By F. D. McHUGH

MORE than 40 years ago, at the very time when Henry Ford was building the car that was to revolutionize land transportation, there appeared in Scientific American an article called: "A Newcomen Steam Engine" and in it the unnamed author commended the directors of various technological museums for their attempts to "give the present generation a vivid idea of the triumphs of some of the great mechanical minds long passed away" through models based on old drawings and engravings. He pointed out, however, that valuable as these models were, they lacked actuality and left a doubt in the mind of the spectator of their literal accuracy, and, further, lamented the fact that more actual examples were not obtained and preserved for posterity.

"At the present moment," the article read, "there is a specimen of an engine built by Newcomen, of Dartmouth, in 1705, rusting away in the open air for want of a friendly hand being put forth for its preservation. . . . The date of its erection in Fairbottom Valley, half way between Ashton-under-Lyne and Oldham, is uncertain, but it was probably toward the end of last century. It is still on the original site."



In the foreground is the "wagon" type boiler that replaced the original "haycock" type which powered Fairbottom Bobs

There followed a technical description of the engine, in which the interesting point is made that to keep the piston joint in good working order, the top was commonly packed with horse dung.

"It appears probable," the article concluded, "that this is the oldest engine in existence, but it is in a most dilapidated state."

It was "Fairbottom Bobs" the author was describing, but he did not know it by that name. This is how it came by its nickname, according to local tradition: When motionless it was hidden from the view of the surrounding countryside by low hills of slag, built up when the valley was still a prosperous mining district, but when it was in operation the beam-ends could just be seen bobbing up and down against the horizon, like a couple of bent old rustics nodding over their cups.

Thirty-four years elapsed between the time that article was written and the time when it was brought to Henry Ford's notice. Meanwhile, the obscure farmer-engineer of Dearborn had become an international figure and the "ruler" of one of the world's greatest industrial empires.

After all those years old Fairbottom Bobs, now well past the two-century mark, still stood its ground, still awaited the "friendly hand" that was to rescue it from oblivion, and the old residents of Fairbottom Valley who had lamented its passing themselves had long since passed from the scene.

Mr. Ford, who had operated (stationary) engines long before he began putting them on wheels, immediately recognized the historical importance of the Newcomen—the first practical form of reciprocating steam engine—and resolved that if possible he should have it as the keypiece of the power exhibit in the great museum then taking form at Dearborn.

When he visited England in 1928, one of his first concerns was to make a pilgrimage to Ashton-under-Lyne, not far from the famous Lancashire cotton city of Oldham, finally reaching the site of the old engine.

AS was to be expected, old Fairbottom Bobs, after working some 70 years in all sorts of weather and standing derelict another 100, was not much to look at when Mr. Ford first viewed it. The beam had collapsed, the connecting chains had disappeared. All that remained visible of the structure was the masonry column that had supported the beam trunnions, the cylinder and its piston rod, which had fallen sideways, the trunnions and their steps and old curved wooden arm, sundry iron work from the beam, and the wreck of an old "wagon" boiler. But that was enough. Mr. Ford had no difficulty in envisioning this great mechanical link with the past restored in its entirety.

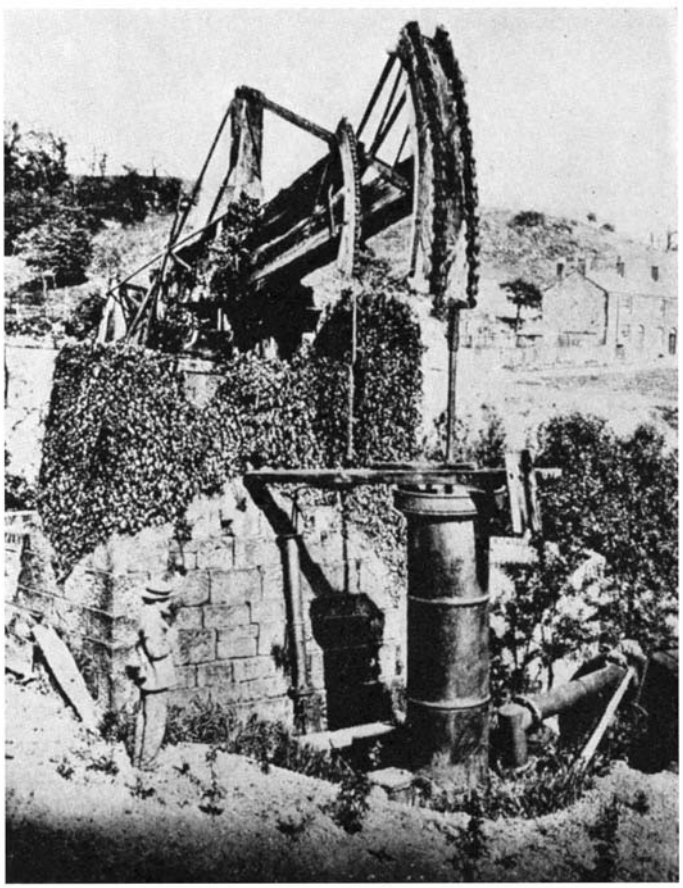
The trustees of the estate of the Earl of Stamford, apprised of the purpose for which Mr. Ford desired the engine, proved to be in utter sympathy with the idea; in fact, insisted that Mr. Ford accept the famous engine as a gift. Only there were, of course, many formalities to be complied with and legal technicalities to be straightened out.

The negotiations between Mr. Ford's agents and Lord Stamford's trustees endured a year and had assumed the proportions of an international treaty when,

in July, 1929, everything having been most satisfactorily arranged, the work of taking down and picking up the remains of Fairbottom Bobs and preparing it for shipment to America began.

It was no easy task—an engineering job in itself. On one side lay slag hills crossed only by narrow footpaths. On the other flowed the Medlock, normally a gentle stream about 12 feet wide, which runs down an 80-foot channel it has cut for itself through the slag heaps and can easily be crossed on stepping stones. After a few hours of rain, however, it becomes a raging torrent.

To get trucks and derrick to the site, and later to remove the carefully boxed remains of the old boilers and 170 tons of masonry and machinery, Mr. Ford's engineers had to build a temporary bridge and lay a narrow-gage railway across it. Several times during the building of the bridge the workmen had to abandon their tools and run for their lives and then, when the water had subsided, recover tools and planks many miles downstream.



Fairbottom Bobs in its original setting. This and the illustration on opposite page are from 60 year old photos

MOTHER Nature gave the Ford forces valiant battle every step of the way. She had spun a web of heavy interlacing branches of ivy about old Fairbottom Bobs. She had sent up tall trees to hide her century's labor and thrust their destructive roots into the crevices of the stone foundation. Chains and other parts of the engine had fallen into the 220-foot pump shaft.

When the engine had been dismantled and all visible parts carefully examined, cataloged, and crated, the work of recovery was only well begun. Next came the turning up of the soil for yards about to uncover parts of the operating gear that through the years had gradually become buried in the earth's surface: cylinder castings, reduction box, jack head pump, suction flange, top and bottom motion shafts, operating levers and the like. It was long, hard labor but well rewarded; as each new find came to light and revealed to the patient searchers more precise knowledge of the actual mechanism of the engine, it was greeted with much enthusiasm.

Next came the removal of the central column, a 14-foot pylon built of some 450 heavy blocks of stone. Each stone was marked in position with identifying colored numerals.

Now began the attempted search of the pump shaft itself. Photographs of Fairbottom Bobs taken 60 years before plainly indicated that certain missing parts must have tumbled down the well when the engine's superstructure fell apart. To reach the bottom of the 220-foot shaft, filled with water to within 18 feet of the surface, was, the searchers realized, a well-nigh hopeless task, and even if successfully accomplished probably would prove a fruitless one, since several generations of Fairbottom boys had amused themselves by tossing bricks and other objects into the well and any pieces of value at the bottom in all likelihood would now be buried under mud and debris. Some of the missing parts, however, might be wedged across the shaft and on that chance heavy grabs were lowered.

The results of this method were nil, so a staging was built down to the water's edge and there a force pump capable of lifting 200 gallons a minute set up. At first this effort seemed to be meeting with success. The water level rapidly fell 10 feet. But it fell no farther. Seepage from old mine galleries far below now easily overcame the pump. The engineers conceded this final minor victory to the forces of nature, and though the water was probed with an 18-foot boathook from the lowered level nothing of value came to light.

They were satisfied, and well might be, for with the material they had and the aid of careful measurements and photographs, the reconstruction of what possibly is the oldest engine on earth could easily be achieved.

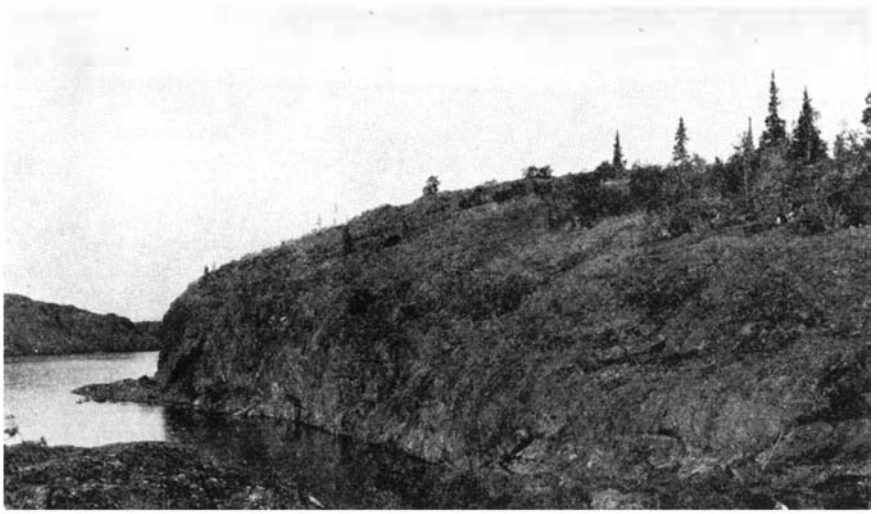
Carefully (and somewhat hastily, because souvenir-hunters were by that time visiting Fairbottom Valley in increasing numbers) the precious relics were boxed and moved across the wooden bridge to waiting railway trucks and shipped to the docks. Meanwhile, as a gesture of friendliness toward the generous trustees of the Earl of Stamford, Mr. Ford ordered a new footbridge erected near the site of the one washed away during the operations, so that today, no matter how merrily the Medlock overflows its banks, the cottagers of the valley can reach their homes dry-shod.

ON November 2, 1929, just four months after operations were begun at Ashton-under-Lyne, Fairbottom Bobs was shipped to the United States. Some months later Mr. Ford's English agents were enabled to acquire another Newcomen type atmospheric engine—one of the three known to be working throughout the world—and this one a particularly interesting specimen, since it has a separate condenser, and is thereby unique. In the neighborhood they found an old "haycock" boiler, of the type used originally with Fairbottom Bobs, the "wagon" boiler having been a later "improvement." This boiler was still in service—as a water tank. It was bought and shipped to Dearborn—where it gives the final and authentic touch to the restored masterpiece of Thomas Newcomen, the blacksmith who gave the world the first practical means of draining mines.

In the operation of the Newcomen atmospheric engine, steam at little or no more than atmospheric pressure was admitted to the cylinder through a valve, a counterweight on the beam raising the piston. A jet of water then entered the cylinder, condensing the steam. Atmospheric pressure, forcing the piston down, did the work on the pump. The next entry of steam expelled the condensed water through a valve.

Fairbottom Bobs has been perfectly restored, with the use of only such new material as was necessary to put it in working order again. And it does work today, or could be made to work, as well as ever it worked in the old Cannell Colleries in Ashton-under-Lyne.

ARCTIC



The cliff which is the site of the richest radium strike to date, at Great Bear Lake in the Canadian Arctic. The productive vein follows along the water's edge

Prospectors working on a claim in the Great Bear Lake mining field

Ores of the Canadian Arctic . . . By Air and Water and Rail to the South . . . Refined and Made Ready for Hospital Use Near Toronto

At a well guarded factory in the small town of Port Hope, Ontario, 60 miles east of Toronto, chemists are busy extracting the world's most precious mineral from tons of carefully guarded and protected rock which have journeyed nearly 3000 miles by air, water, and rail. Radium sells for 70,000 dollars a gram, or about 2,000,000 dollars an ounce.

Radium is being manufactured in Canada from ore found on the shores of Great Bear Lake, on the Arctic Circle. Ontario hospitals are using radium mined in the far north, and the medical world is looking to the Canadian Arctic to supply large quantities of this valuable mineral so necessary to-day in the treatment of cancer.

There is a jump of nearly 3000 miles from the Port Hope radium plant to the mining camps on the shores of Great Bear Lake. It used to take the better part of a year to get into the country. Now, from the mine to the plant, with favorable flying weather to Edmonton or Waterways, railway points, takes but three and a half days. The airplane has to a large extent made possible the rapid development of this new mining region.

Radium from the Arctic dates back but a few years, to the beginning of the decade, when two prospectors struggled against blizzards, snowblindness, and an inhospitable country to reach an island in Great Bear Lake on which they had noted a peculiar mineral formation the previous summer while flying over the region, southward bound.

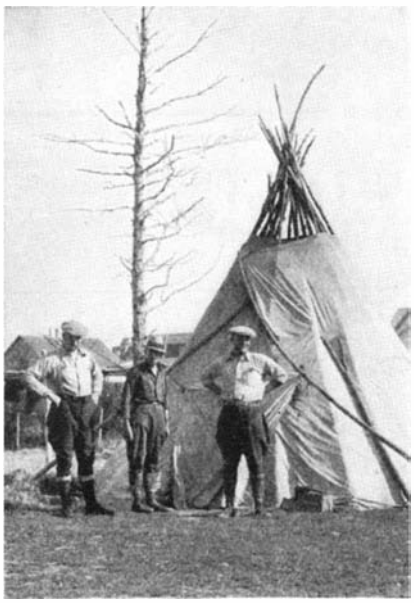
On the shores of Great Bear Lake men are busy, winter and summer, taking from the earth tons of rock rich in silver and radium content. Tunnels have been dug in what a few years ago was an unknown and isolated wilderness, passed through by perhaps a few trappers and a few Indians. Now there are mine railways, ore compressors, workshops, log cabins, stores, airports, and radio stations. Now the lake in summer has the traffic of a variety of boats, while planes land and take off from its sometimes turbulent waters. There, on the shores of Great Bear Lake, the bags of ore are filled, ready for shipment south.

At Port Hope a new method has been developed which cuts the time of extraction from the rough ore to three months.

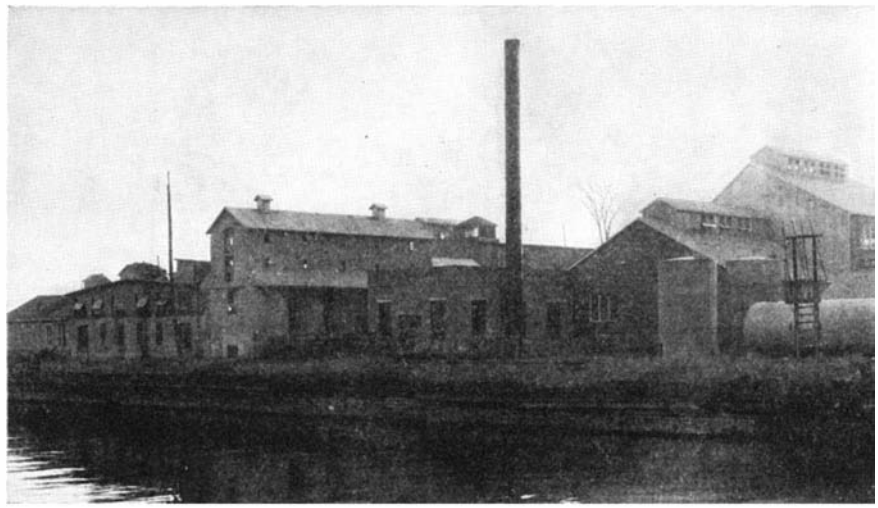
A plane on skis, with freight, at Echo Bay, on Great Bear Lake

Pilots who fly the Canadian northland are nowadays prepared for shipwreck on the many lakes of that region. They carry inflatable folding rubber canoes

RADIUM



Gilbert LaBine, discoverer of the ore at Great Bear Lake (on right)



The plant at Port Hope, Ontario, where radium is being produced from ore mined in the Canadian Arctic. A large plant, considering the circumstances

By JAMES MONTAGNES

Radium can be obtained only by chemical treatment requiring many operations. Three tons of chemicals are necessary to procure radium from a ton of ore. With these huge quantities of chemicals the crushed ore is treated. Every resultant solution and residue are handled over and over again, to extract every particle of radium concentrate from it. With every move in the process so carefully checked, weeks go by before pure radium is produced.

Great care is taken in handling radium bearing ore at the plant, for radium is a dangerous mineral, although it has healing qualities. Even the ore as taken from the mine is likely to damage the skin of any person handling it carelessly or injudiciously.

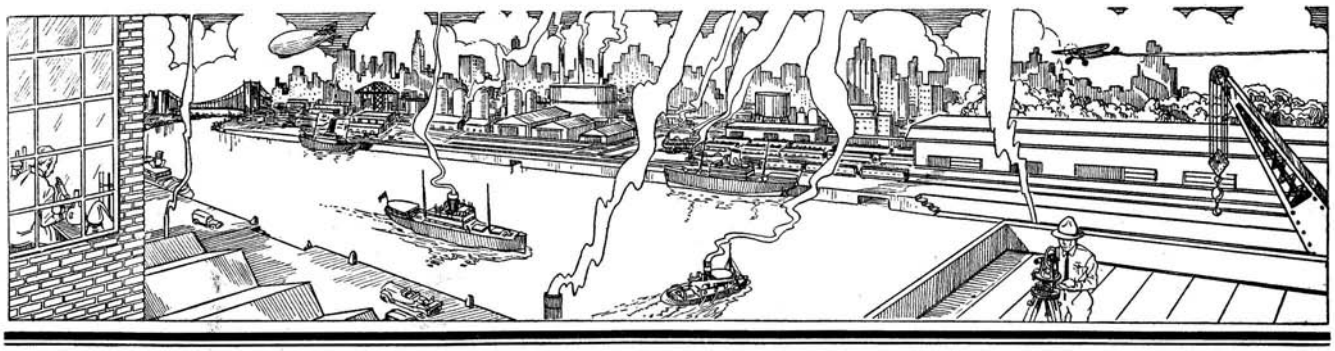
A finished radium "needle," for use in treating cancer by radium

The chemical process of extracting radium from pitchblende develops a number of by-products in the form of salts and minerals of different kinds. These are reclaimed from the various solutions through which the ore is put. Silver, lead, and some minerals used in the paint and pottery trades are thus obtained. Other by-products, such as uranium by-products, are sealed in small glass containers and shipped to recognized laboratories in Canada, the United States, and Europe for certification of radium content.

THE radium plant differs from most mining plants in that it is largely a laboratory, few heavy machines being used, except for the crushing, boiling, and live steam processes. Earthenware jars, glass retorts, and other utensils of the chemical laboratory are mainly in evidence, rather than the bulkier objects one would expect.

Doctors and patients have their eyes on this radium plant. The hopes of many cancer sufferers are centered in this comparatively new industry, for radium treatments are the best cure for cancer ailments discovered up to this time by the medical profession. Only a very small quantity of radium is in use in hospitals—nearly all that is now available. And that small amount is not enough for all the hospitals where cancer sufferers are being treated. The expense and scarcity of the mineral, until recently mined only in the Belgian Congo, have made it possible for only the larger hospitals to have fractional quantities of a gram. A source such as that of the Canadian Arctic is therefore considered of the greatest importance in the medical world.

Refined work in the radium laboratory at the Port Hope radium plant, showing how the ore is reduced to a fraction of a gram for medical purposes



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

In charge, Daniel Guggenheim School of Aeronautics, New York University

A. E. BUCHANAN, Jr.

Lehigh University

Lying-Down Spectacles

"RECUMBENT spectacles"—glasses for invalids and others who have to lie more or less flat on their backs and who wish to read—were shown to the public for the first time at the British Industries Fair, reports *Science Service*. These spectacles

enable the wearer to see more or less at right angles to the ordinary line of sight. They contain a pair of prisms, which project incoming rays of light in such a way that the wearer can read a book held comfortably at arms' length, resting on the waist—in a position where it could not be read at all, ordinarily, without raising the head from the pillow. Corrective lenses for righting defects of eyesight in the usual way can be combined with the two prisms.

Shortage of Coal-Tar Chemicals

A WORLD shortage of important coal-tar chemicals is predicted for the near future by *Industrial and Engineering Chemistry*. The shortage of crude naphthalene is described as acute. Germany has already placed an embargo and indications are that at least one other country abroad will follow suit. Unsettled conditions abroad plus fundamental changes in certain chemical processes aggravate the condition. In the last few years naphthalene has gained an unusually prominent place among intermediates. It is widely used in industry for the manufacture of dyestuffs, explosives, and phthalic anhydride. The latter is a constituent in the manufacture of one of the plastics, the demand for which has grown rapidly, particularly with its inclusion in formulas for protective coatings.

According to the Chemical Division of the Department of Commerce, 4934 metric tons of naphthalene were shipped from Germany to the United States in the first 11 months of 1935, as compared with 8942 tons for the corresponding period of 1934. The domestic demand for naphthalene in Germany has increased to a point where a national shortage is threatened there and as a result the Reich Government has issued a decree prohibiting exportation of crude naphthalene, although refined grades may still be exported under certain circumstances.

The consumption of naphthalene has not appreciably declined for the manufacture of the older products, such as moth balls, and the increase has been for these new uses. During 1934 over 38,000,000 pounds of refined naphthalene were produced in the United States and 48,000,000 pounds of the crude were imported, 22,000,000 of these coming from Germany, 7,300,000 from Belgium, 7,000,000 from the United Kingdom, 5,765,000 from Poland and Danzig, and the balance from Czechoslovakia, the Netherlands, Russia, and Canada.

It is a tribute to the enterprise of our chemical manufacturing industries that there should be a threatened shortage in naphthalene, especially since domestic sources have already developed to the point of furnishing quantities far in excess of all demands that could have been foreseen but a few years ago.—*A. E. B.*

FIFTH AVENUE

JEWELRY, silk stockings, women's dresses, hats, lingerie, cosmetics—many South American women now shop for these things on Fifth Avenue by air.

Japanese Beetles Resisted Winter

COLD weather of the past winter in the area infested by the Japanese beetle—roughly, eastern Pennsylvania and the southern two thirds of New Jersey—seems to have been no hindrance to the grubs that were hibernating in the ground.

Courtesy The White Motor Company

The world's largest strip shovel is shown lifting the world's largest coal truck loaded with 50,000 pounds (total weight 90,000 pounds). This powerful Bucyrus-Erie shovel can move from 2000 to 3000 cubic yards of earth every hour

Recent studies by entomologists of the United States Department of Agriculture show that numbers of this destructive pest in the soil do not decrease in winter, usually the season of heaviest insect mortality. Even the abnormally cold winter of 1933-34 in the east killed comparatively few beetle grubs.

Low temperatures, entomologists explain, stop activities of disease organisms that prey on larvae of the beetle in the soil in warm weather. Furthermore, the larvae, or grubs, of the beetle—the overwintering form—go down so deep into the ground that they are beyond the reach of intense cold.

Japanese beetles in the ground reach greatest numbers early in September at the end of two months of active egg laying. Then they decrease until the weather gets cold. Return of warm weather starts another decrease in the number found in the ground —most striking in May and early June.

New Treatments for Heart Disease

INJECTIONS of alcohol into the nerves beside the spine, removal of the thyroid gland, and a diet of few calories are among the new methods of treating heart disease. These and many others were described by Dr. W. D. Stroud of Philadelphia at a meeting of the American College of Physicians.

Too often the heart is treated for symptoms that are brought on by disturbance of the sympathetic nervous system, Dr. Stroud pointed out. Doctors are finding more and more that prolonged constant anti-syphilitic treatment is of definite value in preventing heart disease due to syphilitic infection.

As yet no vaccine has proved beneficial in arresting rheumatic heart disease, Dr. Stroud said. Digitalis, nitroglycerin, and rest continue to be standbys in treating certain forms of heart disease. For the much-dreaded angina pectoris, Dr. Stroud said that a cheerful outlook, reassurance of the patient as to his condition, and a readjustment of his daily routine with mild sedatives continues to be beneficial.—*Science Service.*

New Automatic Train Stop

AN automatic train stop has been perfected by an Austrian engineer named Kofler, which is apparently free from the defects of those now in use, particularly under conditions of ice and snow which put the present contact equipment out of operation. The Kofler train stop, which is characterized

The "star gazer" in use

by rugged construction, extreme simplicity, low initial cost (said to be about 167 dollars), and low upkeep cost, consists of an arm attached to a signal post. When set at "stop" the arm lowers, engages a tripbar on the locomotive that has direct connection with the wheels and sets in motion the mechanism that brings the locomotive to a stop. The device is illustrated in two accompanying photographs.

PESTS

TWO billion dollars just about covers the damage done by insect pests in this country each year. This sum is estimated from the known amount—about nine hundred million—of the damage done annually by 34 of the more important insect pests.

Star Gazer

MOST practical of all the gadgets we have seen for locating and learning the constellations is a rather simple one invented by Prof. Walter Bartky of the Department of Astronomy at the University of Chicago. A common flashlight battery and lamp illuminate a motion picture film which may be shifted to any one of the common constellations shown on it, simply by pushing the film through to the desired "frame." The whole "Stellarscope" is then held up to one eye, while the other eye beholds the actual sky. The Stellarscope is then moved about until the images in both eyes coincide, and this automatically picks out the whole constellation far more easily than the familiar old method of "Now follow down from that one, a little bit to the left to a red one; and then over to the next one just above Smith's woodshed; and on down again about to the roof; and then over. . . ." Or, even if large illuminated charts are used, the eye must be shifted back and forth, so that the views are not at first seen as a whole, as with this little device. It deserves the commendation it probably will receive. The University of Chicago is using Stellarscopes in its evening class work exercises.

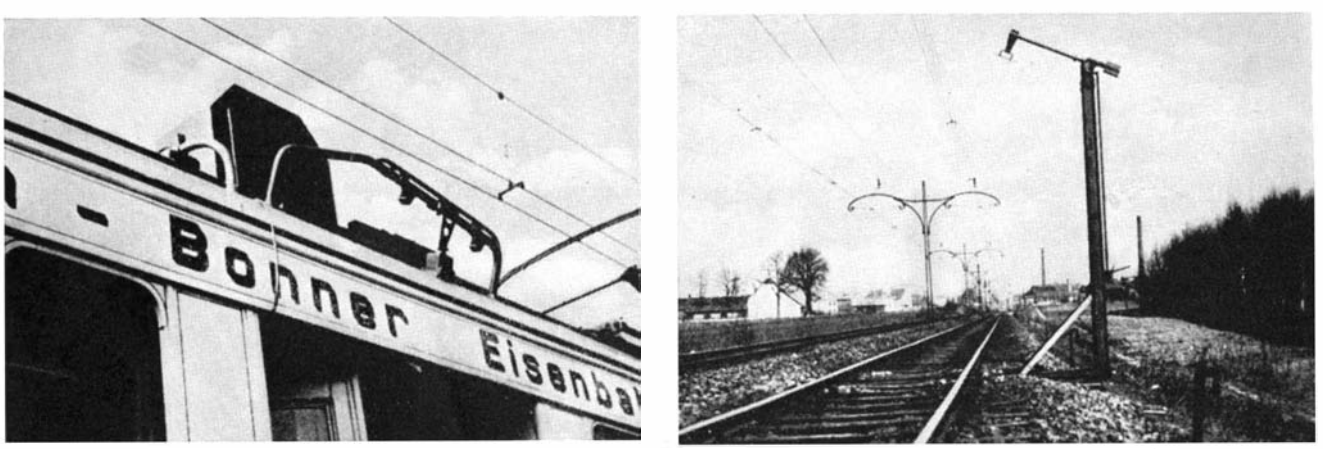
Wood Distillation Comes Back

JUST a few years ago we reported in these columns that synthetic methods for the production of acetic acid threatened the life of the wood-distillation industry. The wood-distillers were not willing to give up the ghost so easily, however, and they put research chemists to work with the result that improvements in wood distillation methods have again put acetic acid from this source in a favorable economic position to compete with the synthetic product. By continuous direct separation of acetic acid, wood alcohol, acetone, and tar from the crude pyroligneous acid from the retorts, substantial savings are effected over the now obsolete process involving the intermediate production of calcium acetate. The azeotropic distillation process yields glacial acetic acid directly.—*A. E. B.*

The Electrocamera

PARALLELING recent developments in the photography of lightning discharges, a new technique called "electrophotography" has produced portraits of electrical discharges through insulating materials. The importance of the new development, according to the *Industrial Bulletin* of Arthur D. Little, Inc., is due to the need for better insulators in modern methods of power transmission and use. Moist oil-immersed photographic film or paper is placed in a light-proof housing with the insulating material being examined, then a high-potential alternating current is passed through and a photographic record is made of the location and intensity of the breakdown of the insulator.

Collision of electrons and charged positive ions produces a local corona, says the physicist, but whether he is right or wrong,



Two views of the automatic train stop, showing the tripbar on the locomotive, and the signal-post arm

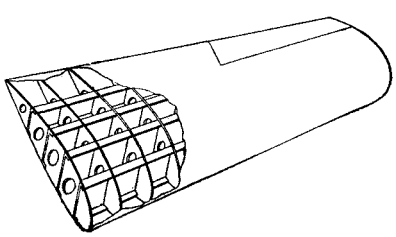
the new method indicates the voltage at which cable destruction will begin, and it may be applied as well to mineral insulating oils, solid insulating materials, the new "superdense" papers and tapes used in cable manufacture, and even impregnating compounds. The very mechanism of electrical breakdown and the factors effecting it may now be studied more effectively, and the modern knowledge of materials brought more successfully to bear on electrical engineers' problems.

Great Circle Aircraft Construction

THE shortest distance between two points on the surface of the earth is on a "great circle." The diameter of a "great circle" is the diameter of the sphere itself. But what has the great circle to do with airplane construction, and why did newspaper announcements of geodetic or great circle construction by Vickers in England arouse such interest?

The most efficient way to build an airplane is to make it a monoplane, and the most efficient way of securing good climb and take-off is to give the monoplane a large aspect ratio, which, in non-technical language, means to give the wing a long span. But when the monoplane wing is long and thin (it should be thin for aerodynamic efficiency) the high bending moments near the fuselage are very hard to meet structurally. The aerodynamic efficiency of the long monoplane wing is counteracted by the high structural weight of the wing.

American designers have been the pioneers in all-metal monoplane wings of large aspect ratio and have designed their structures in a number of different ways. A typical construction is that shown in one of our



Conventional wing construction

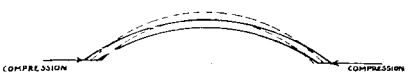
diagrams. The sketch shows a number of rather light spars or longitudinals; at intervals the spars are connected together by rigid bulkheads or ribs; over the ribs and bulkheads there is a metal skin covering riveted to spars and bulkheads; to make the skin of the upper surface of the wing contribute to the strength, this skin is reinforced at intervals with "stringers" (not shown in the sketch).

This construction has proved surprisingly effective, but is also very complicated in calculation and, what is worse, is very hard to build. There are thousands of rivets to be placed—driven in, sometimes in the most awkward positions.

B. N. Wallis of the Vickers company has hit on an entirely new method of construction, the geodetic method, which gives promise not only of greater lightness (or, alternatively, the ability to make the wing longer for a given weight) but also of far greater simplicity.

Suppose we have a curved member of metal as shown, to which a tension load is applied. What happens? The member tries to extend and the center portion of the curved member tries to go down. But suppose we have a curved member of metal, to which a compression load is applied. The member tries to compress and the center tries to go up. If the compression member

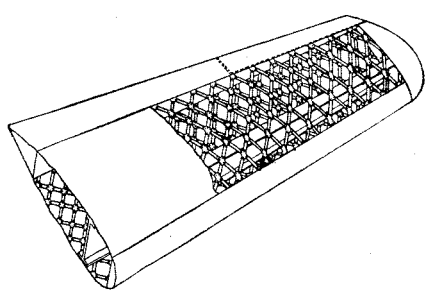
Curved member under tension



Curved member under compression

is thin it will fail very readily. This is the reason why the thin metal cover of the upper surface of a wing has little strength in compression and buckles or crinkles easily.

Now here is Mr. Wallis's brilliant idea: Suppose we connect curved compression members to curved tension members at their centers. The tendency to rise and the tendency to go down at the center points will neutralize and the full strength of the material will be developed. One of the illustrations shows diagrammatically how

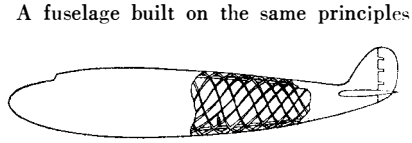


Great circle wing construction

this new and simple principle is applied in the construction of a monoplane wing.

There is still a spar to take up the bending loads, but there is only one such spar. To take up the twist loads, thin strips of metal are wound in contrary directions with a connection between the strips at their intersection points. The whole is covered with very thin sheet. Owing to this neutralization of loads at the intersection points, and the fact that the strips are placed as far as possible from the center line or "neutral axis" of the wing, all the material works in the most efficient possible fashion. These curved strips are "geodetics" or great circle lines—hence the name.

A fuselage built on the same principles



Great circle fuselage construction

is also shown. It certainly is reduced to the simplest form, all other internal members disappear, and a great deal more room is available for baggage, mail, and so on. —*A. K.*

Blind Flying by Sound

IN a recent paper presented before the Institute of Aeronautical Sciences, Luis de Florez, consulting engineer and private plane owner, described some novel experiments demonstrating that blind flying with the ear as a guide is quite possible.

It has long been known that our ears detect the direction of sound through what is known as the "binaural" sense with which virtually everyone is endowed. This directional sense is based on the ability of the brain to interpret differences in phase and volume of sound which occur when sound waves strike the ears unevenly. Thus if a sound be produced to one side, the nearer ear will be struck by the sound waves first as well as in greater volume. When we wish to face the sound we turn the head until the ears receive the sound waves simultaneously and in equal volume. It is upon this principle that Mr. de Florez's experiments are based.

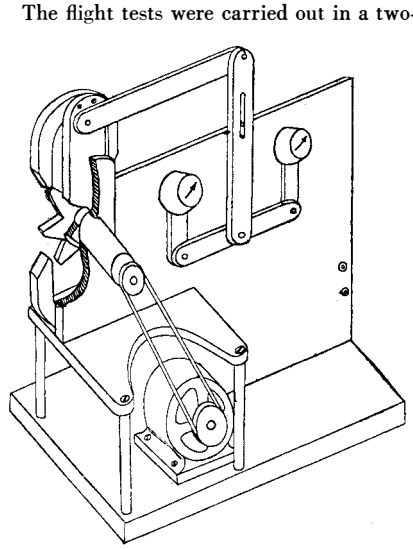
The laboratory experiments were made with very simple apparatus, shown diagrammatically in the sketch. The sound was produced by a six-toothed inductor wheel rotating between the poles of two electromagnets, producing alternating currents in the circuits and setting up a hum in each of a pair of earphones. By varying the speed of rotation, changing the position of one magnet with respect to the other, and manipulating the rheostats, variations in pitch and intensity could be imparted to either ear.

When Mr. de Florez sat in a swivel chair, and someone else operated the apparatus, he found that he could follow the apparent source of the sound all around the room.

The second phase of the experiments was to determine whether the average ear could remember and return to a given pitch. This was done by varying the speed of the wheel and returning it to approximately the same pitch as before such manipulation. It was found that the ear and brain were quite capable of such a task.

The next step was to make experiments in actual flight. The pitch sound was produced by a small wind-driven magneto attached to the flying struts and well out of interference with the wing. If the airplane nosed down and its speed increased, the speed of the windmill would increase also, the acoustic pitch would be higher and the pilot would be "aurally" notified that the nose of his craft was going down. The gyroscopic turn indicator was so connected with the electric circuit that a turn to the right brought the sound to the right ear and vice-versa.

The flight tests were carried out in a two-



Laboratory unit for experiments in blind flying by sound, showing inductor wheel and movable magnet

seater parasol Fairchild 22 equipped with a Warner 145 horsepower engine. Mr. de Florez states that with eyes blindfolded, or in fog, he was able, after relatively little training, to keep a fairly straight course for more than 40 minutes, and carry out turns correctly. After his controlling co-pilot had deliberately put the plane in a spin, he was able to bring the ship back to normal after somewhat more of a dive than usual.

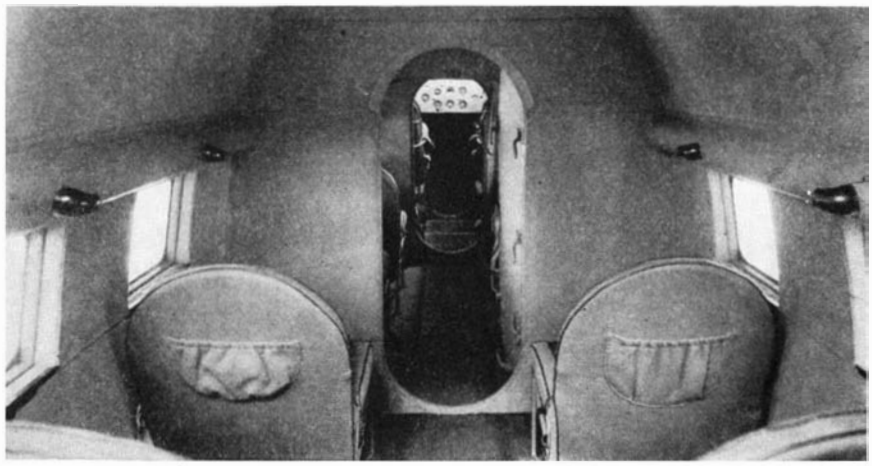
Space will not permit us to go into greater detail. In general, it was found that the acoustic characteristics of the position of flight were interpreted almost subconsciously, perhaps in the same way that dancers follow music without conscious effort. One can readily see what a help it would be to the pilot if in blind flying he received indications subconsciously through his ears while his eyes were free for the many other duties which a pilot has to perform.—*A. K.*

AIR TRADE

THE United States not only leads every country in the world today in air trade with South America, but her yearly trade by air with that continent is greater than that of all other countries of the world combined.

Inside an Amphibian

WE never cease to marvel at the complexity of the modern airplane as compared with the stark simplicity of the early stick-wire-fabric contraptions that flew so daringly. The new Fairchild 91, which is said to be the world's fastest and largest single-engined amphibian, is a splendid example of the remarkable equipment that is taken for granted in the passenger aircraft of to-day. Powered with a Pratt & Whitney Hornet of 750 horsepower, it has a top speed of 173 miles per hour and a useful load of 3904 pounds (crew, radio, fuel, oil, passengers, mail, and express). The gross weight is 10,500 pounds, which means that the useful load is about 40 percent of the gross weight—somewhat of an achievement.



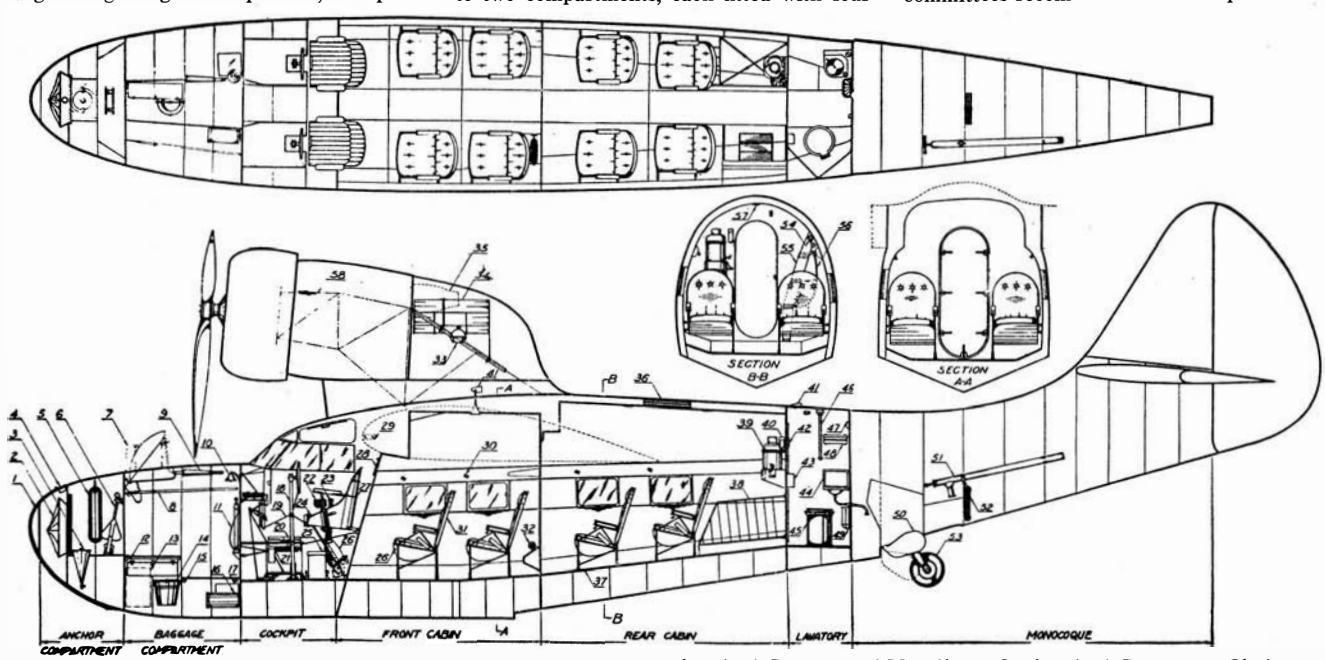
Comfortable interior of the new Fairchild 91 described below

The new craft is to be put in service by Pan American Airways on a 1000-mile stretch of the Amazon River, between Para and Manaos, reducing the run from 10 to 6½ hours, and bringing Manaos, in the wilds of the Brazilian jungle, to within four days' travel by air from New York City.

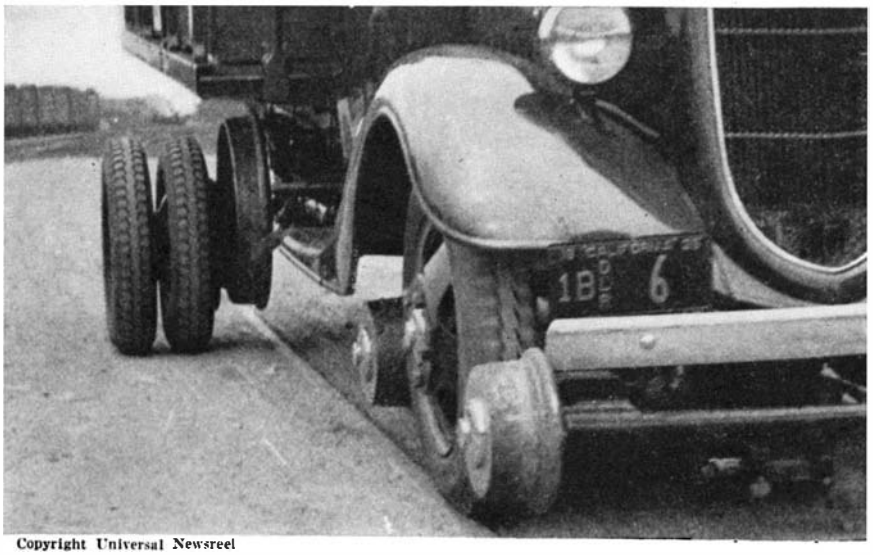
Our photograph shows an interior view of the cabin. The 16-foot cabin is divided into two compartments, each fitted with four reclining seats which are set in rubber. A bulkhead is inserted between the two passenger compartments. There is a large individual window at each seat, and individual nozzle-type ventilation controls. The sound level is low, thanks to scientific soundproofing and because the wing is placed between the engine and the cabin, with the engine well forward. The diagrams supplied by the Fairchild company indicate 58 items in the equipment and installation. What troubles the aircraft designer must have in combining all this equipment with structure, aerodynamics, performance, power plant installation, and other problems! —*A. K.*

Airship Survey Report

ALL airship disasters are probed by investigating committees, and all the committees recommend in their reports that



The equipment of the Fairchild amphibian, illustrated above, is as follows: (1) Tow Line. (2) Sea Anchor. (3) Oil Dispenser for Sea Anchor. (4) Mooring Post, retractable. (5) Utility Line. (6) Anchor. (7) Propeller Guard. (8) Boat Hook. (9) Fog Horn. (10) Bell. (11) High Pressure Pump. (12) Tool Box. (13) Engine and Propeller Covers. (14) Bucket. (15) Baggage Hold-down Rings. (16) Sealed Tool Container. (17) Special Airplane Tools. (18) Dual Control Column. (19) Control Column Lock. (20) Very Pistol. (21) Hand Fire Extinguisher. (22) Axe. (23) Machete. (24) First Aid Kit. (25) Battery. (26) Life Preservers. (27) Pilots' Seat. (28) Log Book Container. (29) Pilots' Ventilator Outlet. (30) Passengers' Ventilator Outlet. (31) Passenger Chair. (32) Hand Fire Extinguisher. (33) Water Container. (34) Life Raft. (35) Life Preserver. (36) Soundproofing and Interior Trim. (37) Cabin Floor. (38) Baggage Rack. (39) Water Jug. (40) Cup Holder. (41) Lavatory Ventilator. (42) Mirror. (43) Tissue Dispenser. (44) Wash Basin. (45) Chemical Dry Toilet. (46) Head Protector. (47) Deodorizer. (48) Paper Towel Dispenser. (49) Waste Receptacle. (50) Retractable Water Rudder. (51) Bilge Pump. (52) Hoisting Sling. (53) Retractable Tail Wheel. (54) First Aid Kit. (55) Entrance Ladder, interior fixed. (56) Entrance Ladder, outside retractable. (57) Dome Light. (58) Engine Nacelle.



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Another type of rail-highway truck that makes possible store-door delivery of freight. The flanged wheels are so arranged mechanically that they can be lowered to the rails, or raised out of the way for highway travel, in a very short time

more airships should be built. The arguments offered are now almost classical—that there are disasters in other fields of transportation as well, that the safety record of small airships is remarkable, that the military or naval value of the airship is well established, and so on. The conclusions of the recent Airship Survey Committee Report and its general character are closely reminiscent of a series of articles on airship safety which appeared in the columns of Scientific American early in 1925!

The Committee suggests, however, that the next large airship to be built for the Navy should not be intended for actual service with the fleet, but should constitute an experiment on scientific lines. That is probably the very best way of really settling the question once and for all.

The Committee recommends that the airship be designed in the light of the most recent studies and advances in structure, aerodynamic theory of the loads imposed, and meteorological science, particularly as regards gusts.

When completed the ship would be used as a giant laboratory. The constructors, in co-operation with the Navy Department, would take strain gage readings at all critical points, and make other careful technical observations under progressively more severe operating conditions. The personnel would be specially trained in weather study.

With the construction of the ship undertaken as a scientific experiment and with no false expectations aroused in the minds of the public, the Navy certainly would be in a "safer" position to undertake the building of another airship.—*A. K.*

Marine Grass Cutter

IF you've ever had to pole a boat through a heavy growth of seaweed or underwater plants of any kind; if you've ever had to clear a weed-fouled propeller; if the channel to your boathouse is so weed-choked that you—but let's omit the profanity and examine a new weed cutter developed by Electri-Craft Corporation.

As shown in the illustrations, this device consists of a circular saw which operates in a horizontal plane at the lower end of a shaft clamped to the stern of a row-boat. The cutter blade is between two plates which have periodic notches to "back up" the plants being cut. The blade is protected by a vertical guard ring; and the shaft is hinged so that when this ring hits a stone or snag, the entire mechanism swings up.

For power, this device depends upon a storage battery, the motor being built into the top of the shaft. In full cutting operation, the motor draws an average of 14 amperes.

Rubber for Caulking Masonry

AN adhesive and caulking material for the building trades, called "Plasoleum," has been announced by the Revertex Corp. of America. The base of the new product is concentrated rubber latex which gives it the water-proofing qualities of rubber as well as its durability and resistance to temperature change. Plasoleum can be spread with a trowel in cold form. Combined with certain fillers, it makes an advantageous material as a filler for expansion joints in buildings and as a caulking material for window frames and the like. Other special uses include its adaptation as an adhesive for laying wood and wood block, linoleum, rubber, cork, and tile on concrete or steel, and for laying linoleum, wainscoting, tile, rubber, and glass on concrete, wood, brick, and plaster walls.—*A. E. B.*

TRANSPLANTED HEARTS

THE chicken heart which has been living for years without a body had better look to its laurels. Now comes news of hearts of animals that were transplanted to the bodies of other animals and kept beating as long as the "adopted" bodies lived. These experiments were carried out on lowly animals: red-spotted newts.

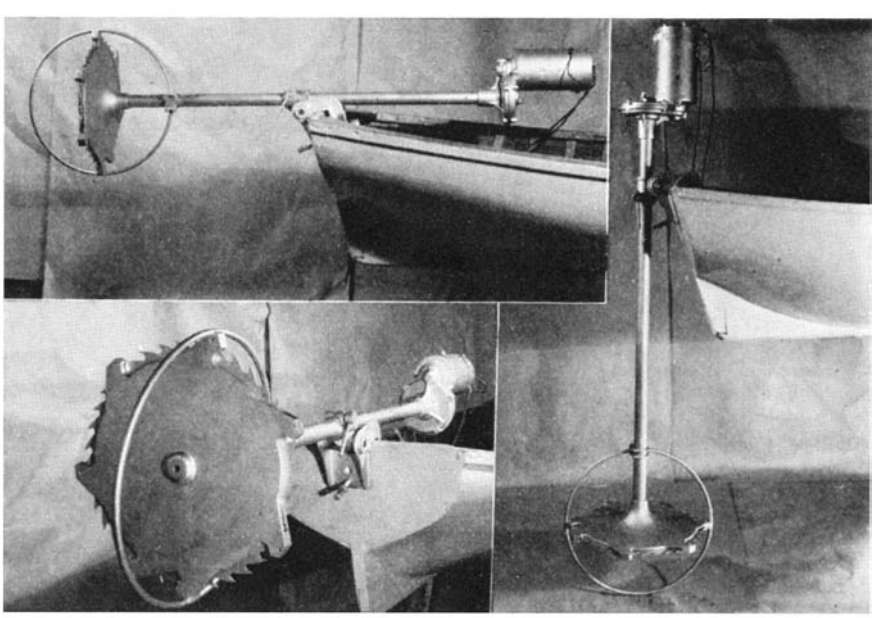
Dust Control

THE recent furore concerning alleged deaths from silicosis at Gauley Bridge, West Virginia, has increased the demands for a better dust respirator which workmen may use when exposed to the dangerous quartz and silica dust. Says Dr. Philip Drinker of Harvard University, who is the inventor of the artificial "lung" known as the Drinker respirator:

"Some firms, driven panicky by the present silicosis-dust racket, have even gone so far as to stock up with 'approved' respirators so that they might be able to show they have on hand the best respirators made in case they find themselves defending a dust-compensation lawsuit."

In a report to the American Society of Mechanical Engineers and just published in *Mechanical Engineering*, Dr. Drinker further points out:

"It can be said of all the mechanical-filter-type of dust respirators that they are a poor substitute for dust control. Ultimately it is not an economy to supply workmen with air-line respirators or with dust respirators instead of installing the proper dust-control equipment. Further, the time is not far off when the courts and compensation



Upper left: **The marine grass cutter in raised position.** ***Lower left:*** **Close-up of the weed-cutting disk and guard ring.** ***Right:*** **The cutter in operating position**

boards will make short shrift of the employer who lets his men work in dense clouds of dust, regardless of what the dust is.

"In general, the employer would do well to try some of the dusty jobs himself, wear the men's respirators, and thus decide whether or not it would be better to install dust control instead of respirators. However, dust respirators are centuries old; they have a legitimate place in industry, and are an important aid in the prevention of dust inhalation, but they are not a substitute for dust prevention and never should be used as such."—*Science Service.*

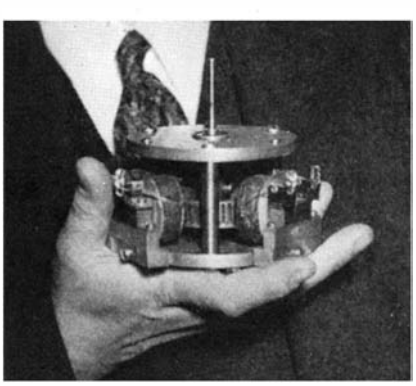
Motor Synchronises with All Television Transmission

NO matter whether a television transmitter is sending 30-line images at the rate of 15 per second or 343-line pictures, interlaced, at 60 per second, they will be automatically synchronized by a new receiver scanning mechanism now being used in the laboratories of the Peck Television Corporation. The secret of this mechanism is a new multi-speed synchronous motor, developed by William Hoyt Peck, to run at a rate governed entirely by the incoming signal.

This motor is but slightly larger than those commonly used in electric clocks, measuring only four inches in diameter and two-and-a-half inches in length, and operates upon much the same principle. The rotor, two inches across and a half-inch thick, rotates between six stationary pole pieces, the windings of which are connected in pairs. The power to energize these windings is drawn from a single stage push-pull audio amplifier, connected in shunt with the amplifier which controls the light modulation. Each frame impulse and each line impulse thus acts upon the field windings of the motor just as the 60-cycle impulses control the ordinary synchronous motor.

Two pairs of the field windings of the multi-speed synchronous motor are connected directly across the output of the power amplifier, the third pair being connected back to the input, so that the current generated in them by the movement of the rotor is fed back in, to intensify the power output. The frequency of this regenerated impulse is, of course, governed by the rate of rotation, so that synchronism is maintained.

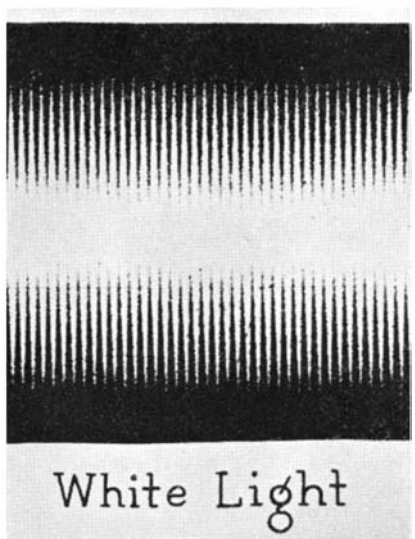
When run directly from 60-cycle A. C., the motor turns at a speed of only 150 revolutions per minute, but when various signals from audio- or radio-frequency oscillators are fed into the amplifier, its speed has been increased up to 28,000 revolutions per minute—well in excess of the 25,725 revolutions per minute necessary for scanning the most detailed picture as yet contemplated by any television concern.



Motor that synchronizes televisors

Sound Recorded by Ultra-Violet

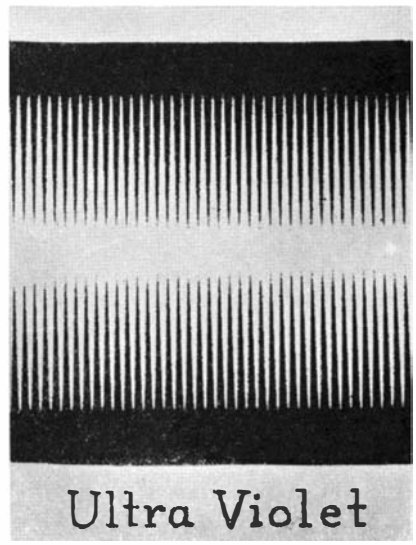
THE lisping and hissing effects which have marred the screen voices of many talking picture stars have been completely eliminated, and the quality of musical reproduction immensely improved, by means of a new sound recording and printing method which utilizes ultra-violet light, in a narrow range above visibility, instead of ordinary white light.



Recording with the new ultra-violet system is a good deal like improving the details of a photograph. In this case the photograph is the picture of the sound on the film. Acknowledging some earlier research along similar lines by Carl Louis Oswald, the RCA Photophone engineers, working in the research laboratories of the Radio Corporation of America, discovered that by restricting the light focused on the film negative, during recording, to a narrow band in the ultra-violet range, sharper focusing of the lenses in the optical system and controlled penetration of the light on the negative emulsion made it possible to photograph the sound patterns with a sharpness and delineation which corresponds more closely to the characteristics of the original sound than ever before.

The tendency for the high-pitched voices of some screen celebrities to sound sharp-edged, especially in the sibilants, has long presented a difficult problem to motion picture sound engineers. The technical reason for these harsh sounding effects is that by ordinary recording and printing methods the finely graded variations in amplitude of which the upper frequency tones are composed become blurred or distorted on the sound track, so that instead of an exact pattern of the speech characteristics there is merely an approximation. The upper frequencies are the tones which make possible realistic reproduction.

When a high-pitched voice, recorded by visible light, reaches the neighborhood of 9000 cycles, it is necessary to cut off the top range of frequencies or depend on extremely critical and laborious printing of the final track to remove the objectionable rasping effects. The new ultra-violet method is said to give such a sharp and clear definition of the peaks and valleys of the high-frequency waves that there are now no practicable limitations in recording and reproducing all the frequencies necessary for faithful reproduction from film.



Compare photographic quality of these sound records as recorded on film by white and ultra-violet light

CHESTNUTS

SINCE the fungus which has destroyed most American chestnut trees originally came from the Orient, it is interesting to note that Oriental chestnut trees are now being planted in Virginia to see whether they are resistant to the blight. The destruction of our chestnuts was a major blow to American forest industries, for the chestnut is a tree of many uses.

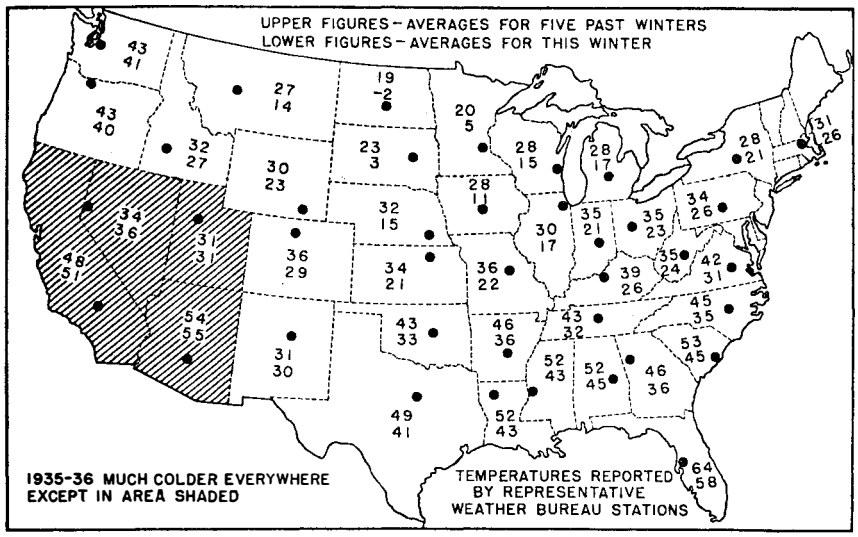
Bad News for Unlucky Parents

IF parents have one malformed baby, are later children born to them likely to be defective too? Physicians are asked this question so many times that one of them, Dr. Douglas P. Murphy of Philadelphia, has made a study of 275 Philadelphia families known to have possessed a congenitally malformed or defective child.

What he found is reported in *The Journal of the American Medical Association.* Dr. Murphy concludes from his study that offspring with serious congenital malformations are approximately 24 times as likely to occur in families possessing a congenitally malformed child as in the population at large.—*Science Service.*

Robot Chemist Detects Gas Danger

A MACHINE that does the work of an analytical chemist was described recently by Murray D. Smith, of the Davis Emergency Equipment Company. The instrument is known as the J-W Combustible Gas Alarm and when installed in a factory, paint shop, or other similar location, it con-



Was the winter of '35-'36 colder than previous winters? This comprehensive United States Department of Agriculture map tells the whole story at a glance

tinuously analyzes the air at any desired point. If, at any time, the air contains a dangerous amount of inflammable gas, the device sounds an alarm, and may also, if so arranged, shut down machinery or start up a ventilating system.—*A. E. B.*

Catapulting Commercial Airplanes

WRITING in the *News Letter* of the Aero Insurance Underwriters, Jerome Lederer advocates catapults for use with commercial airplanes.

An important factor in the finances of air transport operation is, of course, the pay-load for a given horsepower. But increasing the pay-load means increasing the gross weight, and that means a longer and more difficult take-off. Why not use catapults, therefore, to increase the permissible pay-load?

The catapult would have to be designed so as to give a uniform acceleration not greater than the acceleration due to gravity in a falling body. Otherwise the passengers would complain of discomfort. Also, the catapult would have to bring the airplane up to a speed *above* the minimum flying speed, as otherwise the ship would be in very poor control at the instant of leaving the launching device. Another precaution would be the use of powerful flaps so that if the heavily loaded ship "lost" its engines after being catapulted it would not land at too great a speed.

The technical problems in the design of catapults have been solved in naval work, and these devices have also been used on ocean liners for launching mail carriers. With passengers on board the design would have to be worked out more carefully, but the project is undoubtedly feasible. It will be interesting to see whether operators of airlines will give the idea consideration. —*A. K.*

Sun-Spots and Magnetic Storms

PROBABLY the most fascinating characteristic of sun-spots is that of rapid change. Some show changes from week to week, some from day to day, and in some cases the appearance changes even from one minute to the next. And it is only natural that, from the very first, men have tried to connect these changes with occurrences upon the earth. Attempts have been made to correlate sun-spot activity with a large number of variable phenomena—such as rainfall, earthquakes, the price of wheat, and so forth—without reaching any conclusions that have been generally accepted. In fact, of all the influences which sun-spots have been suspected of having upon the earth, only one is so definite that the connection is unquestioned. It is the relationship between sun-spot activity and disturbances of the earth's magnetic field.

Many theories ascribe the origin of the magnetic storm to something propagated from the sun to the earth, such as a stream of electrified particles expelled from a sun-spot, or ultra-violet radiation, but so far no theory has been proposed which adequately explains all the observed facts.—*Dr. R. S. Richardson of the Mt. Wilson Observatory, in "Leaflet 84," the Astronomical Society of the Pacific.*

SPONGE

MAN has never been able to make a sponge comparable with the natural ocean sponge—until now. One recently developed is made of pure cellulose, is a tough compact material when dry, but a soft sponge, comparable with the ocean variety when wet.

Showers Before Swimming Not Enough

SHOWER baths required before swimmers are allowed to enter pools are not enough to prevent the spread of the streptococcus infections of nose and throat, which so commonly develop among those who use pools regularly, W. B. Ardrey of the Michigan State College recently reported to the Society of Bacteriologists, Pathologists and Allied Workers, according to *Science Service.*

Mr. Ardrey found that, when examinations were made of the skin at various parts of the body, streptococci were found in very small numbers except on the hands, and that when swabs were made of the mouth and nose, tremendous numbers of these "germs" were discovered.

Bathers were instructed to take their usual baths before entering the pools and then to stay at the shallow end of the pool and wade around. Few or no streptococci were found in the water until the bathers were told to swim and take exercises which placed their mouths and noses under water. Bacterial counts then made of the swimming pool water showed large increases in streptococci. This was explained on the basis that some water enters the nose and mouth and is immediately blown out again.

Second Highest Dam Built in France

FRENCH engineering skill recently completed the second highest dam in the world—the Sautet Dam at the headwaters of the Rhone River in the French Alps. The structure, a thin wall of concrete 414 feet high, blocks the narrow canyon of the Drac River.

Though second to Boulder Dam in height, it is by far the highest in the world to be built upon tricky limestone, according to *Science Service.* As at the Tennessee Valley Authority's Norris Dam in this country, extreme precautions have been taken to fill the caves and hollows through which water might leak around the dam. Hundreds of holes were drilled into the limestone near the structure—their combined depths total 20,000 feet—and 3000 tons of cement were pumped into them under pressure as great as 500 pounds per square inch.

Engineers were spurred to conquer extreme difficulties in building Sautet Dam because the structure will store water until needed by several power plants downstream. It is also similar to Norris Dam in this respect.

Sautet's power plant is wedged into the bottom of the narrow canyon. Indeed, the space there is so narrow that the plant's six 13,000 horsepower generating units are controlled by cables from the top of the dam.

Safe Electric Fan

WHAT seems to be about the most sensible development in electric fan design and construction has been announced by Samson United Corporation, electrical appliance manufacturers.

It is claimed to be the only fan ever built that is really safe! The reason for its inability to cause injury to even the most careless person lies in its new, flexible blades

Rubber fan blades for safety

of tough, molded rubber. These blades, though rigid enough to deliver a steady current of air strongly, are sufficiently soft to prevent injury to even a child's fingers. Thus the necessity for unsightly and cumbersome guards is eliminated.

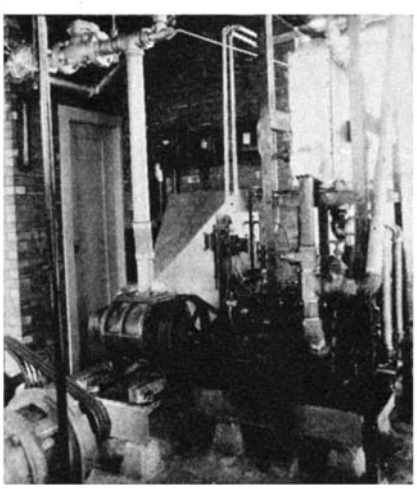
GLASS PAPER

THE Editor recently received from the Owens-Illinois Glass Company a letter on a tough letterhead which feels like damp parchment. We learned that it is made with glass fibers slightly impregnated with a small amount of rubber as a binder.

Motor Runs on Fuel of Its Own Making

OPERATING on methane gas derived from a sewage disposal process which in turn is activated by the engine, the Ford V-8 motor shown in our illustration has achieved something faintly resembling perpetual motion. The engine is in regular daily use at the Greencastle, Indiana, sewage disposal plant.

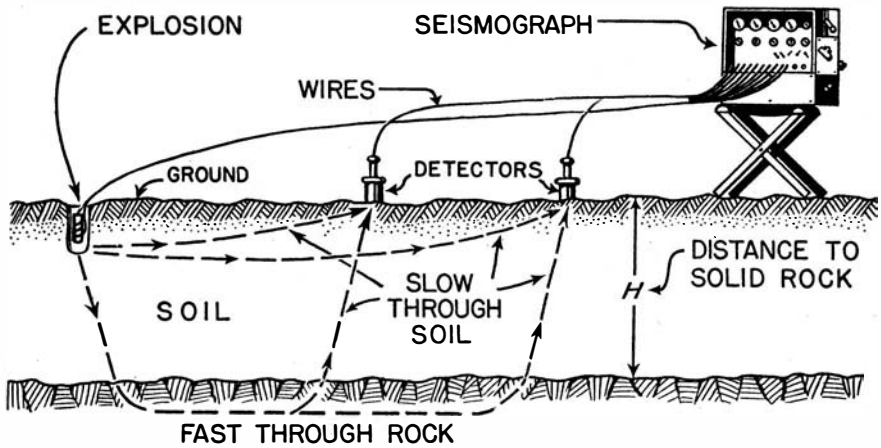
The V-8 engine serves two functions in the plant. Power from the engine drives an air blower supplying oxygen to the aeration basin where bacteria are propagated. Further, heat from the engine's cooling system is used to keep the septic tank at a temperature favorable to bacterial action. Under the conditions thus induced, the bacteria become active, resulting incidentally in the formation of the methane gas. The gas, in turn, is piped to the air intake of the engine where it is diffused with air before it enters the motor.



Motor set-up that runs on sewer gas which it helps to manufacture

The engine has been in successful operation since March 1, 1935, using the methane gas exclusively as fuel. It runs 24 hours a day, seven days a week, at a speed of 1500 revolutions per minute. Two regular Ford water pumps are used to pump the water nearly a quarter of a mile to the septic tank, through the coils and back to the motor. According to the engineer in charge, only minor repairs have been necessary during a year's operation and the engine is performing as well as when first installed.

The sewage treatment process in use is known as the "activated sludge" system. About 30 sludge gas engine plants have been installed in this country, England, and Germany since 1927. As fuel costs are next to nothing, the plants normally pay for themselves in about a year.



How artificial earthquakes are used to locate underground rocks

AIR TRANSPORT INCREASES

THE air lines started the year in excellent fashion. Passengers carried during January were 44,061 against 28,922 in January of last year. Express pound-miles flown were over 195 million against more than 113 million last year, and the total miles flown were 4,245,199 against 3,231,096 last year.

Sound Waves Locate Underground Rock

BY precise timing of sound waves racing through earth and through earth and rock, engineers of the Bureau of Public Roads have developed practical field methods for determining the distance below the ground surface to solid rock. These engineers have perfected an instrument by which measurements can now be made on the surface with apparatus that will indicate within a few feet how far below the surface rock will be found. Engineers need such information in planning bridges and buildings, estimating cost of grading for highways, and for other purposes. The measuring instrument is a sensitive seismograph. The method saves the time and expense of drilling to find out how deep the rock lies.

Accurate results are obtained by measuring the speed with which an impulse from the explosion of a buried blasting cap or small charge of dynamite travels through the ground. Such an impulse will travel through soil at a speed of 1000 to 6000 feet per second but the speed through rock is 16,000 to 20,000 feet per second. A cap is exploded in the ground and at the same time the electric current exploding the cap causes a record to be made with precise apparatus for measuring time. Special detectors are placed at different distances from the explosion and pick up the impulse as it comes through the ground. The detectors are electrically connected with the time-recording device and the time of travel of the impulse from the explosion can be measured to a small fraction of a second.

When a detector is close to the explosion one impulse coming through the soil is received. At a greater distance an impulse coming through soil is received and a second one moving down through soil to rock, through rock, and from the rock up to the surface arrives a fraction of a second later. At still greater distances the impulse moving through soil and rock arrives ahead of the impulse moving more slowly through soil alone. Knowing the speed of travel through soil and through rock and the time of travel through different distances it is possible to calculate how far the impulse went downward through soil before it encountered rock.

This method has been used extensively in prospecting at considerable depth for oil. Elaborate and costly apparatus has been used. The Bureau of Public Roads has now developed simplified apparatus that is giving excellent results.

Iodized Wrappers Preserve Fruit

IODINE, the old reliable of the first-aid kit, is a useful medicine for fruit too, according to *Food Industries*. Experiments by the Food Investigation Board of the Department of Scientific and Industrial Research in Great Britain have established the interesting fact that when paper wrappers for certain kinds of fruit are treated with iodine, fungal rotting is greatly retarded. The appearance and flavor of the product is unimpaired. Bunches of grapes wrapped in iodized paper were found to remain free from mold much longer than those wrapped in plain paper. The same applies to tomatoes and oranges. The iodized wraps also reduce the brown rot of plums and peaches, but certain varieties of these fruits were adversely affected by the treatment, failing to ripen properly and even turning black.—*A. E. B.*

Rickets Prevention

A PROTEIN substance found in milk and called lactalbumin helps in the prevention of rickets, according to Dr. James A. Tobey, reports *Science Service*. The lactalbumin apparently does not have any rickets-preventing effect by itself, but when vitamin D is added to milk by irradiation with ultraviolet light, the dispersed lactalbumin increases the effectiveness of the vitamin's rickets-preventing power, Dr. Tobey explained.

The discovery of the rôle of lactalbumin

in augmenting the rickets-preventing potency of vitamin D in irradiated milk was made by Dr. George C. Supplee at the Borden research laboratories at Bainbridge, New York.

Speeds in Sky: Glides On Land

COL. ROSCOE TURNER, one of America's outstanding speed pilots and winner of many trophies for trans-continental airplane records, is "going places" on land, as well as in the air, these days. In his plane, in which he has often crossed the continent between dawn and twilight, he carries a novel vehicle, which was built especially for

Col. Turner and his "motor glide"

him and which is known as a "motor glide." When he lands at an airport, often some miles from the nearest city, he climbs on his motor glide and speeds away. On the streamline tires of his motor glide, he travels five miles at a fuel cost of one cent.

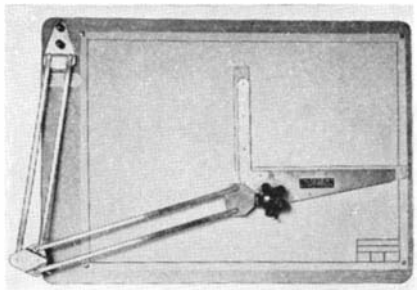
Mystery Springs In North Australia

FIFTY miles south-east of Boulia township, in the far west of Queensland, are two mystery springs. One, known as Elizabeth Spring, consists of a circular hole four or five feet in diameter in which tepid water is continually bubbling up and overflowing. The water, which is perfectly clear, is peculiar in that the human body cannot sink in it owing solely to the force of the water bubbling up from below. About 50 yards away is another called Lubra Spring. Its water is always icy cold and is jet black. The human body sinks like a stone in it. According to the aborigines of the locality, the water in this spring turned black ages ago when a lubra (native woman) jumped into it and was never seen again.—*Australian Press Bureau.*

Professional Drafting Board

A DRAFTING MACHINE to catch the eye of any engineer is the new Wrigraph professional model, shown in the illustration, manufactured by L. G. Wright, Inc.

It is a newly designed drafting machine



A versatile drafting machine

mounted on a 22-inch by 30-inch cleated, white pine board. The parallel mechanism is hand-assembled with all-steel nickel-plated parts and solid phosphor-bronze bearings. This machine is equipped with a vernier-indicating protractor reading to degrees. The protractor unit has a chuck plate to hold the drawing attachments in alignment. The graduated L-square blade is made of Pyroxylin and is riveted to a lightweight aluminum stiffener which has been given a satin finish to eliminate glare. The drawing edges of this blade are transparent.

UREA

THE first organic substance to be made synthetically was urea. Wöhler, a German chemist, produced urea accidentally in 1828.

War Fire

FOGS of fire sprayed from low flying airplanes may be among the new horrors which the next war will bring to civilian populations far behind the actual combat lines, suggests Lieut.-Col. A. M. Prentiss of the Chemical Warfare Service.

Fire, spread by incendiary bombs, shells, and flame throwers, is not dead as a war measure, says this expert, despite the relatively ineffectual success of incendiary techniques in the World War. The rise of aviation since the war is the reason.

While the actual battle forces have become so mechanized that there is little about them to burn but their clothing, the civilians behind the lines will feel the brunt of the warfare by fire.

Writing in *The Military Engineer,* publication of the Society of American Military Engineers, Colonel Prentiss traces the history of fire-making devices in warfare from the first "flame-thrower" used at Delium in 424 B.C., through the famous "Greek fire" of 660 A.D., down to the World War.

Of all incendiary agents used in the World War, thermit was probably most widely employed, he states. Thermit is a mixture of metallic oxide and aluminum which react with an enormous liberation of heat. In fact, it is used in the welding of metals.

For warfare use, thermit was often mixed with a flame-sustaining material. One of the most potent such devices was the British "Baby Incendiary" bomb.

Flame projectors, among the most spectacular of all wartime incendiary devices, not only throw flame, Col. Prentiss points out, but, more important, streams of ignited liquid. Due to research during the war it was finally possible to shoot a stream of liquid which was 30 percent unburned when it reached its objective. There it could spatter and spread its damage. A jet containing a half gallon could be thrown nearly 100 feet with some forms of the equipment. —*Science Service.*

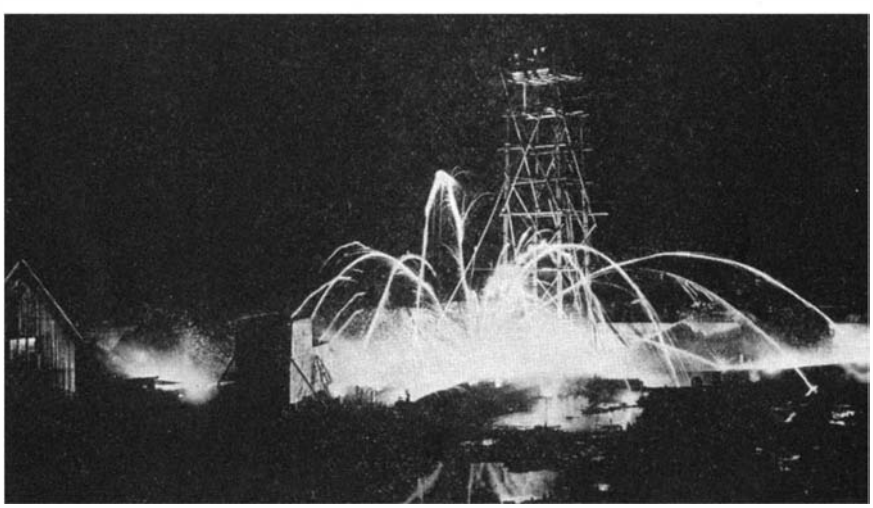
National Noise Standard

RELIABLE standards for the guidance of the 5,000,000 men and women who need mechanical aids to hearing will result from the work of a new committee of the American Standards Association. Headed by Dr. Vern O. Knudsen of the University of California at Los Angeles, a group of manufacturers, specialists, and users will develop national standards for measuring noise so that physicians and the deaf can select devices to aid hearing with scientific guidance.—*Science Service.*

British "Speaking Clock" for Telling Time Over Telephone

A SPEAKING clock being used by the British Post Office department to tell time over the telephone announces the time automatically every 10 seconds, day and night, with an accuracy of one tenth of a second. Each hour the system is checked against the astronomical clocks at Greenwich Observatory.

The telephone time announcements run: "At the third stroke it will be eleven seventeen and forty seconds." The spoken words are followed by three "peep" signals of 800-



Flaming particles thrown from a "Baby Incendiary" bomb exploding at night

cycle tone, at one second intervals and lasting one tenth of a second.

Four glass disks, carrying sound tracks photographically recorded, make the announcement. One disk, turning 60 times each minute, carries records of the odd numbers 1 to 59, and a second disk the numbers 2 to 58, together with the word "o'clock." A third disk speaks the hour and carries also the phrase "it will be." The fourth disk makes the preliminary announcement "At the third stroke" and adds the final part of the speech "and ten seconds."

Optical systems and photoelectric cells turn the disk records into electric current.—*Science Service.*

Anti-Friction Molding Material

WHILE standard phenolic molding compounds are fairly resistant to friction, there are applications where constant friction, plus impacts of varying degrees, require material of greater resistance, such as cam parts, automobile door bumper shoes, builders' hardware parts, refrigerator latch bolts, machine parts in constant friction, and so on. To withstand this friction, General Plastics has developed a new Durez material called "1564," which combines both impact strength and friction resistance. It contains 10 percent graphite, and has an impact strength that is roughly 40 percent greater than ordinary materials. Its most interesting use is the small bumper shoe which bears against the metal wedge on motor-car doors, supporting them and preventing rattling.—*A. E. B.*

Live Bait-Fish Threaten to Spoil Fishing

FISHERMEN in Utah's trout streams are threatened with serious damage to their sport because other fishermen make use of live bait. This ironic situation has received the attention of W. F. Carbine, of the University of Utah.

Small fish used as live bait sometimes slip off the hook, and live to grow up and reproduce. Prominent among fish thus introduced is the chub, a species not particularly esteemed for either sport or food. This fish makes life harder for trout in two ways. It produces many more eggs, in the same spawning grounds that the trout frequent. The more numerous and hardy young chub gobble up a great deal of the food that the troutlings would normally have for themselves.

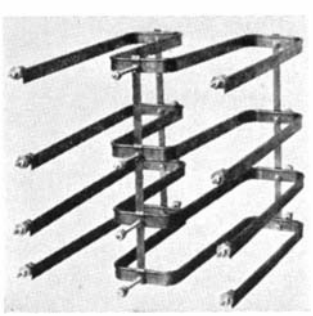
Young trout that survive this period of over-competition for nourishment find that their troubles are not over by any means. As they swim down the streams, the adult chub, which are big fish measuring up to 16 inches in length, pounce on them and gobble them up in numbers. Young chub, on the other hand, are not taken for food to any extent by the adult trout.

To reduce the numbers of this troublesome enemy of the trout, Mr. Carbine suggests forbidding the use of live bait; also netting the chub and lowering of the water level in the lakes which are their favorite waters.—*Science Service.*

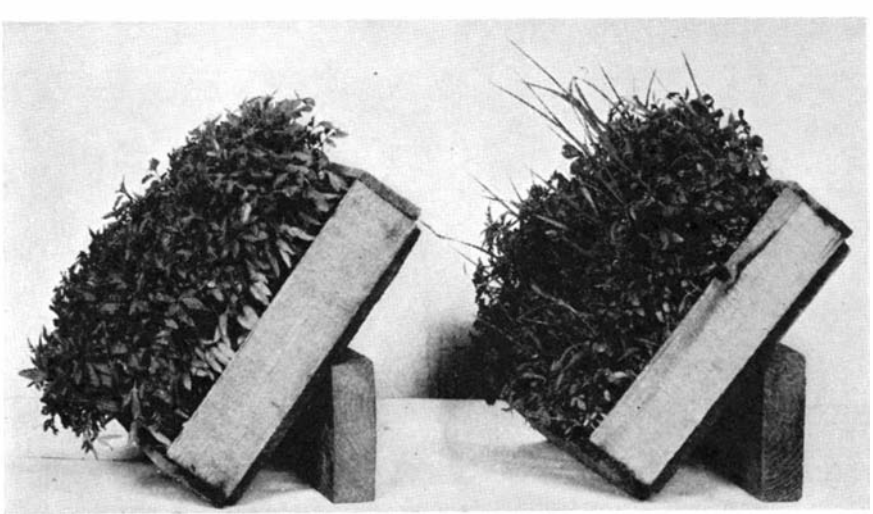
Pasteurized Dirt

CLEAN dirt, not an anomaly but a necessity for florists and specialty growers, can be obtained electrically with the use of equipment just developed. The sterilization process, similar to that employed in the pasteurization of milk, has been performed with steam, hot water, and chemicals, but an inexpensive method was needed to make soil sterilization available to a larger number of plant growers and at the same time to afford a process that was convenient and dependable. The function of sterilization is to increase the temperature of the soil sufficiently to kill any plant enemies, such as weed seeds, insect life, and fungi, as it is only when plants are free from these enemies that they can grow at a maximum consistent rate.

The sterilizing equipment, developed by General Electric, consists of a number of electric heating units, each enclosed in a brass vane, which are provided with mounting straps, studs, nuts, and washers. The grower builds this equipment into a wooden vat or container following plans made to meet his own requirements. A thermostat can be supplied which will maintain automatically the necessary temperature of 160 to 180 degrees, Fahrenheit. Growers have found that the single saving from not having to weed small plants is sufficient to offset the cost of electric sterilizing.

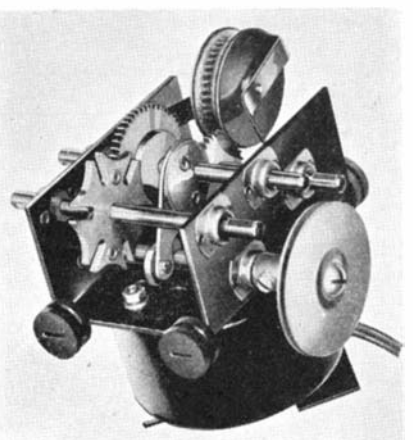


Above: **An electrical heating unit used for pasteurizing dirt.** ***Below:*** **Plants (left) grown in pasteurized dirt, and (right) weed growth in dirt that has not been pasteurized**



Motor of Many Uses

A NEW slow-speed versatile electric motor should be found useful by engineers, chemists, inspectors, and inventors, for it provides an extremely simple, time-saving means of securing the many different speeds and motions required by laboratory and shop testing.



Multi-speed multi-purpose motor

The illustration shows the simple construction of the Testmotor which consists of a slow speed, induction or universal motor, equipped with a cooling fan that circulates air through the motor, permitting its use under extreme heat conditions. The motor is mounted on a heavy steel frame. All shafts are ¼ inch in diameter, in self-lubricating bearings. Each shaft has a thrust washer, so that loads may be taken endwise without excessive wear or special lubrication; a milled flat provides each shaft a positive connection for gears and adapters.

The motor is mounted by rubber grommets that eliminate vibration, insuring silence, or by holes in the frame ears over which these grommets fit. The overall dimensions are 4½ by 4½ by 5 inches and the weight is 3½ pounds.

The shaft motions of the motor are: Fast Rotary—56 R. P. M.; Slow Rotary—6 R. P. M.; Oscillating—70° Movement; Indexing—Stops at 60° intervals for a period of 3 seconds.

For additional speeds, a frame having a gear ratio of 8⅔ to 1 is available.

A few of the many applications of the Testmotor are: With tilting mercury switches, it can be used for all start-stop electrical tests; Life test of electrical switches; Mixing compounds or solutions; Revolving color wheels on spot lights; Display advertising; Turntable for spray painting.

Peanut-Walnut

HAVE you ever had a "peanut-walnut"? So far as is known, there are only two trees in the whole United States which pro-

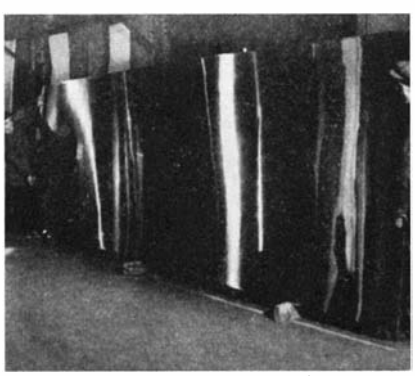
duce this freak form of the common black walnut. One of these trees is somewhere in Ohio; the other grows on the farm of Ralph Throp, near Greensburg, Indiana. From Mr. Throp the department of botany at Field Museum of Natural History has received specimens of the curious peanut-walnuts.

Viewed from the outside there is nothing remarkable about the appearance of peanut-walnuts, but when they are opened the kernel or meat falls out or may easily be removed in a single piece. The kernel is only one half of an ordinary kernel in form, but is larger in size.

The advantages of such a kernel, which can be removed whole, are apparent, and it would be highly desirable to propagate the tree commercially. Grafting experiments, however, have so far been unsuccessful, and, according to Paul C. Standley, associate curator of the museum herbarium, it is questionable whether a freak or sport of this kind would be reproduced in seedlings.

Huge Stainless Sheet

PRODUCTION of what is believed to be the largest, polished, stainless steel sheet yet made, has just been completed by the Allegheny Steel Company. This sheet, one of an order of 15, is slightly over 208 inches long, 72 inches wide, 3/16 of an inch thick, and weighs approximately 810 pounds. According to the records, the largest similar sheet previously produced was 90 by 84 inches.



Largest stainless-steel sheet

These sheets were all furnished with a bright smooth finish and are used in the textile industry, in forming the bottom of dye kettles through which articles being dyed are conveyed.

Bureau of Standards "Visitor's Manual"

THE Bureau of Standards publishes an interesting "Visitor's Manual" (Misc. Publ., M153), giving a brief synopsis of its history, functions, and facilities, according to the magazine *Nature*. An afternoon visit to certain of the laboratory rooms is arranged every day. It is mentioned that the discovery of deuterium (heavy hydrogen) was the result of co-operative work of the laboratory with Columbia University. The use of the lowest temperature so far attained in the United States—the melting point of liquid helium (–456 degrees Fahrenheit)—has made possible the study of the properties of materials at very low temperatures, in particular the supra-conductivity of metals. The Bureau constructed the first "altitude" laboratory for studying airplane engine performance under flight conditions. In it, the low air pressures and temperatures encountered at altitudes up to 30,000 feet can be duplicated. The Bureau workers were the first to discover that a thin coating of pure aluminum greatly decreases the atmospheric corrosion of duralumin, an alloy largely used in aircraft construction. They worked out the very successful process of plating steel and other metals with chromium, the hardest metal known; this more than trebles the life of gages, printing plates, and similar devices. The Bureau developed the paper now used for printing United States paper currency, which has extended the total service life of such notes at least three times. It discovered that certain waste water from paper mills makes satisfactory material for tanning leather, and it established the dextrose (corn sugar) industry. It keeps the public well informed of its work, and its staff has increased by 50 times since it began in 1903.

Vanilla Paint

CAN you imagine walking into the hardware store and asking for a can of white paint, vanilla flavor? Strange as it sounds, you'll be able to buy just that if a new plan for "killing" the odor of paint is generally adopted. In a statement by Dr. Henry A. Gardner, issued by the scientific section of the National Paint, Varnish & Lacquer Association, it is disclosed that ordinary vanillin—one part in 2000 parts of paint—is rated very highly for deodorizing or rather changing the odor of paint to one that is not obnoxious. The vanillin is slightly higher in cost than other types of industrial perfumes. Vanillin may be dissolved in turpentine or linseed oil to make a concentrated base which can be added in the proportion referred to above when treating interior paints.—*A. E. B.*

First All-Metal, Streamlined Milk Tank Car

THE first all-metal, streamlined milk tank railroad car ever built—a giant "thermos bottle" refrigerated so that even in summer milk can be transported 200 miles with a rise of not more than one degree in temperature—was recently "launched" at Hoboken, New Jersey, by H. A. Cronk, President of the Borden's Farm Products division of The Borden Company. The car was immediately placed in service in the New York area.

This giant "thermos bottle" throws additional safeguards around the safety and purity of the milk of city dwellers. All future replacements to the present 60 tank cars the company now operates in the New York metropolitan area will be of the streamlined type.

Fifty percent better refrigeration will be brought about by the use of six inches of cork insulation between the two 12,000-quart, glass-lined tanks in the car and the all-steel outside. Tests indicate that the all-metal construction will result in lower repair and painting costs and much longer service.

The new car is equipped with standard passenger train brakes and trucks, so that it can be coupled to fast passenger trains for speedier milk service from outlying dairy districts to the metropolitan area.

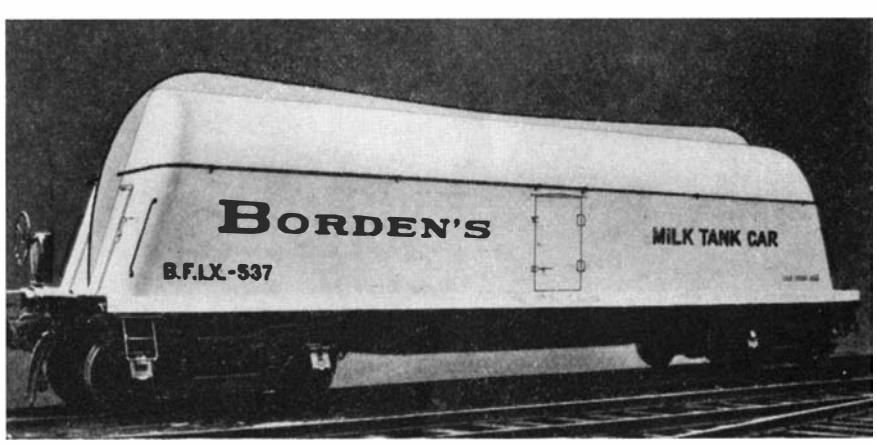
Tiny Glass Tube Put in Blood Vessel

A METHOD of gaining new knowledge on obscure diseases of blood vessels and on the watery swellings known as edema was described by Dr. Eugene M. Landis of the University of Pennsylvania Medical School at a meeting of the American College of Physicians. For the development of this method, which was called the most outstanding piece of medical research in 1935-36, Dr. Landis was awarded the John Phillips Memorial medal of the college, reports *Science Service*.

The method is designed to give information about the state of minute artery endings called capillaries. These are found at the tips of the fingers and toes, in the nail beds, and just under other outer surfaces of the body. In certain conditions like Raynaud's disease, in which the fingers and toes are always cold and an unhealthy white color, physicians know that a disturbance of the blood flow through the capillaries is to blame. Just what the disturbance is and what to do for it are still unsettled questions which are engaging more and more the attention of medical research workers.

The method Dr. Landis devised for investigating the state of these capillaries is to insert a very tiny glass tube called a pipette into a single capillary in the bed of a man's nail or in tissues of other animals. The capillary blood vessels and the glass tube are both so small that Dr. Landis has to work under a microscope.

By this method he has measured the passage of fluid through the walls of normal capillaries into the surrounding tissues. With this as a standard, he measured the

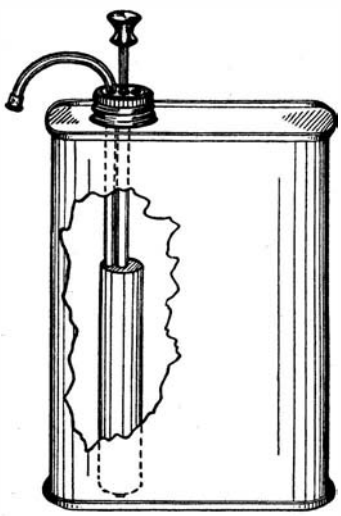


This streamlined tank car for milk is a giant "thermos bottle"

passage of fluid when the capillary walls had been damaged by chemicals or by mechanical injury. He found that the fluid passed through the damaged capillary walls from five to seven times more rapidly than normal. This finding shed light on the condition known as edema in which apparently too much fluid passes through the capillary walls.

Automatic Liquid Measuring Pump

A NEW liquid measuring pump has solved the problem faced by chemists, engineers, druggists, and others who must constantly dispense measured small quantities of oils, glycerine, and other liquids. This inexpensive little device is built for use with a standard quart can, or standard gallon can, the first delivering one half ounce of liquid per stroke and the latter one ounce of liquid per stroke. This pump is a convenience to engineers and oilers of pumping stations, power houses, steam boats, and other power machinery, for use in replenishing oil cups.



Accurately measured quantities of liquid are delivered by the pump

Underground Pipe "Wrapped in Cellophane"

WE have become accustomed to having almost everything "wrapped in Cellophane," but had to admit the novelty of an application described in a recent issue of *Western Gas*—underground pipe is being wrapped in Cellophane! The wrapping is said to serve admirably as a protective measure against moisture and soil impurities. The theory underlying the use of two layers of Cellophane or Kodapak adjacent to one another, is that a slip joint or a "lubricated" surface between the inner and outer coats of asphalt or coal tar is effected. In other words, the steel pipe, the priming material, the first two layers of asphalt or coal tar, and the first layer of Cellophane or Kodapak, constitute one unit which will move freely within the second unit, consisting of a second layer of Cellophane or Kodapak, asphalt coating, and Kraft paper. This outer casing or wrapper, due to the stresses caused by expansion and contraction in the heavier types of soils, will be gripped as in a vise. The slip joint created by the two layers of Cellophane or Kodapak allows the pipe to

contract and expand without breaking the bond between the coating and pipe. From recent examinations of pipe protected as above outlined and laid in heavy adobe soils where soil stresses are very severe, it appears that this reasoning is logical.—*A. E. B.*

Aeronautics in Naval Architecture

PROBABLY no two branches of engineering are so closely connected as naval architecture and aeronautical engineering. Ideas and progress in one field very soon make themselves felt in the other. That is why a paper, under the above title, by C. P. Burgess, the well-known airship authority, recently read before the Society of Automotive Engineers, has a decided appeal for anyone interested in either water or aircraft.

We are apt to be very proud of the various *Miss Americas* and their constructor, Gar Wood. But Mr. Burgess gives us some comparative figures which may make Mr. Wood less satisfied with his speedy hydroplanes. A modern flying boat such as the *China Clipper* will transport a ton of gross weight 16 miles at 125 miles per hour, with energy derived from one gallon of gasoline. In *Miss America X*, a gallon of gasoline will be responsible for less than two ton miles at 110 miles per hour. The flying boat has by far the best of it!

The difference lies in the ratio of lift to drag in the two types of craft. The *China Clipper* has a lift-drag ratio of 13 or thereabouts, whereas in the most efficient hydroplanes this ratio is only 5.

This difference is not due to the fact that the *Clipper* operates in air, and *Miss America* in water: the laws of flow and resistance are almost the same in both media. The explanation is that the *Clipper* derives its lift by "circulation" flow around the wing which is wholly immersed in the air. The hydroplane derives its support solely by the impact of the water on its under side, a far less efficient method of securing lift.

If the hydroplane is ever to have an efficiency comparable to that of the airplane, it may have to be carried at high speed by hydrovanes, metal wings totally immersed in the water and lifting the actual hull of the boat far out of the water.

The suggestion that hydrovanes be used for very fast water craft is not new. Graham Bell, in experiments in Nova Scotia in 1919, attained a speed of 60 miles per hour with moderate power and in spite of a choppy sea. More recently Dr. Tietjens of the Westinghouse Electric and Manufacturing Company has made interesting experiments along the same lines. Why is it that this idea is not more generally adopted, particularly if it is acknowledged that hydrovanes would give much smoother operation (being completely immersed) than the hydroplanes of to-day which undergo such terrific pounding?

The answer is that a number of practical difficulties are involved. The hydrovanes, to be efficient, should be long and thin and hence fragile. Also they are likely to catch up seaweed or floating objects. The hydrovane acts as a wing and derives the major part of its support from the suction on its upper surface. But when this suction reaches the atmospheric pressure of 14.7 pounds per square inch (or 2100 pounds per square foot) then the water leaves the upper surface of the vane and air takes its place. This phenomenon, termed "cavitation," not only means rapid erosion of the hydrovane surface but also complete loss of lift. And the critical speed at which cavitation occurs is only 27 knots.

Mr. Burgess also gives a few hints to those intrepid though somewhat archaic souls who cherish the arts of sailing and yacht building. He suggests that while the air resistance of a yacht is not as large as a streamline-conscious public might suppose, it is important nevertheless. Particularly in racing yachts it might be advantageous to round the edges of deck erections, make the decks flush, make the masts streamline, and provide devices for revolving the mast. These devices have been considered by others from time to time, but yachtsmen are people of tradition and do not like to depart from accepted forms. In fact, racing rules prohibit such devices. It would be interesting to see a sailing race in which all such rules were held in abeyance and in which aerodynamic ideas for hull and sails were given free play. Some wonderful new records might be made by our yachtsmen!—*A. K.*

Bright Finished Aluminum

WITHIN the last few years research and invention have solved the problem of the aluminum reflector for lighting purposes, and the solution may be aptly designated as "brilliant" in both senses of the word, says *Chemical and Metallurgical Engineering*. An anodic electrolytic brightening treatment which raises the reflectivity of a buffed aluminum reflector from about 70 percent to approximately 85 percent, while fully retaining the specular quality of the original surface, and which then can be protected with an oxide coating that causes substantially no reduction in reflecting efficiency and is resistant to weather, would have seemed a fantastic dream to the industry five years ago. The Alzak process is now doing this commercially to the satisfaction of the world's foremost lighting engineers. This, of course, opens up a new market for aluminum in a field where silvered glass or silvered brass formerly held almost undisputed sway.—*A. E. B.*

Rotary Duplicator

FROM England comes a new and simple spirit duplicating machine which operates in a fashion similar to the hectograph and mimeograph processes but is superior in that it will reproduce in colors. This machine, called the Fordigraph, is now being distributed in the United States.

In operation, a piece of hectograph carbon is placed with its ink side on the back of a sheet of master paper. Typing, sketching, or writing is then done in one, two, three, or four colors, as desired, by the application of different colored carbon papers. The master sheet is then ready to be placed on the large roller of the Fordigraph, from which copies may be made at the rate of 40 per minute or more.

The machine does not use stencils, gelatin or ink; instead it is necessary only to use the hectograph carbon and to moisten the reverse side of the master sheet by a liquid which is carried in the tank of the machine.

The moistening is, of course, automatic.

It is claimed by the distributors that tissue paper may be run on this machine without wrinkling and that regular letter paper, postcard stock, cardboard, or blotters may follow the tissue without any adjustment of the machine. It is further claimed that 500 or more copies can be obtained from a single master sheet.

Eradication of Syphilis Possible

A BATTLE cry against one of man's most dangerous disease enemies was sounded by Dr. Thomas Parran, Jr., New York State Health Commissioner, at a recent meeting of the American College of Physicians. It was a stirring "fight talk" from a leader to his captains in the war on disease.

This disease ranks with tuberculosis and cancer as a major cause of death. It causes untold misery; denies many married couples the privilege of parent-hood; causes helpless, innocent children to be born blind or deaf; cripples, and finally drives insane, many of its luckless victims.

The name of this dastardly disease is syphilis, a word that many persons do not like to speak or print or read. Not so long ago there was the same feeling about cancer, tuberculosis, even appendixes and gall bladders. Yet these have become part of every-day speech. Syphilis must also be read about and heard about so that this deadly foe can be vanquished. Refusing to name the enemy ends in defeat, not conquest.

This disease enemy of the unmentionable name, syphilis, can be conquered, Dr. Parran told the physicians. The outlook for the control of syphilis is far more hopeful than for the control of cancer. It is far more hopeful than was the outlook for the control of tuberculosis 30 years ago.

"The practical control and even eradication of tuberculosis in this country is a goal clearly in sight," said Dr. Parran.

By comparison, the job of controlling syphilis should be far quicker, for medical scientists know the "germ" that causes the disease. They can diagnose the disease as soon as the patient becomes infectious and dangerous to others. They have remedies which will quickly make the infectious patient non-infectious and prevent his giving the disease to others.

The big thing is to think of syphilis as a disease, to think of the person who has it as a sick person whose ailment is catching, but who can be treated so that in a short time he will not be in danger of giving the disease to anyone else. Another hopeful thing about this disease is that, if discovered and treated thoroughly at the start, the damage it may do to body and brain and to future generations can be prevented.—*Science Service.*

Makes Heat Transfer Visible

CALCULATION of the rate of heat flow is a common but often very complicated problem for the chemical engineer. While others have been working out complicated mathematical formulas for the solution of this problem, Prof. A. D. Moore, of the University of Michigan, has been devising a clever apparatus in which he can actually watch the flow of heat and measure it with a ruler. The Moore device, demonstrated at a recent symposium on heat transmission at Yale, is known as the Hydrocal. It operates on the principle of causing water to flow in a manner exactly analogous to heat, by forcing it through capillary tubes of calibrated resistance. The flow is streamline and, as in heat flow, the rates are directly proportional to driving force. The height of the liquid column is exactly analogous to temperature. Solving a problem consists of connecting the correct resistance tubes in the apparatus, opening some valves, and reading water heights on a series of manometer tubes at the end of specified times. The device is particularly useful for problems of the unsteady state and for some cases, such as an irregularly varying heat source, makes solutions possible which are impossible with formal mathematics.—*A. E. B.*

Babylon's "Solid Beer"

"SOLID beer" was a standby of the Babylonians and ancient Arabs when they went on a long journey. Just what this stuff was, and how it was made, has been traced by Prof. Paul Lindner, veteran Berlin bacteriologist, with the assistance of Dr. Engelbert Huber, student of the history of brewing.

The early Arabs, according to ancient texts, knew the "solid beer" under the name of "saviq"; their predecessors, the Babylonians, gave it the more bubbly title of "hubur bulug gar." It was not sold by liquid measure, but in lumps by weight, and was carried wrapped up in packages on camel-back. When the caravan made camp, some of the lumps were soaked in water, and the mixture quickly fermented into a refreshing drink of low alcoholic content.

The lumps of "solid beer" appear to have been made of a special kind of bread, in which barley malt was a prominent ingredient, and frequently containing also a considerable proportion of sweet date pulp. This bread was baked at a moderate temperature on hot stones, and then packed up.

The quick fermentation, Prof. Lindner is convinced, was due to the action not of yeasts but of a species of bacterium which he himself discovered and identified some years ago, known as *Termobacterium mobile.* It is found in warm regions throughout the world, and plays a leading part in the quick fermentation of the milder beers made of palm sap and other ingredients by primitive peoples. Prof. Lindner believes that this bacterium would be left unkilled by the mild baking of the "saviq," and that it would readily find its way into the mash by soaking it in water.

The art of making "saviq" has apparently been lost by the town-dwelling Arabs of the Near East, but it may possibly survive among the nomadic tribes of the desert.—*Science Service.*

Insanity Increase

TIME and time again the question has been asked: "Is not the stress and strain of the depression responsible for the great increase in mental disease in this country?" Time and time again that question has been answered in the negative, and the correct explanation given. Yet the explana-

tion seems not to have reached many people, for the question reaches us over and over from different quarters.

Dr. Carney Landis, of the New York Psychiatric Institute and Hospital, recently stated the case plainly. In 22 years, he said, one type of mental disease has increased from 2 per 100,000 to 14 per 100,000—a rise of almost 700 percent. But this is the *only* type that has increased during those years, and it affects *only* persons beyond middle age. This particular type of mental disease is due to a hardening of the arteries of the brain.

The reason for the increase is, therefore, obvious. Due to the great advance in public health work and preventive medicine, we have more old people than formerly. Twenty-two years ago, about one fifth the population was 45 years old or older; but this group had increased almost to one fourth in 1934.

"After all," said Dr. Landis, "a man must die of something, and if typhoid does not take him at 30, hardening of the arteries in the brain may at 60."

SIX NEW AIR RECORDS

THREE American aviators brought three international air records to the United States during February, besides setting a like number of national records.

Miss Helen Richey of Pittsburgh, Pennsylvania, flying an Aeronca C-2 Scout established a national and international speed record for 100 kilometers for Class C, light airplanes at a speed of 72.224 miles per hour.

Terris Moore of Cambridge, Massachusetts, captured an altitude record for light seaplanes, third category, Class C, in an Aeronca C-3, reaching an altitude of 11,558 feet, establishing both a national and international record.

Miss Iona Coppedge of Dayton, Ohio, in an Aeronca C-3, set a feminine altitude record for light airplanes for the third category, Class C, by reaching an altitude of 15,253 feet. No record had previously been established in this category and accordingly the present one stands as both a national and international record.

The standing of nations with regard to international aviation records at the time of writing is: United States 42, France 37, Italy 28, Germany 8, Poland 8, and England 1.

A BANNER YEAR FOR AVIATION

THE year 1936 has opened up for American aviation in the most auspicious manner. Large Army and Navy contracts; a war scare in Europe; higher airmail rates; ever growing volume of passengers, mail and express; and a promising private plane market, all combine to make the industry extremely cheerful.

Technical progress is certain to keep pace with growing prosperity. Even in the leanest of the depression years, American aviation progressed steadily. Profitable operations will induce even greater advances in construction and operation of aircraft. It is not out of place, therefore, to expand a little on the predictions of immediate developments which are made by Jerome Lederer of Aero Insurance Underwriters:

1. *The adoption of the nose-wheel undercarriage for small airplanes.* The Department of Commerce development program of

a light plane for private flying has not been revolutionary to date, but it certainly has shown the value of the front wheel in preventing nosing-over and in decreasing the hazards of cross-wind landings.

2. *The installation of independent auxiliary power plants in large transports to supply energy.* Power is now needed in the transport airplane for radio, lighting, starting, and operation of the retractable landing gear and flaps. Sooner or later the controls themselves will be power operated. Instead of batteries, wind driven generators, or geared connections to the engine, it would indeed seem logical to install an additional unit to take care of all these miscellaneous power requirements.

3. *Higher payloads through greater fuel economy and higher octane fuel.* With more power it is possible to secure greater speed, which really means lower costs in operation.

4. *Counter-propellers to absorb the torque of high powered engines on single-engined airplanes.* When the power of a single-seater fighter approaches 1000 horsepower, the torque generated by the engine and propeller becomes relatively so high that lateral control is difficult. We understand that the Army Air Corps is even now considering proposals for the design of tandem propellers driven by the same engine, but rotating in opposite directions so that the torque effects are eliminated.

5. *The use of the catapult for starting heavily-loaded ships.* While Mr. Lederer is predicting the catapult, the Mayo-Short composite aircraft is nearing completion in England. As our readers will remember, a small heavily loaded flying boat is to be carried above the wing of a very large flying boat, and is to be released when sufficient altitude has been reached.

Mr. Lederer's predictions are both timely and logical.—*A. K.*

"Radio" Alarm Foils All Intruders

THE kidnapper and the thief, the two oldest human parasites, today menace the property owner of position more than ever before. All people of prominence and means are potential victims of these desperate enemies of society. Daily we read of invaded homes, of children, adults, and elderly persons attacked and injured by intruders. People are kidnapped from their own residences at the point of guns. Treasured possessions are stolen or wantonly destroyed by vandals. While such conditions persist, people of position cannot afford to be without protection against the marauder.

About two years ago, an organization of expert electrical engineers foresaw the wave of kidnapping and violence now sweeping our country. These men turned their energies towards devising an adequate and foolproof protective system for the fine home. The Teletector Property Protection System was the result. Today this scientific development is installed and operating in many fine homes, guarding against trespass.

The Teletector is a sensitive electrical apparatus operating on advanced radio principles, the function of which is to encircle all doors, windows, or openings in a home or nursery with an invisible "radio"

(*Please turn to page* 290)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

IN this magazine last June Professor Russell described the Schmidt telescope—or camera, to speak more exactly, since it cannot be used to advantage as a visual instrument—and this present month with his article (pages 248-249) we have reproduced photographs, one celestial, the other terrestrial, taken with a Schmidt made by the Lowers of San Diego. The little picture on the present page is another, and the camera itself, its box uncovered, is shown at the bottom.

For photographic work the Schmidt telescopic camera, with its oddly curved correcting lens in front, is as far ahead of a telescope camera having an ordinary paraboloidal mirror without a correcting lens, as a paraboloidal mirror is ahead of a spherical mirror for usual work—farther, in fact. Oddly enough, the Schmidt reverts to a spherical primary but it is its correcting lens that does all the business of knocking out the coma that otherwise puts tails on star images at the edge of the plate and, in fact, on all except the central eighth of a degree or so of plates taken with paraboloidal mirrors such as the 100-inch. But a Schmidt gives a good field 12° or more diameter—no tails. The spherical primary is said by some writers who have never tried to make a real sphere to be easier than a paraboloid but, be that as it may, the real grief or "piece of resistence" in the Schmidt job is in the correcting plate. This is a thin piece of glass at the outer end of the tube, its curve so inconspicuous that the plate resembles an ordinary piece of thin, unaltered glass. But the extremely shallow curve is neither spherical nor paraboloidal but decreases in radius as the edge is approached, and it must be made by means of a flexible lap and a combination of patience, intuition, experience, bad language, cut and try, and occasional sheer good luck. It is not beginner's work and perhaps it is not merely fairly experienced work, but definitely is advanced work. The whole business—theory and practice—will be covered in the "A.T.M. Supplement," due in a few months—please don't ask when, for this depends on when the last cunctative contributor sends in his material. The last contributor whose long-promised "copy" comes in is to receive a prize of an invisible telescope in an intangible, imponderable carrying case.

In the meantime, here are Harold Lower's comments on some of the first photographs he and his father, Charles Lower, took with the Lower Schmidt, which embodies the famous "Soup Bowl" mirror. "The 'candid camera' shot of Dad lighting a cigaret shows what one second exposure does, by the light of a match," he writes. "This is made at a distance of 12 feet. Lens wide open. The night picture of San Diego (page 249. —*Ed.*) was made from Point Loma, across the Bay. Exposure 10 seconds, and over-exposed. By examining the negative with a glass one can count the windows in buildings which are more than four miles away, but it is so badly over-exposed that they don't show in the print. The two pictures of the camera with one side removed were made before the interior was blackened, so as to show the parts in position."

The crossed strings in the left hand (lower) picture were placed there for help

Lower Sr. caught smoking cigaret

in the very delicate, critical collimation, and are not a permanent feature.

ON the opposite page are drawings of two items from Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada. The first is a gadget to permit easy reading of setting circles in the dark. "The scale proper," Wates writes, "is a disk of 1/16" Celluloid, one side of which is sprayed with black Duco. The scale divisions are cut through the Duco with a sharp knife, and the numerals scratched with a scriber. Work with a light under the Celluloid. This method gives very fine markings.

"The scale is attached to a collar which clamps to the declination axis by a set-screw. The drawing shows the common German type of mounting, but the same principle could be adapted to any mounting. The lens is a ten-cent magnifier. The mirror may be thin glass, silvered on the front and lacquered. I used a bit of chromium plated metal. The 'index' is a piece of Celluloid with a vertical line scribed and blackened. It should be as close to the scale as possible, in order to avoid parallax. Note that the Duco side of the scale must be next to the lamp, and that the base of the numerals must be toward the edge, as the mirror inverts.

"The lamp is a 3-volt flashlight globe working on one cell, to give a faint light. The socket and one side of the switch are 'grounded' on the mounting. This scale is delightful to use. The divisions are seen very clearly, yet the eye is not dazzled as when using a flashlight."

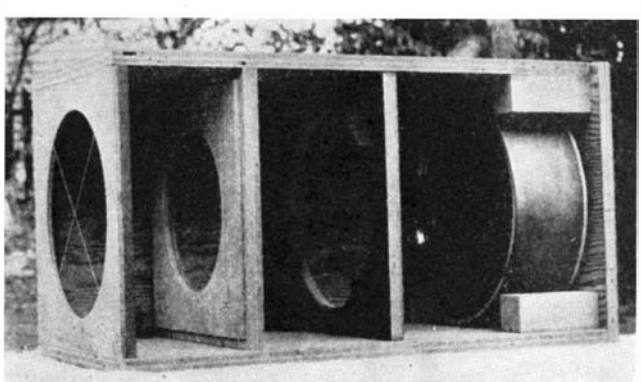
It is suggested that the light be of as low candlepower as will clearly reveal the markings, thus not unduly causing the pupil of the observer's eye to close. Mr. Wates' next item is a suggestion for a drive for an equatorial mounting. The drawing is his.

"This drive is planned for a very heavy, double yoke mounting for a 12" telescope, but could easily be adapted for other mountings, such as the common German type, by means of an extension on the polar axis.

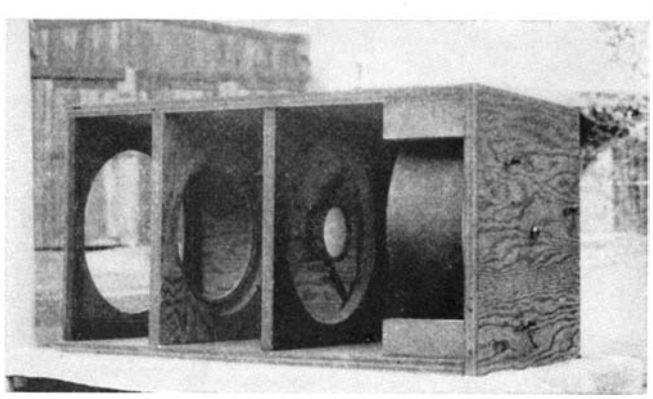
"The actual drive consists of a screw such as is used in screw-cutting lathes, with a split nut. These screws are accurate within .0003" per inch length. The nut runs in guides (not shown), and has a thrust ball bearing at the top. The screw turns (by means of suitable gearing) at a speed slightly in excess of 30 rev. per hour. The motor should be variable speed if possible.

"Mounted on the polar axis is a pulley, 72" in circumference. A suitable pulley could be picked up at any junk shop, although possibly not of the exact diameter. It would be a simple matter to alter the design and gear ratio to accommodate any pulley or screw that happened to be available.

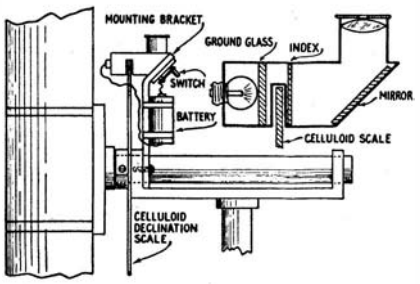
"On the left is a heavy drive weight suspended on a suitable steel wire passing around the pulley. On the right is a steel tape attached to a yoke, which in turn is fastened to the nut. The wire and tape lie



The interior of the Lower Schmidt camera. Note stops



Same interior, showing thin, clear correcting plate



Wates' circle reading gadget

on the pulley side by side—they are not joined. Each is fastened to a stud on the face of the pulley. The pulley is a loose fit on the polar axis and can be clamped thereto by a clutch, not shown. The fine adjustment is obvious from the drawing.

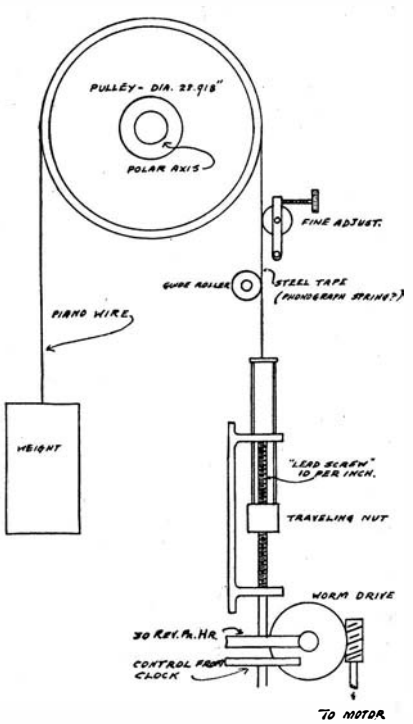
"Exact speed control will be by the so-called 'Chaser' system. The wheel marked 'control from clock' is not attached to the screw drive in any way, but is an entirely separate wheel driven by a pendulum clock at 30 rev. per hour sidereal time. A contact on this wheel plays between two contacts on the screw drive wheel. If the latter gains, the motor is slowed down, and vice versa.

"No means of restoring the nut to the bottom of the screw is shown, but it is planned to have the motor and gears slide to the right, disengaging the worm and engaging a suitable gear direct from the motor shaft to restore the nut and weight. Contacts will of course be provided so that the motor will be shut down when the nut reaches the bottom.

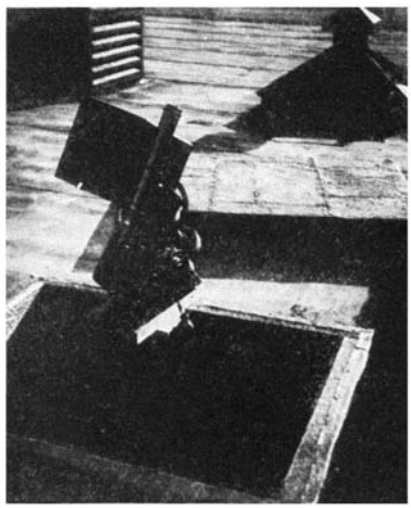
"Except at the equator, the piano wire will run over a pulley to the weight."

"IN all fairness to others and to the best of my belief I feel I can safely lay claim to the distinction (if any) of having the smallest observatory of any practical use. It measures exactly 60" x 17" x 25". To be precise, it is the scuttle hole to the roof of the house."

This is our old friend Bill von Arx, broadcasting a fighting challenge to the world



Proposed telescope drive—Wates



von Arx's petite observatory

from his sky hole observatory at 573 Monroe St., Brooklyn, N. Y. What he writes shows the sad circumstances under which we poor metropolitan observers work (kindly start weeping here); in fact, your scribe's telescope is now in moth balls in the attic, because a gas station 200′ distant has converted his yard into near daylight with three big flood lights. For two cents the company's name would be revealed: a famous ocean was named for it. In revenge, no gas is being bought there—will the company fail? But to return to Bill von Arx with his head sticking out of the sky hole.

"Being one of the many sufferers from city lights and cold wintry breezes," he says, "I mounted a small equatorial camera on the southern edge of the scuttle, as shown in the photograph. Standing on a substantial shelf 60″ below the level of the roof it is quite comfortable to do all the observing and photographing any avid amateur might want to do. Of course, several regions of the sky are obscured by neighboring chimneys, ventilators and vent pipes, but in the main these are not disadvantageous because the sky light in the lower altitudes is so bright that most of the stars are lost.

"Besides the equatorial camera I have a little 80-mm. triplet telescope of 22″ focus and doubtful pedigree, on a mobile alt-azimuth mount which can be trundled to the roof level with little difficulty. It is mounted on a pair of two by fours about 2′ long, joined at right angles at their ends. Resting the legs of the mount on the combing of the scuttle—the mounting being fastened at the union of the two—it is quite easy to move this little glass in any position favorable for the observation being made. This manner of mounting has proved more than satisfactory in that it is light, easy to handle, and quite rigid even in strong winds.

"Between the roof and the ceiling below there is a space a little over a foot high which makes a very convenient place to keep odd maps, books, binoculars, eyepieces, as well as the two instruments mentioned above. A board laid across the ceiling makes a convenient desk for jotting notes. This is even more comfortable when a stool of small dimensions is squeezed up on the shelf with the observer. An extension cord from the outlet in the room below gives current for the drive clock on the equatorial, as well as for a small ruby light for reading charts, etc."

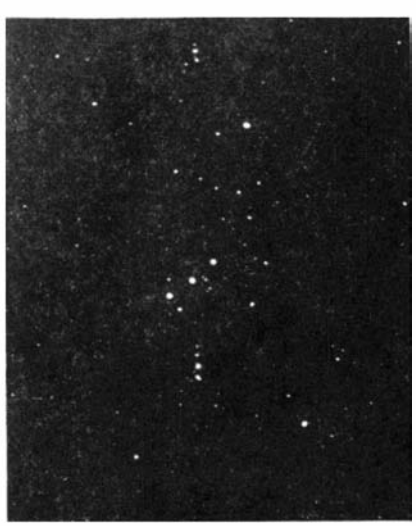
We asked Bill what his family does for heat while the sky hole is open and he tells us the family heat simply passes out, after which the seeing is better. Whether the family does the same seems uncertain, but it was a cold winter.

R. E. CLARK, Box 112, Langeloth, Pa., writes: "I have been experimenting with the following wrinkle, which I think is new, and thought you would care to pass it along to some of the fraternity who make a specialty of spoiling good glass. Instead of using glass for a tool, try the following: 4 parts clean, 60-mesh silica sand, 2 parts clean, 200-mesh silica flour, 3 parts Portland cement. Add lots of water and mix again very thoroughly. Pour into a mold the size you want your tool. Eliminate all air bubbles by stirring with the finger, smooth off the top, which will be the back of the tool, and allow to cure for 72 hours. If properly made there is little danger of scratches from detached grains of sand. Use plenty of water in mixing, so that the sand grains will segregate and form the working face."

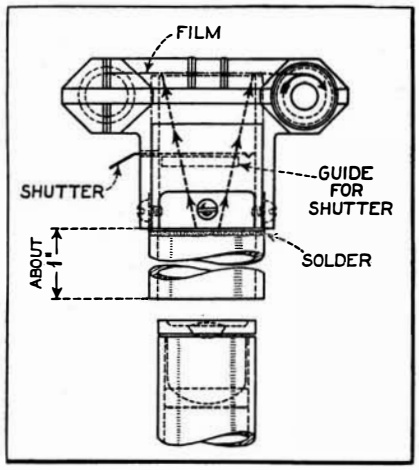
GEORGE MEIGHAN, 774 34 St., North Bergen, N. J., suggests this dodge: "Instead of using the glass tool I use a round metal plate—stove lid or other. If the pitch hardens before I can get the grooves properly made, I hold the plate over the gas burner and soften it up again."

NOW and then someone sends in a blueprint of a telescope, made at some cost of labor, and wishes it reproduced. A blueprint cannot be reproduced at all. The tracing is reproducable but generally the draftsman forgets that when the drawing is reduced the lettering will be reduced in proportion. In general, we dislike blueprints, which smack of the standardization idea. Drawings of individual features of telescopes are of interest, but few wish to "copy" a whole 'scope.

AND now a club of telescope enthusiasts has been organized in St. Louis, the "St. Louis Amateur Astronomical Society," which is the astronomical section of the St. Louis Museum of Science and Industry. C. F. Hellweg, 5246 Cote Brilliante, is the secretary-treasurer.

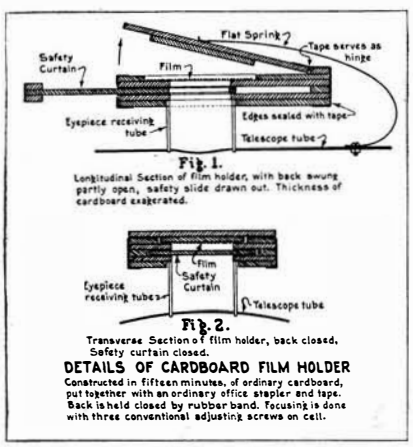


Orion as photographed by von Arx with camera shown above. Exp. 60 m. *f*/4.5, Schneider Xenar 10.5 cm. focus. Gaevert Super Chromosa plate



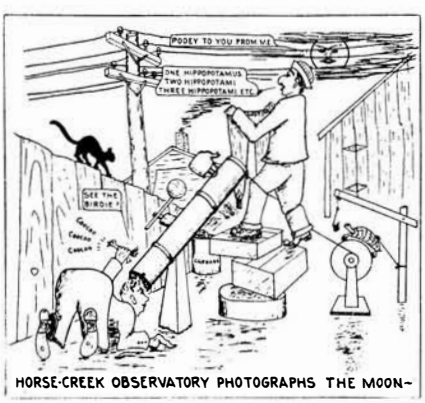
Mowry's photographic adaptation

THE top drawing, after a little study, shows how Nelson A. Mowry, 302 Garland St., Edgewood, Pittsburgh, Pa., converted a 39-cent Model A Univex camera into a celestial camera for attachment to a telescope. The lens and shutter were removed and a brass shutter inserted into a jig-sawed slot. Good pictures an inch in diameter were taken.



Johnson's simple film holder

In the second drawing, made by Vance Johnson, 821 West 27th St., Cheyenne, Wyoming, this draftsman-artist-telescope-maker shows how he and "Bertha" (that is his telescope—Bertha Johnson), and the other cow hand photographed the moon, using Pan film and a dingbat of their own invention. The lower objet d'art, also drawn by Johnson, reveals details of the new Cheyenne Mounting, with its slow motion drive.



Astro-science in wild Wyoming

CAMERA ANGLES

Conducted by JACOB DESCHIN

Travel Photography

TO travel without a camera is to forfeit half the value of a trip—the aftermath of pictured memory. Everyone realizes this, so practically everyone who goes a-journeying, however little he or she may know about photography and even if the outfit is the most modest, packs a camera and films as one of the necessities to be included even at the cost of leaving something else behind. The more zealous the photographer, the more sacrifices he will be willing to make in this regard.

Don't neglect buildings

Whether it is mountain, land or sea, subject-matter will be found everywhere. We have but to look for it. A little reading of photographic literature dealing with the type of atmosphere—sea or high altitudes or land and sky or whatnot—into which you are traveling will help to jog memory on some points you may have forgotten and in addition give some valuable hints you had not thought of, as well as project you into thinking along the photographic lines which cover the type of pictures you will most likely be making.

In general, it is advisable to take one of the relatively smaller cameras, not necessarily the miniature type, although the latter can be very useful for the reason that they are so convenient and easily accessible, and because they carry a large loading of film at one time, thus obviating changing film rolls too often. A camera equipped with a range finder or one of the small reflex cameras would seem most suited for travel purposes, although other types of cameras up to 3¼ by 4¼ and 4 by 5 inches will be found easier to work with if landscapes and similar subjects are what you seek most to get. Range finders for cameras not so equipped may be had today at a low cost. In the case of the larger cameras you will now and then wish to use a tripod and focus on a ground glass. Ground glasses have been known to drop and break, leaving the worker helpless and the camera well-nigh useless, so be on the safe side and take along an extra one.

Be generous with your film supply. It is hard to estimate how many pictures you will be likely to take. The number will depend on the type of pictures to be made, the picture-taking opportunities offered by the locality, the length of time you plan to be away and on a number of other considerations which will come up in individual cases. Take as much film as you can accommodate; film you do not use on the trip can always be used up on returning home. Include in your equipment a light tripod, a lens sunshade, a filter or two (an ultra-violet one if you plan to take pictures from mountain peaks), a good exposure meter—a photographic "diary" in which to record exposure data and one or two other small items that may seem to you important. By no means, however, need you take along equipment for processing negatives en route. You are not trying to make a deadline—you go on a vacation trip to get away from deadlines—so you can take your time about seeing the results of your handiwork. Besides, processing negatives en route would take time and trouble which should be de-

The Pickle Seller

$100 IN PRIZES

FOR AMATEUR PHOTOGRAPHS ON SCIENTIFIC AND ALLIED SUBJECTS

HERE is a real chance for advanced amateur photographers to achieve international recognition of their skill. Scientific American offers $100.00 in cash prizes for the three photographs, submitted according to the following rules, which the Judges decide are the best. Furthermore, there will be ten Honorable Mention awards, each of a one-year subscription to Scientific American. The publishers also reserve the right to purchase, at regular rates, any non-winning photographs submitted in this contest.

Read the rules carefully and then go to work. But please be sure that your entries comply with all the rules as the Judges cannot be held responsible for entries which do not.

RULES OF THE CONTEST:

1. Photographs entered in this contest must depict some phase of science, industry, engineering, aviation, or kindred subject.
2. Entries will be judged on the basis of pictorial value and photographic technique. The decision of the Judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.
3. All of the photographic work involved in producing prints for this contest must be done by the contestant.
4. Photographs submitted must be printed in black and white on glossy paper and must be mounted.
5. Prints must not be under 7 inches or over 14 inches in their longest dimension. Mounts must not be larger than 14 by 17 inches.
6. Photographs must be submitted by first class mail, with sufficient cardboard included in the package to protect the print.
7. Each entry must have the following information written on the back of the mount:

   Name and address of contestant;
   Camera and lens equipment used;
   Size and emulsion of negative;
   Filter used, if any;
   Diaphragm opening and time of exposure;
   Month, time of day, and quality of light;
   If indoor, contrast of paper used;
   Developers used for negative and paper;
   Additional aids employed.

8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.
9. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.
10. Non-winning entries will be returned only if postage is included when the prints are submitted.
11. No entries will be considered from professional or commercial photographers.
12. All entries in this contest must be in the hands of the Judges by June 20, 1936. The results will be announced in our issue dated September, 1936.
13. This contest is open to all amateur photographers who are not in the employ of Scientific American.

PRIZES:

First Prize, $50.
Second Prize, $30.
Third Prize, $20.

Ten Honorable Mentions, each to receive a One-Year Subscription to Scientific American.

The Board of Judges of this contest will be announced in a subsequent issue.

Address all entries to:

Photograph Contest Editor
SCIENTIFIC AMERICAN
24 West 40th Street, New York City

voted to the purposes for which you took the trip—rest and picture-taking. Take care, however, that you mark the exposed film rolls or packs in some way to identify them and take the additional precaution to segregate them in some definite place in your grip away from the unused material.

Nor ought you to yield to the temptation, however strong, to see "how they came out" and rush to the nearest local photo finisher. He may do a good job, but on the other hand, he may do an awfully bad one. At any rate, why take the chance?

Vacation trips imply a period of two or three weeks for most of us. For this reason we should take pictures as we meet them and not put off until the next moment what can be done right away. The first impression is the freshest and most vivid. If a subject strikes you "right between the eyes" —or in the heart—lose no time to record it in the best way you know. You may never feel exactly that way about it again.

On the return home, survey your developed negatives with a critical eye. The enthusiasm and excitement of the moments when the pictures were made are gone, so you can look upon the results in a relatively objective way. Do not hesitate to throw away what seem, on afterthought, to be

worthless things, but watch for the "worthless" negative in which some detail may be salvaged by the enlarging camera and turned into something quite presentable. The resultant batch may be printed up for arrangement in a book which will ever after call up the memory of the trip as no mental recollections of it can ever do.

Daylight Silhouettes

SILHOUETTES of persons or objects taken indoors by having the light behind the person or object and the shadow projected on a white sheet may be duplicated with outdoor lighting and without the use of the sheet. The accompanying illustration shows how this is done. The exposure, of

". . . against the outside brightness"

course, is based on the outside light. The interior in which the subject is placed being relatively dark, even with normal lighting in the room or other enclosure, the subject is silhouetted sharply against the outside brightness. A profile, of course, is essential, and the "true" silhouette, the one in which no detail whatever appears, is the most striking. However, a "semi-silhouette," where the front part of the face has some light on it, is sometimes effective too. The "semi-silhouette" is made by having a person close to a window or door. To insure a "true" silhouette, on the other hand, the person must be placed a bit away from the window or other aperture so that the daylight does not strike his or her face directly.

Glycin Paper Developer

USUALLY associated with fine-grain film developing, glycin has now been adapted by the Edwal Laboratories for use as a paper developer. In perfecting the developer, trisodium phosphate was substituted for potassium carbonate and three formulas evolved; the Edwal 102 for deep black tones, the Edwal 106 for brown tones on chloride and chlorobromide papers, and the Edwal 108 for greenish or olive tones. No. 106 is called a "stunt" developer by the manufacturers because different tones can be had by lengthening exposures, the longer the overexposure the browner the print, with chloride papers capable of being toned in this manner to reds, greens, and sepia tones. All these developers are obtainable

in made-up form, an arrangement becoming increasingly popular for many types of formulas because of the convenience of not having to weigh out the individual chemicals. It is much simpler just to add water and mix.

35-MM. IN BULK

FOR those who buy their miniature 35-mm. film in lengths of 25, 50, and 100 feet and later cut them to the little over five feet accommodated by the magazine, Agfa has devised a convenient form of bulk film which does away with the necessity of measuring the required lengths in the darkroom. Their Agfa Superpan now comes packed in rolls of 27½ feet and 55 feet, the first divided into five lengths by notches to indicate where to cut the film, and the larger film roll notched for ten lengths. This gives a length of 5½ feet for each loading, which will give the usual total of 36 pictures.

NEW FLOOD LAMPS

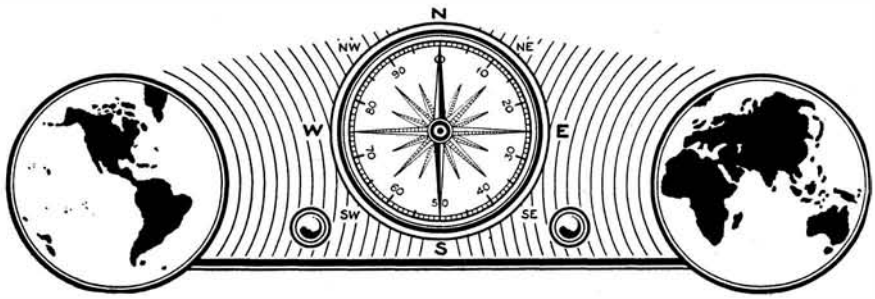
A SERIES of lamps for indoor camera workers is now on the market under descriptive names which indicate their span of life. They are offered as "Five Hour Picture Flood," "Five Hour Filter Flood," "Fifteen Hour Jumbo Picture Flood" and "Fifteen Hour Jumbo Filter Flood." The term "Jumbo" refers to greater size and lasting time, the term filter to the fact that these lamps are made of a special blue glass said to be ideal for Dufaycolor use indoors.

SCOTCH ADHESIVE TAPE

SCOTCH opaque photographic tape can be used for so many things that it is easily the handiest thing about the darkroom and studio. It clings to the surface immediately, requiring no moistening. If you happen to have made a mistake it can as easily be removed without leaving a stain. Thus it can be used over and over again, which is perhaps the reason for its name. It is opaque, waterproof, soft and pliable, and will not crack. When applied to the edge of a negative for masking purposes it will neither wrinkle nor curl the negative but will lie perfectly flat. Its uses include the holding of negatives to the plate glass during printing and for blocking out desired borders, for making masks and for binding lantern slides, for repairing broken negatives, photographs, and camera bellows. It does a more efficient job than thumb tacks or wetted gummed paper and gives a neat appearance to the finished product.

LENS HOOD AND SKY FILTER

DESIGNED for the Rolleiflex and Rolleicord cameras, a new lens hood and graduated filter has just been introduced with the distinguishing feature that the filter goes over the front of the lens hood, sliding vertically in a holder. The filter is adjusted with the aid of the finder lens, then transferred to the taking lens for the exposure. As is usual with sky filters, no increase in exposure time is needed. The manufacturers designed the new sky filter arrangement on the theory that the usual sky filter has little, if any, effect when placed directly over the lens; the new method, they feel, keeps the filter at the correct distance from the lens.



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

"The Shadow" Discovered

NO form of interference to radio reception has caused such intense interest, and speculation as to its nature, as has "the shadow." It has been attributed to the workings of a foreign government intent upon disrupting the communication channels of the world; it was thought by some to be the work of an intellectual crank; others have suggested that it might be some new and odd form of radiation from another planet.

It has fooled some of the best engineers in the field for the reason that its true location could not be determined. To make matters worse, it had been reported from England, from Africa, from Japan. It was heard on the high seas, and it was heard on practically every channel from 30 meters down. And it is still heard, but "the shadow" is no longer a mystery.

It has been definitely determined that this interference is the radiation, not from a single, but from a number of new type high-power diathermy machines used in hospitals and health institutions. The coils used for treatments, through which the high-frequency currents pass, act as excellent antennas; so excellent, in fact, that presumably a single machine in operation is capable of radiating a strong "sky wave" that can cover immense distances.

Steps are being taken to equip these machines with suitable devices to prevent radiation of the high-frequency power. Until this is accomplished, world-wide radio will have to get along as best as it can.

There are no limits to the repercussions of progress. Who would have believed that a listener in San Francisco could hear the electrical oscillations warming a man's leg in New York?

Smallest Micro-Wave Transmitter

THE engineers of the National Broadcasting Company have designed an ultra short-wave transmitter so small that it just nicely fits the palm of one's hand. It looks like a toy but is far from being one; in exhaustive tests of the first working model completed, distances up to four miles were attained.

The midget transmitter is not intended for broadcasts direct to listeners' radio receivers, but for actual program service of the "Vox Pop" type, at any point of origin, to extend the scope of pick-up for present radio networks.

Announcement of the tiny transmitter marks the first NBC disclosure of results of more than two years' experiment in the micro-wave field, as part of the extended series of ultra-short-wave propagation tests conducted in the field and from the tops of skyscrapers in New York.

The new micro-wave unit, as explained


The smallest micro-wave transmitter, showing the two-rod antenna

by O. B. Hanson, chief engineer of NBC, is the culmination of attempts to develop a "coat-pocket" transmitter to enable footloose announcers to carry a microphone to any desired point, or circulate at will among large assemblages, for purposes of broadcasting or to feed a public-address system from the floor of a hall or auditorium. The transmitter is not available commercially.

Hanson explained that investigations in the micro-wave field suggested that work in the band of 300,000,000 cycles and more would permit the use of the midget antenna equipment necessary for the compactness sought. Micro-waves also offered a phenomenal degree of penetration through intervening structures, so the tiny waves were employed in developing the new portable transmitter.

Earlier units of portable type, more cumbersome in size and operating on longer wavelengths of the order of 7 to 10 meters, were tested by NBC during the Horse Show at Madison Square Garden last fall, where they worked with marked success in relaying instantaneously to the gallery the decisions of the judges on the floor.

In its present stage—as shown in the accompanying illustration—the micro-wave

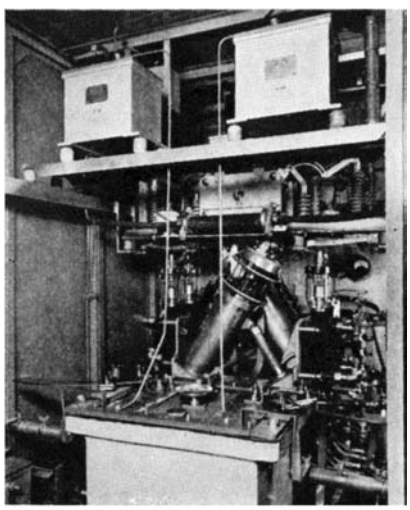
*Editor *All-Wave Radio*

set is a three-inch cube, with two ten-inch rods as the antenna system. It transmits on a wavelength of one meter or less at a power of two tenths of a watt. The latest type of RCA "acorn tube" is used. One of these small tubes is shown on the table in the illustration.

Current is fed to the midget set by a small battery unit of 90 volts. The complete battery unit weighs less than four pounds; the transmitter proper less than a pound.

British Broadcasting

THE Empire Broadcasting Service of the British Broadcasting Corporation recently completed its third year of operation. With the addition of a sixth transmission period added last year, designed



Power output stage of the Empire Broadcasting station at Daventry

primarily for listeners in Western Canada and audible in the United States, a daily program from Daventry became available for all parts of the British Empire at convenient local listening times.

The present wavelengths of the Empire Transmitters, and their call letters, are as follows:

Call	*Frequency* (Megacycles)	*Wavelength* (Meters)
GSA	6.05	49.59
GSB	9.51	31.55
GSC	9.58	31.32
GSD	11.75	25.53
GSE	11.86	25.29
GSF	15.14	19.82
GSG	17.79	16.86
GSH	21.47	13.97
GSI	15.26	19.66
GSJ	21.53	13.93
GSL	6.11	49.10
GSN	11.82	25.38
GSO	15.18	19.76
GSP	15.31	19.60

Correspondence received by the Corporation from overseas listeners exceeded 27,000 letters and other reports, approximately double the number received in 1934.

Politics and Power Loads

IT is an interesting fact that electric lighting loads in metropolitan areas increase many hundred percent during the President's "Fireside Chats." The additional load is divided between the increased number of radio receivers and electric lights turned on during these periods.

Apparently the power companies can gage to a nicety the radio audience of any program of national interest, but it is doubtful if the power load curves could serve as the basis of a straw vote: for one thing, the average farmer owns a battery-operated receiver. . . .

Ten Meters

IF your all-wave receiver tunes down to ten meters, it will be well worth your while to listen in frequently at that amateur band. It extends from 28 to 30 megacycles, but only that part from 28 to 29 megacycles is provided for use by amateur radiophone stations.

This is by no means a new amateur band, but it has been comparatively inactive until recently. Now it is a very active band, and it is not uncommon for an amateur 'phone station to contact all continents in a single day.

The band is unreliable in the sense that some days only transmissions from United States amateur stations can be heard, whereas on other days the whole world may come pouring in. Like the little girl with the curl hanging down on her forehead, when the band is good, it is very, very good; when it is bad, it is horrid.

But ten meters packs enough thrills to satisfy any person with sufficient patience to wait for the good days when the band is "wide open." It is distinctly a "daylight" band; therefore listening should be done before nightfall.

Receiver Alignment

FEW radio receivers can maintain perfect alignment of tuned circuits over long periods of time. If sensitivity and tone quality are to be maintained, re-alignment at fairly regular intervals is desirable.

It is not easy to determine when a receiver is out of alignment. The change in circuit values is usually so gradual that the listener is not aware of the drop in sensitivity or the alteration of tone quality. A condition of this sort can be detected only through the use of radio servicing equipment; the ear is not sufficiently precise.

Noise Silencer Adapters

A BRIEF explanation of the Lamb Noise Silencer appeared in these columns in the April issue of *Scientific American.* Since then, a number of companies have placed on the market noise silencer adapters suitable for use in conjunction with the average type of superheterodyne receiver.

One type of adapter is designed for use with a receiver having but one stage of intermediate-frequency amplification; another type is made especially for a receiver having two stages. It is highly important that the correct type be used, as the adapters are not interchangeable.

It is also important that the intermediate frequency of the transformer used in the adapter be exactly the same as the intermediate frequency of the receiver with which the adapter is to be used.

The adapters will not silence all man-made static, but they are of great assistance nevertheless. After a bit of practice, the average listener should have no difficulty in operating one satisfactorily.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 279)

field, and, having done this, to operate an alarm system of some type the instant this field is penetrated or disturbed by the presence of a human body attempting to enter the protected area. Although the action is immediate and absolutely foolproof, the field thrown from its antenna system is harmless and cannot be detected by the intruder.

The control mechanism is installed within the protected area, generally in the cellar or in a closet. Antenna wiring is run to openings or areas it is desired to protect and from this antenna the sensitive "radio" field is generated only where desired. Installation of the antenna wiring may be completely concealed, as the generated field readily passes through wood, glass, tile, and so on.

When the system has been turned on and is in operation, protection exists regardless of whether windows or doors are open or closed, and immediate warning is given *before* the criminal has entered. Frightening the marauder before rather than after he has gained entry, gives the greatest possible protection to the members of the household, as the criminal trapped within the home is a highly dangerous individual.

Fireproofing Cotton Duck

THE use of cotton fabrics for awnings, tents, canopies, wagon and stack covers, and for other out-of-door purposes has always been accompanied by fire hazards. Also, the danger from fire exists elsewhere and was instrumental nearly a generation ago in leading the English chemist, William Henry Perkin, to make a search for a way to fireproof flannelette which was widely used at that time for children's clothing. This chemist discovered the fireproofing properties of tin oxide and widely publicized the possibility of fireproofing clothing by impregnation with this oxide. Many of his claims were not substantiated in practice and his treatment never attained wide use.

Water will not remove tin oxide from cotton cloth and it would seem that treatment with tin oxide would be excellent for awnings, tents, and like articles. Unfortunately, tin oxide only flameproofs the fabric and at the same time actually increases the tendency of the fabric to smolder. In fact, an awning treated only with tin oxide would burn up just as surely, if a lighted cigarette butt was dropped on it, as would an untreated awning, although no flame would be apparent.

Another fault possessed by the tin oxide is that it causes the fabric to lose its strength when exposed to the sun. At the end of one season the treated fabric would scarcely support its own weight because of this effect.

The Bureau of Chemistry and Soils has found that certain pigments can be put into the fabric which will retard this rotting effect of the tin oxide. Just as important, they also found a way to increase the efficiency of the flameproofing effect of tin oxide so that now only 5 to 10 percent of tin oxide need be used instead of 15 to 20 percent as was necessary with the Perkin's process. This is important because tin is an expensive metal.

The Bureau also developed a new chlorinated resin which is especially suited for use on fabric in connection with the pigmented tin oxide. This resin prevents the smoldering tendency and thus the combined effect yields a fully fireproofed fabric which lasts longer in out-of-door service than untreated fabric.

The complete process including the production of chlorinated resin is being put on a commercial basis as rapidly as possible.

The advantages of such a treatment are obvious. There is absolutely nothing that can be washed out of the fabric and consequently the fireproofness remains throughout the life of the fabric. The usefulness of canvas for awnings, tents, salvage covers, implement covers, and so on, is greatly extended as a direct result of permanent fire-resistance. Aside from use which industry and the farmer may make of fire-proofed canvas, increased use of cotton will react indirectly to the benefit of the cotton farmer and the cotton goods manufacturer.

Rubber Joints for Concrete Roads

RUBBER joints for concrete roads may open an extensive new market for rubber if present trials in New England continue to prove satisfactory, says Arthur D. Little's *Industrial Bulletin*. One of the constant troubles with concrete roads is that the asphalt filler for expansion joints is forced above the road level when the road expands and does not recede properly when it contracts. Hard ridges are created which provide rhythmic but unpleasant bumps for the traveler, and the spaces from which the ridges came are eventually filled with water. The damaging effect of water expanding to ice in such confined spaces is well known.

Rubber latex compounds of a creamy consistency that vulcanize in two weeks to a compressible elastic mass have been found to overcome many of the difficulties encountered with asphalt. Labor costs on the maintenance of the present asphalt joint are so great that a rubber latex-bond cost of the order of 1200 dollars per mile for each lane of road is apparently a net economy. Experiments have been conducted over a period of more than two years, and while it is still too early to make predictions, apparently no serious drawback has been found, and both road engineers and rubber men are following the method with interest.—*A. E. B.*

"Jumpy" Screen Makes Smooth Movies

YOUR favorite "movie" actor and actress will be made to perform in front of a "jumpy," or, rather, vibrating screen during the "shooting" of scenes if the motion picture producers adopt the method for making more perfect "movies" recently perfected by Willis H. O'Brien, of Los Angeles, Calif. The jumpy screen actually makes a "smoother" picture.

The invention is for use in making composite scenes. These scenes eliminate the necessity for companies to go on location

when they already have available in their film library pictures of the desired background.

In this method of making movies, if a Paris, New York, or jungle background is required, the director selects a film of such a scene from the film library and uses a projecting camera to throw it on the back of a huge ground-glass or equivalent translucent screen. On a set in front of this screen the actors perform while the movie camera simultaneously "shoots" the actors and the scene projected on the screen.

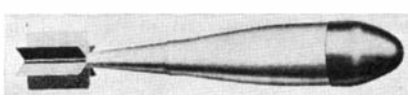
When the film is developed and shown on the usual screen, the effect is the same as though the scene was taken in the locale of the background. However, any defects in the background screen that show up in enlargement, such as grain and irregularities, may spoil the effect. Inventor O'Brien has found out that he can literally shake these defects out of the picture by vibrating the ground glass screen during scene "shootings." This is accomplished by suspending the screen from two springs so that it can slide up and down in guide grooves in two vertical supports, and then vibrating it with a cam turned by an electric motor.

Brazed Tear-Gas Projectile

IN the manufacture of a new long-range projectile for use with tear or nauseating gas, the Lake Erie Chemical Company has adopted electric-furnace brazing as the most (and probably the only) practical method of providing five strong, gas-tight joints between seven important main members of the assembly.

Soldering and torch-brazing were found unsuccessful because it was necessary to

Above: **Gas gun and cartridge.** *Below:* **Projectile that is made gas-tight by electric-furnace brazing**



obtain joints which would withstand high gas pressures without leaking and because the design of the shell embraces certain small, complicated parts having surfaces that are difficult to reach. Electric-furnace brazing in a controlled furnace atmosphere, a process developed by the General Electric Company, is making it possible to fabricate the shell with joints that are absolutely tight and able to withstand pressures of more than 3000 pounds per square inch. In one test, the shell failed at a pressure of 3300 pounds per square inch, but the brazed joints remained sound.

The brazing is accomplished in a 20-kilowatt batch-type electric furnace operated at 2100 degrees, Fahrenheit, and used in conjunction with a combustion-type furnace-atmosphere controller. The latter reforms a mixture of natural gas and air, supplying a reducing atmosphere which acts as a flux for the brazing metal. The shell parts, assembled with copper wires tightly wound at the joints, are laid on trays and placed in the heating chamber of the furnace for 15 minutes. The copper flows into all parts of the joint by capillary action, and the process is completed by passing the work into the cooling chamber of the furnace, where it remains for an hour during which its temperature is reduced to about 200 degrees, Fahrenheit.

The shells thus manufactured are approximately nine inches long and an inch-and-a-half in diameter. Loaded in a cartridge and fired from a 37-millimeter shoulder gun, they have a range of 500 yards and may be sent through a window at 100 yards. In appearance, they resemble an aerial bomb, being shaped like a torpedo and having a finned tail. When a rapidly moving shell of this type strikes a solid object, a percussion cap is set off, firing an explosive charge which bursts the shell and liberates the compressed gas.

Because of its long range and the accuracy with which it can be directed, the new projectile may be used to advantage by police officers. For example, when attempting to capture criminals barricaded in a building, instead of exposing themselves to gunfire, as might be necessary with commonly used hand-thrown grenades, the officers will in many cases be able to fire the new projectile into the building from a position of safety, thus overcoming the criminals with the gas and making possible their capture.

Spare the Heat— And Save the Meat

COOK meat at moderate temperature, says the Bureau of Home Economics. Meat is a protein and, like white of egg, is toughened and hardened by long heating at high temperatures. Broil, roast, or fry tender, well-fattened cuts from young animals, in an uncovered dish without water. Braise, simmer, or stew less tender, leaner cuts with a cover, with or without water.

All cuts of pork, lamb, and veal are tender. Pork and lamb are fat enough for roasting and broiling. Veal usually is fat enough only for braising—generally with a little liquid added.

The less connective tissue there is in beef—the more tender it is. Tougher cuts are made tender if cooked as pot roasts, "smothered" or braised steak, or stew, or if ground or chopped and cooked as tender meat in hamburg steak or meat loaf.

To pan-broil tender steak or chops, brown both sides in a lightly greased, sizzling hot skillet, lower the heat and cook slowly, turning the meat to insure even cooking. Pour off accumulated fat or the meat will fry. Never cover or add water in pan-broiling.

How many minutes per pound a roast takes depends mostly on oven temperature and whether the meat is to be rare, medium, or well done. A standing beef roast, seared for 20 minutes in a hot oven (about 500 degrees, Fahrenheit) and finished in a moderate oven (about 300 degrees, Fahrenheit) usually is rare in 16 to 18 minutes to the pound, medium in 22 to 24 minutes, and well done in 30 minutes. Rolled roasts take from 10 to 15 minutes more per pound than standing roasts. The only sure guide, however, is a roast-meat thermometer inserted into the thickest part of the meat. Beef is rare at about 140 degrees, medium at about 160 degrees, and well done at about 180.

CURRENT BULLETIN BRIEFS

(Bulletins listed as being obtainable through Scientific American can be supplied only by mail)

HOW TO BRONZE-WELD is a practical presentation of the fundamental theory and technique of bronze-welding and bronze-surfacing, bringing out the advantages of speed and economy and also the ability of bronze-welding to accomplish jobs that would otherwise be difficult or impossible. The step by step procedure of bronze-welding is given, together with special information and advice. *Write for Bulletin 536A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE QUESTION OF LIVING BACTERIA IN STONY METEORITES, by S. K. Roy, Field Museum. Are claims for bacteria arriving from space in meteorites true or false? *Field Museum of Natural History, Chicago, Illinois.—20 cents.*

YOUR NEW PLANT: MULTISTORY OR SINGLE STORY—WHICH? is an 8-page pamphlet putting forth the results of a serious analysis of plant construction cost which has served as a guide to many industrial executives in determining the character of plants to be built. The booklet illustrates different types of factory buildings, together with floor plans. *Write for Bulletin 536B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

RODENTS AND MOLES AS PESTS IN BULB PLANTINGS considers various flower bulbs as a food desired by moles, mice, and other pests, and gives definite details of methods of preventing the ravages wrought by them. Numerous illustrations are included showing rodent traps and barriers. *Superintendent of Documents, Washington, D. C.—5 cents.*

HOW TO INSURE YOUR CROPS is an informative pamphlet giving specific directions for treating with formaldehyde the more common grains and vegetables. The text also presents a new method of soil treatment with particular reference to greenhouse work. *Write for Bulletin 536C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE AUTOMOBILE USER'S GUIDE, in 96 pages, tells just about everything that the owner of an 8-cylinder Pontiac will want to know about his automobile, its mechanism, and its operation. *Write for Bulletin 536D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

LIVE AND LET LIVE is a sincere plea for safety on the highways of this country, dramatically presented in a series of striking cartoons and tabulations. Some of the illustrations are presented in full color. *Write for Bulletin 536E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

DIESEL—THE MODERN POWER is a 32-page illustrated pamphlet which surveys the development of power units from the earliest days of beasts of burden up to the present time. It then describes simply yet comprehensively the Diesel engine and its operation and devotes several pages to its present and future applications. *Write for Bulletin 536F to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

PRECIOUS AND SEMIPRECIOUS STONES (Gem Minerals). By Sydney H. Ball. Annual report on gem mineral production, with side data. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

THE SOARING CYCLE is issued in mimeographed form with occasional drawings and is published from time to time in the interests of a thorough and critical research in the theory and practice of soaring flight. It also deals with the lessons that may be drawn from the records of careful observers of the flight of birds. *The Soaring Flight Co., Departmental Bank Building, Washington, D. C.—25 cents per copy, 10 copies $2.50.*

CHEMISTRY AND WHEELS carries the subhead The Automobile Is a Chemical Factory on Wheels. It goes on to show how and why this is the case, in simple, straightforward text and with numerous illustrations. *Write for Bulletin 536G to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE PINTO BASIN SITE, by E. W. C. and W. H. Campbell. An account of archeological work done at a very ancient aboriginal camping ground in the California desert (Riverside County) by two amateurs who acquired professional technique. 51 pages, illustrated. *The Southwest Museum, Highland Park, Los Angeles, California.—50 cents.*

FLOODS IN THE UNITED STATES, U.S.G.S. Water Supply Paper 771. By Clarence S. Jarvis and others. Records of stage and discharge of past floods in 225 rivers of the U. S. Analysis of such data to estimate magnitude and frequency of future floods. *Superintendent of Documents, Government Printing Office, Washington, D. C.—$1.00 (cash).*

THE PORT OF NEW YORK AUTHORITY, 15th ANNUAL REPORT, gives a complete picture of development work, covering in particular the mid-town Hudson Tunnel. Illustrated. *The Port of New York Authority, 111 Eighth Avenue, New York City.—Gratis.*

AIR ELECTRIC WIND DRIVEN POWER AND LIGHT PLANTS is a circular describing modern windmill electrical generators built in various sizes for all services where central power plants are not available. *Write for Bulletin 536K to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

PRACTICAL AIR NAVIGATION AND THE USE OF THE AERONAUTICAL CHARTS OF THE DEPARTMENT OF COMMERCE is a 64-page book, including typical portions of two full color

charts. The text deals with the three principal methods of air navigation—piloting, dead-reckoning, and radio navigation. In a final section a number of practical examples are worked out step by step. The book shows graphically the advantages of the aeronautical charts of the Department of Commerce to all those interested in aerial flight. Special Publication No. 197, *The Director, Coast and Geodetic Survey, Washington, D. C.—30 cents.*

WHEN THE WHEELS REVOLVE presents an interesting running story of exactly what takes place in the automobile when it is in operation. Many analogies are given to familiar objects in order to assist to a complete understanding. *Write for Bulletin 536H to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

IMPROVED FABRICATION OF 18-8 CHROMIUM STEELS is an 8-page illustrated booklet showing the use of oxy-acetylene welding with this type of metal. *Write for Bulletin 536I to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

AIR HYGIENE FOUNDATION OF AMERICA, INFORMATION CIRCULAR NO. 1, puts forth briefly the purposes of the organization and presents its code of regulations and its by-laws. The pamphlet will be of interest to various industries and to town planning committees, particularly in areas where industrial smoke and dust are menaces. *Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.—Gratis.*

ZINC AND LEAD DEPOSITS OF NORTHERN ARKANSAS is a 303-page paper-covered book, with maps, on the geology and mines as described. *Superintendent of Documents, Washington, D. C.—$1.00.*

RUST-PROOFING BY THE CROMODINE PROCESS is a beautifully prepared booklet of 18 pages, thoroughly illustrated with photographs showing the results obtained with the Cromodine process used as an under-coat for various types of paints. *Write for Bulletin 536J to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THE NEWEST IN THE FAMILY OF MUSEUMS outlines the purposes of the Museum of Science and Industry. *New York Museum of Science and Industry, RCA Building, Rockefeller Center, New York City.—Gratis.*

STUDIES OF THE RELATIONS OF RAINFALL AND RUN-OFF IN THE UNITED STATES. By W. G. Hoyt and others. U.S.G.S. Water Supply Paper 772. An analysis of climatic and hydrolic data and their effect on rainfall, run-off, and related factors. *Superintendent of Documents, Government Printing Office, Washington, D. C.—25 cents (coin).*

THE 200-INCH TELESCOPE

(*Continued from page* 240)

available site for the 200-inch telescope. After many tests, extending over several years, Palomar Mountain, in San Diego County, has been selected. Here, on a tract of about 600 acres, several structures have already been erected, under the general direction of Captain Clyde S. McDowell, U.S.N., Supervising Engineer. These include large storage tanks for water and gasoline, a pumping and distributing plant, a dwelling house, and so on. The site for the 200-inch telescope dome has been levelled, and it is hoped that foundations for the telescope and dome, as well as the lower (fixed) part of the building, can be erected during the present year.

Every large telescope, if efficiently used under good atmospheric conditions, not only adds to our knowledge of existing problems but reveals new ones for solution. Thanks in part to increased light-gathering power, and to the development of new auxiliary apparatus, the volume of space opened up for investigation may prove to be fully 50 times as great as that partially explored in 1928.

It goes without saying that all observatories, large or small, should have a well defined scheme of research. The Astrophysical Observatory of the California Institute will deal with the investigations for which it is especially adapted, in harmony with the observational and theoretical work of the Mount Wilson Observatory and the various departments of the California Institute. In view of its great light-gathering power, one of the most important tasks of the 200-inch telescope will be the study of the structure and radial motion of the extra-galactic nebulae, especially in their bearing on the still open question of the nature of the "expanding universe". The nearer large spirals, such as the Great Nebula in Andromeda, offer many problems for detailed examination, while the Galaxy, within which we live, presents scores of questions awaiting their turn for study with powerful instruments.

Take, for example, the critical analysis of the brighter stars. Ever since I began work at Kenwood with a ten-foot Rowland grating, I have felt hampered by the comparatively low dispersion of the spectrographs ordinarily used for the study of stellar spectra. In fact, my chief incentive toward the construction of larger telescopes 40 years ago lay in the possibility of obtaining stellar spectra of high dispersion, comparable with that used in those days only on the sun. High dispersion has since been realized at the coudé focus of the 100-inch Hooker telescope, and the 200-inch should permit us to take another step in the same direction. Its increased light-gathering power, aided by the new types of spectrographs recently devised here, should be especially serviceable.

If such research problems as I have mentioned lie chiefly in the field of astrophysics, it should not be forgotten that the new observatory may also play an important part in the field of pure physics. Scores of physical questions await attack in an observatory, simply because the conditions of high temperature or of extremely low or extremely high masses and densities encountered in many celestial objects cannot be duplicated in the laboratory. As chemical questions are also involved, it is evident that the new observatory may be expected to contribute materially to several branches of science.

Books SELECTED BY THE EDITORS

GLANCES AT INDUSTRIAL RESEARCH

By Edward R. Weidlein and William A. Hamor

"DURING Walks and Talks in Mellon Institute" is the sub-title of this volume and while it appears to be just that—a collection of essays written at various times—it has been extremely well done and the various pieces so well organized as to make a most readable book. Some of the sections, each covered by several features, are as follows: Industrial Research Procedure of Mellon Institute; Industrial Research Successes and Opportunities; Professional Aspects of Industrial Research; Questions in Industrial Research Management; Literary Activities in Industrial Research; and there is a final section on the Progress of American Chemistry since the Outbreak of the World War. This discussion should prove valuable to those now engaged in, or desiring to do, industrial research.—$2.90 postpaid.—*F. D. M.*

MEN OF SCIENCE

By J. G. Crowther

TO understand science, it is necessary to work back into its roots. More than any others, five great men of science living in one century, the 19th, have altered our lives and outlook. These were Davy, Faraday, Joule, Thompson, and Maxwell. This book, whose author occasionally writes for the Scientific American, is not merely a set of biographies of these men but it also traces the direct significance of their discoveries on life today.—$3.65 postpaid.—*A. G. I.*

FUN WITH ELECTRICITY

By A. Frederick Collins

IT is all very well to write about the fundamentals of some particular phase of science, but how much more interesting it becomes when the reading can be supplemented by easily performed experiments which demonstrate certain facts. In this book such informative reading is coupled with complete and specific directions for performing such experiments. The author has divided the book into three parts dealing with direct currents, alternating currents, and high-frequency currents. Wherever he describes some specific phenomenon, he gives directions for the performance of an experiment which proves the text. Although the book is written as far as possible in words of one syllable and is essentially intended for the curious-minded boy, it will undoubtedly find a ready acceptance by more mature minds which are intrigued with completing interesting experiments with their own hands. The section of the book dealing with high-frequency currents is especially recommended as it gives specific directions for constructing a power transformer as well as Tesla and Oudin coils, together with the other necessary equipment.—$2.15 postpaid.—*A. P. P.*

JANE'S FIGHTING SHIPS FOR 1935

Edited by Francis E. McMurtrie

THERE have been so many millions expended in the modernization of capital ships in the United States and Japan and recently in England, on replacement programs, and on new ships, that it was necessary to revise radically almost the entire volume of Jane's. New silhouettes, new photographs, and new details of armor and weapons are given in this latest volume, the first under the editorship of Mr. McMurtrie. As usual it is a magnificent job, complete for most of the navies of the world. To those who do not already know this annual, let us repeat that it is the one comprehensive picture of world navies.—$18.00 postpaid.—*F. D. M.*

STARS AND TELESCOPES

By James Stokley

THE well-known director of the Fels Planetarium in Philadelphia observed that no existing popular astronomical book covered the ground which people who visited the planetarium wished elucidated, so he prepared a book which would cover it. "The most important and interesting points, rather than a complete treatise on astronomy," is the ground covered. The chapter subjects indicate the scope: the heavens, motions, ancient ideas, modern ideas, the telescope, improving the telescope, telescopes of today, amateur telescopes, bigger and better telescopes, methods and attachments, time, moon, sun, planets, comets and meteors, stars, clusters, nebulae, galaxy, spirals, life in the universe. In style this book is informative, is on the easy side of the mean, and is aimed at the average man who would visit a planetarium rather than at the more serious student. Included with the numerous illustrations is a photograph of an amateur or "back yard" astronomer, with his telescope surrounded by feminine underthings hung on a clothesline—quite typical.—$3.15 postpaid.—*A. G. I.*

SCIENCE IN THE WORLD OF WORK Volume I: APPLIED MECHANICS

By Frank R. Deming and Joseph T. Nerden

DEVELOPED originally to meet the demands of students in trade schools, the present book embodies material also suitable for use in high schools. It is essentially a humanized physics book, dealing with that corner of physics known as applied mechanics. Illustrated with many photographs and line drawings, it is written in simple, understandable language with many helpful analogies that serve to explain the principles involved.—$1.45 postpaid. —*A. P. P.*

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THE same comments given for Volume I, reviewed above, apply also to this book which deals specifically with such phases of applied physical science as the properties of liquids, heat and cold, light, electricity, and sound.—$1.65 postpaid.—*A. P. P.*

GERMANY TODAY AND TOMORROW

By Henry Albert Phillips

WHATEVER may be our personal feelings regarding the present political activities in Germany, reasonable human beings will admit that there must be a Germany which has been obscured to a great extent by the larger, much featured issue. Mr. Phillips, a trained observer in foreign lands who has written other successful books of this sort, gives us an insight into part of the truth about Germany today. He understands the uses and abuses of propaganda and passes that aside in getting at the meat of his story. After discussion of the transition from the old to the new Germany, he carries on to a discussion of Naziland.

as he calls it, of youth marching with banners continually, of the labor camps, Communism, kultur, of the neo-paganism, and finally ties this in with Borderland Rumbles, or the influence upon neighboring countries. Neither he nor anyone else can predict the future for Germany so he simply ends with a chapter "Where Do We Go From Here?" Nevertheless, his discussion is provocative throughout.—$3.15 postpaid.—*F. D. M.*

AMERICAN PETROLEUM INDUSTRY

A SURVEY of the present position of the petroleum industry, and its outlook toward the future, published by a noted organization of oil men. Demand, production, supply, transportation, refining, marketing, taxation, labor—these are the main aspects discussed. The rumor, once more rampant, that our oil supply is almost exhausted, is once more knocked down. A good book for the reader who wishes to keep up to date about the oil industry in general. 200 pages, cloth binding.—65c postpaid.—*A. G. I.*

RAYON AND SYNTHETIC YARN HANDBOOK

By Dr. E. W. K. Schwarz and Herbert R. Mauersberger

SILK seems rapidly to be losing out in the competition against rayon, which today can be produced in fabrics practically indistinguishable from the silkworm's product. This volume covers the subject so thoroughly as to give an indication why this may be so. Although a technical treatise, it gives the historical background of the European and American rayon industry. Then, following the economic and statistical background, is given a complete study of raw materials and their preparation and the later processes which turn the fiber into beautiful textiles. Dyeing and printing, dry finishing, testing, and laundering of rayon products are discussed in considerable detail.—$3.90 postpaid.—*F. D. M.*

PRESS PHOTOGRAPHY

By James C. Kinkaid

TO the average person it must seem that the news photographer moves and lives in a little world of drama all his own. With the well known order "get the picture," it is his job to do just that regardless of consequences. The author has collected what might almost be termed a textbook for the press photographer. It is, however, much more than that. It goes into complete detail regarding cameras used, dark rooms, development, enlarging, and so on, and gives as well numerous hints regarding the proper operation of cameras under adverse conditions. The book itself is a beautiful piece of printing and engraving, being illustrated copiously with some of the most striking press photographs that have ever been produced. It is printed on fine, coated stock and contains 282 pages. If you are interested in any phase of photography, if you thrill to stories of achievement in everyday life, or if you have any ambitions to become a press photographer, this is a book you cannot afford to miss.—$3.20 postpaid. *A. P. P.*

THE PHENOMENA OF LIFE

By George Crile, M.D.

THE noted Dr. Crile, of the Cleveland Clinic, sets down in this semi-popular book the basis for his hypothesis that electricity is the basis of life. Oxygen, he says, produces radiant energy, this generates electric currents in protoplasm, and the normal and pathological phenomena of life are manifestations of protoplasm, hence life must be due to radiant and electrical energy. This hypothesis has not yet been accepted by science, but its discussion makes fascinating reading, and Dr. Crile's standing in the world of medicine is high.—$3.70 postpaid.—*A. G. I.*

MODERN RADIO ESSENTIALS

By Kenneth A. Hathaway

HERE is a well written discussion of the underlying principles of radio communication as it stands today, presented in general form and avoiding completely the use of specific equipment for explanatory purposes. This is one of the best books that we have ever seen for supplying a background of knowledge of a specific subject, without overburdening the reader with unnecessary side issues. The author has built up the text admirably by first describing the separate functions of various instruments and then showing how these functions are coupled to achieve a desired purpose in a completed circuit.—$2.15 postpaid.—*A. P. P.*

PHENOMENA IN HIGH-FREQUENCY SYSTEMS

By August Hund

RESEARCH workers, serious-minded students, and teachers will find in this reference book a thorough discussion of high-frequency phenomena applied to measurements. The subject matter is strictly up to date both as to theory and practice. Anyone who has the necessary background and equipment for carrying on high frequency measurements or research work in this field will find this thorough-going volume of inestimable help. It has a splendid index. 642 pages, 6 x 9 inches.—$6.25 postpaid.—*A. P. P.*

THE PRACTICAL ASPECTS OF PSYCHOANALYSIS

By Lawrence Kubie, M.D.

READERS with some—though not necessarily large—background with regard to psychoanalysis, also general practitioners in medicine, may use this book as a help or guide in getting hold of the right kind of psychoanalyst rather than some of the "pseudo" kind who have pinned the label psychoanalyst on themselves, much to the confusion of the public and the detriment of psychoanalysis. It also contains a list of accredited psychoanalytic societies. The author is a member of the College of Physicians and Surgeons at Columbia University.—$2.15 postpaid.—*A. G. I.*

ELEMENTS OF DIESEL ENGINEERING

By Orville Adams

DIESELS are so rapidly coming to the fore that numerous books concerning them are being published every day. Here is one which gives fundamental information concerning stationary, marine, locomotive, and automotive Diesels and goes into the question of their engineering quite thoroughly. We might say that a study of this book would be the first step toward a complete understanding of the principles of Diesel engines, of the equipment that must be designed for them, and of the fuel they use. Many illustrations serve to make the discussion more lucid.—$4.25 postpaid.—*F. D. M.*

DIESEL OPERATING GUIDE

By Julius Rosbloom

COMPREHENSIVE language is the keynote of this 543-page volume. A careful examination indicates that it is one of the most complete books of its kind available today. It is divided into a number of sections, including one on the high-compression oil engine, one on maintenance of Diesel engines, one on instruction for safe operation of Diesel engines of either two or four cycle types, one on oil, and others on auxiliaries, waste heat recovery, accessories, Diesel electric drives for locomotive and rail cars. This is the first edition of a volume which apparently will be revised from year to year.—$5.25 postpaid.—*F. D. M.*

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