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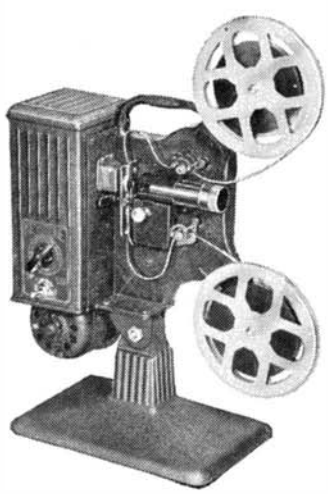

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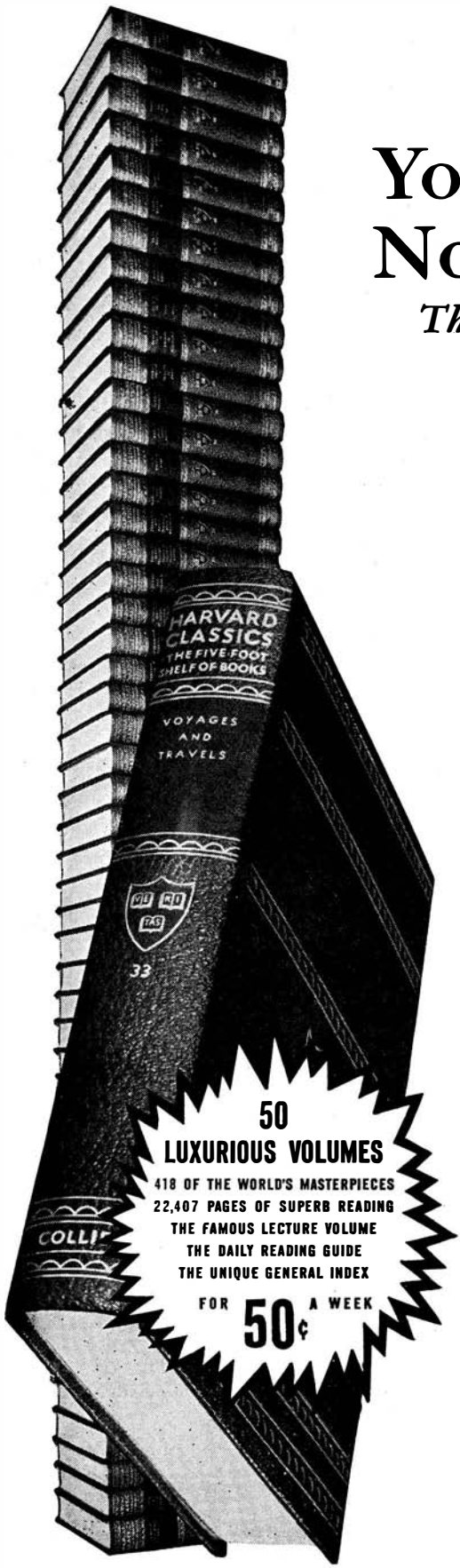

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HUGE quantities of airplanes do not necessarily offset smaller quantities of higher quality, for military purposes. This fact has been definitely established by the war in Europe, as outlined graphically in the article starting on page 278 of this issue. The military ships shown on this month's cover are United States Army P-26's, photographed by Robert Yarnall Ritchie during maneuvers, Perico Island, Pacific side, Panama Canal Zone.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • ORSON D. MUNN, Editor

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MAY • 1941

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OUR Point OF VIEW

M. T. B.'s

OF SPECIAL interest in naval circles are the motor torpedo boats described in some detail on page 281. In the design of these comparatively tiny vessels but little attention is paid to the factor which is of such great import in most naval vessels—armor. Mahogany hulls an inch thick, the whole structure so light and bouyant that it will float even with every water-tight compartment flooded, afford little protection against any projectile larger than that from an air-gun. But an "armor" more invulnerable than mere steel plating is provided; speed and maneuverability. Fastest war vessels on the seven seas, these swiftly striking mosquitos of the navy may be expected ultimately to revise certain ideas in the field of naval tactics.

It must be remembered that these little boats are not exactly an unproved experiment. The United States Navy has been toying with them for several years, has now settled down to a program of building and testing that holds great promise. Other world powers have also built many of them and have found a multitude of uses in many phases of naval maneuvers. For example, it is reported that 18 British motor torpedo boats were particularly effective in the evacuation of Dunkerque. By reason of their shallow draft and great maneuverability not one of the 18 were lost in that action.

Some idea of the tactical uses of these boats is given on page 281. There also will be found a photograph of an American type, showing the machine-gun turrets on deck. The high speed of the mosquitos makes them a poor target for aircraft attack, but if a pilot should attempt to engage one of them, he would find these machine guns to be particularly effective. When a dive-bomber, for example, pulls out of a dive, it is an especially good target for the expert machine gunners on the mosquito, handicapped though they may be by the high-speed, bucking shell on which they ride.

Only a major naval engagement will prove the worth of these tiny war vessels; it is apparent, however, that they can give a particularly good account of themselves in repelling enemy invaders. In such work their speed and ability to maneuver rapidly should place at their mercy the larger, slower, more ponderous vessels against which they would be pitted.

Here is a construction program in which American mechanical ingenuity should be able to show its much vaunted superiority. Past experience should enable us to build the best, fastest, most flexible boats of this type; with these available to both this country and to Great Britain, we will be taking one more step in the right direction.—*A. P. P.*

HYSTERICAL LEGISLATION

COOL, calm contemplation of the job to be done under our national "all-out-aid" policy, exemplified by passage of the lend-lease bill, begets sane, orderly action; undue excitement and failure to think through our problems to their logical conclusions fosters and engenders hysteria. Such unbalance in the country's thinking is at once reflected in councilmanic, state, and federal legislative chambers by introduction and consideration of proposed laws which are often impossible of enforcement, inadequately prepared for the purpose in mind, and even inimical to the public welfare.

Indicative of such hysterical legislation is the present rash of bills proposing registration of what are termed privately owned "sporting firearms." Latest advices are that no less than 20 state legislatures have such bills under consideration and that sooner or later the Congress intends discussion of a similar statute.

The avowed purposes of sponsors of laws to register these privately owned guns are usually two: to remove deadly weapons from hands of subversive groups and individuals, and to "take an inventory" of guns which might prove helpful in national defense.

Contrary to popular belief, firearms are not the chief weapon of the "5th column." Most foreign agents are, first of all, fact finders and news gatherers who uncover information that may be of value to the homeland. Others are propagandists and saboteurs who make use of this information to destroy public property and hinder defense preparations, but not with shotguns and sporting rifles. The conclusion is therefore logical that the only arms registrants would be the law-abiding citizens.

As to "inventory" of the "arsenal" collectively owned by the hunters and target shooters of the nation: Already filed with the state conservation departments today are the names, ages, places of birth and residence, postoffice addresses, and naturalization details of these gun owners, all obtained when the nimrods annually buy their hunting licenses.

True, the files do not show how many and what kind of firearms these men and women own, but it is evident from conservation department records of takes of game and from Department of Commerce statistics relative to the manufacture of guns by the firearms industry that by far the majority of them are shotguns, which have a pitifully negligible value as defense weapons. The deer rifles, varmint guns, and target guns that would be inventoried could *not* be used to equip an army. Ordnance experts state that the conduct of modern war demands simplification of equipment to the extent that one and only one kind or caliber of small arms ammunition should be manufactured, and further, that only one kind of rifle should be used to shoot that ammunition.

Any such inventory of sportsmen's guns would disclose literally scores of sizes of ammunition necessary to fire the rifles and shotguns. Where, then, is the value or need for such a law? Is it not an example of legislation fostered by the excitement of the times? In past periods of national stress cloudy thinking, inadequate investigation, and public hysteria have saddled us with improperly prepared laws, affecting many phases of our national life, that have hindered far more than they have helped.—*A. D. R., IV.*

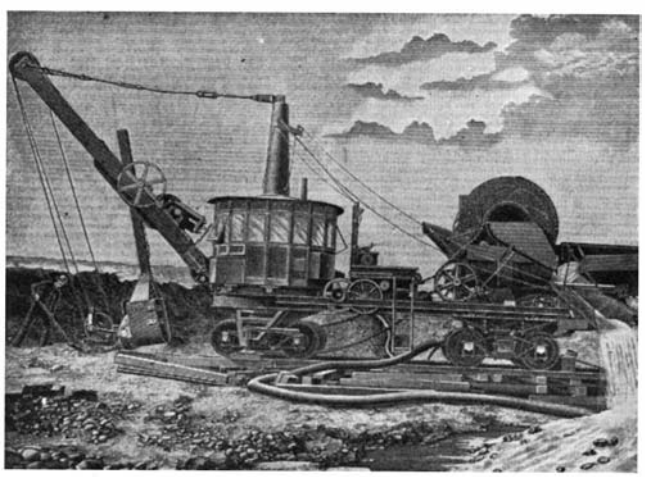
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of May, 1891)

NAVAL STRENGTH—"We have no navy worthy of the name, and nearly all our seaports are without proper defenses. . . This is a very humiliating position for a country like ours to be placed in. The indifference of Congressmen to the naval defense of the country is astounding. They waste their time over party squabbles, vote billions of money for schemes intended to help bring votes to their respective sides on election day; but as to the immediate creation of an enterprising, prompt and effective navy, which is of vast importance to the country, but little is done, and that little very slowly. . . There should be fifty ships where now there is one. Every harbor in the country should be guarded by efficient sentinels consisting of vessels of high speed, ready for instant action, to maintain and enforce the authority of the republic."

MECHANIZED MINING—"We illustrate a process that has been before the public for some time in California and Colorado, and which is now brought to a practical shape.



The work done by the machinery is of sufficient importance to attract the attention of placer miners, on account of the fine gold it saves, as well as the coarse, and for the new and advanced construction of the entire plant. This plant consists of the Bennett amalgamator, dredge, electric plant, and power house. . . The dredge is arranged to be propelled forward or backward on a screw, or on its own track, by its own power. . . Mounted on the dredge are four electric motors, one of which handles the dipper, another lifts it through its cut, a third swings the dipper to the hopper, while the fourth operates the amalgamator which is upon the rear of the platform. . . The ground upon which this plant has been operating has been variously estimated as paying from 7 to 10 cents per yard, but by the process we have described about 40 cents were extracted for each yard handled."

RAIL SAFETY—"When the railroads of this country had grown to such proportions that the trains had to be run under short headway, it was found essential to adopt some plan whereby the safety of travelers might be made to depend upon something better than the caution of the engineer, and out of that necessity was developed the block signal."

FILTER—"Sawdust and shavings, practically waste substances, are turned to account by M. Calmant, of Paris, for the production of a finely divided vegetable charcoal, which is intended to be applied as a filtering medium, especially in distilleries, where it is said to be capable of filtering forty times its volume of alcohol, whereas the vegetable charcoal of commerce, gradually becoming scarcer and dearer, will only filter about three times its volume. . . Carbonization, which lasts about an hour, is effected in fire clay, plumbago, or cast iron retorts, of about 600 cubic inches capacity."

HYDRAULIC POWER—"The Hartford, Conn., Electric Light Company has nearly completed a notable undertaking for utilizing water power. . . Under contract with the Farmington River Power Company, which owns the dam, about 300 feet long, across the Farmington River, nearly ten miles from the city, the Electric Light Company has erected a station with a full equipment of dynamos, etc. . . Six dynamos are now in operation, supplying 250 street lights. Four more are to be added, which will then generate enough electricity to supply the rest of the street lights."

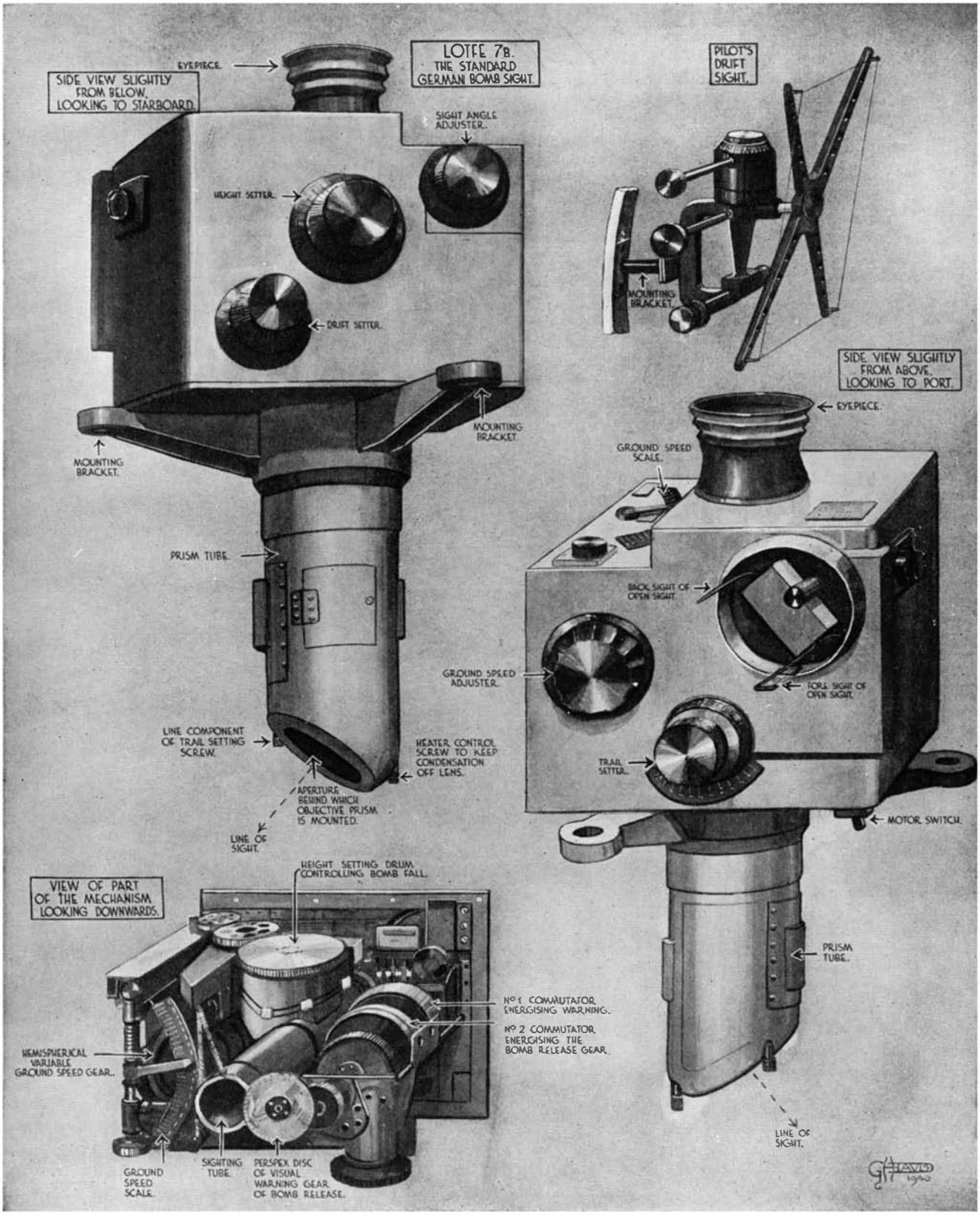
EXPLOSIVE—"In a recent lecture on gun cotton delivered by Prof. Munroe, of the Torpedo Station at Newport, the lecturer declared that gun cotton, correctly prepared and handled according to directions, was the safest of explosives to use. It was dangerous only when the materials had not been thoroughly purified, or the union of acid and cotton incomplete."

FLIGHT—"The annual meeting of the National Academy of Sciences began at Washington on the 21st of April in the National Museum. A number of interesting scientific papers were read. That of Professor S. P. Langley, of the Smithsonian Institution, on 'Flying Machines,' attracted the greatest attention. . . In summing up Professor Langley said that he did not say that man could traverse the air, but under certain conditions and with our existing means, so far as the power is concerned, the thing was possible. The difficulties would be in getting started, in coming down to the ground again, and in guiding one's self through the air. . . He thought all aerial navigation would pass out of the sphere of charlatanism and into the hands of engineers in a short time, possibly months instead of years."

TIN—"The first ingots of tin ever made in California lately arrived in San Francisco from the mines of the San Jacinto estate, Cajalco, San Bernardino County. . . Oil fuel is used in the furnace, this being much cheaper there than coal."

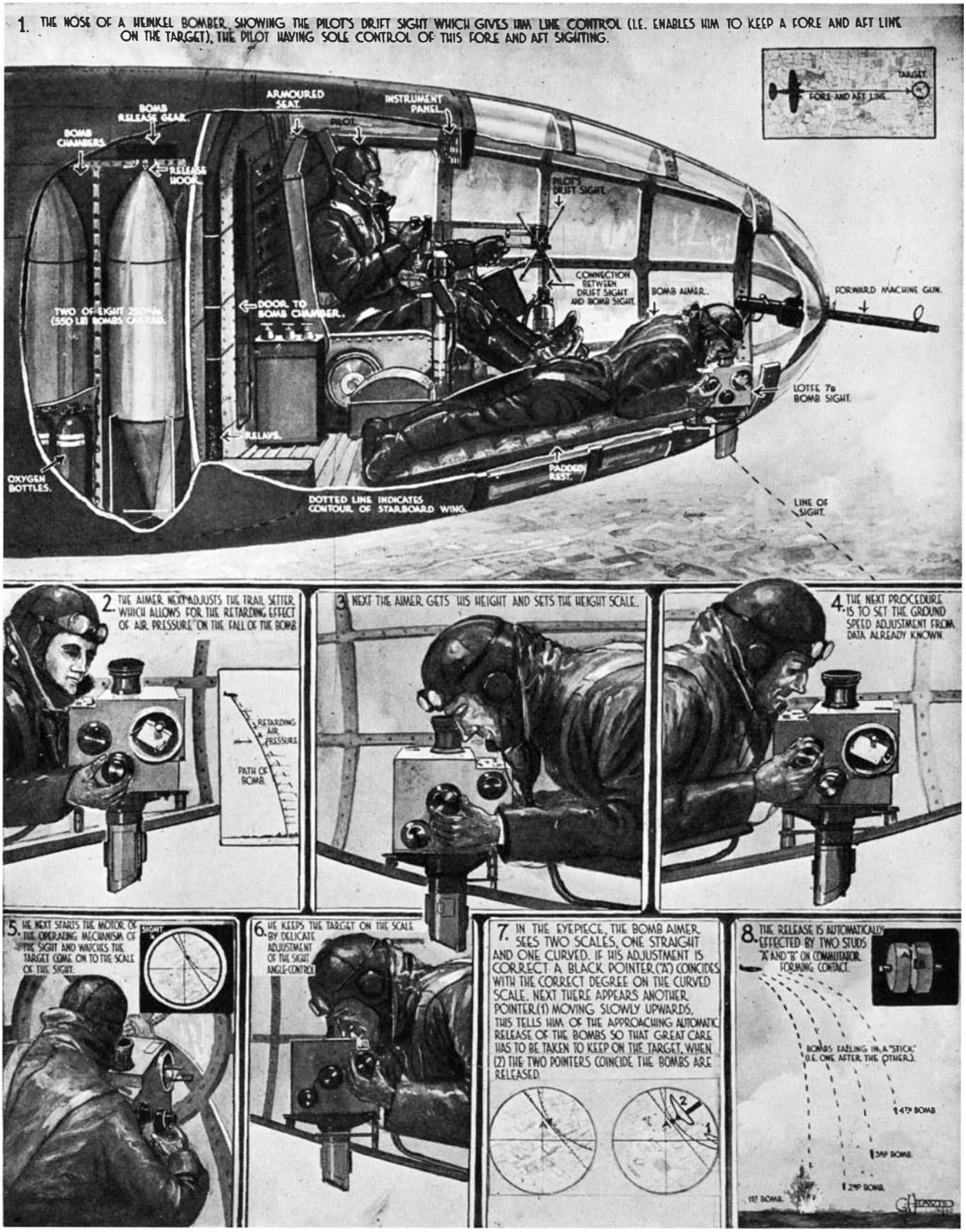
TELEPHONY—"The telephone line between London and Paris went into regular operation on April 2 with much success. The charge is $2 for a talk of three minutes. . . The distance is 297 miles, of which 23 miles are by cable laid under the British Channel."

EFFICIENCY—"Investigations of Langley and Very are of the greatest interest as showing that the attainment of an enormously higher efficiency in the production of artificial light is contrary to no law of nature, and may suggest a system of electric lighting destined to supersede the enormously wasteful methods at present in use."



DETAILS OF A GERMAN BOMB SIGHT

COMPLEX marvel of the modern bombing plane is the mechanical bomb sight which permits more or less accurate placement of bombs from high altitudes. Shrouded in secrecy are even the minor details of the bomb sights of most nations; from official sources, however, G. H. Davis, special artist of *The Illustrated London News,* has obtained data on the German Lofte 7B sight. From these data he prepared the drawings



(*Continued from preceding page*) reproduced on these pages, used here through the courtesy of the magazine mentioned. Most of the details are given in the illustrations. Communication between pilot and bombardier or aimer is provided by telephone or automatic controls. All the pilot has to do is to keep the plane on its course to the target. The rest of the work is done by the aimer, as shown by the picture sequence above. With this sight, the bombs are automatically released when, through the manipulations of the aimer, two pointers on the bomb-sight screen coincide. In one part of the drawing on the preceeding page is shown an open sight on the side of bomb-sight unit. This is for use when the aimer has difficulty in locating the target through the optical system, and is geared to operate parallel with the sighting prism.

OUR SEARCH FOR THE SUPERNATURAL—II

Did Queen Elizabeth's Spirit Appear?

A. D. RATHBONE, IV
Secretary Scientific American Committee for the Investigation of Psychic Phenomena

THE first of many applications to demonstrate spiritistic powers before the Scientific American Committee for the Investigation of Psychic Phenomena came as a result of the announcement of our search for the supernatural in the April 1941 issue. Rose Ann Ericson, an ordained minister of The Chapel of Eternal Star, and a medium with a large following, addressed Dunninger, Chairman of the Committee, as follows:

"Dear Sir:

"For years I have been aware of your offer to anyone who could demonstrate psychic phenomena, and although I have been reluctant to appear before your committee because I prefer to carry on my work privately among my numerous friends, nevertheless I feel compelled, because of the constant urgings of my friends, to accept your challenge and prove once and for all the absolute reliability of contact with the Spirit World.

"I am willing to appear before your Committee any time, providing the surroundings and atmosphere are satisfactory and in no way interfere with spiritual communications.

"Since a very young girl, I have been gifted with the power of sensitiveness which has been so instrumental in establishing contact with the great beyond. During my sittings it is absolutely imperative that everyone in the room should co-operate to maintain the utmost silence so as not to snap the invisible ray that connects my earthly self with the equally invisible ethereal bodies that send forth their messages to me.

"For some time I have had remarkable communications from Elizabeth, the last of the Tudors, and she is sorely vexed at us earthly inhabitants—and yet with it all—so sympathetic with our problems—she wants to aid us—she is so human in her understanding—she wants to contact the world through me and give them a message—for the sake of a bewildered humanity — she keeps urging me to speak her words. It is difficult to explain in this letter.

"But—I can and will produce definite proof of contact with the spirit of the great Queen—before any legitimate Committee of Truth Seekers—who wish to know and see for themselves manifestation of the Spirit of Queen Elizabeth Tudor. . . May I hear from you? (Signed) Rose Ann Ericson."

PSYCHIC RESEARCH

● **Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue.** ●

In view of Madame Ericson's reference to her contacts with the spirit of Queen Elizabeth, the Committee for the Investigation of Psychic Phenomena instituted a search for surroundings and atmosphere which would most favorably lend themselves to communication with spirits of the Elizabethan Era. It was learned that some years ago Mr. William Randolph Hearst had purchased and brought to the United States the wainscoting from "The Old House," previously known as "The King's Lodging," of Sandwich, England, the latter designation being derived from the fact that Henry VIII stayed there many times. The present interior embellishments, however, date from the Elizabethan era, the upper room, called "The Queen's Bedchamber," having been specifically prepared for Queen Elizabeth's visit in 1572.

The psychic possibilities of such a room, which, fully reconstructed, forms a part of the Hearst collection of objects of art now on display at Gimbel Brothers' New York store, were at once apparent to Dunninger, who called them to Madame Ericson's attention. Receiving her approval, arrangements were made through the courtesy of Dr. Armand Hammer, whose organization, The Hammer Galleries, has been entrusted with the sale of the Hearst collection. With the cooperation of Gimbel Brothers, a seance was arranged for the evening of Monday, March 17.

AS DUNNINGER, whose 20 years of research into the occult field have so ably prepared him for his present work, clearly stated on that night to the assembled representatives of the New York press and other periodicals, as well as to members of our Psychic Committee and their guests: "The seemingly impossible of today is the commonplace of tomorrow."

"All of us present," said Dunninger, "are seeking for knowledge, for something we hope to find in the future. There is here no brief against or for any religion or cult. It is a scientific effort toward a background of the psychic, toward a basis of fact on the part of a research committee which is not interested in trickery or subterfuge. What we do seek is the truth about psychic phenomena.

SCIENTIFIC AMERICAN Committee for The Investigation of Psychic Phenomena

A common interest in the subject of psychic research characterizes these men from wide fields of endeavor who have consented to act as an impartial committee to supervise and conduct our investigation of the spiritistic realm.

Dunninger, Chairman
Walter C. Alvarez, M. D., Mayo Clinic
Vincent Bendix, President, Bendix Aviation Corporation
Thornwell Jacobs, President, Oglethorpe University
Waldemar Kaempffert, Science Editor, New York Times
Daniel H. Kane, New York Bar
Joseph H. Kraus, Editor, Science Observer
M. Luckiesh, Director, Lighting Research Laboratory, General Electric Company
A. Paul Peck, Member, Universal Council for Psychic Research
A. D. Rathbone, IV, Secretary

"Do ghosts, spirits, vampires, or phantoms return to this world from another, of which we know nothing? In our effort to find basic facts, if any, underlying so-called spiritistic phenomena, mediums reputed to possess the kind of powers we desire to study can be of great assistance. Thinking people want this question answered once and for all. The public at large desires to know whether the entire psychic situation has a substantial foundation, or if it is merely a gigantic hoax.

"This medium, Madame Ericson," declared Dunninger, "has a wide-spread and excellent reputation. However, nothing has been done to hinder trickery, should it exist in the demonstrations to come. She has not been disrobed to determine whether she may have concealed on her person mechanical means for producing occult effects. What will happen in the seance that is to follow," he concluded, "no one knows."

Before the lights were extinguished, Madame Ericson requested complete quiet and asked that guests refrain from smoking. She stated that she could guarantee nothing, but that she intended to try to communicate with the spirit of "Good Queen Bess." With that the lights went out, and doubtless all present felt that if only the ancient wainscoting from old England could talk, through the spirit of Queen Elizabeth, or even some of her contemporaries such as Henry Hudson, or Sir Francis Drake, Ben Jonson, or William Shakespeare, it would be, to say the least, an amazing display of psychic powers.

After the guests had sat in complete darkness for several moments, with accompanying phonographic music, there came an indistinguishable muttering, presumably from Madame Ericson. Next, the medium's voice was heard, strained and unnatural. She said, "Keep your eye on Russia," and with that some witnesses later claimed they heard rappings from the table at which were seated Madame Ericson, Dunninger, and A. Paul Peck, who is a member of the Universal Council for Psychic Research, as well as a member of the Scientific American Committee. [Throughout the entire demonstration Messrs. Dunninger and Peck each held one of Madame Ericson's hands.—*Ed.*]

Then the medium said: "Many there are today who doubt, but I have every reason to believe that my country will be saved and that Hitler will be demolished." [Presumably the spirit of Queen Elizabeth voicing its opinions, although there was no specific mention of any spirit up to this moment—*Ed.*] "A peak is reached between April and May," continued the voice of Madame Ericson, "and the war is not over. No, this war is not over. There will be a period of five years of turmoil from ocean to ocean, with brother against brother, country against country."

AT THIS juncture the medium, still conversing in a strained, unnatural voice, stated that a figure was materializing before her, and asked whether any in the audience could see the apparition. A woman, identified later as a member of the medium's belief, replied in broken English that she could see the spirit.

Dunninger, alert to seance developments, asked the woman to describe what she saw. The reply was that the spirit, as seen by the member of the Chapel of Eternal Star, stood in front of the medium's table; that it was a feminine figure, about five feet, eight or nine inches, tall; that it wore a gray dress, but no hat. In response to Dunninger's

These two flashlight pictures, taken, as were others, at the exact moments designated by the medium, fail to indicate materialization of spiritistic presences of either Queen Elizabeth or the Earl of Essex

question as to the color of the hair, the witness said she could discern no color. By way of further description of what she said she saw, this woman claimed that the spirit had rather high cheek bones and deep-set brown eyes. Madame Ericson added that she thought the spirit was greatly worried and looked extremely tired. In a low voice she then said to Dunninger: "Tell them to take pictures." Immediately two flash bulbs were set off with dazzling brilliance.

Climaxing this performance, Madame Ericson next said she could see the spirit of a man, that he was tall and handsome, dressed in Elizabethan style—that he was no less a person than Robert Devereux, second Earl of Essex, an in-and-out court favorite of England's Virgin Queen.

AT THIS point Madame Ericson's voice seemed to be pitched slightly higher. Her words, although scarcely audible, came with a more rapid tempo. Suddenly rappings were distinctly heard by some at the front of the room and Dunninger exclaimed: "There are rappings coming from the table! Some of you probably cannot hear them, but they are audible. Peck," he continued, "do you feel a vibration?"

The answer was affirmative, and in view of the fact that Messrs. Dunninger and Peck were still each holding one of the medium's hands, it is obvious that the rappings could not have been produced through physical contact of her hands with the table.

Just then Dunninger spoke, rather sharply. "There is a substance visible at her lips. Can anybody see it? I think it is indicative of an ectoplasmic demonstration. Yes, it is! It is ectoplasm! Can you see it?"

Shortly after ectoplasmic demonstration, medium collapsed

Flashlight photograph, with camera and all eyes focused at point near table where Madame Ericson claimed spirit of Queen Elizabeth appeared

A momentary pause in absolute quiet followed this announcement as it was apparent that all eyes were straining through the darkness for a glimpse of the psychic phenomenon known as ectoplasm. And then, dramatically, the seance ended. Dunninger cried out, "Here, what's the matter with her? The lights, somebody, the lights!" Instantly a photographer's flash bulb was set off, followed by the turning on of large dome lights in the ceiling.

As the audience blinked in the sudden glare, it was seen that Madame Ericson had fallen forward onto the table. Dunninger and others sprang to her assistance, straightened her in her chair. Her head slumped back and her eyes were closed. Water was called for and she was revived, but she still appeared in a trance-like state.

A canvass of those present indicated that several, including Dunninger, had seen evidence of an ectoplasmic demonstration, but that only two persons, both members of The Chapel of Eternal Star, had seen the manifestations of the spirits which, according to Madame Ericson, had been those of Queen Elizabeth and Essex.

At an immediate conference of the members of the Scientific American Committee for the Investigation of Psychic Phenomena who were present it was determined that the request of Madame Ericson for another sitting would be granted.

At the conclusion of the evening's seance, Dunninger said: "The emission of ectoplasm from the medium's lips was very slight, but it was distinctly visible for a few seconds just before one of Madame Ericson's followers wiped it away with her handkerchief. It is not surprising that the ectoplasm was not discernible by most of you, as it was a demonstration of exceedingly minor character, and for that reason could hardly be said to be visible to the average naked eye."

"As in the case of the spirits of Queen Elizabeth and Essex, which I did not see," continued Dunninger, "and which were discernible by only two of those present, I trust the pictures, taken at the suggestion of the medium, will show us what our visual senses could not detect. In summation of the evening's demonstration," he said, "I would say there was nothing visible to the naked eye which requires explanation. Everything will depend on the pictures, and we can only hope that the photographers have been fortunate enough to secure some unmistakable evidence of either the ectoplasm or the spirits." [Subsequent development of the negatives exposed during the seance failed to produce any photographic evidence of psychic phenomena, although, as will readily be seen from facial expressions, the timing of the pictures with the reported appearance of the phenomena must have been as accurate as possible.—*Ed.*]

What Light For Industry?

Relative Freedom from Heat and Glare, Plus Color Control, In Fluorescent Tubes

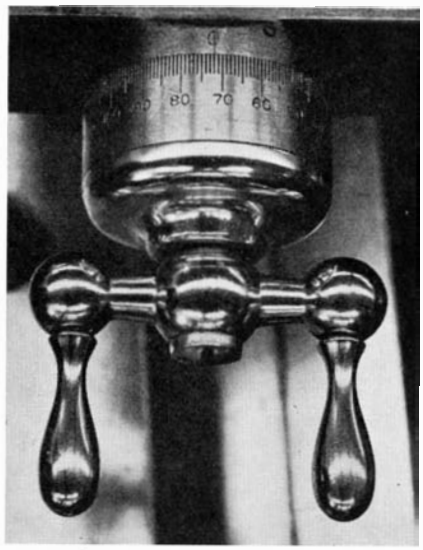
A. P. PECK

IF, WHEN fluorescent lighting emerged from the laboratory four years ago, there was any suspicion that here was just another stunt which would never become practical, that suspicion has completely vanished by now. Industrial applications of these tubular lamps without filaments have increased to such an extent that, it is estimated, 25,000,000 of them will be manufactured during 1941, approximately three times as many as were made during 1940. In the face of these figures it is easy to visualize this particular part of the lighting industry as one of the nation's fastest growing industrial infants.

Fluorescent lighting offers many desirable qualities that recommend it especially to application in factories, offices, stores, and so on. Its efficiency is high, it is relatively cool as compared to incandescent lighting, there is little glare, after-images are absent even when the worker has to look directly at the light source for a considerable period of time, and, by the selection of the proper tubes, lighting with a wide variety of colors may be obtained directly without the use of filters or other supplementary means of color modification. Of these qualities more later; first, let's see just what fluorescent lighting is and how it works.

In the fluorescent tube, advantage is taken of the phenomenon of an electrical discharge through gas. This principle is by no means new and has been widely used in other lighting applications, of which neon and mercury-vapor tubes are probably the best known examples. But in the fluorescent tube the discharge itself does not give rise directly to visible light; in fact, every effort has been made to reduce visible light of the discharge to a minimum and to bring to a maximum ultra-violet generation at one specific point in the spectrum—at the 2537 angstrom line, to be exact. The reason for this is that ultra-violet radiation of this wavelength is the most efficient for obtaining the end result of fluorescent lighting.

Within the tube of a fluorescent lighting unit is a drop of mercury and a small amount of argon gas to facilitate starting. Coating the interior wall of the tube is a material—phosphor is the general term applied to these coating materials—which has the property of glowing when acted upon by ultra-violet, thus giving forth visible light of a color that is determined by the particular phosphor used. Behind this process is a highly complicated physical explanation that can briefly be reduced to the following statement: The phosphors used have the property of absorbing radiated energy at one wavelength and of reradiating energy in a continuous band of visible wavelengths. Thus the ultra-violet of wavelength 2537 is absorbed by the phosphor and the resulting reradiation is in the visible part of the spectrum, giving useful light at a relatively high efficiency and with little heat.



Large area of fluorescent light sources reduces glare on scales

As was mentioned above, there is a small amount of mercury within each fluorescent tube. This metal was selected because an electrical discharge through mercury vapor results in high-efficiency production of ultra-violet radiation in the region best suited to activation of the phosphors.

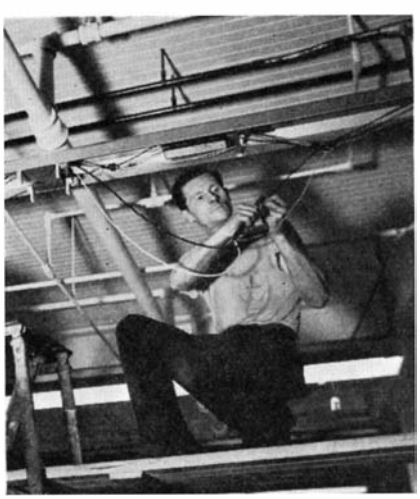
One of the difficulties of fluorescent lighting is the fact that the tubes will not start when cold; it is not sufficient to apply current to the two terminals as in the case of incandescent lamps. Something more is needed to create the elec-

Fluorescent tubes in angular reflectors illuminate a drafting room

trical discharge that results in light. In each end of the tube, therefore, there is placed a heating electrode; externally is an automatic starting switch. The circuit is so arranged that when the current is turned on, it flows through the two electrodes in series, generating heat that vaporizes the mercury, thus providing a path for the electrical discharge through the tube. When this condition is reached, the starting switch automatically disconnects the current from the heaters, but permits it to continue its path through the gas. Included in the circuit is a choke coil which limits the arc or discharge curent.

ONE type of starting switch, made by Mazda lamp manufacturers, uses a bimetallic strip in the following manner: When the current is turned on a glow discharge is set up between the bimetallic strip and a center electrode in the starting switch. This discharge creates heat that causes the strip to expand and make contact with the center electrode, thus completing the circuit through the heating electrodes of the fluorescent tube. When this contact is made, the glow discharge ceases and the bimetallic strip contracts and breaks the circuit in the starting switch. An inductive kick from the choke now starts the discharge through the fluorescent tube. From this point on in the cycle the voltage at the starting switch is insufficient to set up the glow discharge and hence the switch is inactive and consumes no current during lamp operation.

Now to get back to the qualities of fluorescent lighting mentioned in the second paragraph of this article:



Installing industrial lighting fixtures for fluorescent tubes

Overhead fluorescent lighting, plus individual units on assembly benches

It is easy enough to make statements regarding efficiency, as compared with more conventional lighting, and let it go at that. For example, it can be said that a daylight fluorescent in the 40-watt, 48-inch size, is almost three times as efficient as the familiar 60-watt filament lamp, or that the white fluorescent is of even higher efficiency. But that is not the whole story. When it comes to replacing existing lighting installations with fluorescent lamps, there enter such considerations as amount of rewiring, quantity and color of light required for the job in hand, and other factors of economy that complicate the problem. Even though there has been a drastic reduction in retail prices of fluorescent tubes since their introduction, first cost of installation still plays an important part.

The following statements by a Westinghouse lighting engineer give a hint to the problems involved. "The general lighting of factory areas can usually be done most economically by means of filament lamps or mercury vapor lamps. This is particularly true for high mounting. Where machines or assembly lines are in long parallel rows, the fluorescent white or daylight lamps may be applied successfully. . . . Single units mounted over inspection tables are particularly good for inspecting metal parts. The large diffuse source facilitates the detection of imperfections and makes the reading of gages more precise. . . . The same unit may be used over drafting tables with excellent results. Freedom from shadows, absence of unpleasant radiated heat and light of daylight quality combine to make this type of lighting increasingly popular."

It will readily be seen, therefore, that any attempt to generalize regarding the efficiency of fluorescent lighting for a particular application, or its desirability in a wide range of industrial uses, might result in misunderstandings. Only when all factors are considered and weighed in their proper proportions can definite recommendations be made.*

OPERATING temperatures of light sources are of interest in two main respects. First, where temperature of the source is high, it is evident that much of the energy being consumed is appearing as heat rather than light. This phase, of course, bears on the subject of efficiency just discussed. If the temperature of a light source is low in relation to the light delivered, it is evident that efficiency is high. High temperature, in turn, indicates low efficiency. Everyone is

*Readers who desire more detailed data on the applications of fluorescent lighting in industry will be referred to comprehensive sources if they will address the writer at 24 West 40th Street, New York, N. Y.

Fluorescent lighting fixture for inspection of metal strip. Inspector sees both sides of strip by use of the mirror shown

familiar in a general way with the high temperature quickly reached by an ordinary incandescent light bulb, if for no other reason than the memory of trying to remove one from its socket immediately after it burned out! On the other hand, when a fluorescent tube is operating at a room temperature of from 70 to 80 degrees, the glass tube itself will reach a temperature of only 100 to 120 degrees—relative coolness for a light source.

THE second point of interest in light-temperature ratio is the effect that high-temperature light sources have on surrounding objects. Persons whose work demands that they be close to a bright light source may be forced to work under uncomfortable conditions when incandescent lighting is employed. In such cases, fluorescent lighting can have very definite advantages. Even where the source is not close to the work, but is of high intensity, the heating effect of incandescent lighting on the whole room can be marked, especially in warm weather. The generally accepted figure of comparison between fluorescent and incandescent lighting is that the sensation of heat from fluorescent lamps is, roughly, only one quarter that from filament lamps for the same amount of light delivered.

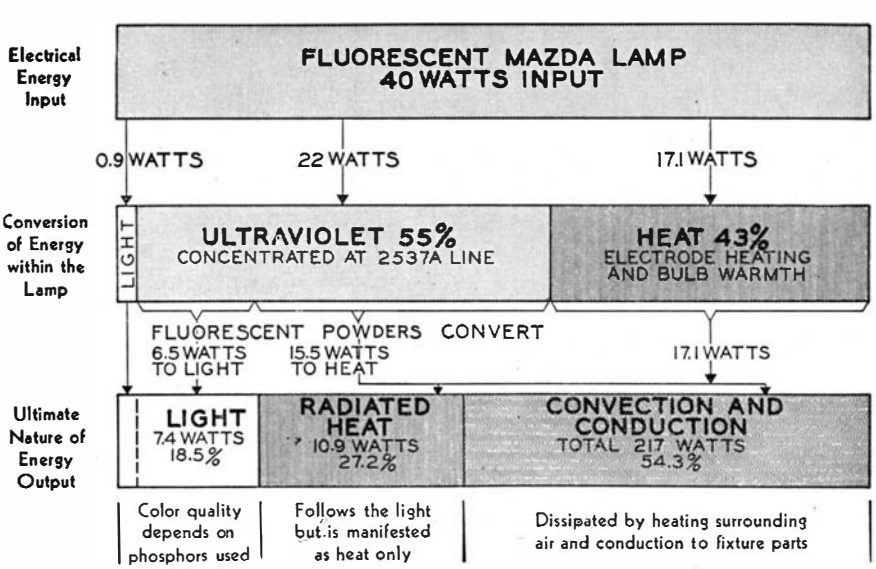
This last statement is based on the following facts: While a kilowatt-hour of electrical energy represents a heating effect of 3414 BTU's, regardless of how consumed, the lesser sensation of heat from fluorescent lamps is accounted for by the fact that only about 50 percent of the energy is radiated as heat, compared to 80 to 90 percent for gas-filled filament lamps. Because light production efficiency of a fluorescent lamp is double to triple that of filament lamps, and because the radiant heat is approximately half that of a filament lamp, the rough figure of one quarter the sensation of heat, given above, is reached.

While dealing with the temperature characteristics of fluorescent lamps, it is interesting to note that the temperature of the surrounding air has an effect on the operation of the lamp itself. At low temperatures the mercury condenses out and the production of ultra-violet is reduced. At high temperatures, the vapor pressure within the tube is increased and some of the ultra-violet radiation is shifted to longer and less desirable wavelengths. There is also an increased re-absorption of the ultra-violet radiation at 2537 by the mercury vapor. In the case of low temperatures, the effects can be offset to a great extent by enclosing the lamps; at high temperatures, air movement may help to compensate.

Undesirable glare may be produced under either natural or artificial light when direct or reflected light from the source reaches the eye without sufficient diffusion. Glare has been defined, by a General Electric lighting expert, as "light out of place." It causes the pupil of the eye to contract, thus restricting the amount of useful light that enters the eye. It gives rise to nervous tension and fatigue and thus, especially in the industrial plant, paves the way for reduced efficiency and for accidents.

When light comes to the work from a concentrated source, as in incandescent lighting, the possibilities of glare are manifold, resulting in a number of expediencies in the form of light diffusing means to reduce glare. In the fluorescent lamp, on the other hand, the light source is of large area and relatively low intensity. Hence there is less possibility of glare, although even here it is usual to incorporate some shielding means in the lighting fixture. It is notable, however, that little or no "after-image" effect is found even when the eyes are exposed to the direct light from a fluorescent tube. This is of particular advantage in industrial plants where workers have to change their angle of vision constantly and cannot always avoid looking directly toward the light source for a few seconds at a time. Airplane assembly is a case in point; workers on the final assembly job may be bent over some part of the operation one minute and working on an over-head unit immediately after. The diffused light of fluorescent tubes is of particular importance in such instances.

THE wide range of colors available in fluorescent tubes—the color is a property of the phosphor and is not due to colored glass—gives these tubes a multitude of uses from severely practical to highly ornamental. Colors that can now be obtained include "daylight," white, blue, green, pink, gold, and red. (The last two do use colored glass to increase the saturation of the resultant light.) The daylight and white types find the greatest application in industrial lighting, although the other colors have their



Courtesy General Electric Company

Conversion of energy in a fluorescent tube

own usefulness for special purposes.

Brief descriptions of two outstanding industrial applications of fluorescent lighting will serve to indicate present applications and future possibilities. A paint company in Ohio is making use of these light sources in their color matching room where samples of lacquers and enamels are checked against standards. The installation consists of 24 of the 36-inch tubes and 12 of the 18-inch tubes. The lamps are backed by Alcoa sheeting, used primarily because of its non-selective reflecting properties. The lamps are in three circuits, each circuit providing approximately 175-footcandles on the samples, making possible a maximum of about 500-footcandles. The lowest light level—175 footcandles—is used for matching whites and other colors of high-reflection factor. The second level is used for colors of medium-reflection factor, and the high level of 500 footcandles for blacks and other low-reflection colors. This type of installation is well adapted to other inspection problems with materials which exhibit a surface sheen that interferes with ordinary visual inspection. It also holds possibilities for production inspection on conveyor belts.

Underway now is the installation of 35,000 of the 48-inch, 40-watt tubes in an airplane plant in California. These lamps, mounted in open-end fixtures arranged in parallel rows 40 feet above the floor, will provide workers with an average light level at their work of 45 footcandles. This level is stated to be more than four times that on desks in the average office today.

Recitation of applications of fluorescent lighting, installed and underway, could go on for pages and would include examples from almost every field of endeavor. From cotton mill to drafting room, from machine shop to printing plant, would go the list, indicating that fluorescent lighting is finding its place in the American way of doing things. That it is the last word in lighting, or that it will completely replace other forms are statements that should not lightly be made. There is no doubt that better, more efficient lighting systems will come out of the laboratories in the future, and that each of them will have advantages and disadvantages. In the meantime, however, fluorescent lighting will progress, side by side with other forms of lighting, doing its part to give to industry the better lighting that it must have if it is to function at highest efficiency.

High pressure is used in this hydraulic press in which the damp clay mixture is formed into high-strength non-porous insulators for a wide range of applications in electrical work

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New Porcelain Insulation

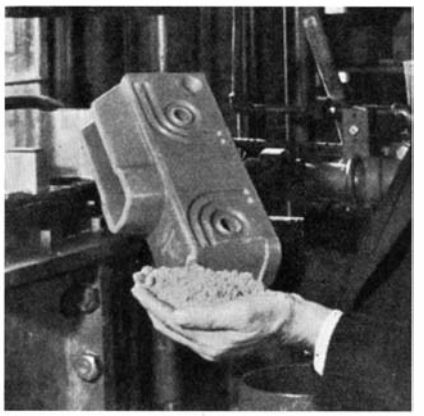
High Mechanical Strength and Electrical Resistance in Die-Pressed Material

H. T. RUTLEDGE

NEW and better insulators are of prime importance to the electrical industry. No electrical instrument or installation can be better than the insulating materials used at strategic points to keep the current flowing in the proper channels and from wandering off the straight and narrow path. Not only must these materials have high electrical resistance; they must also be mechanically strong to prevent undue breakage when subjected to sudden stresses. And as better insulating materials are developed, the way is opened to increase efficiency of electrical work.

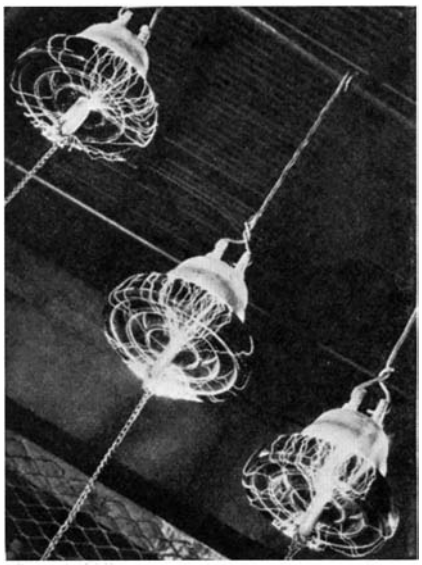
Pouring the dampened Prestite mixture into the forming die

Porcelain is one of the materials that has been widely used in high-voltage insulators, its value being dependent upon its lack of porosity and the mechanical strength that could be made inherent in its structure. Highly porous porcelain has poor insulating qualities; the less porous the porcelain can be made, the better it will do its job. Incidentally, it is usually found that hand in hand with decreasing porosity goes increased mechanical strength.



A handful of clay used in making the new electrical insulating material, as described on this page, and a formed fuse box

Both dry and wet methods of making porcelain have been employed in the past for making high-voltage insulators. In the former, dry clay is molded into the required shape and then glazed and fired.



A flashover test of Prestite insulators, in which is applied seven times the potential for which they are designed

In wet methods, the clay, containing as high as 31 percent of moisture, is either cast or pressed to shape and then finished.

In a new porcelain process, the clay to be processed is moist, being neither wet nor dry. In this state it is molded in steel dies under tremendous pressure. Because of the method of handling, this new porcelain, called Prestite, can be molded into shapes as intricate as are possible with dry molding, but the resulting material shows mechanical and electrical strengths that heretofore were impossible of attainment. Finished Prestite insulators, according to E. H. Fischer, Westinghouse engineer who developed the process, are non-porous and consequently erect a strong barrier against the flow of electricity. Because of this increased insulating property, the new material can be made thinner to perform insulation work that formerly required much larger and thicker porcelain insulators.

With the new process it is possible to turn out one Prestite insulator every three minutes as compared with two or three a day per mold in the old wet casting system. The Prestite body mixture is simply poured into a die and molded by a hydraulic press. Drying takes 20 percent less time than with cast or plastic porcelain, and the shaped Prestite form requires a minimum of trimming before being glazed and fired.

For the present this new porcelain will be manufactured only as insulating parts for high-voltage equipment such as fuse boxes, switch bases, lightning arrester caps, and suspension insulators. It is expected that the field will later be extended to cover all high-voltage insulators within its scope.

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INSPECTION

Gamma Rays Pierce Steel, Show Defects

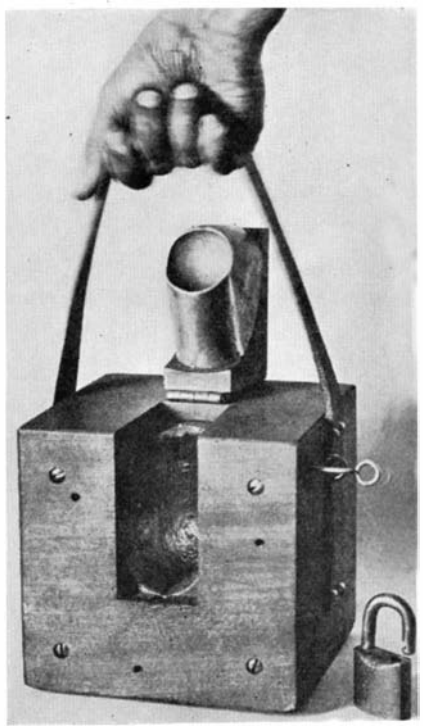
PIN-POINT "power plants," minute grains of radium sulfate, are at work inspecting national defense equipment as it is rushed through production in the Westinghouse Steam Division Works. The mites of radium salt produce gamma rays potent enough to penetrate 10 inches of steel, registering the metal's internal condition on film. Radium sulfate is used to examine parts of steam turbines, propulsion gears, and auxiliary apparatus for United States Navy fighting ships. The inspection process, worked out by Navy engineers and research scientists, also is being applied to commercial power equipment.

As a step in speeding up national defense work, 500 milligrams of radium sulfate have just been acquired. This brings the supply at the plant to 825 milligrams, a strange tool of science about half the size of a boy's small marble. A pound of radium sulfate would cost about $11,500,000, would be about the size of a tennis ball.

In radium sulfate, the atoms split spontaneously. This perpetual disintegration generates gamma rays which can pierce the hardest steel. Flaws in the metal appear on the film as dark areas. The rays are able to reach the film with greater intensity during an exposure period through flaws than through solid metallic structure.

Gamma rays revealed flaw areas; welding fuses in the new metal

Air bubbles and impurities in metal parts of steam and ship propulsion equipment are ferreted out to prevent later development of any weakness. Turbine steel must withstand steam temperatures up to 1000 degrees, Fahrenheit, hot enough to melt zinc. The steam hurtles through the machines at pressures as high as 1500 pounds per square inch. The steel structure of a turbine steam chest resists expanding forces which are equivalent to the weight of the largest railroad locomotive.



Lead-lined container used for transporting radium sulfate; direct handling is dangerous

When a piece of equipment is brought into the laboratory for inspection, a technician fishes a radium capsule out of a sunken safe. The walls and bottom of the safe are four-inch slabs of lead. Inside it is a block of lead with small wells to hold the radium sulfate containers. A lead lid locks into place over the safe.

The capsules are suspended on a midget rigging placed within or beside the metal being tested. As many as 20 films have been taken in the Westinghouse laboratories at the same time. A belt of film can be placed around circular pieces of metal, such as pipe. These films

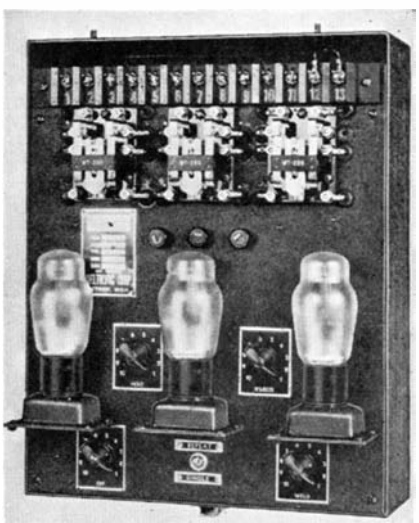
register gamma rays from a single radium sulfate source fixed in the center.

Exposure times vary from a few minutes to 48 hours. Time of the exposure is gaged by using a special slide rule, developed for the purpose by Navy engineers.

TIMER

Eliminates Pressure Switch in Spot Welding

DESIGNED to eliminate the necessity of an air or hydraulic pressure switch in resistance welding and to provide accurate timing control for any air-operated stationary or portable single or multi-spot welder, a new electronic tube type



Four dials adjust "squeeze" "weld," "hold," "off" times

timer has been added to the line of timers and controllers manufactured by Weltronic Corporation.

Featuring a minimum of moving parts as well as eliminating the need of a pressure switch, the Model 75 insures a minimum of maintenance costs with down time being virtually eliminated, it is claimed.

Using a repeating timer to eliminate the need of a pressure switch requires one additional timing function. The four adjustments required are: "Squeeze" time, "weld" time, "hold" time, and "off" time. The "squeeze" time is the interval between the instant the initial welding pressure is applied and the welding current is "on," which allows sufficient time to permit the full welding pressure to build up before welding current is applied. Thus, the timer will compensate for the effects of lowered room temperatures or extreme distance from pressure switch to welder and should insure uniform performance and better quality welds.

The four adjustments are made by "dialing" the control knobs on the front of the panel. The wide range of optional time selection from 2 to 30 cycles in close steps is sufficient to provide accurate timing for almost any stationary or portable, single or multiple spot welding operation where air or hydraulic pressure is used. Single weld or automatic repeat operation is optional to suit the work. A toggle switch on the front of the panel permits rapid change-over as required.

Timer is mounted complete in a compact cabinet to facilitate moving with a portable unit, or built into a stationary welding machine as needed.

INDUSTRIAL FILM

New Form of Synthetic Has Many Uses

THE DEVELOPMENT of a method of processing Koroseal, a synthetic thermoplastic material, into a transparent and highly durable film with wide industrial application, is announced by the B. F. Goodrich Co. The film development is the seventh major product field invaded by Koroseal, the synthetic created from limestone, coke, and salt, according to Dr. H. E. Fritz.

"Quite unlike other films," Dr. Fritz said, "Koroseal film is resistant to outside exposure—sun, oxygen, and extremes and changes of temperature. In addition, the new film is extremely water and moisture-resistant, our tests have shown."

Glass-clear and highly flexible, the film is now being produced in

Of limestone, coke, salt, water

gages ranging from one-thousandth of an inch and up. It is made in a variety of colors in transparent, semi-transparent, translucent, and opaque forms.

While the chief uses of the film are in waterproofing and packaging materials, its chemical inertness, flame resistance, and electrical properties make it valuable for laminating chemical containers for holding acids and corrosives and for insulating fine electric wire and cable. Other more obvious adaptations are rain-wear garments of all kinds, shower curtains, window draperies, aprons, refrigerator bags and food coverings and other applications where flexibility and moisture-resistance are desired.

TOOL ROOM LATHE

Has Telescopic Taper Attachment

A NEW tool room lathe announced by the South Bend Lathe Works has a number of features which save time on tool room operations. This 16-inch swing underneath belt motor driven precision lathe, Series S, is made in 6, 7, and 8-foot bed lengths, having distances between centers of 34, 46, and 58 inches. The headstock has a capacity of 1⅜

New control arrangements save time and effort; reduce fatigue

inches through the spindle and takes collets up to one inch capacity.

The arrangement of controls on this new lathe saves time and effort, reducing operator fatigue and assuring maximum production. Large diameter hand wheels make possible precision adjustments on close tolerance work. Adjustable micrometer collars on the cross feed screw and the compound rest

screw are large in diameter with clear-cut, easy to read graduations.

Tool room attachments supplied with the lathe include hand-wheel type draw-in collet chuck, telescopic taper attachment, micrometer carriage stop, thread dial indicator, and chip pan. An electric grinding attachment, milling attachment, and other attachments, chucks, and accessories are supplied to order.

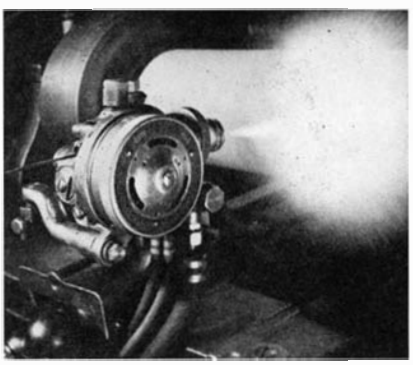
The enclosed underneath motor drive provides eight spindle speeds ranging from 21 to 725 revolutions per minute. Vibration-free operation at high spindle speeds is achieved by using a direct belt drive to the balanced cone pulley and spindle assembly.

A quick change gear mechanism provides a series of 48 power longitudinal carriage feeds .0015 to .0841 of an inch, a series of 48 power cross feeds .0006 to .0312 of an inch, and a series of 48 right and left hand screw threads from 4 to 224 per inch.

METALLIZING

New Type Gun has Controlled Feed

THE process of metallizing, in which metal wire is melted and then atomized and sprayed on any base metal, is finding increasingly wide uses in various industries. It has been applied to the restoring of worn machine parts, such as bearing surfaces, shafts, pump



Controlled feed for uniformity

rods, and so on; to repairing defects in castings; and for the application of corrosion resistant coatings of zinc, lead, tin, and other metals. Aluminum coatings so applied have proved successful in retarding heat corrosion or oxidation on engine exhaust manifolds, furnace parts, and similar equipment.

In the new type of gun illustrated in these columns, the design has been so worked out as to give uniform and steady wire feed regardless of fluctuating conditions that affect the operation of other guns. In previous guns the wire feed has been controlled by regulating the flow of air to the air turbine which provides the power for feeding the wire. This has the disadvantage of considerable speed fluctuations under varying load, requiring constant regulation by the operator. In the new type of gun, with its "controlled power unit," the speed of the wire is regulated by means of a governor which allows full power input at all times and eliminates speed fluctuations under varying loads.

OVERLOAD DEVICE

Flexible Bearing Acts in Novel Manner

POSSIBILITY of the use of a flexible bearing as a low-cost overload device for various types of power-driven equipment subject to only occasional overload of short duration is suggested by the operating characteristics of the "Torflex" flexible bearing.

In its capacity as a flexible coupling capable of compensating for parallel or angular misalignment, the bearing itself would transmit power and so serve as overload device at the same time.

Although originally designed and used as a vibration dampener, shock absorber, and noise eliminator, capacity tests made in the laboratories of Harris Products Company show that, when the bearing is greatly overloaded, the mechanical bond between the rubber wall and the inner sleeve will slip intermittently. This slippage is momentary, however, and immediately the overload is reduced, the rubber wall resumes its grip on the inner metal tube with its original load capacity. Under overload conditions the rubber (or neoprene) wall is twisted. The twisting or "winding up" of the rubber has the effect of contracting the thickness of the rubber, thus permitting slip to occur.

Due to the method of manufacture, there is a mechanical rather than a chemical bond between the rubber and the inner or outer metal walls. In the process of manufacture, rubber is stretched between the inner and outer walls and then permitted to seek its original position or state. The forces exerted by the rubber in so doing exert a high capacity mechanical bond which is present under all operating conditions found in normal service, except elevated temperatures.

Use of the bearing as a clutch is not recommended since the heat generated by more constant slip

The type of flexible rubber-and-metal bearing that can be used as a temporary overload device

would not only destroy the holding force exerted by the rubber but the rubber itself.

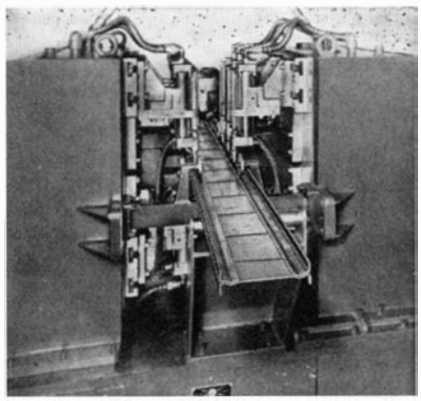
Neoprene can be substituted instead of rubber where required and, if corrosive conditions dictate, stainless steel for inner and outer sleeves or brass or graphited bronze sleeves are also combinations that are available in standard sizes.

WELDING SPEEDS UP

Multiple Spot Machines Increase Production

MADE necessary by the defense housing program and having a combined production total of 2400 lineal feet of Stran-Steel members per hour under present operating methods, two new multiple-spot welding machines designed and built by Progressive Welder Company were recently placed in operation at the Jackson plant of the Stran-Steel Corporation.

The new equipment, which is sufficiently flexible to handle numerous combinations of sizes, shapes, and so on, places the fabri-



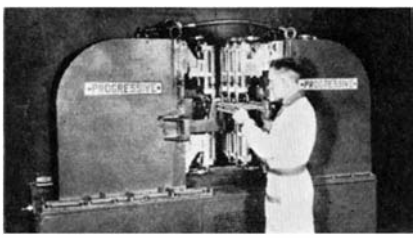
Multiple spot-welding machine speeds mass-production efforts

cation of such material on a mass-production basis.

Previously riveted and later spot welded by means of a single spot machine, the entire line of Stran-Steel joists, studs, half-studs, and narrow studs of light-gage copper bearing steel is first formed into angles or channels and then so joined as to provide a nailing space along the entire length of each member. The projection formed by bubbles stamped at regular intervals along one half of the completed section provides this nailing space.

Two identical machines are used, each employing twelve vertically opposed sliding contact guns and six welding transformers (one for each spot weld made). An air-hydraulic booster with a large reservoir and high pressure capacity is actuated by air to supply sufficient hydraulic pressure for the simultaneous operation of the 12 guns.

To accommodate various widths, provision is made for adjustment as to distance between guns on each side. Guns may be moved also for



Opposite end of multiple welder

the proper spacing between spots longitudinally. This, together with the provision made for cutting out the guns on either side (permitting the machine to be used for welding half stud members) makes each machine capable of welding any of the sections.

Since the varying gages of metal require different welding pressure, time, and current, provision for adjustment of each is made.

Assembly of the sections preparatory to welding is done by the welder's helper who places the angles (in the case of joists) in position and clamps them. The clamped assembly, usually measuring some 30 feet in length, is then started through the welding machine. The section is pushed through until the first bubble on each side of the section is in position at the first welding gun station, a weld is made, and the "C" clamps removed.

The three bubbles on each side of the section are then positioned for welding by the three sets of guns. The operator closes the pilot and the 12 guns come together on the work making the six welds (three on each side of the section) simultaneously. This is repeated until the entire section has been welded. The section is then cut to required length.

BURRS

Blast Cleaning Machine Speeds Production

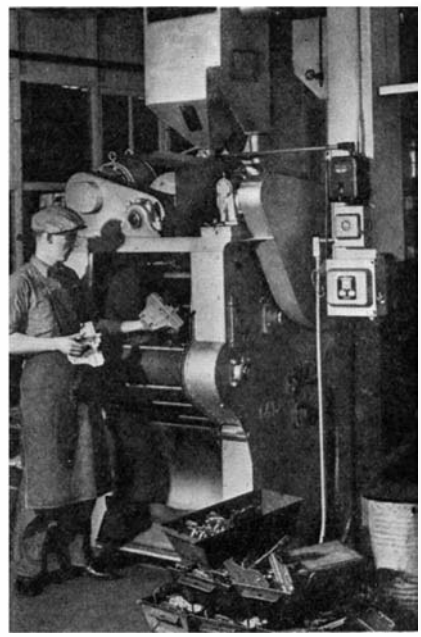
REMOVING burrs from machined parts can often be a most vexing and expensive problem. Usually it is entirely a manual operation, consisting of hand grinding, filing, or scraping. In one plant producing small parts on automatic screw machines, for example, the problem of removing burrs was of such consequence that the entire production schedule was thrown off balance.

Someone suggested that the burrs might be removed by blasting with a fine metallic grit in the Wheelabrator Tumblast, an airless blast cleaning machine, which they were operating in another department. They tried the idea and were surprised to find that the machine did a fine job after a short blasting, without injuring the machined part itself.

Another manufacturer was confronted with an equally difficult burr removal job. He had booked a large order for small steel shafts from a customer who demanded a perfectly clean finish. Trouble arose when it was found that a long burr remained in the cut after notching one end of the shaft. Grinding the burr promised to be a costly and a long-drawn-out process, because of the quantity of shafts involved. The producer was faced with the loss of his entire profit on the job unless he could remove the burrs faster and at less expense.

After some experimentation with various abrasives it was found that a small Tumblast machine would remove the burrs perfectly. As a result, a machine was installed. Later the manufacturer reported that the savings from this one job alone repaid his investment and that it is now being used on other cleaning operations.

In another instance, burrs were forming on the end of coiled springs



Blasts burrs from castings

during the grinding operation, because the heat generated was sufficient to weld some of the fine steel particles that were ground off. A few minutes blasting in a Tumblast removed the troublesome burrs from these springs and convinced the worried production manager that here was the ideal way to do the job quickly and inexpensively.

These are only a few of the many burr removal jobs being handled by this unusual method. Generally speaking, the process can be successfully used for this purpose whenever blasting the product with a fine grit is not an objection.

In instances where the finished part is later plated, enameled, or given any other finish such as lacquering, metallizing, painting, and so on, this process not only removes the burrs but also provides a perfect bond for the subsequent coating.

DURAMIN

Age-Resisters Prolong Life of Rubber

DESCRIBED as an important research contribution for conserving supplies of natural rubber, Duramin, a combination of chemical age-resisters discovered in the Akron laboratories of the B. F. Goodrich Company, will find immediate use in automobile tires.

"By carefully selecting and combining the most effective age-resisters, in the development of which the company was the pioneer,"

states John L. Collyer, president of Goodrich, "our research staff has created Duramin, a combination that acts on rubber to keep it tough and alive, much as vitamins act on the human system. So potent is Duramin that it is effective in minute amounts. In tires, the quantity used ranges from ¼ of 1 percent to 2 percent of the amount of rubber in the compound."

When used in sidewalls and treads, Duramin retards wear by imparting greater resistance to abrasion, which is an important factor in tire mileage. According to the B. F. Goodrich president, the vitamin-like material is also used in the important portion of the tire between carcass and tread. Here, he pointed out, it produces a cooler-running stock by both reducing the amount of heat generated and better resisting it.

MONEL SPEEDS SOAP

Razor-Steel Doctor Blades Replaced

In a large soap manufacturing plant, it was formerly necessary to halt production for ten minutes during every eight-hour shift while the doctor blades that scrape the soap from the drying rolls were honed. The continuous scraping against the hard metal rolls, together with the corrosive action of wet soap, dulled the English razor-steel blades after such short usage.

Since the capacity of this drier was 3000 pounds an hour, or 50 pounds a minute, this ten-minute loss meant a production loss of 500 pounds every eight hours. And this department was working on a 24-hour shift 2½ days a week. These frequent honings caused a total production loss per operating week of 3750 pounds.

In an attempt to remedy this trouble, it was decided to install doctor blades made of heat-treatable "K" Monel. At the end of 188 hours of continuous operation with these new blades, only two honings had been necessary — an average of 99 hours between hones. The wear and corrosion resistance of "K" Monel had sped up production more than 7000 pounds during each 99 hour period.

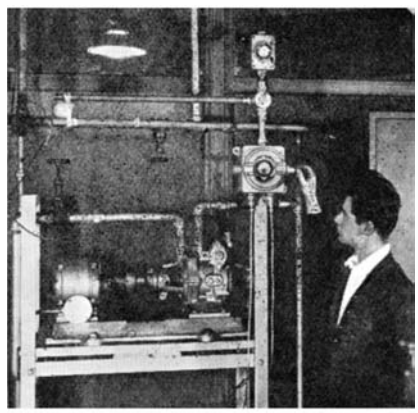
Although no complete records are available after the first 188 hours, it is reported that the new blades are never removed more than once in 60 hours, and usually not so often as that. Thus there is a performance ratio in favor of these blades of more than seven to one over the old type.

GAS ALARM

Explosion-proof, for Sampling Atmospheres

Instant warning is provided by an explosion-proof combustible gas alarm when gas concentrations exceed a predetermined limit. This device, developed by the Mine Safety Appliances Company, may be adapted for automatic control of manufacturing processes or for use in ventilating systems.

The gas alarm, including the sampling pump, is contained in an explosion-proof housing and can be safely installed in gaseous atmospheres, eliminating the need for long sampling lines. The instrument itself is specifically calibrated for the particular gas or vapor which it will test, and is so constructed that the operator can adjust the measuring circuit to operate a warning signal at any predetermined point within a wide range.



Gas tester increases safety

PRESERVING WOOD

Long-Range Test Shows Promise

From the time man first began to use wood as a construction material, one of its most serious drawbacks has been its susceptibility to the destructive action of termites and fungi. Wherever wood construction has had contact with soil and water, myriads of microscopic organisms have attacked even the most costly of wood structures.

Industrial chemists, naturally, sought to develop a means of combating termites and fungi, and a number of years ago The Dow Chemical Company began conducting extensive laboratory research accompanied by widespread field testing programs to develop a positive wood preservative.

According to Dow chemists and technicians, they found pentachlorphenol to be a most effective preservative. In this product they claim to have a material which combines all the advantages of other materials and in addition provides 100-percent protection.

Preliminary experiments were so encouraging that some years ago the company began a testing program to determine the effectiveness of a wide variety of wood-treating compounds. A large number of test experiments were prepared. Sections of wood two by four inches, two feet long, were impregnated with various compounds by means of a full cell process (vacuum impregnation). In this method the sections are placed in a vacuum tank until the air has been withdrawn from the wood. Preservative material dissolved in a suitable solvent is then forced into the cells of the wood under high pressure.

After impregnating in this manner, treated sections were buried in the ground in two testing fields, in locations which were selected because the soil and climatic conditions are particularly suitable for the desired tests.

Yearly checks have been made to determine the effectiveness of the compounds in resisting termites and decay under conditions favorable to both. The results obtained to date show that pentachlorphenol exhibits high efficiency as a wood preservative since at the end of four years untreated sections of samples show only 10 percent of sound wood while all those treated with pentachlorphenol at the rate of 1.58 pounds per cubic foot of wood show 100 percent sound wood.

It is pointed out that pentachlorphenol exhibits outstanding advantages over other materials. It is clean, does not spoil the appearance of the lumber, and is economical to use.

Because of the scope of these experiments and the time necessary before final conclusions may be reached, a complete report on results of tests is not yet available.

INDUSTRIAL TRENDS

PETROLEUM'S FUTURE

DESPITE astronomical figures of petroleum production and consumption, there is still no reason to fear depletion of this natural resource for many years to come. Even though the petroleum industry should do nothing more to develop processing methods than has been done in the past, there is sufficient "black gold" in our developed and proved underground reserves to supply needs for at least 15 years to come. Add to this the undiscovered reserves, which geologists are constantly searching for (and discovering), and the time of depletion is placed further into the future. Add again the fact that science has shown how to obtain gasoline from shale, coal, and other natural deposits, and a variable figure is obtained for the depletion point that may be conservatively placed at some 2000 years hence.

But the petroleum industry *is* doing things about oil, doing many things that not only increase the efficiency with which petroleum products are obtained from the natural crude but, at the same time, open new fields for these products. Indicative of increased efficiency of processing is the new fluid catalytic process of continuous gasoline production recently announced by Standard Oil Company of New Jersey. Claims for this process are economy of plant equipment, more gasoline from a given amount of crude, and higher octane rating for the product.

The trend toward higher octane rating in gasolines holds significance for the entire automotive industry and for every individual motor-car, truck, and bus user. For many years the gasoline division of the petroleum industry progressed side by side with the automotive designers. Better gasolines and better motors were developed simultaneously and the question of which came first would be almost as difficult to settle as the one regarding the hen and the egg. Now, however, it is quite evident that the petroleum industry has forged ahead of developments made by its best customer and has produced gasoline which is so high in quality that existing engines cannot use it to best efficiency.

That the engine designers will rapidly take advantage of this better fuel is a foregone conclusion. With 100-octane gasoline available, and 125-octane fuel a proved possibility, the near future will see automobile engines that will far outstrip present prime movers in such matters as economy, power output for a given motor size, flexibility.

Although the automotive trade is the best customer of the petroleum industry, consuming some 60 percent of its total production in the form of gasoline, lubricating oils, greases, and Diesel fuels, other factors are at work shaping the future trend of those organizations which produce crude. Several rubber substitutes are manufactured wholly or in part from petroleum products, "butyl rubber" being the one that looms most importantly in the field at the present moment. Then there are a score or more of other industries that make extensive use of petroleum. Their products range from plastics to cosmetics, from alcohol to paints, from dyes to medicines. Even explosives can be based on crude oil; it is reported that at least one plant is thus producing toluol, important ingredient of T.N.T., while another is under construction.

From this brief statement of fact regarding the petroleum industry it is not difficult to see that the trend is toward a dual goal: increasing efficiency in production of present products, and diversification of the uses of crude oil and its derivatives.

AFTER THE BOOM, WHAT?

ALREADY the machine-tool industry, heart of national-defense production, is rapidly opening the bottle-neck which has been so widely publicised as to have rendered the very phrase itself a cliché. Millions are being poured into plants and equipment for producing tools, and it is estimated that for at least another two years this industry can look forward to a period of continuing activity.

But then what?

When production plants are tooled-up and in full swing, will the props be knocked out from under an over-expanded machine-tool industry with the tragic result of a slump that descends far faster than the rate of climb to the peak? Will it be found that, in order to provide the tools for emergency production, an industry has been built up that cannot continue on an economically sound basis?

These are questions that must not be lost sight of when considering the present upward trend. Of course, there will always be the necessity of a machine-tool industry geared to normal production. The expected growth of civil aviation, the routine changes in motor-car design, the needs of military aviation even after the crisis has passed, all the normal requirements of industrial production in its many-faceted forms will contribute to a certain stability for machine tools. Then, too, during manufacture for defense, as well as in peace-time production, there is always the need for tool replacements and repairs.

Nevertheless, there will eventually be a downward turn; its severity will largely be governed by the care which is exercised in present planning. The machine-tool industry is undoubtedly the one which will be the first to feel the morning that always comes after the night before.

IF TIN SUPPLIES ARE STOPPED

IF IMPORTS of tin were suddenly stopped, our national reserves of the metal would rapidly disappear. Without going into the international intricacies of the problem, however, it is safe to say that tin consumption in the United States could be radically reduced without working too great a hardship. Lacquer can replace tin in many types of cans; cadmium can be used in place of tin in solder with some advantages, but with the disadvantage of increased cost; lead is a tin substitute that can be pressed into many services; graphite and plastic bearings offer possibilities in replacing tin-using babbit; glass, plastic-treated papers, water-proofed cardboard, and similar materials may be used to fabricate containers of many types that now make demands on tin plate. All of these are proved possibilities that need only the impetus of an emergency to translate them from positions of minor importance to major roles in our national economy.

— *The Editors*

A Strange Picture

Photometers and Spectroscopes Afford the Interpretation of an Odd Double Star

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

LONG ago, in 1784, Goodricke observed that the third magnitude star Beta Lyrae loses more than half of its light at intervals of a little less than 13 days. As Figure 1 shows, there are deep minima, which last more than a day, alternating with much shallower ones, half-way between. The obvious explanation is that two stars of unequal brightness alternately eclipse one another. The two stars, being very close together, are distorted into egg-shaped figures by their mutual attraction and look brighter halfway between eclipses, when we see them broadside-on, than at any other time. The effects are illustrated by the dotted line in Figure 1, whose minima show how much light we would get from the stars in the end-on position if they did not eclipse one another. Evidently the real difference in brightness of the two stars is much greater than we would suppose if we had not made this correction.

At the primary eclipse, where star *A* is behind star *B*, 36 percent of the whole light is lost; and at the secondary, 12 percent. At the first, *B* hides part of *A*. At the second, *A* hides the same area of the disk of *B*. Hence *A* must be three times as bright per square mile as *B*. It must also have not less than 36 percent nor more than 88 percent of the combined light.

To fix its value, within these wide limits, we need more information. Precise observations of the shape of the eclipse curve should give this, but such measures show that the variations during successive cycles are not exactly the same. Besides the eclipses, there must be something else at work to change by a few percent the amount of light which gets to us. Effects of this sort are probably also responsible for the unsymmetrical shape of the curve at the bottom of the deeper eclipse. Spectroscopic observations show that there is a bright star, with a spectrum closely resembling that of Rigel, which moves in a circular orbit and gets to the far side of it (when an eclipse would occur) just at the time of principal minimum. This is clearly our Star *A*. If Star

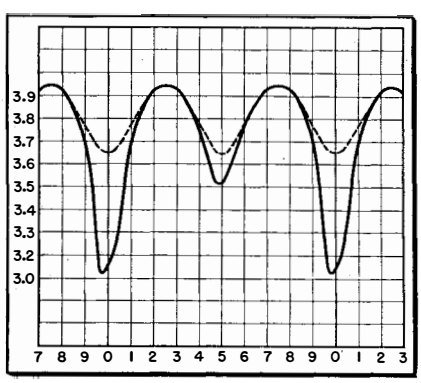


Figure 1: **Light-curve of Beta Lyrae, from observation by A. Danjon, Strasbourg, 1923-1926**

B were comparable in brightness we would expect to find a second set of spectral lines, shifted to the red when those of *A* went to the violet. No such lines have been observed: so we can be sure that *B* is much fainter than *A*. It is probable that *B* is also smaller than *A;* but we can set a limit to this. If we assume that *B* is completely hidden behind *A* at the secondary minimum, then *B* gives 12 percent and *A* 88 percent of the whole light. At the primary minimum, *B* cuts off 36 percent of the whole light, or 41 percent of the light of *A*. Hence its diameter is 64 percent of *A*'s—exactly if the star disks appear of uniform brightness, and approximately in any case.

We still want to know the relative masses of the two stars. Dr. Kopal—to whom the calculations just described are due—has found this in a most ingenious way. The observed variation of light outside eclipse must almost all come from the bright star *A*. Hence, comparing the end-on and side-on brightness, we can find its shape, allowing for the fact that on an egg-shaped star, the parts farther from the center are faintest. Kopal finds that the equatorial radius of the bright star, pointing toward the companion, is 15 percent greater than the one at right angles to it. The mass of *B* required to produce this distortion by its attraction comes out 74 percent of *A*'s mass.

Taking the Sun as standard, he finds

	Mass	Diameter			Density
		Longest	Intermed.	Polar	
Star *A*	65	56	48	41	1/1700
Star *B*	48	35	32	31	1/720

With a surface temperature of 11,300°, corresponding to the spectral type, the (visual) brightness of *A* comes out 14,000 times that of the Sun. The "invisible" component *B* would then be 2000 times as bright as the Sun. Were it not drowned out by the glare of its enormous neighbor, it would be most emphatically visible.

THE spectrum is extraordinarily complex. It shows the lines of Star *A* and does not show Star *B*—which is easy to understand. But there is also another set of numerous dark lines, corresponding pretty closely to a spectrum of Class *B5* (that is, to a higher temperature than Star *A*) which hardly shift at all in the orbital period but are displaced, all the time, by an amount corresponding to a recession from the center of the orbit of *AB* at the rate of about 50 kilometers a second. These lines are very strong just after the primary eclipse, and faint shortly before the secondary. There are also strong, wide, bright lines, such as would be produced in an envelope of gas of very low density, surrounding the binary pair and rotating with a maximum velocity of about 300 kilometers a second. Finally, shortly before the primary eclipse, strong dark lines appear on the red side of the principal lines of Star *A*, shifted by an amount corresponding to a motion toward the star at 200 kilometers a second. These disappear abruptly a few hours before the middle of eclipse; and, just after this, a new set of companion lines suddenly appear, shifted to the violet by an amount corresponding to recession from the central star at 300 kilometers a second.

There are more details—but those are sufficiently strange.

A practically complete explanation of these extraordinary phenomena was given recently by Struve. Its general outlines can be understood from Figure 2. This shows Star *A*, with *B* going around it in its orbit in the direction of the arrow. From the surface of *A* a great stream of gas flows outward past *B*, as suggested by the arrows, at speeds up to 300 kilometers a second. Part of this swings around *B* to the other side and probably finally falls into it; the rest spreads out in space and forms some sort of ring, or shell, *C*, enclosing both stars, as indicated very roughly by the dashed lines. The gases of *C* absorb the light from *A* and produce the "stationary" B5 spectrum. They have to get rid of the light which they absorb and do so by shining on their own account—thus producing the bright lines. The ring as a whole is rotating, so that the lines emitted from one side are shifted toward the red and from the other toward the violet, producing wide blends. The ring is continually expanding and dissipating into space, as well as rotating; hence the part of it in front of *A* is receding from the center of the system, producing the shift of the absorption lines.

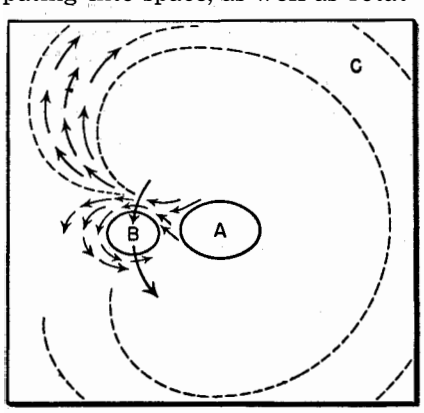


Figure 2: **Interpretation of the motion of gases near Beta Lyrae**

Before eclipse, the inward-swinging stream of gas on the front side of *B* comes into line between us and *A*, and produces the satellite lines shifted to the red. At the middle of eclipse these get out of the way while the outflowing stream behind *B* produces the "violet satellites." At this time, and for a day or so later, there is more outflowing gas than usual in front of *A;* hence the B5 spectrum is strengthened.

This strange picture is worked out by Dr. Struve in convincing fashion, taking account of a multitude of fine details which there is no room to speak of here, and there can be no doubt that it accounts for the spectroscopic facts.

But is it physically reasonable? Can there be, near these stars, a "wind that blows between the worlds", not cold, but incandescent, and blowing almost a million miles an hour? What drives it, and where does it go?

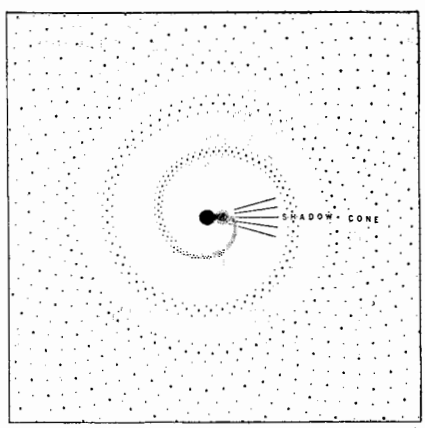
An answer has been given by Kuiper: it depends on surprisingly simple physical and dynamical principles — though the mathematical details are intricate. The main reason for the disturbance is that Stars *A* and *B* are of unequal density. Kopal's calculations indicate that this is a fact; and Bethe's work shows that it has to be that way—if, indeed, the two stars are at least roughly similar in composition.

A star of larger mass will send out more heat, all told, and more per ton; but, since the rate of heat-production increases enormously with the internal temperature, this will not be much higher than for a smaller star, and this means that the more massive star will be of lower density.

SUPPOSE that in some way a pair of stars of unequal masses and diameters were brought so close that they almost touched one another, and set in motion in circular orbits; and consider a small particle in the gap between the stars. It will be attracted by the two, in opposite directions. If the forces on it are properly balanced, it will remain suspended in space—otherwise it will tend to fall into one star or the other. (The centrifugal force, due to motion about the center of gravity of the system, which lies inside the larger star, has, of course, to be taken into account.)

For a pair of stars nearly equal in mass, but decidedly different in density, such as Kopal's calculations indicate in Beta Lyrae, the attraction of the smaller but denser body will preponderate, so that material in the gap—or even at the end of the Star *A* which faces it—will be attracted toward *B* and stream across the gap into it, producing the current shown in Figure 2. The gases of the current will be attracted straight toward *B;* but, before they get there, *B* will have moved forward in its orbit, so that the stream will flow on its following side.

If the material is not going too fast, the attraction of *B* will pull it in close to it, producing the return current on its preceding side. But if its speed is great enough, it may escape, and spread out into space to form the ring *C*. Kuiper, after an extensive mathematical discussion of the possible motions, concludes with the diagram reproduced here as Figure 3. This represents the position of the ejected matter at a given moment. To follow its motions we must suppose the whole diagram to revolve about its center so that an expanding spiral of gas surrounds the revolving stars.



Courtesy *The Astrophysical Journal* (Vol. 93, No. 1)

Figure 3: **The system of Beta Lyrae in rotation. From Kuiper**

The ejected matter, as shown in Figure 3, would form a substantially flat disk, lying in the orbit plane. This must be almost exactly edgewise toward us (since the ejected gases get in front of Star *A*). These must be somewhat opaque to light of all colors—and differences in the amount of material ejected during different revolutions will explain the irregular variations in brightness.

This is perhaps the most remarkable picture of a celestial object that has ever been seriously presented. But it depends in detail upon careful dynamical calculations as regards the motions, and on thorough physical studies as regards the spectra. It brings order out of apparent chaos and combines practically all of the perplexing facts of observation into a consistent and intelligible whole. Its authors are heartily to be congratulated upon the solution of a particularly troublesome problem.

Most of the puzzles are thus cleared up, but one big one remains. How did these stars get that way? This we cannot presume to answer.

Quality in Warplanes

How the British, Out-Numbered in Aircraft, Forced a Change in German Tactics

• CONFLICTING opinions arise everywhere regarding the relative efficiency of the British and German air forces. Hence it was refreshing and informative to read, in a recent number of *The Engineer* (London), a calm analysis of the whole situation. With the permission of the publishers of that magazine, we present herewith a slightly condensed reprint of that analysis. It should serve as a basis for evaluating much of the war news printed in the daily press of the United States.—*The Editor.* •

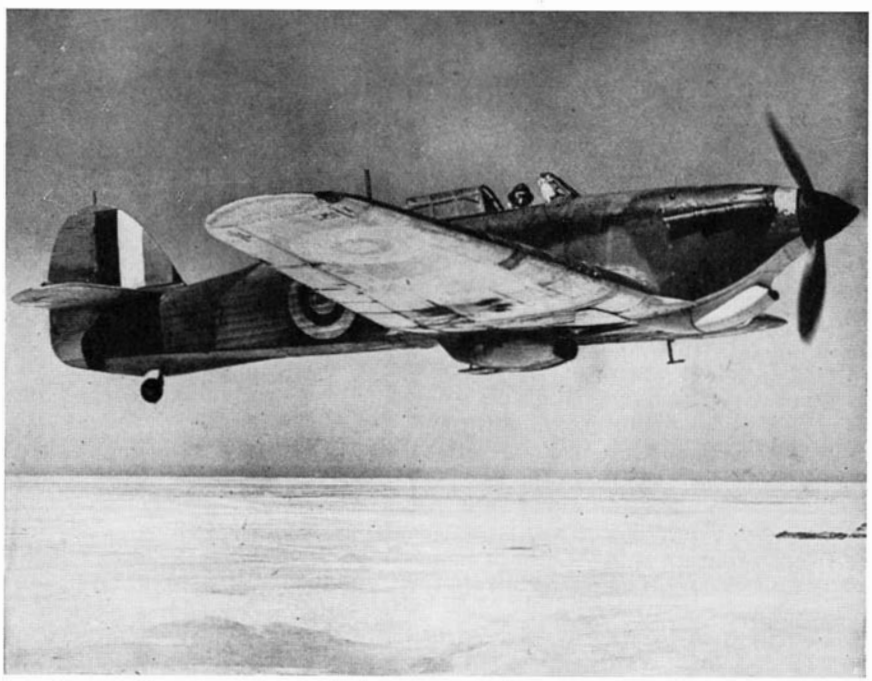
AFTER the first four months of war, it became possible to assert with considerable confidence that if we fell short of the enemy in the number of first-line aircraft at our disposal, British airplane types had, machine for machine, demonstrated their superiority over those of the Germans. Twelve months' additional experience has more than confirmed that early conclusion. We still lag behind the enemy in numerical strength, but the quality of our aircraft—and of our pilots—has been put to repeated and searching tests and in no way has it been found wanting. Again and again British squadrons have routed the enemy at great odds in numbers. Repeatedly our aircraft have returned from aerial combats and from raids damaged to an amazing degree, but still capable of flying and landing at their bases. Much, very much, must be attributed to the superlative courage and skill of our airmen, but it is self-evident that all the heroism in the world could not have achieved what they have done without aircraft of outstanding design and construction.

In September, 1939, Britain was fortunate in having several types of aircraft, possessing notably high performance characteristics and a number of exceptional features, which had fairly recently reached the stage of quantity production. Chief among these aircraft were the Vickers-Supermarine "Spitfire" and the Hawker "Hurricane" eight-gun single-seater fighters, the Vickers "Wellington" long-range bomber, and the Bristol "Blenheim," a bomber-fighter. Chance had played its part in providing us with these designs just when they were needed. The "Spitfire"—and, to a slightly less extent, perhaps, the "Hurricane"—were the direct outcome of the work done in previous years in developing the series of seaplanes with which this country finally won outright the Schneider Trophy. It will be recalled that the contest for this trophy, in its last phase, was frowned upon by the Government of the day and that our success in winning it and all the lessons learned from the efforts made to secure victory would not have been ours but for the generosity of the late Lady Houston.

Private enterprise and encouragement also played a part in the evolution of the prototype of the "Blenheim." As for the "Wellington," with its unique "geodetic" system of construction, it can be truthfully asserted that its existence in numbers at the outbreak of the war is to be ascribed to the courage with which Vickers adopted Mr. Wallis's revolutionary ideas and the skill with which they quickly adapted their works for quantity production.

Nevertheless, although chance played a fortunate part in the position with respect to aeronautical equipment in which we found ourselves in September, 1939, it would be foolish and ungrateful to ignore the deliberate part played by the Air Ministry. The approaching storm was long heralded. The new types of aircraft were not as yet fully developed and were not ready for mass production, either in the works of their designers or in the "shadow factories," which were being organized. It would have been an easy solution to standardize the existing less efficient designs of aircraft and to prepare the way for mass-production on the outbreak of war.

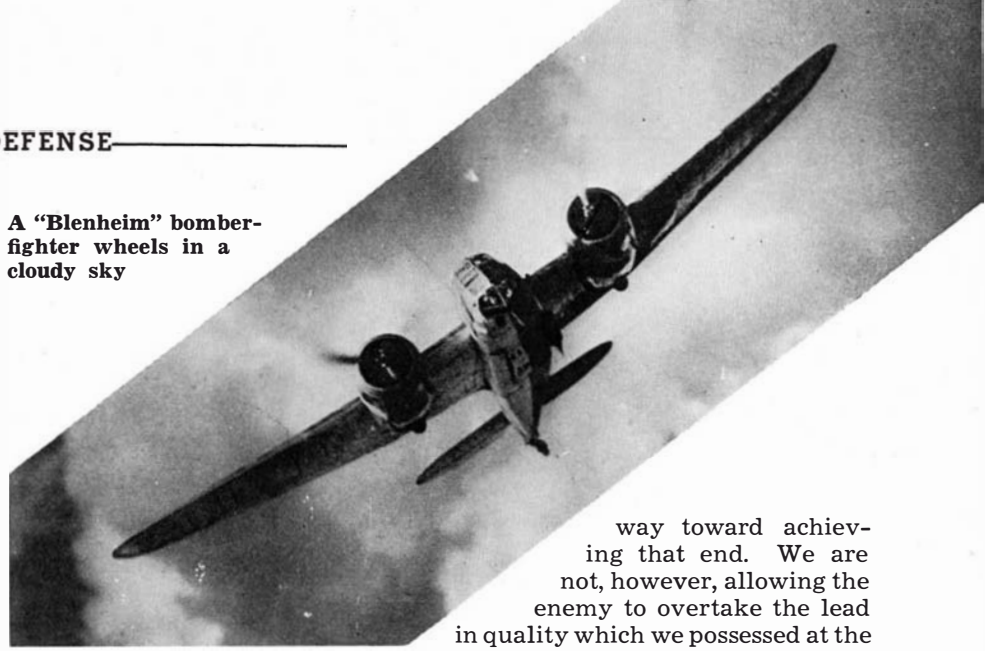
SOME people have criticized the Ministry for choosing the advanced qualities of the new designs in preference to the increased numbers which would have been forthcoming had it adhered to the established types. Where, one may wonder, would we now be if the Ministry had acted otherwise than it did? We can obtain some inkling of the answer to that question by noting the experience of the enemy. The Germans elected to obtain numerical strength rather than the strength which comes from qual-



A British "Hurricane" on desert patrol. Note wing guns

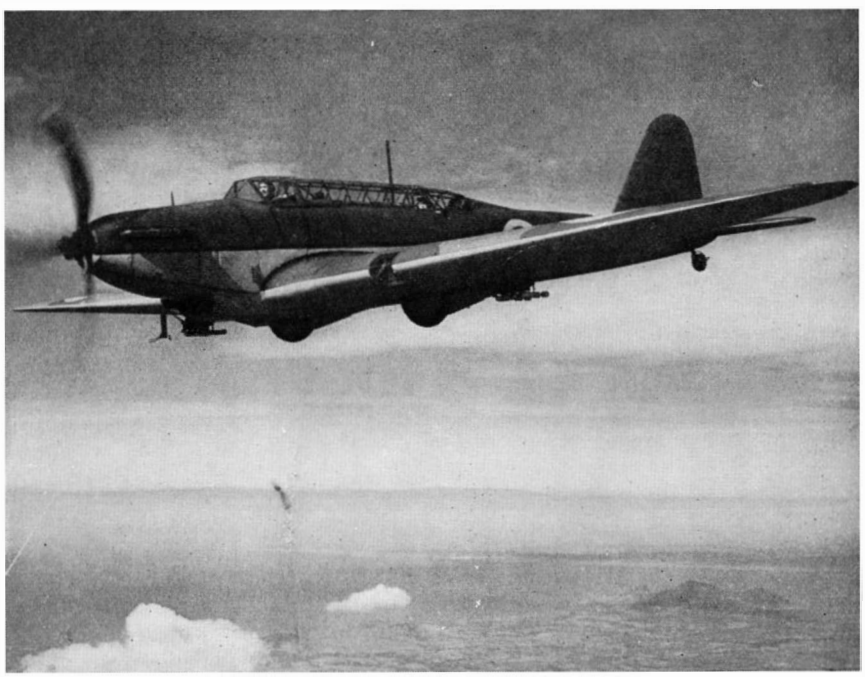
ity. They standardized their production for war at least two years before we did. Those two years were marked by vital developments in aircraft production. They witnessed the advent not only of the new British designs to which we have referred, but of the power-operated gun turret and other devices which have fully proved their worth in battle during the past 12 months. The Germans missed most of these developments and are still struggling to catch up with them.

A specific illustration of the above remarks can be given. The most notable, or notorious, type of German "Stuka," or dive bomber, is the Junkers 87 monoplane. It achieved considerable success against the Polish and French forces, but in both cases these forces lacked anti-aircraft defenses and training against dive-bombing attack. The moral effect of these "Stukas" was very great, but their success was quite disproportionate to their intrinsic qualities. Actually, the Ju. 87 design is about eight years old. Not until after the capitulation of France did it find itself pitted against modern air and ground defenses on an adequate scale. When, during August and September, the Germans employed Ju. 87's against our shores and shipping, more than half those engaged were destroyed, chiefly by our "Spitfires" and "Hurricanes." While it is not permissible to say what improvements we have made in the dive-bombers with which we started the war—such as the Blackburn "Skua" and the Hawker "Henley"—it can be stated that a recent American design, the Douglas DB 7, has a top speed of about 330 miles per hour. That speed is not far short of that possessed by the early patterns of "Spitfire" and "Hurricane." In contrast to it the Junker 87 has a top speed of only about 240 miles per hour.



A "Blenheim" bomber-fighter wheels in a cloudy sky

From these facts we may infer something of the penalty which the enemy has had to pay for his too hasty decision to standardize his aircraft production. That decision might have been a profitable one to him had the war started a year earlier than it did. As it was, the Munich conference gave us a year's breathing time and enabled us to win the race for quality as against numbers. Today we are bent on making up the disparity in numbers, and, with the aid of the United States and Canada, we are in a fair way toward achieving that end. We are not, however, allowing the enemy to overtake the lead in quality which we possessed at the beginning of the war. New designs, such as the Bristol "Beaufort" bomber, the Boulton-Paul "Defiant" fighter-bombers, and the Fairey "Fulmar"—the Fleet Air Arms' counterpart to the "Spitfire"—have already been brought into service, and others of which no mention may be made are on the way.



Ready to lay its eggs; a Fairey "Battle" bomber

DIFFERENT opinions have been expressed concerning the quality of the workmanship and materials revealed by the German aircraft which have fallen into our hands. Some assert that the Messerschmitt 109 fighter is an inferior product, both in general design and in construction. It has no bulletproof windscreen and no armoring for the pilot. The fuel tank is badly positioned relatively to the center of gravity and is very vulnerable. Its armament and equipment, it is said, are so inferior that, given two pilots of equal skill, the Messerschmitt must be shot down every time by a "Spitfire" or "Hurricane." On the other hand, equally competent investigators have found no sign of *ersatz* material in any German aircraft which they have examined. They praise particularly the design and quality of the enemy's self-sealing petrol tank and his engines. It has been asserted, too, by some, that many German aircraft are poorly equipped with flying and navigational instruments, while others have found no deficiency whatsoever in these respects. It seems probable that these contrasting opinions may both be well founded and that there is a very considerable variation in the quality and construction of German aircraft. Doubtlessly, opinions based on the examination of aircraft constructed before the war or during its early and less intense months are likely to be different from those derived from the in-

spection of more recently constructed machines.

If there is thus some difference of view concerning the quality of German aircraft there is none concerning that of British machines. As we have already said, numerous reports have been received of British aircraft returning safely to their bases in an amazingly damaged condition. One typical instance may be quoted. A "Wellington" bomber during a raid collided with a balloon cable which cut through the leading edge of the starboard wing, tore off the wireless aerial, damaged one of the airscrews, cut completely through the starboard aileron and severed it, ripped off the bomb doors, and did other smaller damage. Nevertheless, the machine succeeded in reaching home in safety. It is needless to say that in the last war any such mishap to an airplane would have meant its instant destruction.

Several instances, too, have occurred of British aircraft catching fire while under bombardment. In the last war, with the machines largely of wooden construction, fire almost invariably spelled immediate disaster. Today it has been proved that, with prompt and courageous handling, fires on aircraft can be extinguished and that the machine after its ordeal can still be safely brought home.

Large-scale air attacks on this country were begun by the Germans on August 8th. At first they were principally confined to daylight hours and were primarily directed against our shipping in the English Channel and our southern coastal towns and ports. It took some time to convince the enemy that he was at last fighting a country which was prepared and able to hit back at him. At the end of 12 weeks, however, our fighters, anti-aircraft gunners, balloon barrage, and other elements of defence, had accounted with certainty for 2433 enemy bombers and fighters, omitting all those which were "probably destroyed" or "damaged." In that period over 6000 German airmen were killed or taken prisoner for a loss of 353 pilots on our side. Gradually the enemy started to change his tactics. He began by providing stronger fighter escorts for his bombing squadrons and continued to develop this plan until it reached an almost fantastic scale with hordes of fighters accompanying one or two bombers. His losses diminished somewhat, but equally, too, did the damage he could do.

BY THE beginning of September it was as clear to the Germans as it was to us that daylight air attacks were very costly, far too costly to be continued on the scale which they had previously followed. For the time being, at least, we had mastered them with our fighters and our guns. As was to be expected in these circumstances, the enemy resorted to night attacks. In these attacks he has certainly found a field congenial to his brutal soul. He need no longer fear our "Spitfires" and "Hurricanes;" he can fly, if he chooses, as he generally does, at such a height as to be beyond the effective range of our searchlights—and beyond the range at which any pretense of precision bomb aiming is a farce; he can come over in nearly all kinds of weather, for his code of warfare does not compel him to emerge from the clouds to seek his target, and, with the location of aircraft at night in its present state of development, he has much less to fear from our anti-aircraft guns than he has been taught to feel from his experience by day.

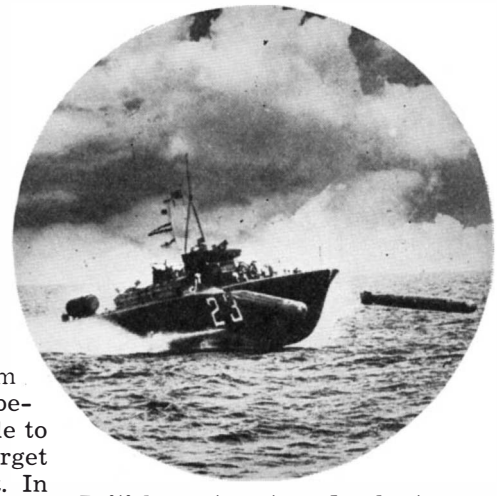
Vickers "Wellington" long-range bombers

It may be noted that of the 2433 enemy aircraft destroyed during the 12 weeks beginning on August 8th, to which we have referred above, 341 were shot down by our anti-aircraft guns, an average of a little more than four each day. Our gunners have certainly given a good account of themselves by day. They have improved their practice to such an extent that on at least one occasion they have secured a direct hit on an aircraft flying at a height of about five miles. Nevertheless, it is no disparagement of them to say that their performance after night has fallen, judged by the number of machines which they shoot down, and is far from equal to that which they have achieved by day. The gun barrage 'round London and other centers has now reached a great magnitude. It is not possible to say how many raiders have turned back before its intensity, but it can be asserted that night after night it has failed to prevent a number of machines from reaching their target area. It is certainly not the fault of our devoted gunners that their strenuous efforts by night meet with relatively little success. The fault seems to lie in the fundamental crudity of the system whereby we seek to destroy or damage an airplane in rapid flight by flinging lumps of steel at it more or less with our eyes blindfolded.

Meanwhile, our bombers have been taking their toll on Germany, and will doubtlessly continue to do so with ever-increasing effort as the strength of our Air Force rises. Unlike the enemy, we have from the first concentrated on military targets and on works of all kinds which are contributing to his war potential. Our operations conducted from this country have extended from as far east as Danzig to as far south as Naples, and from all accounts have met with much success. The enemy, it would seem, is still as far off as we are from finding an adequate means of preventing successful attack by night-raiding bombers, in fair weather and foul.

Speed and Sting—the M. T. B.'s

Motor Torpedo Boats Attain Speed of 60 Knots, Carry Four Torpedoes, Machine Guns



British motor torpedo boats have proved their worth in war

A FLEET of tiny speedboats which dart in like rapiers, stab deep into an enemy's vitals, and withdraw speedily may soon become one of the bulwarks of national defense, if the motor torpedo boats now being tested by Uncle Sam's Navy measure up to expectations.

The little sea hornets are able to reach a speed of 60 knots. They can maintain this rapid clip and carry out their mission in waves running from 12 to 15 feet high.

The drive behind such terrific speed is furnished by three 1200-horsepower supercharged Packard engines of 12 cylinders each, which are housed in the engine room aft. To obtain maximum efficiency of operation, 100-octane gasoline is used, and enough is carried to give a boat a cruising radius of 3000 miles.

The method of attack used by motor torpedo boats is to dash in, deliver a telling blow and dash out again. The boat's silhouette is so low against the horizon that it is almost invisible to the commander of an enemy ship. The enemy commander doesn't hear the onrushing mosquito boat because its powerful engines are muffled. By the time he sees it and tries to aim his guns, the little fellow has begun to zigzag sharply from side to side so as to make of itself a target that is almost impossible to hit. In close, the motor boat cuts loose its torpedoes, whirls "on a ten cent piece," and is gone.

One of these torpedoes packs sufficient wallop to send an aircraft carrier to the bottom, and a squadron of motor boats, armed with four torpedoes each, is potent enough to sink the largest battleship, experts believe. Each boat carries half the hitting power in torpedoes of a modern destroyer.

Simplicity in launching its torpedoes is another advantage of the motor torpedo boat. Its helmsman puts it on a collision course with its intended victim and holds that course at torpedo speed. The torpedoes are discharged over the side at an angle to the boat's course and return automatically, at a safe distance, to a course parallel to that of the boat.

In addition to four torpedoes of the latest type, four machine guns on twin mounts and a smoke laying apparatus comprise each vessel's armament.

American motor torpedo boat, showing torpedoes, machine-gun turrets

The new motor torpedo boats are undergoing rigid service tests to develop and determine their capabilities and limitations under all conditions encountered at sea. They have already proved that their combination of high speed and maneuverability enables them to outmaneuver all surface ships, even in waves running 15 feet high. Later tests will match them against destroyers in war games, to determine whether or not the destroyers can run them down. Similar tests conducted by the Germans are reported to have shown the motor torpedo boat a more effective sea weapon than the destroyer.

A boat crew consists of eight men and an officer. The men must be young—under 35—and tough, and they are carefully selected for their experience and ability in handling torpedoes, torpedo controls, machine guns, and gasoline engines.

Boats which are subjected at high speeds to such a pounding as the mosquito boats require lightness and strength in the construction. Hull planking, which is double, is of African mahogany with a total thickness of almost an inch. Laying the planking diagonally imparts great strength, and doped fabric between inner and outer skins assures water tightness. So buoyant is the structure that it would float even with all watertight compartments flooded.

Its beam of 22 feet gives a motor torpedo boat great stability in rough water and its draught of only five feet enables it to venture into waters far too shallow for larger fighting craft.—From *Ethyl News*.

Atom Smashing: Two Methods

Why the Weaker Electrostatic Atom Smasher Thrives Despite the Powerful Cyclotron

C. W. SHEPPARD
Professor of Physics, South Dakota School of Mines

FOR many years prior to the 1930's, physicists had studied the outside of the atom. The rules governing the behavior of the minute electrons which revolve about the central nucleus at tremendous speeds were just commencing to become clear. Scientists were then making every effort to get in beyond the exterior and probe into the secrets of the nucleus itself. By the opening of the decade, they felt that they were beginning to "hit the jackpot."

One method of research which suggested itself was to shoot at the nucleus and see what could be knocked out of it. Already, some success had been achieved in shooting into atomic nuclei the minute, charged projectiles emitted by radioactive materials. These particles, emitted in radioactive "explosions," were known to be the nuclei of helium atoms and went with such speed that scientists said they had energies of several millions of volts.

This strange way of speaking can best be explained if we know what was going on in their minds during that time. Suppose, they said, that one could bombard the nuclei of atoms with charged particles. To obtain these, the experimenter would take simple atoms such as hydrogen, or helium, and knock off the outer electrons by throwing them violently around in an electrical discharge or in some other way. The gadget in which this "knocking off" process occurred would be connected to a large, highly evacuated glass or porcelain "accelerating tube." The particles could be led into this tube and, by the application of high voltage, could be accelerated or shot against a target covered with the atoms of the element to be investigated.

But how does this acceleration occur? Let us imagine for a moment a battery connected to an electric circuit. To speak of the "voltage" of the battery is merely another way of referring to its ability to push electricity or electrical charges through the circuit. If we could have a battery of a million volts, its ability to push electricity would be very high. Now suppose, in place of an ordinary circuit, we have a large, evacuated, accelerating tube full of charged particles which we wish to use as projectiles. Since the particles have lost one or more negatively charged electrons in the knocking off process, they are now positively charged. The battery will still be able to push, and this will cause electricity to pile up so that one end of the tube will be highly charged positively and the other end highly charged negatively. Since like charges repel and unlike attract, the atomic projectiles inside will be repelled from the top end and attracted to the bottom end, and will shoot down the tube at very high speeds. The more positive charge the particles have gained by losing their negative electrons, and the higher the voltage on the accelerating tube, the faster they will be shot. These two things will then determine their energy of bombardment. It is thus most convenient for the experimenter to measure the energy of bombardment of his particles in terms of voltage and electronic charges, or electron volts. For simplicity, we shall call them just plain volts.

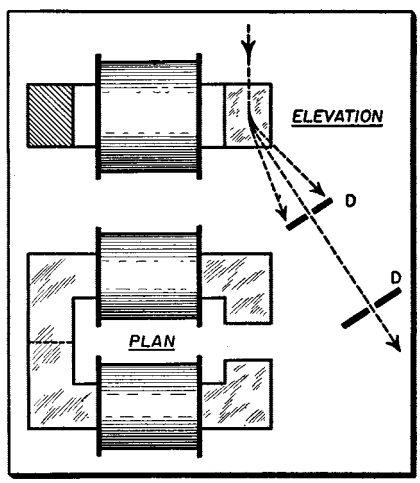


Figure 1: **Principle of the magnetic separator. The bombarding beam is shot between the poles of a powerful electromagnet, which deflects the particles. The lighter ones are more strongly bent than the heavier ones. The magnet is set so those particles which weigh just the amount desired for use in bombardment are deflected just enough to pass through holes in the two diaphragms *D,D*, while all the unwanted particles are caught and do not get through**

When physicists sat down to figure out how much voltage they would need to do all of this, it looked pretty hopeless. Nuclei—that is, the targets—carry a positive electrical charge, and the only particles heavy enough to do them any damage are other nuclei. Since these also carry a positive charge, a strongly repulsive force is set up. To shoot a projectile into a nucleus against this force takes such fast particles that several millions of volts are required for their acceleration. This explains why only the particles from radioactive sources had been successful previously.

IN spite of the dark outlook, by the turn of the decade, physicists had begun to lick the high voltage and high velocity problem. The future also appeared brighter for another reason. Theoretical physicists were making abstruse calculations by means of the new and mysterious quantum mechanics, and their theories showed that, if one shot a particle at a nucleus, it could "leak" in despite the repulsion tending to prevent it. Only half believing such a weird idea, two English physicists, J. D. Cockcroft and E. T. S. Walton, tried bombarding the metal, lithium, with hydrogen nuclei, or protons, and found that their experiment worked and that they had succeeded in disintegrating lithium artificially. When they announced their success, many other laboratories throughout the world set about with renewed vigor to build high-voltage equipment. A great deal of ingenious, elaborate, and frequent-

ly fantastic apparatus was tried and either adopted or rejected.

Such apparatus, when adopted, was frequently very crude but was used for lack of anything better. For example, one laboratory used "raw" alternating current from a set of 1,000,000-volt transformers built for electrical testing purposes. Such a voltage supply varied from 0 to 1,000,000 volts many times each second, making impossible any knowledge of the energy of bombardment. On the reverse half of the cycle, electrons were accelerated, making large quantities of X-rays, which seriously interfered with the experiments.

Other laboratories were using equally crude methods. Little success was had in focusing the bombarding particles into a fine beam or getting rid of the many foreign particles present in their "ammunition." Frequently, the apparatus would not run steadily but would fluctuate, making correct experiments difficult. Also, the results of these experiments usually gave only tantalizing glimpses into the secrets of the nucleus. Physicists found themselves longing for apparatus with steady bombarding voltage which could be

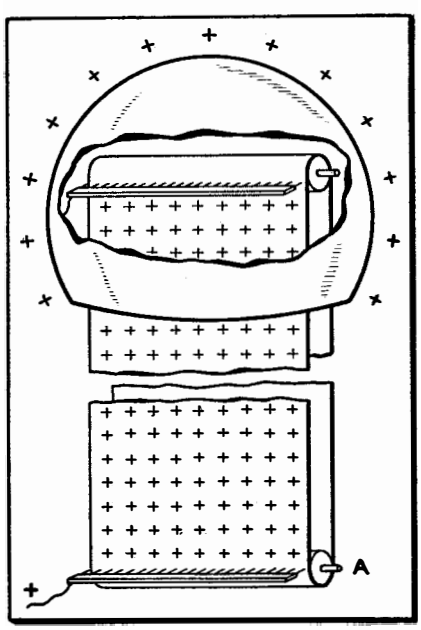


Figure 2: **The working principle of the Van de Graaff generator**

carefully measured and which could be varied at the turn of a rheostat. They desired a small, fine beam of bombarding particles which they could shoot at atoms and measure the angles at which they bounced off. Such a beam was also desirable because it could be put through a magnetic selector, and unwanted particles "strained out" (Figure 1). If the energies of all particles in such a bombarding beam were closely equal, accurately known, and easily controlled, it would afford a rare chance to examine the response of atoms to varying energy of bombardment. Physicists then could have learned more about the critical energy levels which some nuclei possessed, in which they reacted vigorously to certain very sharply defined energies and not at all to energies of a few thousand volts, more or less. At the time, however, these day-dreams seemed more utopian than practical.

DURING all this early furore, R. J. Van de Graaff, a young electrical engineer, was conducting novel experiments with high voltage electricity at the Massachusetts Institute of Technology. Any person who has worked in a mill or factory where large belts are used doubtless has had the experience, on a dry day, of putting forth his finger and drawing sparks from such belts. Van de Graaff proposed to use this principle to generate high voltages but, instead of doing it accidentally, his belts were purposely designed to carry electricity. Since high voltages, but small currents, are required for speeding up particles to bombard atoms, this type of generator promised to be ideal. Preliminary experiments showed that the principle (Figure 2) was a sound one. A large spherical metal conductor was made and mounted on the top of a hollow insulating cylinder. Inside, a belt ran between two rollers, one in the sphere and one on the floor. High-voltage electricity was "sprayed" on the belt by the use of a metal comb charged to a few thousand volts by a direct-current voltage obtained from a transformer and rectifier. It was then taken from the belt at the top and transferred to the sphere by means of another comb and connecting wire. By this means, Van de Graaff was able to produce long, high-voltage sparks. Persons standing near the generator found their hair standing out because of the strong electrical field produced.

Encouraged by his success, Van de Graaff laid plans for a 5,000,000-volt installation, which was soon built in an old dirigible hangar at Round Hill, Massachusetts. Some physicists shook their heads when they saw this impressive piece of machinery. True, it made tremendous high-voltage sparks 40 feet long, but they felt that the problems associated with such an undertaking were still too great. In the first place, it could only make high voltage. No accelerating tube had yet been developed that could withstand such voltage, and the

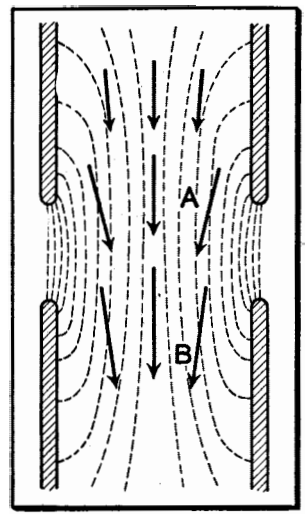


Figure 3: **Principle of the electron lens. Arrows represent speed and direction of particles. At top, particles are traveling slowly. Those off the axis are deflected inward by converging lines of force at *A*. At *B*, lines of force diverge, are deflected outward. This now has less effect as they have been speeded up by action of accelerating voltage. This divergence is not enough to overcome inward velocity acquired at *A*. Result is a converging action on beam**

development of apparatus to convert such energy into a stream of bombarding particles promised to take several years of work.

There was one physicist, however, who came, saw, and was convinced. This was Dr. Merle A. Tuve, of the Carnegie Institution of Washington. Starting out more conservatively, he and his coworkers set to at once and constructed a low-voltage Van de Graaff generator connected to an accelerating tube. It turned out to be so successful that they at once undertook to build a larger installation running at 1,500,000 volts. A year or two of hard work showed that they were on the right track. They used a method by which bombarding particles were accelerated down a long tube through a series of metal cylinders, each of which had a higher voltage than the one below it. The gap between each cylinder and the one below it

formed an electrical "lens" which had a strong converging action on the particles, focusing them into a small beam (Figure 3).

This focusing could be adjusted by varying the voltage from gap to gap. The gap voltages were adjusted by using the corona effect. That is, if a conductor is charged to a high voltage, the air about it becomes charged and these charges leak away, allowing the electricity to leak from the conductor. This leakage is small from very flat surfaces, but it becomes very large when the curvature is great, and it will become very large indeed if there are points on the conductor. Tuve connected his focusing cylinders to rings or hoops surrounding the tube outside (Figure 4) and connected to adjustable corona points. By adjusting the corona points between stages, he was able to create a sort of electrical waterfall down the outside of the tube, cascading from the large conductor at the top to the ground. By moving the spacings of these points, he could adjust the voltages and focusing of the various stages until a fine beam of bombarding particles was produced at the bottom in which the velocity, and thus the bombarding energy, was uniform, steady, and easily controllable.

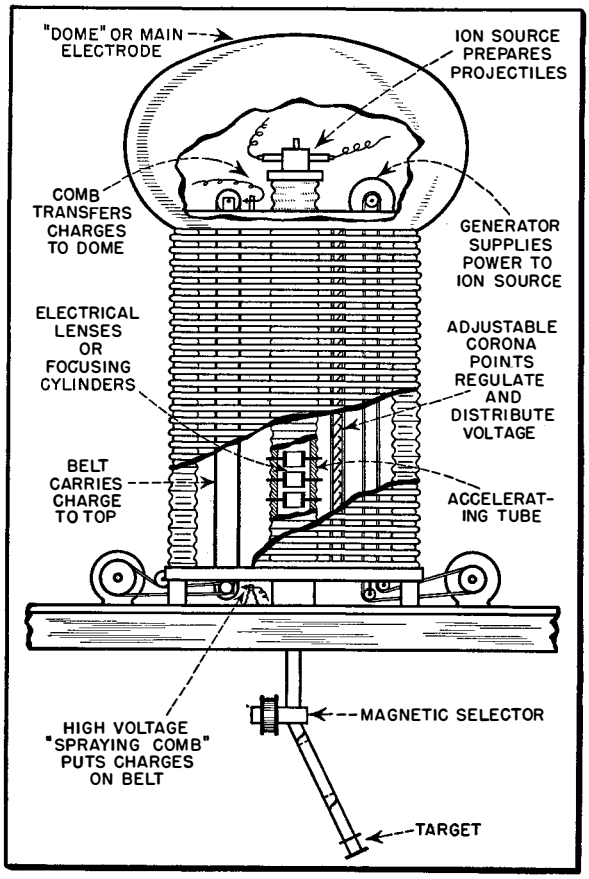


Figure 4: **Tuve's type of Van de Graaff high-voltage generator (see description in text)**

BUT there still was room for improvement. The performance of the generator was subject to atmospheric conditions. On a rainy day, the high humidity prevented successful operation. Then, too, the 1,500,000 volt installation was quite bulky. The only prospect of increasing the voltage lay in cutting down the corona leakage from the large spherical conductor at the top. To do this, it was necessary to cut down the curvature of the conductor by making it larger. This made it necessary to build even larger equipment, increasing the mechanical difficulties.

However, about this time, Dr. R. G. Herb was experimenting in the basement of the physics laboratory at the University of Wisconsin with a strange piece of apparatus which looked like a steam boiler. He was trying to give direct expression to an idea which had long been dormant in the minds of physicists. They had often thought that, instead of making the generator bigger, one might put the entire apparatus into a tank filled full of compressed air at a pressure of, say, 100 pounds per square inch. Under high pressure the corona leakage of air is greatly cut down, and the same voltage increase can be effected with no increase in space.

Herb had set himself an engineering problem of the first magnitude, yet by 1937 his generator was in operation and producing spectacular results. With a tank 20 feet long and 5½ feet in diameter, he was able to generate almost 2,500,000 volts, accelerate particles, and focus them into a small beam which was as steady as a rock and with a voltage which was uniform to a fraction of a percent. With this generator, he and his assistants quickly turned out research which earned the admiration of all the other physicists working in the same field.

AT ONCE Tuve laid plans for an enormous generator of the same type, with which he hoped to generate 5,000,000 volts; and at the Westinghouse Research Laboratories, a similar installation was soon begun. These generators were of truly gargantuan dimensions. The Westinghouse installation, with its pear-shaped housing, for example, is 47 feet high. One can readily imagine the new technical problems which arose in designing and building such massive apparatus. In the construction of Tuve's generator, an additional problem arose. Due to zoning restrictions in the neighborhood, no "laboratories" were permitted. The difficulty was resolved by surrounding the tank with a streamlined structure built of glass bricks and calling it a "nuclear physics observatory."

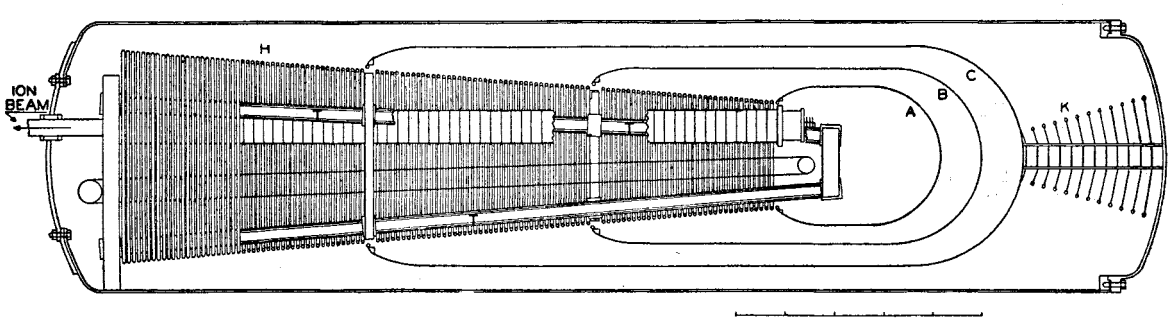


Figure 5: **The most recent, remodeled form of the Herb version of the Van de Graaff generator. *A, B* and *C* are aluminum shells. *T,T,* Textolite tubes. *H,* aluminum hoops. *K,* Textolite tube with corona gap system**

Preliminary tests on these large generators showed that there were many "bugs" to be eliminated before they would deliver the expected voltage. However, the Westinghouse generator was able to accelerate particles to 3,750,000 volts, and the men working with it had already done some important research even before attempting to push the voltage higher.

Dr. Herb was still undaunted by all this streamlined competition. Retiring to his basement, he opened up his tank and started remodelling the interior. By the middle of last summer he was able to announce he had succeeded in increasing his voltage to 4,500,000 volts! To do this, he had merely surrounded the single main conductor of the previous generator with two additional, larger, concentric conductors charged to intermediate voltages. (Figure 5.) In such an arrangement, each conductor exerts an electrical "shielding" effect upon the one inside of it, so that discharges and electrical corona are cut down, thus making it possible to reach much higher voltages on the inner conductor.

No doubt, in recent months many people have read about the enormous cyclotrons now being built and have marveled at the tremendous voltage such apparatus can deliver. To them it may appear somewhat peculiar that certain scientists are still building expensive and bulky generators which will produce only 5,000,000 volts. The reason lies in the fundamentally different use to which the Van de Graaff generator can be put. Here one has a steady, uniform beam of particles whose voltage can be raised or lowered from zero to the maximum at the mere turn of a knob. This flexibility is something the cyclotron lacks.

No intelligent physicist today would say that one or the other type of apparatus was the "better," since it is not a question of absolute superiority. There are some types of research in which one does not require any of this gargantuan apparatus at all. For example, the discovery of the neutron was effected with a little radioactive polonium, a plate of beryllium, some paraffin, and a few radio tubes. But there are other research jobs in which no amount of ingenuity or hard work will replace the necessary expensive apparatus. If the job happens to be one that requires very high voltages, a cyclotron is necessary. On the other hand, if it requires a finely focused beam of uniform voltage which can be easily regulated, it is a job for which the Van de Graaff generator is best adapted.

Those jobs which require both high voltage and precision are the ones which still offer a challenge to the physicist. If he is clever enough, he can lick the problem. If not, such research still lies within the unknown realm into which scientists are constantly striving to penetrate.

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PETROLEUM RESEARCH

Increased 539 Percent in Eleven Years

PETROLEUM research has expanded so rapidly that the industry now ranks second in scientific investigation, Dr. W. A. Hamor, associate director of Mellon Institute, reported recently in a survey published by the American Chemical Society.

In the past 11 years the amount of research by the petroleum industry has increased 539 percent, Dr. Hamor said. From seventh among all industries, it has risen to second place.

HOME-IDITY

Heated Houses More Humid Than Generally Believed

VERY little definite information has been available concerning humidity conditions actually prevailing in occupied houses. To obtain trustworthy data, a humidity survey was made by the National Bureau of Standards. Measurements of relative humidities in a number of houses in each of 26 localities in the northern part of the United States were made during the first part of the year 1938. The results of this survey have been published as Building Materials and Structures Report BMS56, obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C.

As was to be expected, the interior relative humidities are low when the outside temperature is low, and they rise when the outside temperature rises. The air in an occupied house has, however, a considerably higher moisture content than the outside air, because of the moisture supplied by various sources within the house. The survey also indicates that many humidifying devices in use produce little effect.

AIR TRIGGER

Odd Sequence of Events Sets Off Many of Our Earthquakes

EARTHQUAKES are shocks or jars caused when parts of the earth's crust slip past one another. The quakes do not cause the slipping, but the slipping is the cause of the quakes. Cause of the slipping is the gradual accumulation of greater and greater forces since, if this goes on long enough, a slip must occur. Many earth scientists suspect, however, that actually in numerous instances some tiny outside force precipitates the slip when the forces of pressing rocks almost balance the strength of the rocks—much as one could think of a plank which was almost but not quite ready to break, suddenly breaking on the addition of a feather or under a puff of breath. "Trigger effects," these are called.

One suspected trigger effect in the case of some earthquakes is the constantly changing weight of the air bearing down on the earth, as the weather changes. Something like this is the basis of a theory advanced by Dr. H. Landsberg, geophysicist at the Pennsylvania State University.

Climatological and meteorological conditions, especially the change of seasons, produce a transport of large masses of air from one hemisphere to the other, across the equator. This causes a change in mass-distribution of the earth itself. That, in turn, results in a slight change in position of the earth's poles of rotation. Such a shift of the poles brings each region of the earth under a different centrifugal force. If there are in any part of the earth's crust, or in the material beneath the outer crust, latent energies piled up to the verge of breaking, the small change in centrifugal force may act as a trigger that releases them.

On test, a comparison of the earthquake record with hemispherical changes in atmospheric pressure over the decade 1921-1930 indicates that this kind of force did act as a very important trigger to set off quakes.

Human Hibernation

What Today of the Frozen Sleep Therapy for Cancer? Failure, or Success?

BARCLAY MOON NEWMAN

CRYMOTHERAPY, popularly known as "frozen sleep" and "human hibernation," is proving to be an important medical advance. Originated by the logic of Dr. Temple Fay, of the Temple University School of Medicine, Philadelphia, it has been extended with conservatism and utmost caution. Though its medical sponsors make no claims as to therapeutic value, careful use of crymotherapy has already had successes in surprisingly different fields.

In 1932, Dr. Fay had occasion to make standard neurological examinations involving taking of skin temperatures at many body sites. As he went on with this work, nature appeared to give one of her rare hints. In normal human beings, the lowest body temperatures—88 to 90 degrees, Fahrenheit—are constantly found along the skin of the extremities, below the elbows, and below the knees. In the breast region, higher temperature is steadily maintained. A question darted into the neurologist's mind: Can temperature differences explain differences in the incidence of cancer? Breast cancer has a high incidence, whereas cancer rarely spreads below elbows and knees. These phenomena he pondered.

Four years later, Dr. Fay had the opportunity to experiment, and essayed to find at what temperatures cancer cells flourish best, what other temperatures retard tumors. He demonstrated that sustained cold—between 40 and 50 degrees, Fahrenheit—can retard cancerous growth in the body. But there are difficulties, sometimes insuperable. The temperature of the whole body cannot be lowered to such an extent, and local refrigeration, by means of cold water circulating through metal tubes, is applicable only where the tumor is accessible. It has, however, been effective in a few cases. Next, as the pioneer significantly relates:

"After two years of observation on the destructive effects of cold when applied to local cancer, and with the confirmation from tissue culture and embryonal studies that 'critical' temperatures exist below which cell activity ceases, it naturally followed that attempts should be made to reach the deep tumor masses which are not accessible to local refrigeration."

A side discovery provided an essential basis for refrigeration of the whole body: prompt and dramatic relief of pain follows local cooling. Patients in extreme agony and in immediate danger of death from inoperable cancer would surely be benefited, not harmed, through such therapy if it were carefully extended. Relief of pain in itself therefore gave ample justification for Dr. Fay's first effort to combat cancer by refrigerating the entire body.

A carcinoma sufferer, packed in cracked ice—painless sleep

Was it possible and safe to reduce the temperature of the deep organs of the body significantly—say below 90 degrees? In December, 1938, a female patient had undergone local refrigeration and had shown no untoward reaction. Her tumor was extending its growth. Rapidly sinking, she volunteered for general crymotherapy—the first in history. She was anesthetized. In a cool room, she was surrounded by ice packs, and the most careful observations were made at brief intervals of heart action, pulse, respiration, blood pressure. Slowly her body temperature went down—down as low as 90 degrees; it was not allowed to go lower. The combined actions of preliminary anesthetic and cold kept the woman slumbering painlessly for many hours. Removal of the ice and very slow warming successfully lifted her again into the world of awareness. She recalled nothing. A great discovery had been made. It is possible, and under appropriate conditions with the suitable patient it is safe, to lower the body temperature to a level hitherto universally believed lethal. Pain was relieved for days. There was a slight improvement in the general condition of the sufferer. No effect on the tumor was noted. More prolonged refrigerated slumber, at lower temperatures, was in order, with hope of greater benefit.

Dr. Temple Fay introduced medical scientists to treatments established upon a new plane of being—existence at low temperatures. Efforts are now being made to standardize procedures, hospital after hospital opening clinics of general crymotherapy.

IN one standard procedure, as tentatively adopted by the Crymotherapy Clinic of the Lenox Hill Hospital, New York City, the patient is given narcotics the night before crymotherapy is to start, another drug in the morning, and a final sleep-inducer to take away all consciousness, as a prelude to his voyage of cold in a specially equipped, air-conditioned room where the temperature is maintained at 55 degrees, Fahrenheit. He is laid naked on a bed, a thermocouple used as a thermometer is attached, and his wrists and ankles are padded and bound. About the trunk, from shoulders half way down the thighs, cracked ice is packed. After a couple of hours, or when the thermometer dial registers 90, the ice is removed. Body temperature continues its fall in the chilly room. Now 10 degrees, or even 18 degrees, below normal is considered safe. If there is too great a drop, blankets and bags of tepid water are used for warming. If there is a rise, ice bags are used. With a nurse in constant attendance, every half hour, day and night, the temperature, pulse,

blood pressure, and respiration are charted. The telephone summons a physician in the event of any marked change.

Every hour, a solution of salt and glucose is instilled through a stomach tube. Twice daily the stomach is siphoned out, and once daily is washed with salt water. Every 12 hours, the bladder is drained.

Though quite painless, refrigerated slumber is not altogether peaceful. Usually there is continual shivering, though the cold is not felt by the slumberer, and restlessness is often marked. Fleeting moments of awareness sometimes permit contact with the "frozen" mind, and in infrequent instances simple questions can be answered, dazedly. Yet, invariably, after the therapy there is no recollection of the days of cold. If dreams have flitted through the chilly dark, they are forgotten. The crymotherapeutic state is as close to temporary death as is physiologically possible to go. No drug or anesthetic so profoundly reduces all basic bodily processes. It is said that no patients have, in retrospect, regarded the treatment as unpleasant, though some complain of ill-defined pain upon being brought back to consciousness.

RATE of use of energy, or basal metabolism, is lowered during the cooling. Arteries, veins, and lesser blood vessels are astonishingly contracted, and the blood is withdrawn deep into the body, away from the chill. The pulse is slowed, perhaps down to 50 from the normal of about 72 throbs per minute. Cancerous growth, caused by cell multiplication, is probably stopped for the time, but not permanently. The profounder alterations of body physico-chemical reactions are as yet unknown, but such changes must occur; increased understanding here will lead undoubtedly to many medical advances.

When the period of refrigeration is terminated, operation of the air-conditioning system is suspended. The room temperature rises. The patient is covered with blankets. Very slowly, through six to eight hours, the body temperature ascends to normal. Rarely, there is an after-fever for a day or so.

Of course, there are dangers, but they are not as great as might be imagined. Bed-ridden patients are not good risks, nor are the anemic. Pneumonia incidence is low—provided no minutest lung cancer is present. With increasing knowledge of reactions, dangers will undoubtedly be much diminished.

With cancer primarily in mind, conservative Dr. Fay explains: "Refrigeration must be recognized as merely another physical agent with potentialities of cellular destruction if properly applied. . . We have some indication at the present time that 60 degrees, Fahrenheit, is sufficiently cold to produce definitely progressive influences on certain tumor tissues. There is a limit, however, to which the temperature of the human body can be reduced—70 to 75 degrees. Whether the spread and growth of carcinoma can be permanently influenced remains to be seen."

General crymotherapy has already proved its value in reducing extreme pain in many different conditions as well as in cancer. The pain always returns, but sometimes not for a month or two. Is it a wonder that at least one patient, temporarily relieved by crymotherapy after long months of intense suffering, asked: "When can I have another go?"

Because alleviation of pain has, in the majority of trials made thus far, been sufficient to justify dispensing with the previous regular administration of narcotics for varying lengths of time, a natural step has been experimentation in addiction to narcotics. Several apparent cures have been brought about, the patient passing the period of deprivation of his morphine in refrigerated slumber, and afterward seeming well able to endure life without drugs—despite years of chronic addiction.

The method is a "sleep" treatment, as is insulin shock for schizophrenia. Hence trial is being made in mental cases. What the future holds in this line, none can say. The probability of at least limited application appears high. Other efforts are directed against the one-celled animals of chronic tropical diseases, against acute bacterial infections of the heart, against Hodgkin's disease, wherein lymph nodes and lymph glands give rise to tumorous masses—the neck may be swollen to enormous size, for instance.

To date, eight days of unbroken refrigerated slumber has been the maximum attained. This period of hibernation can be extended, with results that cannot be guessed. Methods permitting lowering of the temperature possibly down even to 70 degrees, Fahrenheit, are believed to be on the way. Such amazing feats will have value in many practical procedures besides those already adopted. Meanwhile, we can remain convinced that an utterly new plane of life—cold life—has been given to medicine for profitable exploration.

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LIKE HUMANS

Bacteria Have Their Own Periods of Weakness

BACTERIA no less than men are subject to the laws of heredity, giving rise to countless generations of bacterial "tough guys" as well as physical weaklings. Dr. Harvey C. Rentschler, director of research for the Westinghouse Lamp Laboratories at Bloomfield, New Jersey, has verified this fact through research to collect data on the bactericidal action of ultra-violet radiation.

Laboratory tests and experiments which have been made over a period of two years has disclosed and authenticated other new biological facts of bacterial life. Bacteria vary in strength according to the stages of their life cycle, the scientist says. During a bacterium's weakest moments it is eight to ten times less strong than during its most healthy period of life.

"This variation is considerably greater than was suspected and must be seriously considered in making any tests to determine the effectiveness of bactericidal agents," Dr. Rentschler states. "In working with an ordinary culture of bacteria," Dr. Rentschler continues, "it was found that the lethal ultra-violet radiations for different individual bacteria in the same stage of their life cycle may be different by as much as threefold." It is now indicated that the deadliness of bactericidal agents is not only dependent upon the family of bacteria being killed, but also upon whether or not the bacteria are young, middle aged, or decrepit, as well as upon the definite strain of organism.

These experiments and others which were carried out to even greater lengths, demonstrated that some bacteria were more resistant than others and that the "tough guys" passed on their vigor to their children and grandchildren and on down the line.

Electrical Gold Mining

Giant Dredge and Gold Recovery Plant Are Gleaning Gold Near Famous Comstock Lode

NEW in magnitude, yet old in conception, is the "electrical miner" that is now taking 19-ton bites in the gold-bearing gravel of the historic Nevada ghost-town of Dayton. Proof of the age of its conception will be found on page 260 of this issue where, under the heading of "50 Years Ago in Scientific American," will be found a brief description of a similar "miner" that was in operation half a century ago.

Nineteen tons of gravel in one big bite—and the placer gold miner of yesteryear, working by hand, took one shovelful at a time. Twenty thousand tons—40 million pounds—in one three-shift, 24-hour working day. That's more "pay dirt" than 1000 average hand miners of yore could turn over with pick and shovel, and wash in their crude sluice boxes, in a week.

That's the story of the "electric miner" which is seeking, in 20th Century fashion, flecks of the precious yellow metal which Dayton's hardy—if transient—miner folk of 75 years ago sought with pick and shovel, gold pan and sluice.

The "electrical miner" of today is, in reality, two separate machines, P. S. Crocker, superintendent of the Dayton Dredging Company recently explained. One is the gold recovery plant—the largest of its kind in the world—which floats on a small artificial pond created by pumping water from nearby wells. It contains the washing and jigging apparatus that gleans the flakes of gold. The other machine is the "walking dragline," which resembles a power shovel as it scoops up 10-ton loads of gravel as far away as 150 feet and delivers it to the recovery plant.

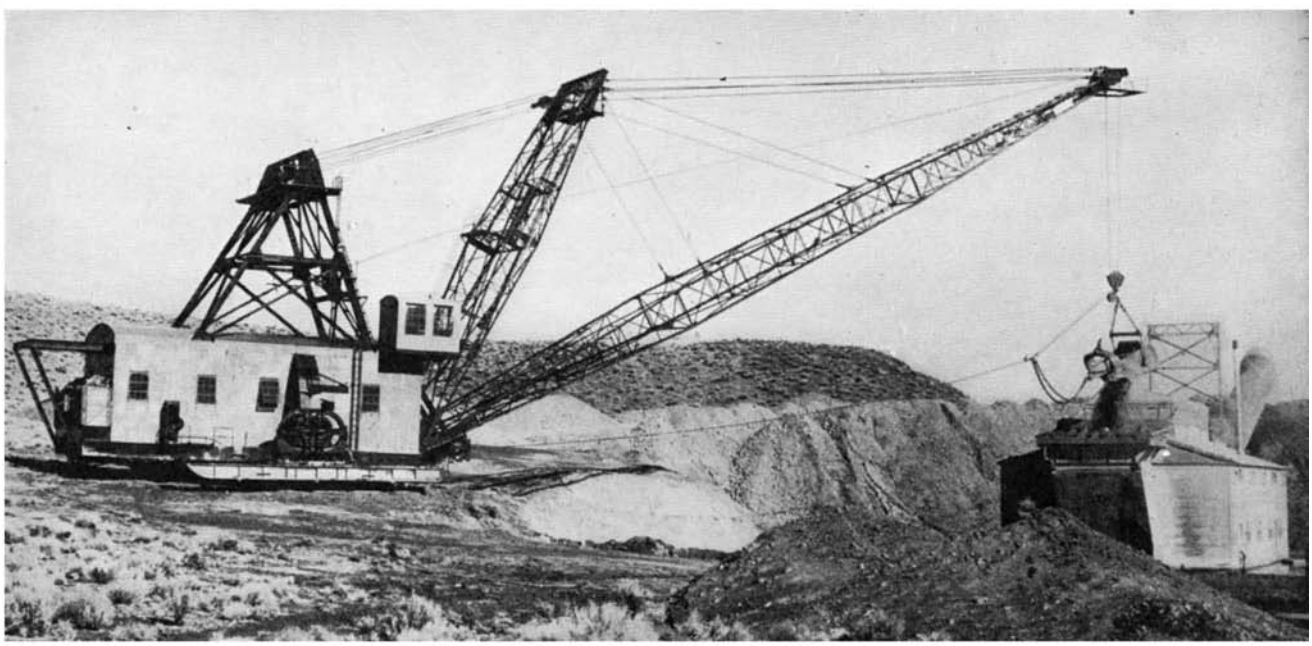
A crew of half a dozen men operate the "electrical miner." In the recovery plant, most of the work is done by 24 Westinghouse motors and gear-motors, which in one day can supply power to recover the gold from 15,000 cubic yards of gravel.

"Heart of the operation," Mr. Crocker said, "is the floating gold recovery plant. This is simply a vast, efficient, modern version of the old gold pan, the sluice box, and the 'riffles' by which the hand miner of yesterday captured little flakes of gold in quicksilver."

Gravel from the dragline bucket is dumped into a hopper at the front end of the recovery plant. "Grizzly bars" across the mouth of the hopper prevent the entry of oversize rocks and boulders. The smaller material — gold-bearing sand and gravel—passes into a huge steel cylinder called a trommel, which is nine feet in diameter and 60 feet long. The trommel is placed on a slight slant and is revolved slowly by a 125-horsepower gear-motor, said to be the largest motor of its type ever employed in the washing plant of a dragline dredge.

In operation, a 150-horsepower motor pumps high-pressure streams of water through half a hundred nozzles and onto the sand and gravel passing through the trommel. More than half the cylinder's 60-foot length serves literally as a "sieve," through the holes of which pass gold-bearing sand and pieces of rock and gravel one-half inch in diameter or smaller. Larger pieces travel to the end of the trommel and fall onto the conveyor belts of the caterpillar-like "stacker" at the rear end of the plant.

Sand and gravel passing through the holes in the trommel go to concentrator devices called "rougher jigs," in which the material is continually shaken. The shaking serves to settle the heavier, gold-bearing material to the bottom, where it is drawn off as "rougher concentrate" into a concentrate sump. The lighter, hence non-gold-bearing, material from the jigs



A view of the gigantic "electrical gold miner" with its bucket, capable of taking a 19-ton bite

goes to the stacker, thence to the gravel pile.

From the concentrate sump, the rougher concentrate is conveyed to a "cleaner jig," in which the shaking process is repeated. Rejected materials from the cleaner jig go overboard. The concentrate goes next to the "amalgamator," where mercury combines with the gold to produce an amalgam. The amalgam is taken periodically to retorts on shore, where it is heated, the mercury passing off as vapor. It is then condensed for use again. The gold remaining in the retort after treatment is shipped under guard to the U. S. Mint in San Francisco.

Some gold may be left in material which is rejected by the amalgamator. This may include small pieces of quartz, for example, containing concealed or partially concealed particles of gold. Such material is washed over "rubber riffles," in the pockets of which mercury combines as amalgam with some of the remaining gold.

The remainder is fed to a "ball mill," which is rotated by a five-horsepower motor. The ball mill contains hundreds of chrome steel balls about an inch in diameter. As the mill rotates, these balls crush whatever gold-bearing rock remains. The resulting substance is washed over more rubber riffles, and the remainder of the gold is amalgamated with mercury.

Such is the method by which modern miners are extracting gold from the earth, where hand methods would not pay out. Here, on the edge of the famed Comstock Lode mining country, this mechanical monster is chewing away at the rate of 19 tons to the bite. Tomorrow—a tomorrow not too far in the future—the site of Dayton, Nevada, will be one vast stretch of gravel, and then the sage brush and prairie grass will reclaim it.

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Pulling the Wool Off Your Eyes

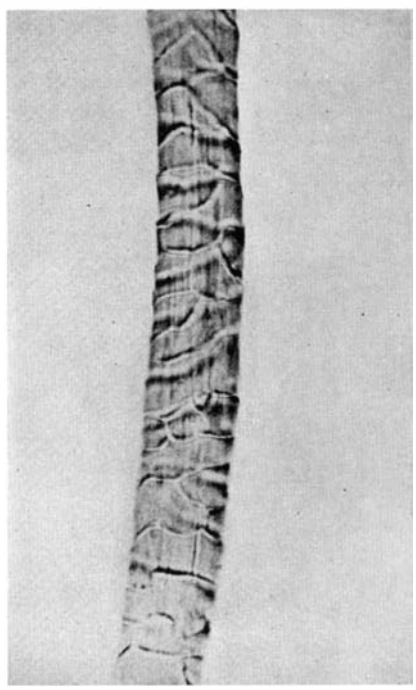
New Federal Law Defines "Wool," Sets Up Standards for Labeling Fabrics Honestly

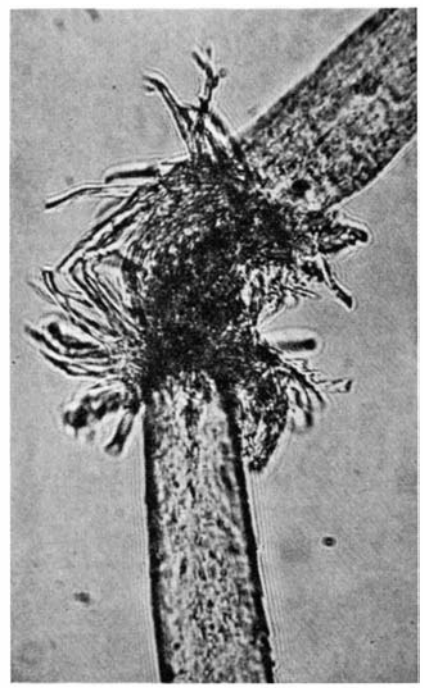
As a descriptive phrase, "all wool and a yard wide" is all right as far as it goes—but it does not go far enough. So Congress has just enacted a law that defines just what wool is and which requires that all articles made of wool, from a pair of socks to a blanket or a suit of clothes, be labeled to set forth the exact wool or other fiber content.

The law provides that the term "wool" means virgin wool; that is, new wool just as it is produced by nature. The individual fibers of virgin wool are relatively long, unbroken, resilient, and lively. These characteristics are important because they give the fabric beauty, unexcelled tailoring qualities, and, most vital of all, long wearability. Because the fibers are undamaged, they retain their natural thermal qualities, and afford the protection against extremes in temperature which virgin wool alone can give. A garment of virgin wool holds its shape and is not easily wrinkled.

Reprocessed wool is defined as wool that has been fabricated, but which has never been used by the consumer, and reclaimed wool is wool which is reclaimed from clothing or other articles that have actually been used. These materials, before being re-spun and re-woven, must be torn up into a fibrous mass. This tearing process inevitably damages the fibers and makes them relatively shorter, weaker, less resilient. As a consequence, fabrics containing reprocessed or reclaimed wool have poorer tailoring qualities, hold line and pressing less readily, and afford less wearability than comparable fabrics made of virgin wool. Because reclaimed or reprocessed wool fibers have been damaged, their natural thermal qualities are impaired, and clothing made from them provides appreciably less protection.

A fabric made of any of these fibers, or of any variety of combinations of them, may be "all wool and a yard wide," but there would be a vast difference in quality. Or the fabric might not be actually "all wool," for the old woolen rags that were reclaimed may have contained liberal percentages of cotton, rayon, or other fibers, and of course these would go right into the new fabric. The use of cotton, rayon, and other adulterants in products implied to be of virgin





Left: **A strand of virgin wool, magnified 1000 times, showing unbroken form and the scales that give it the qualities needed for durable fabrics.** ***Above:*** **A strand of reprocessed wool, at same magnification. Note absence of scales and broken, torn condition of the fiber, making for poor wearing qualities**

wool has been constantly increasing in recent years. In the most recent year for which comprehensive figures are available, manufacturers of wool fabrics used 220,000,000 pounds of clean virgin wool, but mixed in with this were 80,000,000 pounds of cotton, 70,000,000 pounds of rayon, and 114,000,000 pounds of reclaimed and reprocessed wool. In other words, of all the products offered to the public without qualification as wool, over half the fiber content was other than new, long-wearing virgin wool!

Members of Congress themselves got a sample of what the consumer is up against when they undertook to write the legislation. Among the witnesses called before congressional committees was Curt E. Forstmann, president of the Forstmann Woolen Company of Passaic, New Jersey. When Mr. Forstmann appeared before the committee, he took with him three suits which appeared to be identical. In fact, they were identical in every detail of spinning, weaving, dyeing, and finishing. Yet there was a vast difference, for one was made entirely of virgin wool; one was made of 50 percent virgin wool and 50 percent reprocessed wool; and the third was made entirely of reprocessed wool.

Members of Congress who inspected them could not tell one from another. They tried to tell the difference by feeling the texture, by rubbing, by pulling, and by minute inspection. Yet invariably their choices were wrong.

Then Mr. Forstmann produced some charts to show what happened in the laboratory when the fabrics were subjected to scientific tests duplicating the effect of actual wear and service. On the abrasive machine the virgin wool fabric had withstood the equivalent of several years of hard usage; the fabric containing 50 percent virgin wool and 50 percent reclaimed wool had failed after half the wear of the virgin wool fabric; and the fabric of reclaimed wool had broken through after only one fifth the abrasion. In tensile strength the virgin wool fabric withstood five times the pull that tore apart the fabric of reclaimed wool. The fabric made half of virgin wool and half of reclaimed wool had a tensile strength proportionately between the two.

The new law does not prohibit the use of reclaimed or reprocessed wool, cotton, or other adulterants. It merely requires that any wool product shall carry a single label showing by percentages the different fibers which have been employed in its manufacture. Most wool products already carry a label of some sort, showing the name of the retail store if nothing else; the law simply calls for the added factor of fiber identification. The manufacturer of the basic fiber must pass this information on to either the converter or the retailer, as the case may be, and they in turn must present it to the consumer. The retailer can use the manufacturer's label or he can substitute his own. Enforcement of the law is entrusted to the Federal Trade Commission.

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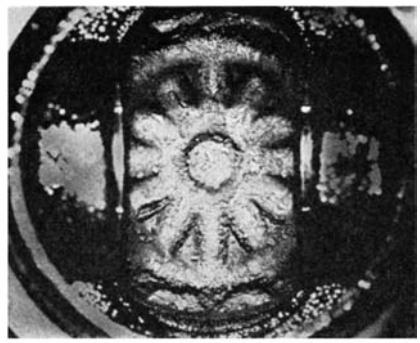
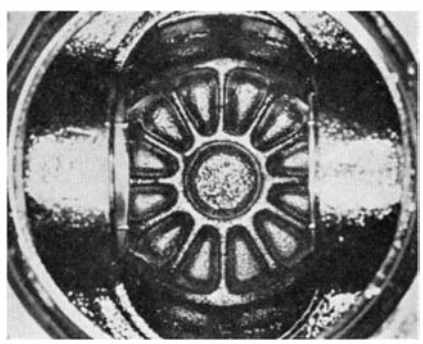
Lubricant 'Washes' the Engine

Designed for Heavy-Duty Gasoline and Diesel Engines, New Oil has Detergent Properties

A NEW type of engine lubricant, developed to overcome piston varnishing, ring sticking, and other major lubrication troubles which have limited output of many heavy-duty, high-speed Diesel and gasoline engines, just announced, marks the first time the petroleum industry has been able to offer highly "detergent" or "washing" properties incorporated in a stable, high "viscosity index" base oil. The new Essolube HD has a viscosity index of approximately 100, nearly twice that previously available in special detergent oils meeting the full range of known heavy-duty engine requirements. This new lubricant has, in addition to inherently natural resistance to oxidation and high temperature, an exceptionally high ability to wash out sludge deposits, protect bearings from corrosion, and substantially to prevent deposits of varnish on pistons.





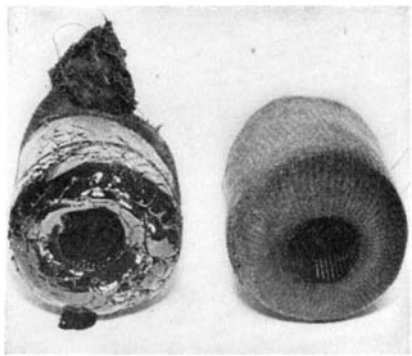
Above: **Underside of Diesel piston, lubricated with mineral oil, is heavily carbonized.** ***Below:*** **Piston operated under comparable conditions with new HD oil is clean, almost carbon-free**

Detergent type oils in themselves are not new. Heretofore, however, oils with sufficiently high detergent properties to eliminate ring sticking, varnishing, and sludge deposits in the full range of present heavy-duty engines have had, for chemical reasons, to utilize base stocks of relatively low viscosity index. While such oils did markedly improve engine cleanliness, many engines have required, in addition, high resistance of the base oil itself to oxidation and bearing corrosion. A major problem for petroleum chemists, therefore, has been to develop an oil which, while possessing these detergent properties, had in addition the high stability usually characterized by lubricants of high viscosity index.

Viscosity index, while primarily a measure of an oil's ability to resist changes in "body" or viscosity with changes in temperature, is also a useful measure of the stability and protection furnished in service. A high viscosity index oil, by retaining its body when hot, is best able to lubricate cylinder sur-

faces and to resist leakage past rings where oil would be consumed. Laboratory evidence shows, moreover, that the stability of an oil against oxidation and heat increases, in general, with the viscosity index of the oil.

Essolube HD has been tested exhaustively in the laboratory and on the road in actual service operations. It has passed the severe General Motors Diesel test, which calls for a 500-hour run in a General Motors high-speed Diesel under full load and at full speed without oil change, and has also been formally approved by the Caterpillar Tractor Company for use in its Diesel engines, passing the well known and exceptionally severe 1000-hour endurance runs in a Caterpillar engine under both laboratory and field conditions. Essolube HD is the first high viscosity index lubricant to obtain Caterpillar approval and the first high viscosity lubricant to have passed both the Caterpillar and General Motors engine test requirements. This is said to be of particular importance since many engineers consider the requirements of these two engines so different that any one lubricant which satisfies both is well suited to the full range of present-day heavy-duty engines.



Both of these filters have gone 3000 miles. One at left was in engine using ordinary oil; one at the right filtered new HD oil

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SPRAY POISON

Kills Codling Moth

Worms, Spares Bees

DEADLY to apple worms, harmless to bees, are virtues found in the new poison-spray material, phenothiazine, now being tested by the United States Department of Agriculture. The discovery is subject of a joint report by L. M. Bertholf of the Bureau of Entomology and Plant Quarantine and J. E. Pilson of Western Maryland College, according to *Science Service*.

One of the great problems involved in control of the worst of apple enemies, codling moth (whose larvae are the "worms" found in apples), is the deadliness to bees of the arsenical sprays commonly used. Beekeepers and orchardists are constantly at feud over this question.

In the tests reported recently, bees were given heavy doses of phenothiazine without any apparent ill effects. In contrast, minute doses of calcium arsenate proved deadly, and lead arsenate was also an active bee poison in the doses bees are likely to get in gathering pollen from sprayed orchards.

Phenothiazine is not yet recommended for general use in orchard spraying, because thus far it has not produced uniform results on the codling moth larvae. It is hoped that further experiments will make it more completely dependable and useful.

ANISEIKONIA

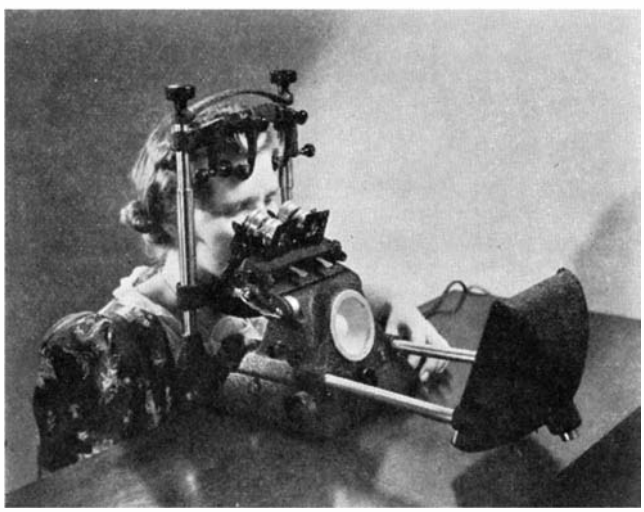
Device Detects Important Eye Defect

MANY puzzling cases of eyestrain, sick headaches, nervousness, and some traffic and flying accidents may be eliminated through the development of a new and simplified instrument to detect and measure aniseikonia, recently discovered eye defect described in a recent article in these pages.

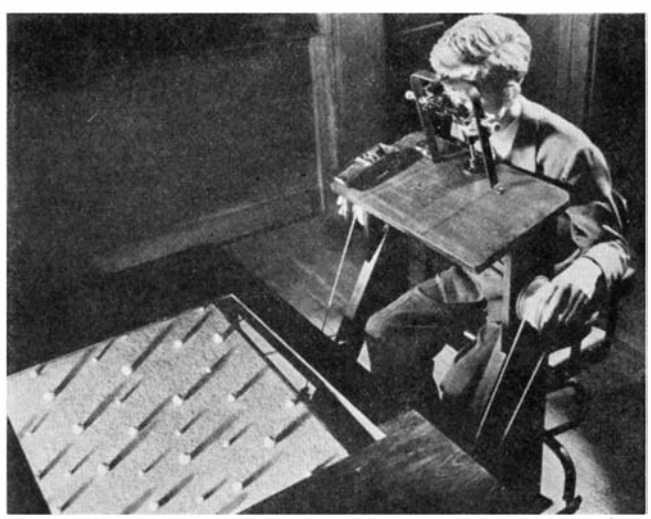
Aniseikonia, discovered by Dartmouth research scientists, causes pictures of objects received by the brain through the two eyes to be unequal in either size or shape, or both. It occurs fairly frequently. The strange eye condition may affect stereoscopic vision so that objects in space appear tilted, rotated, and distorted.

As faulty depth perception makes flying hazardous, systematic tests have been inaugurated to determine any existing relationship between aniseikonia and the flying performance of pilots.

Heretofore, it was necessary for victims of aniseikonia to visit clinics in New York, Boston, St. Louis, Baltimore, and Hanover, N. H., to have the defect corrected. Approximately 5000 cases have already been treated. Assisted by the new instrument, specially trained eyesight specialists



Aniseikonia, recently discovered eye defect, is detected and measured by this unit, the eikonometer



When a person with aniseikonia is asked to level the table covered with white balls, he is unable to do so

throughout the country will soon be in a position to make the necessary examination and correction of this eye defect.

The new test instrument measures the relative size of the two ocular images. By means of special lenses, an illuminated screen, and polarized light, chief components of the eikonometer, both eyes are trapped into revealing their comparative efficiency in transmitting images to the brain.

First, the eyes are examined for any refractive errors and corrective trial lenses are placed in the instrument. Telescopic lens systems with variable magnifying properties are also placed before the eyes.

The patient looks through the battery of lenses at an illuminated target of lines forming a cross. At equal distances from the center of the cross, four pairs of numbered opposing arrows are located perpendicular to the lines.

By means of Polaroid film the light coming from the odd numbered arrows is polarized in one direction, the even numbered in the direction at right angles. Correspondingly oriented Polaroid plates placed before the eyes permit the patient to see the odd numbered arrows with one eye, the even numbered arrows with the other.

If the four pairs of arrows are not seen in alignment with each other, a size difference, or aniseikonia, is present. This difference is measured by adjusting the magnifying lens units until the opposing arrows are in alignment. The defect is then corrected by iseikonic lenses which are so designed that they not only correct any existing refractive error but also aniseikonia.

PENCIL POINTER

Electric Driven Sharpener for Office Use

AN electric pencil pointer which, it is claimed, will give substantial savings in time and pencil waste, has recently been placed on the market. Known as the "Electro-Pointer" it is powered by a self-balancing, non-stalling A.C. or D.C. motor which is operated automatically when the pencil is pushed into the hole in the housing.

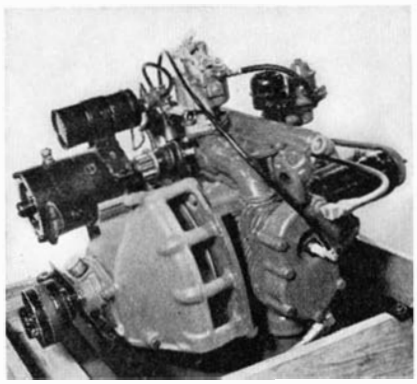
Points pencils automatically

The unit is housed in molded black Durez, is weighted so that it will rest on a desk or table top without having to be screwed down. The shaving-receptacle drawer is large enough so that it need not be emptied as frequently as in most conventional pencil sharpeners.

INBOARD BOAT

Economical Marine Engine in Small Power Boat

AN adaptation of the small gasoline engine used in the Crosley automobile has now been applied to marine use. In the design of this motor, economy has been stressed both in original cost and in upkeep. Equipped with an electric starter,



Two-cylinder marine engine adapted from automobile motor

it can be applied to small boats of various types and is also used as the power plant of the Crosley "Watersprite" shown in one of our illustrations.

In adapting the automobile engine to marine purposes it was changed from an air-cooled to a water-cooled type, the cooling water passing out through the exhaust pipe. The engine itself is of the two-cylinder opposed, four-cycle type and is claimed to use less than one gallon of gasoline per hour at full throttle, and less than one-half gallon per hour at cruising speed. Horsepower rating is approximately 10 at the recommended maximum engine speed of 3000 revolutions per minute. The total weight, including the electric starter, is only 190 pounds. The

"Watersprite", plywood boat that uses new engine described

motor has a 3 inch bore, 2½ inch stroke, displacement of 33.5 cubic inches, a compression ratio of 5 to 1, and a crankcase oil capacity of 2½ quarts.

The hull of the "Watersprite," the boat for which this motor was specifically designed, is made of plywood, four layers being molded into plastic form with a phenolic water-proof resin glue. There are no seams in the hull, which has been molded with a reverse flare to give additional speed and to deflect water from the sides of the boat.

HEARING AID

Vacuum Tube Amplifier Used in New System

NOT only is sound amplified far above its normal intensity, but various portions of the musical range can be amplified by different amounts by a new vacuum tube hearing aid recently announced by the Western Electric Company. With these decided advantages for the hard-of-hearing, tones which are normally heard very poorly can be clearly reinforced, and those which are heard fairly well may be amplified only a small amount. Thus it is possible for the Orthotronic Audiphone, as the new instrument is called, to compensate admirably for individual types of hearing deficiencies. A further advantage is that the circuits are so designed that nearby voices or distant sounds are amplified only sufficiently for the purpose, the "shock effect" of loud noises being eliminated.

This last advantage also gives the wearer control in noisy places against the possibility of certain noises being amplified and interfering with the desired sound. By flipping a small switch it is possible to reduce annoying rumbles and deep vibrations while essential speech sounds pass unhampered. Another control regulates volume of the reproduced sound.

The microphone, which, with

the amplifier, is contained in a housing only slightly larger than a cigarette case, is of the crystal type. The miniature receiver to which it is connected through the amplifier is of the magnetic type and may be coupled with the hearing mechanism either by the air conduction or bone conduction method. The manufacturer states that the crystal microphone is stabilized both for temperature and humidity, assuring the wearer of natural hearing regardless of extremes in weather conditions.

SALES EDUCATION

Sound Recorder Enters A New Field

INDICATIVE of the possibilities of quality sound recording equipment is the use of Presto recorders in a recent sales audition and contest held by Westinghouse. In this contest, household appliance salesmen were encouraged to prepare sales talks which were eventually recorded and then reproduced for final judging.

It would be entirely possible to extend this use of sound recorders to many other fields. Wherever it is desirable for salesmen or an executive to be able to hear his own spoken words in order to evaluate their effect, home sound recorders can serve a very definite purpose. A complete sales argument, a speech, or any similar exposition can be completely recorded and then played back as many times as desirable. Thus it becomes possible to "edit" the material before it is finally used for its intended purpose. These recorders, as now available, can be used by anyone, regardless of technical training; they are almost as simple to use as is an ordinary phonograph.

Recording a sales talk for future reference

PENCIL BLUEPRINTS

New Drawing Medium for Draftsmen

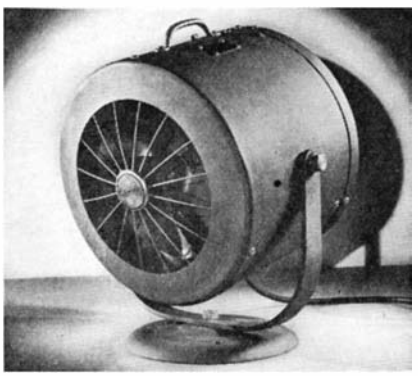
BLUEPRINTS and Blacline prints made from pencil drawings on a new transparent medium are as sharp and clean as those made from conventional India-ink drawings on tracing cloth. This new medium, not a tracing cloth and not a vellum, has astounding strength and body, is moisture-proof, and is lower in cost than conventional drawing mediums. Due to the surface of this Post Tracing Medium, as it is called, pencil detail is as opaque as if drawn in ink. Coupled with this is the extreme transparency of the medium, both contributing to the quality and sharpness of the final printing results.

Standard 20-yard rolls of this material are available in widths from 30 to 54 inches; it may also be had in sheet form.

UNIT HEATER

Fan and Heater in Compact Housing

FOR year around use in office and stores, a new fan-type all-electric unit heater is now available in two, three, and four kilowatt sizes at 115 and 230 volts A.C. The units have an output of 7000, 10,000, and 14,000 B.T.U. per hour respectively.



Heater and fan in one unit

The all-metal heaters are cylindrical in shape, with a swivel bracket designed for both vertical and horizontal adjustment. The overall dimensions are 16¼ by 13¾ by 11½ inches deep.

A Westinghouse Corox heating element is used to give long life, dependable performance, and economical operation. The switch for winter operation controls both heating element and fan, and a bimetal thermostat removes motor and heater from the line in case of overheating. The fan operates independently for summer use as an air-circulating unit.

Smooth and quiet operation is assured by special motor and fan construction. Baffles direct the flow of incoming air over the motor and protect it from radiant heat. Unusually wide fan blades assure maximum air delivery against any possible back pressure.

SOLID SHOT

Believed Effective Against Tanks

BECAUSE of the increased thickness of armor on tanks, armies of the world have developed larger and still larger guns to combat them. Needless to say, the cost of operating these larger guns, with their much larger shells and explosive charges, has increased enormously. Brig. Gen. R. H. Somers, of the U. S. Army Ordnance Department, suggested recently that smaller guns firing solid shot would be just as effective and a great deal less expensive to operate.

Those who have examined tanks at close quarters can easily understand how one solid shot, once it

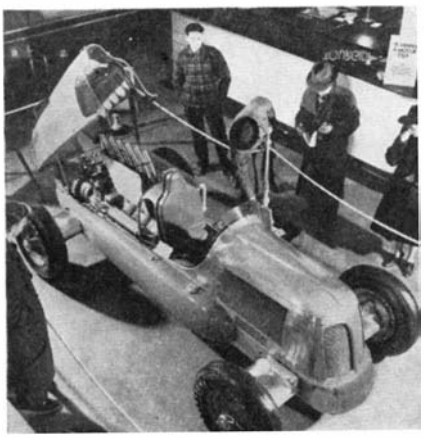
penetrates the "cabin" of a tank would certainly cause damage. That small compartment must accommodate not only the driver, the tank commander, and one or more gunners, but it must also have all the controls and the magazine containing all ammunition. A solid shot would find numerous vulnerable parts which it would put out of action. It is believed, further, that a solid shot would do serious damage to the treads or to any exposed engine parts.

RACE CAR

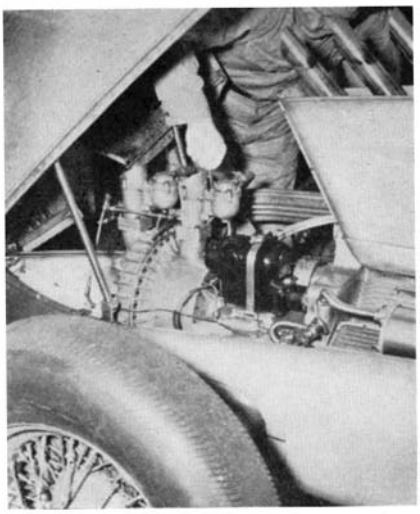
Uses "Pump" Gasoline, Breaks Speed Records

FOR years it has been taken for granted that highly doped and blended gasoline is used by the daring race drivers who crack speed records. Most of these fuels contain only about 10 percent actual gasoline, the balance being benzol, alcohol, and plenty of "ethyl." But George Barringer and his experimental Miller Special, shown here, have proved that records can be broken with ordinary service station or "pump" gasoline in the tank and regular motor oil, not castor oil, in the crankcase.

On Utah's famous Bonneville Salt Beds, Barringer cracked 14 international records and set 19 new American marks (certified by the Contest Board of the A.A.A.) with his rear-engined speedster. All records for Class "D" racing, from 5 to 500 miles were broken, not by small margins, but by a minimum of 18 to a maximum 32 miles per hour. The 142.799-mile clip for 500 miles is almost 25 miles an hour faster than the Indianapolis Speedway record for this same distance. The low-slung racer was specially designed by Harry Miller, dean of Indianapolis builders, to use conventional gasoline and oil, and was built by the Gulf Research Laboratory at Harmarville, Pennsylvania.



Rear-engine race-car uses ordinary "pump" gasoline efficiently



Carburetors and supercharger of the Miller rear-engine race car

The car is built almost entirely of aluminum. Its six-cylinder supercharged engine is placed in the rear. Combined with a four-wheel drive, this engine has sent the racer roaring along at speeds of nearly 160 miles an hour.

Miller selected a six-cylinder engine for the power plant because it would combine smoothness and simplicity. The 529.5-pound motor has a displacement of 183 cubic inches and develops over 1.35 horsepower per cubic inch. This is about three times the power of the average stock engine.

In order to provide for quick dissipation of heat and to reduce weight as much as possible, the motor block is of cast aluminum. The engine is of the usual Miller design, using two overhead camshafts, gear driven from the crankshaft. No rocker arms are used, the cams acting directly on the followers which are mounted in contact with the valves. Babbitt bearings are used.

The supercharger is of the centrifugal type designed by Miller; the nine-inch impeller is driven at 34,000 revolutions per minute at the engine's top speed of 7000 revolutions per minute. Two carburetors serve the supercharger, and air is taken in direct from outside the hood.

The car's performance with conventional No-Nox gasoline and Gulfpride motor oil leaves little to be desired. Even though the compression ratio is very high (12.5:1), there has been no trace of knocking. Still more remarkable is the condition of the engine after the many gruelling tests at high speed. Pistons, valves, sleeves, rings, and bearings show hardly a sign of wear or deterioration.

Cost of operation is considerably reduced by the use of service station gasoline which costs from one-half to one fifth as much as "doped" fuel. The castor oil compounds, which last only a few hours, are supplanted by conventional motor oil which can be used for months.

FIRE AID

Seals on Extinguishers Keep Them Always Ready for Use

THE NATIONAL need for uninterrupted production demands that fire extinguishers be kept ready for emergency use. They must not be tampered with. After use, they must not be returned empty to their brackets. They should be inspected often.

To facilitate frequent inspection and to tell at a glance whether pump type extinguishers have been tampered with or used, Gardeseals have been introduced by the Pyrene Manufacturing Company. These seals, placed over extinguisher handle and bracket, are bright red, visual signals that are destroyed the moment an extinguisher is taken from its bracket. Gardeseals, easily applied by soaking in water and placing over handle and bracket, shrink to a tight seal in an hour.

An easily broken seal between fire extinguisher and bracket shows instantly whether extinguisher has been used

HORIZONTAL WELLS

New Technique Taps Oil Sources

HORIZONTAL drilling of oil wells, after 25 years of working out the problems involved, at last appears to be an accomplished new technique of the petroleum industry, bringing materially increased oil production from certain types of

fields, and offering promise of further extension in the future.

The first horizontal well, drilled into an outcrop in a creek bed in Ohio, penetrated an old field where engineers reported that no oil could be recovered by conventional vertical drilling. After this well had been on production for six weeks, it is stated, it was producing oil at a rate greater than the combined total of the nearest 50 producing vertical wells in the field.

Success of the well encouraged the sinking of a large vertical shaft, from the bottom of which six horizontal wells have been drilled. The wells were drilled in diametrically-opposite pairs, two at a time. The same set of tools was used for each pair of wells; the operation of pulling the drilling rods out of one hole to change the bit moved them into the opposite hole for drilling.

Advantage of horizontal drilling, in the shallow fields where it now may be applied, obviously lies in the fact that instead of having only a small portion of the well hole actually in the oil formation, the entire length of the well is in the formation, with a consequent increase in production per well.

COFFEE IN GLASS

Vacuum Sealed Containers Protect, Yet Display

ONE of the new types of glass, a product of research, is now finding a field in the packaging of merchandise. Duraglas, as the material is called, is a high-strength glass which makes possible a light weight container with sufficient durability for ordinary handling.

In this new container coffee is now being offered to the buying public. Air-tight, rubber-lined caps seal the container perfectly and facilitate resealing after the container has been opened. Thus the advertised freshness of the coffee is not only guaranteed up to

Glass — yet light, strong

the time of purchase but also while the container is in the home.

Although coffee has been merchandized in glass containers in the past, the new Owens-Illinois technique of manufacturing Duraglas presents the advantages of lightweight containers which materially reduce the shipping costs.

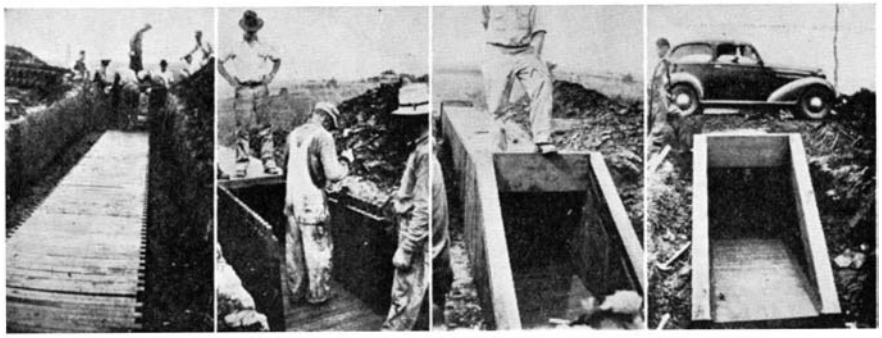
CULVERTS

Laminated of Pressure-Creosoted Wood

INEXPENSIVE culverts that can be rapidly constructed of prefabricated wood members are finding increasing usage in railway construction, highway design, airport drainage, in waste and storm sewers, and in other locations where their relative freedom from maintenance problems is a desirable feature.

These culverts are made up of pressure-creosoted wood members which are assembled by unskilled labor at the point where they are to be used. Interlocking features make it possible to install a culvert with a minimum loss of time. An accompanying series of illustrations show a culvert that was completely installed in three hours.

The prefabrication of the sections used is accomplished by nailing the individual members into laminated sections up to four feet in length. Side, top, and bottom sections interlock and are field erected without the use of additional hardware. The design is such that every member in the side sections has a bearing surface for every top and bottom member, thus insuring maximum strength.



Photograph at left was taken at 9 A. M., one at right at 12 noon. In the elapsed three hours the laminated wood culvert was completely installed

These laminated culverts have sloping head walls and underground curtain walls at both ends, thus preventing erosion, backwashing, and overflow. It is stated that the pressure-creosoting of the wood used results in exceptional durability.

PLANETARIUM

For Navigation Studies and the Astronomy of Position

WHAT is believed to be the first basic advance, in several centuries, in devices to simulate the movements of celestial bodies and their relation to terrestrial phenomena has been developed by Fred Hagner, of San Antonio, Texas, who previously invented the Hagner Computer, now in use by the United States Army Air Corps for air navigation.

The new instrument, the Hagner Planetarium, is designed to facilitate a grasp of the principles of nautical astronomy, in their application to problems of celestial navigation, but the device also may be set to solve the astronomical (spherical) triangle, inherent in all off-shore or air navigation "arguments."

The planetarium consists of an assembly of metallic rings and arcs, graduated in hours and fractions, and degrees, according to their respective functions; a horizon, or azumith disk, the center of which represents the position of the observer and the periphery of which represents the observer's horizon; and two globes, one terrestrial and one celestial (star), which are interchangeable in the frame with each other, and with the azimuth disk.

Some of the functions of the planetarium are: Identification of stars and constellations, the names of which may be read direct through a sighting tube, after the proper settings have been made on the arcs concerned; determination, in advance, of stars that will be visible above the observer's horizon at a given hour of local time in a given latitude; measurement of the Sun's altitude; determination of true north, to check compass error; computation, mechanically, of a line of position for mariners; reproduction of the Sun's motion at different seasons; demonstration of differences in lengths of days in various places; times of sunrises and sunsets at different points on the Earth; differences of time in different cities at any given instant; determination of correct local time at any instant; demonstration of beginnings and endings of seasons.

The parts of the Hagner planetarium described on this page

ODOR ADSORBERS

Reduce Air-Conditioning Costs

BECAUSE the new outside air introduced in air-conditioning sys-

tems consumes the bulk of the conditioning energy, modern systems are being designed to *re*-circulate a maximum of the total air circulated. This maximum is, however, limited to the health and comfort of the occupants — which requires from 15 to 30 cubic feet of pure, odor-free air per minute per person. By applying odor adsorbers to the recirculated air, it becomes possible to reduce the outdoor air supply to from three to five cubic feet per minute per occupant (more than ample for oxygen requirements) and thereby provide air-conditioning comforts at considerably reduced air-conditioning costs.

Savings of this sort, afforded by odor adsorbers such as the Dorex type, are frequently as high as $160 per annum for each thousand cubic feet reduction in outside air, or over 100-percent annual return on the cost of the odor-adsorbing installation. These installations may be applied to existing as well as new air-conditioning systems.

Dorex odor adsorbers are the commercial application of the gas-mask principle. Employing specially processed, highly activated coconut shell carbon, they adsorb, or, more simply, extract and hold, odorous gases and vapors in a condensed state. Upon saturation the carbon may be economically reactivated and re-used.

RUBBER TRACKS

Efficiency of Army Tanks Increased

WHEN the modern mechanized army rushes over all manner of rough terrain on "caterpillar" tracks, anything that can be done to contribute to the efficiency of the

Comfort, efficiency, for tanks

equipment or of the operating crew is highly desirable. Rubber is now playing its part in this respect. By cushioning tank treads with rubber blocks it is possible to reduce the wear and tear on the tank itself, to operate the tanks at higher speeds on paved roads, and to contribute a certain amount of comfort to the crew.

One of our photgraphs, taken in a factory of the Goodyear Tire and Rubber Company, shows tank track blocks with these rubber pads attached. It is said that thousands of these blocks are being manufactured under sub-contract for manufacturers of Army tanks.

TRAFFIC LINES

Glass Beads Increase Night-Driving Safety

ANY way in which the visibility or effectiveness of the traffic stripe on highways can be increased during the hours of darkness, will make a worthy contribution to highway safety.

One method, which is now being experimentally employed in California, uses glass spheres or beads to reflect headlight beams and hence to make the traffic stripe more visible. The process of application is quite simple. A bead dispensing machine is placed directly behind and approximately 18 inches away from the spray nozzle of the paint rig. When in motion, the rubber tired wheels of the machine turn a fluted cylinder in a hopper, which, by gravity, feeds the glass spheres onto the wet paint. As the lacquer dries, the beads become embedded and firmly locked into place.

It is not necessary to clean traffic lines when painted with beads. Any small accumulation of road dust collected between the spheres is quickly removed by the action of traffic.—*California Highways and Public Works.*

EXTRUSION DIES

Graphite Lubrication Improves Product, Protects Dies

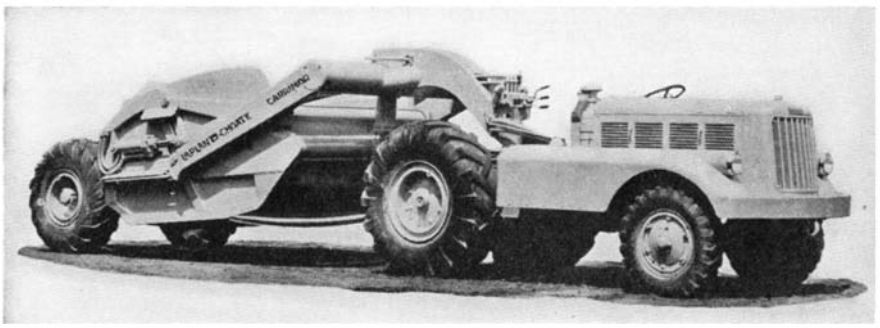
TO INCREASE the number of "pushes" between successive redressing operations on extrusion dies, Revere Copper and Brass, Incorporated, is using "dag" colloidal graphite as a lubricant.

Extended tests have shown that by using this form of lubricant it is possible to increase the number of pushes by an average of 20 percent; of even greater importance is the fact the improved surface obtained with graphite-lubricated dies will effect a considerable reduction in scrap produced by unsatisfactory surface conditions in the extruded products.

The method of applying the graphite to the dies is simplicity itself. Each time the dies are removed for redressing, they are coated with a graphite dispersion using an ordinary spray gun. The dispersion is made up from the Acheson colloidal graphite concentrate, thinned with distillate of 200-second viscosity. This is suitable for dies that are still warm from use. When dies are cold, the dispersion is thinned further with carbon tetrachloride.

The sections produced by the extrusion process range from various architectural shapes, such as window frames, sills, angles, T's and Z's, to thin ribbed and corrugated forms suitable for moldings and

Applying white lacquer and glass beads to a traffic stripe



New rubber-tired tractor and versatile scraper

cover strips. Use of the colloidal graphite has proved of greatest importance with the thinner sections where the decorative value of the product may require a consistently smooth, bright finish.

LIGHT CURRENTS

Electric Potential Set Up in Light Beam

A POWERFUL beam of light can act as a battery, so that electricity can be collected from it at two different points. This is indicated by the experiments of Dr. Felix Ehrenhaft, Director of Physical Institute of the University of Vienna in the days before Austria ceased to exist.

The experiments were made by watching the behavior of minute particles which floated in the air in the path of the light beam, reports *Science Service*. The particles were surrounded by an electrical field and sometimes they moved towards the light, sometimes away from it. This was due, Dr. Ehrenhaft believes, to the interaction between the field of the beam itself and that induced around it. Similar effects were obtained with magnetic fields, showing also that the light beam is magnetized.

From these studies he concludes that along the beam at different points there must be differences of electrical potential, as there are between the terminals of a dry cell, though far smaller. Thus, theoretically, it would be possible to insert electrodes into the beam at different places, and draw current off, though it is difficult to imagine how such minute currents could be detected.

SCRAPER

Handles Materials From Sand to Gumbo

A NEW, high-speed, hydraulically operated scraper has been announced by the LaPlant-Choate Manufacturing Company, Incorporated, engineered and designed for use with the new rubber-tired tractor which the Caterpillar Tractor Company is making available. It is a high-speed scraper which loads, transports at speeds up to 18 miles per hour, and spreads earth or other material under its own power. It is free from overhead obstructions so that it can be loaded by dragline or shovel, if desired.

Finger-tip hydraulic control of the scraper matches the hydraulic brakes and steering of the tractor. Hydraulic rear wheel brakes on the scraper are operated simultaneously with the brakes on the tractor. A low center of gravity and correct balance eliminate bobbing, weaving, twisting, and the danger of jack-knifing. This also adds to the comfort of the operator. The bowed design of the cutting edge make loading easier and faster; the guide arrangement insures correct operation of the rear ejector gate.

Extremely important is the honeycomb construction of the bowl bottom, an exclusive feature which means much greater strength and rigidity. Another "exclusive" is the independent apron operation. This permits uniform spreading of any material from sand to gumbo.

POWER ALCOHOL

Would be an Additional Tax on Consumer

SPORADICALLY there crop up attempts to introduce alcohol as a motor fuel in the United States, most of the attempts being based on the assumption that the alcohol would be made from domestic farm products and hence would constitute an additional source of revenue to the farmer.

The subject of power alcohol has been carefully studied by the Committee on Motor Fuels of the American Petroleum Institute and this or-

ganization recently released the following pertinent conclusions:

"The power alcohol idea has been under consideration for over 30 years but is no more practicable today than it was at the beginning.

"Alcohol cannot be manufactured from farm products under present and prospective conditions for less than five to six times the cost of gasoline.

"Mixtures containing 10 percent of alcohol would consequently cost around three cents a gallon more than straight gasoline.

"Use of a 10 percent mixture would increase the nation's fuel bill by $690,000,000.

"The claim that technical advantages of alcohol-gasoline fuels justify their extra cost is not supported by facts.

"Europe's experience with alcohol mixtures, instead of proving their value as proponents have claimed, showed clearly that the scheme is not economically sound.

"Because farmers buy one-fourth of the motor fuel consumed, because relatively few could actually sell products to alcohol distilleries, and because of adverse influences on sales of other products, on soil fertility, and on independent farming, the net effect of the power alcohol scheme on farmers' interests would be adverse.

"Pretensions that alcohol is needed as a substitute for irreplaceable oil supplies are answered by the fact that petroleum reserves are greater today than ever before, while conservation methods are still improving rapidly. Also that methods already developed of synthesizing oil from coal assure a continuing supply of oil as far into the future as any need can be foreseen, at cheaper prices than are in prospect for alcohol."

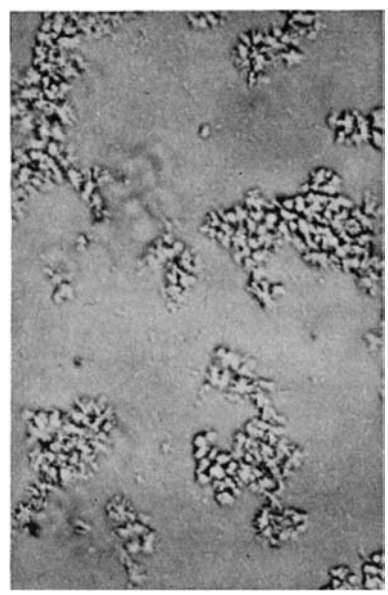
PAPER SCIENCE

Electron Microscope Reveals Differences in Coatings

PHOTOGRAPHS of paper pigments, made with the electron microscope, were shown by A. R. Lukens, C. G. Landes, and T. G. Rochow of the American Cyanamid Company to demonstrate difference between ground and precipitated calcium carbonates to the Technical Association of the Pulp and Paper Industry at a recent meeting.

Particles of calcium carbonate pigments, such as used in making the paper on which this magazine is printed, are so minute that certain significant differences in their structures escape observation with the light microscope. However, photographs taken under the extraordinary power of the electron microscope make these differences in pigments prepared by different methods clearly apparent.

Electron micrographs at a magnification of 36,000 times natural size showed that a typical precipitated calcium carbonate (precipitated chalk) is made up of tiny elongated crystalline prisms massed together to form groups having extremely porous internal structures and rough external surfaces. In contrast, a new type of pigment, called Cal-Micro and pre-



Electron micrograph at left (approximately 18,000x) shows calcium carbonate to be made up of tiny, elongated crystalline prisms. Compare definition with photo (right), made with light microscope, about 1000x

pared by a special process involving water-grinding of natural calcite rock, is shown to consist of solid, non-absorptive rhombs and fragments. Photomicrographs made with a light microscope, at 2000 times natural size, shown for comparison, failed to reveal complete details. [Photos were reduced one half for reproductions.—*Ed.*]

The important differences between these ground and precipitated pigments in use lies in the proportions of adhesive (casein) required by each to form a satisfactory coating for high-grade paper. The lower casein requirement of Cal-Micro is explained by the non-absorptive structure of its particles, the report stated.

This is the first application to paper pigments of the electron microscope, by which minute objects can be pictured at as much as 100,000 times natural size. The instrument used in this investigation is the first one commercially built in the United States.

GREAT BASINITES

Artifacts in Caves

Date Early Indians

WHILE evidence of an immediately post-ice-age culture, perhaps 10,000 years old, has been accumulating for several years just east of the Rockies, the Great Basin region across the Continental Divide remains much more of an enigma.

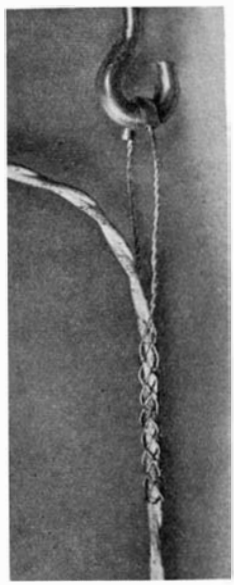
Dr. Julian H. Steward, of the Smithsonian Institution's Bureau of American Ethnology, explains that, immediately after the retreat of the ice, the barren land of today, deluged with heavy rains, was much more fertile and inviting to human beings. There were deep lakes and broad rivers. Windswept waves of the lakes beat against the rocky shores and created large underwater caves. Then came the dry period which, with a single interruption, has continued to the present. The lake levels sank. One after another, the caves were left high and dry, affording excellent shelter for human beings of a low culture level who seem to have drifted into the Great Basin. They left artifacts scattered over the cave floors.

Thus the present evidence, Dr. Steward says, indicates strongly that parts of the region were occupied between 10,000 years ago and the first appearance in the southwest of the Basket Makers—probably less than 2000 years ago. The story of 8000 years remains to be reconstructed from such bits of evidence as can be uncovered by the spades of archeologists.

WIRE HOLDER

Ancient Trick Applied To Modern Purpose

A DEVICE based upon an old Chinese trick has recently been placed on the market for use in holding wires in position. As one of our photographs shows, the woven material



Wires, cables, or ropes may be suspended from hooks or otherwise by the use of simple modern version of an old Chinese trick

of the wire holder is slipped into place and suspended from a hook or other fastening. As the device stretches it tightens around the wire, holding it firmly. Telephone wires, radio aerials, or almost any type of wire, cable, or rope can be held in place by this device.

METAL USE

Increases with Greater Applications of Plastics

ODD as it may seem at first glance, the rapidly expanding use of plastics will boost and not decrease the use of metal. The substitution of plastics for metals in certain parts of commercial and household machines will reduce costs of production substantially, according to Dr. A. A. Bates, manager of chemical and metallurgical research for Westinghouse Electric and Manufacturing Company. "The result will be increased demands for the machines, leading to a larger volume of production and use of more metal in parts that plastics cannot replace," Dr. Bates said. Recalling

the olden days, a time when the automobile was replacing horse-drawn vehicles, and comparing it with the present trend in plastics, he said that "it was then predicted that all blacksmiths would be thrown out of work, but . . . the automobile industry now employs more blacksmiths than were employed before."

"We now have plastics which, weight for weight, are as strong as steel. Since we can mold plastics into almost any shape, they simplify fabrication by eliminating many of the screws, bolts, and rivets which take up so much valuable time in the manufacturing process. Many of the plastics are also fireproof and acid resistant. Most of them are not affected by water, so that they wear longer when exposed to the weather."

Looking into the future, Dr. Bates said that the development of the airplane will probably lead to increased use of both plastics and metals. Small airplanes in which plastics are used because of their simplicity and adaptability to streamlining may have the same effect on the aircraft industry that the flivver had on the automobile industry.

"After the war is over we may expect a flood of these small planes to come off the production lines at prices that many people can afford. Commercial transports will probably continue to be made of metals for many years," predicted Dr. Bates, in conclusion.

Supercharging the Pilot

Aeroembolism Prevented by Pre-Flight Administration of Oxygen

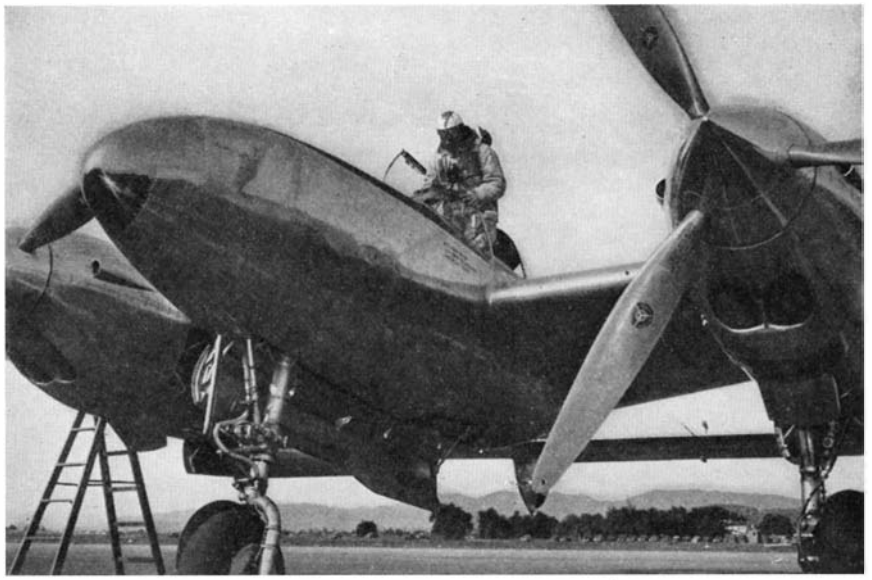
ALEXANDER KLEMIN

Aviation Editor, Scientific American. In charge, Daniel Guggenheim School of Aeronautics, New York University

THE new Lockheed-built Army Air Corps interceptor-pursuit, the P-38, equipped with the 1100-horsepower Allison engines, is said to have broken many speed records and to have shown tremendous climbing ability. With new, fast bombers capable of flying at 30,000 feet and higher, and with the advent of pressure cabins, the pilots of the interceptors must be prepared to go to 34,000 feet, or higher. If the cabin of the interceptor cannot be supercharged (because of weight and performance requirements), then the pilot must be "supercharged," if he is to retain his efficiency at high altitudes, or even survive. With the advice of the Mayo Clinic, Lockheed Aircraft has recently made an experiment in supercharging its ace test pilot, Milo Burcham, and in safeguarding him against aeroembolism or aerial "bends," which are similar to bends experienced by deep-sea divers who come to the surface too fast.

Medical authorities are quite certain that man cannot long survive above 18,000 feet unless artificially supplied with oxygen. He has an even more serious weakness, however. When the pressure is lowered, the gases in his system expand. The less the pressure, the greater the expansion, and the faster the climb to high altitudes, the greater the danger to the aviator. One of the gases in the human body is nitrogen. When this expands, it forms bubbes in the tissues and blood stream, and the resultant aeroembolism connotes temporary paralysis and even unconsciousness. Since a modern pur-

Breathing pure oxygen, and exercising leisurely, the airplane pilot soon becomes "supercharged"



Still breathing oxygen, the "supercharged" pilot climbs into his plane

suit can dive to the ground at 600 miles an hour, unconsciousness for even a short period means great hazard. The case for "supercharging" the pilot is convincing, and the necessity all the more imperative when planes can climb at a mile a minute.

The Lockheed experiments with Mr. Burcham are based on a comparatively simple process developed originally by the Mayo Clinic. Before a high-altitude flight, the pilot exercises for 30 minutes. The combination of exercise and oxygen eliminates the nitrogen from the body. On the advice of the Mayo Clinic, Lockheed built a special decompressor room near its test hangar. The equipment consists of bare essentials—a stationary bicycle, oxygen cylinders, inhalation apparatus, complete set of oxygen fittings, and emergency oxygen flasks. To decompress or "supercharge" himself, the pilot dons the inhalation apparatus, consisting of a naval face mask, breathing bag, and rubber tube connected to the oxygen cylinder, turns the valve to start the flow of oxygen, and then begins to pedal the bicycle. The pace set is equivalent to walking at the rate of 2½ miles an hour, and is maintained for 30 minutes. To prevent becoming overheated, the pilot exercises in light clothes. From the time he starts breathing oxygen in the decompression room, however, until he has nosed his plane back to lower altitudes, the pilot cannot take a breath of "fresh air." One whiff of air containing nitrogen would undo all his supercharging effort and expose him to the "bends." As a result, the pilot puts on his flying suit in the decompression room, while still "hitched" to the oxygen cylinder. Before leaving to climb into his ship, he switches to a small portable oxygen flask which is carried to the plane, where the pilot connects his inhalation apparatus to the plane's oxygen tanks.

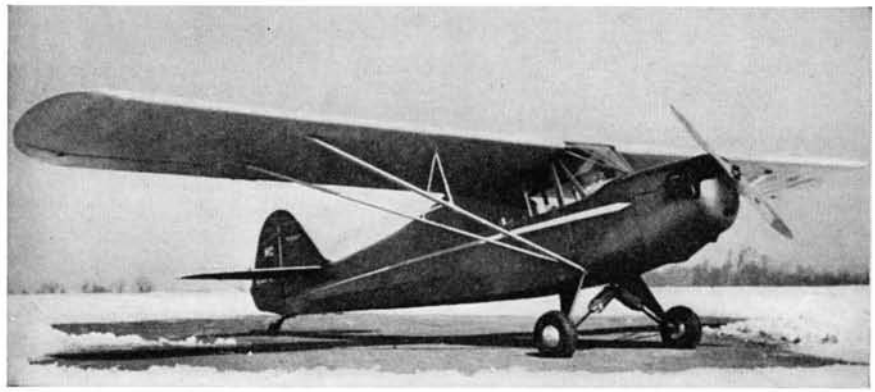
Mr. Burcham was examined before and after these tests, and rapid flights to well above 30,000 feet proved entirely successful. Marshall Headle, chief test pilot for Lockheed, believes that to make the new fighting planes fully effective, decompression rooms should be made available to all combat pilots awaiting the call of duty.

PLANE LOCATION

Triangulation-Plus

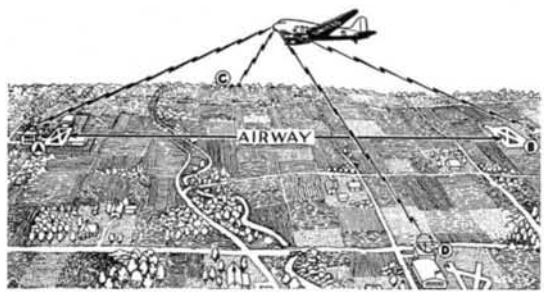
Spots Transports

A THOROUGHLY practical method of locating the exact position of a transport in the air has been announced by J. R. Cunningham, Director of Communications for United Air Lines. The airplane, equipped with a high-frequency radio transmitter, emits a signal from time to time. On top of a building at the terminal a large metallic frame is rotated by an electric motor. When the antenna is bearing directly on the airplane and receiving a signal of maximum intensity, automatic equipment indicates the bearing of the craft on a map in the dispatcher's office. Given two stations communicating with each other at a known distance apart, and the bearing of the plane from these stations, it is a simple matter to secure the loca-



Adaptability to training purposes, for use in the C.A.A. Flight Training Program, is one of the features of the Taylorcraft Tandem plane shown

tion of the aircraft by drawing two lines on the map and seeing where they intersect. Then the pilot can be told, by phone, where he is if and when he needs such information. The artist's sketch actually indicates four stations at work, one at each end of the airway and two off the airway, but this is merely to provide a check. The experimental tests proved highly successful and standard usage will follow. Our readers will readily grant the utility of this device, which, while not quite new in principle, is efficient and rapid in operation.—*A. K.*



Airplanes can be successfully located while in flight by using the method developed by United Air Lines. The plane's radio transmitter sends out a signal at regular intervals. These signals, picked up by two or more receivers, give data for triangulation on a map

PLANE CONVERSION

Sport Plane Converted to Tandem Military Trainer

WITH the enormous number of young men who are learning to fly under the auspices of the Army Air Corps or the Civil Aeronautics Authority, it is essential to have efficient, modern, training planes at the most reasonable prices possible. The manufacturers of the light planes of today, who have indeed brought prices down and production up, have met the situation splendidly by converting their side-by-side cabin two-seaters into two-place tandem planes, with instructor behind the pilot. Thus Taylorcraft Aviation has brought out a Taylorcraft Tandem, adapted for training purposes. With seat cushions removed there is full provision for seat and back parachute packs. Other interesting features are ball-bearing, self-aligning controls, giving the smooth operation necessary for instruction purposes.

Seats are quickly adjustable to take tall or short students. There is a single exhaust and an efficient muffler. Specifications indicate how our light planes are increasing their performance. With a 65 horsepower Lycoming, Continental, or Franklin engine and a gross weight of 1200 pounds, top speed is 102 miles per hour; cruising speed, 92 miles per hour; service ceiling, 15,000 feet; rate of climb, 600 feet per minute; range, 300 miles; landing speed, only 35 miles per hour. Wing area is 180 square feet; span 35 feet, 5 inches; overall length 22 feet, 9 inches.—*A. K.*

CRASH BLAME?

CERTAINLY the regulation of aircraft has been a political football. First we had the Aeronautics Branch of the Department of Commerce; then an independent Civil Aeronautics Authority; and now a Civil Aeronautics Administration back in the Department of Commerce. It would be infinitely better to have the important task of regulating aircraft safety left in one particular bureau, board, or what-not long enough for its functioning to become effective. But, on

the other hand, it is entirely unfair to place all the blame for the recent airline crashes on the Civil Aeronautics Administration as at present constituted. No board in the world, whatever its composition or organization, can guarantee safety; this is a complex problem of regulation, radio, instrumentation, flying and ground personnel, and a thousand and one items.—*A. K.*

TWENTY YEARS AFTER

Aviation Communication Makes Mighty Strides

THE air transport industry, the Post Office Department, and cities along the San Francisco-New York airway recently celebrated the 20th Anniversary of the first transcontinental day-and-night flight of

Captain Jack Knight

1921. Featured in the observance was Captain Jack Knight, of United Air Lines, pilot with 2,400,000 miles to his credit, who covered the entire night portion of the flight from North Platte to Chicago with the aid of farmers' bonfires. What a long way air transport in the United States has moved from those early days, and what magnificent aids to navigation have replaced the rudimentary devices!

Quite recently there have been important developments in aircraft radio communications. Thus, the Civil Aeronautics Authority is installing ultra-high-frequency radio-range stations between Chicago and New York. The ultra-high-frequency range is superior to the low-frequency type now in use because of its fidelity of transmission and freedom from static. Frequencies range from 119,000 to 126,000 kilocycles as compared with the present 200- to 400-kilocycle band. Similar installations will be made on all the nation's airways. To match the new radio ranges, United Air Lines has begun the installation of 100 special radio receivers on its entire fleet of mainliners at a cost of nearly $100,000.

United announces other ambitious undertakings in aircraft radio communications. After months of research and development by the airline and the Federal Telegraph Company, new 5000-watt radio transmitters are being erected, which are described as the most powerful aviation transmitters in the world. Superseding the 400-watt transmitters now in use, they will operate on ten different frequencies, and planes will now be able to hear ground stations under all weather conditions. With the new transmitters, there will be installed on the transport planes new combination receivers and transmitters, also operating on ten frequencies, any of which can be automatically selected by the pilot. Using this light, compact unit, pilots of a plane in flight over Cheyenne were able to talk to ground stations on the Pacific and Atlantic Coasts simultaneously.

A third and highly impressive project of United's communications experts is the construction of a

Control units used in connection with the new radio installations described on this page. Shown also are the special typewriters and record forms used in keeping complete and accurate logs of all voice communication between ground and airplanes

new antenna. It is 1200 feet long, 500 feet wide, and 100 feet high, covering an area of 600,000 square feet. Around each of the four poles of the antenna there is strung a quarter-inch copper-clad steel wire. The new antenna gives a greatly amplified signal because of its directional characteristics. The receiver is absolutely silent, until it is automatically switched on by signals from planes or ground stations. Receiver, transmitter, and antenna are all linked with a communications center where the radio operators are stationed.—*A. K.*

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Three-Color Printing Simplified

MORE amateur workers than you can shake a stick at have been scared away from color photography by the bugaboo of lengthy processing and other matters. It is true that such a process as carbro, for example, is rather involved for the average worker, but this should not deter him from making color prints; there are now on the market several color-printing processes that provide a simple routine. One of these is the Chromatone Process, which was described here upon its announcement several years ago. The latest to make its appearance is the Iso-Color Process, which introduces a new idea in color printing, one of the principal advantages of which is that it simplifies the procedure and thereby cuts down the working time to well under an hour.

Iso-Color is a dye-coupling process, similar to the Develochrome monochrome toning method discussed last month. Developing and toning of the three prints required to make up the finished three-color result are done simultaneously, the black silver image being later eliminated by bleaching.

Three separation negatives form the basis of this as of other color-printing methods. These are obtained either directly by exposing three films through three filters in one camera, or by "separating" the colors in a transparency, such as Kodachrome. Several firms have introduced the service of making separations from Kodachrome at nominal prices so that at the start, at least, you need not be concerned about this end of the routine.

The Iso-Color Process calls for nine separate steps. The basic materials are furnished in a kit. Other chemicals, such as hypo, sodium sulphite, and potassium bromide, are presumed to be part of every dark-room worker's normal stock, and acetone is readily obtainable. Besides these, the following materials are required: Chromatone Print Paper (the stripping film); support paper (any smooth, white paper of suitable weight); sheet of plate glass or other hard, flat material for assembling the final print (should be somewhat larger than the print to be made); flat squeegee; gummed paper tape one inch wide; brown bottles, three 4-ounce, two 16-ounce, one gallon.

Full particulars and the necessary formulas are provided in the instruction booklet packed with the kit, so we shall give merely an outline of the process, just to give you an idea of how it is done. We recommend starting out with a set of separation negatives ready-made for you from one of your own Kodachromes. The printing time for the red, yellow, and blue images will vary, but the difference in exposure will also be indicated for you by the makers of your separations.

Figure 1: **Stripping**

Figure 2: **Stripped**

The key to correct exposure is the negative from which the red image is to be made (the negative that was exposed through the green filter in making the separations). A test print of a section is made as in ordinary black-and-white printing and is developed in the red developer and fixed. After this the worker selects the exposure necessary to turn out a black-and-white print of good quality. This exposure time is used to determine that of the other two negatives, which may be done simply by following the printing ratios indicated for your ready-made separation negatives.

Development is the second step. This takes five minutes at 65 to 70 degrees, Fahrenheit. Each print is developed in its own color developer, one for the red, the second for the yellow, the third for the blue. Since

Figure 3: **Squeegeeing**

all solutions must be discarded after one use, one tray may be used successively for each of the three baths, though it is obvious that three trays, one for each color, would be more convenient. After development, rinse quickly in running water, and fix in the hypo-sodium bisulfite bath for five minutes.

All the foregoing steps are carried out by the light of the Wratten OA safelight. The room lights may now be turned on.

Bleaching is the fifth step. The prints are taken from the hypo, without rinsing, and are placed in the bleach for about two minutes. What happens here is a small miracle. When the exposed print was placed in the color developer it developed a black as well as a color image. After the bleach only the color image remains, the silver image having been bleached away.

The prints now go into the hypo solution, without rinsing, and stay there until the yellow stain disappears. Then comes washing, which takes only two to five minutes in running water.

The next step calls for stripping the film away from its paper support. This comes off very easily, and the paper support may be saved to use for the final assembly.

Figure 4: **Taping**

The support paper is soaked in water for about five minutes and then placed gelatin side up on a glass or other flat, waterproof surface. The prints are now assembled by superimposing the red on the yellow print and the blue on the red, all in perfect register, using a squeegee to fix each print firmly in place. The final detail is to tape the print down with one-inch gummed paper tape on all edges. In this condition it dries, and the result is your first three-color print.

Dogs Can Pose

GIVE a dog a comfortable place to sit or lie down and you will have no trouble getting him to pose for you, as did this one, "Black Michael." An easy chair with a soft seat was just the thing on the night we were shooting Michael. We had tried a harder seat before, but no soap; he'd rather have the hard stone floor. Once on the soft seat, however, we could have had him posing for us all night. A

"Black Michael"

1000-watt main source light and a No. 2 Photoflood as an accessory light provided enough illumination for good exposures at f/4 and 1/50 of a second.

Developing Contrasty Subjects

WHERE the subject photographed is illuminated with very contrasting lighting, normal development usually results in shadows without detail. One worker, confronted with such a problem, hit on the idea of cooling the developer down to about 50 degrees; that is, to a point where the developer is practically inactive. He then placed his film-loaded reel into the tank, closed the top and allowed the film to soak in the developer solution for about 3 to 5 minutes. He next poured off the developer, gave the film a quick rinse, and poured in plain water, where the film remained for about 15 or 20 minutes. The temperature of the water was raised to about 70 degrees. This warmed the developer that had soaked into the film and allowed development at a very slow rate, giving an opportunity for the

shadows to come up without blocking up the highlights. It is important, when attempting this method, not to agitate the tank when filled with water because this may shake off the developer and dilute it too greatly.

Angle the Easel

"THE greatest thrill of my life came when I learned about angling the easel," an enthusiastic professional worker told us recently. He found that in making portraits a sharp turn-

"Ivy"

ing of the easel off vertical gave him an entirely new and lively impression of the subject that appeared static when printed in the usual way. Like other deviations from the straight and narrow path of straight printing, this method must be practised with some caution and considerable exercise of good taste. "Ivy," reproduced here, is an example of moderate easel-angling, enlarged from a negative in which the head was vertical and included about half the boy's figure.

Waxing Prints

TO GIVE prints a sprightlier appearance, a wax rubbing down is often employed. An effective method is to use the following formula: dissolve 800 grains of mastic in a quart of spirits of turpentine; to this add 16 ounces of melted white wax well stirred. Then put this preparation in a warmed jar and when it has cooled apply it with a flannel to the print, rubbing well. When you have finished, you may observe a few streaks due to uneven application of the wax. By warming the print for a few minutes, the streaks will disappear.

1 and 2, not 1 to 2

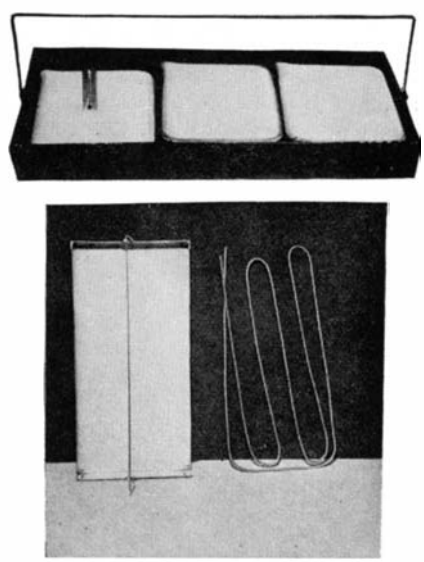
RECENTLY we were called to task for using the term, "one to two" when indicating that a certain stock solution was to be diluted one part stock to two parts water. The gentleman in question was a chemist, who explained that, in chemist's language, such numbers refer to volume and that when a chemist states "one to two" what he means is that one part of solution is to be increased to a total volume of two by the addition of one more part of water. In stating the matter the way he does, he says, the photographer calls for only one part of water to one part of stock solution when what he actually means is two parts of water to one part stock.

We explained to the chemist that this phrase has been well understood by photographers from 'way back as a short way of saying "one part of stock solution to two parts of water," and that if a phrase is understood, even though it may not be exactly correct, that is all one expects. In chemist's language, by the way, the term is "one and two," which means one part stock and two parts water. That this makes the matter more clear, is our chemist's argument, and maybe he's right.

Temperature-Controlling Tray

DEVELOPERS for printing papers such as Azo or Kodabrom give best results when the solution is between 65 and 70 degrees, Fahrenheit, with varying and unsatisfactory results when the temperature is below and above this standard.

Keeping the solution at the required temperature can be easily accomplished (in summer) by constructing a special metal tray of galvanized iron, in which the usual processing trays



Top: **Temperature-controlling darkroom tray.** *Lower:* **The tray, and tubing that carries water**

are placed. Soldered to the inside of the bottom of the galvanized iron tray is a grid made by bending a length of one-quarter inch copper tubing, the open ends of which project through holes drilled in one side of the tray. One end of the spiral tube connects with a flexible rubber tube to the cold water faucet; the other end, through a similar piece of the tubing, goes to the basin drain.

The idea is to allow cold water from

the kitchen faucet to spiral its way through the copper grid in the bottom of the large metal tray and empty out as described; in so doing, it will have a cooling effect on a metal photographic trays resting on top of the copper grid tubing. If three metal photo trays (they can be stainless steel or enamel) are placed on the grid, then all three will be at the same temperature, which is what is wanted in developing prints. Blisters and stain occur when a print is changed from a cold developer to a warm stop bath and finally to an even warmer hypo fixing bath.

The sides of the temperature-controlling tray should extend upward about an inch higher than the sides of the photo-trays. The large tray can also be fitted with a bail handle bent up from one-quarter inch steel rod. Before soldering the galvanized tray joints at the corners, the solder will work better if the places to be soldered are first brushed with a solution of 28-percent acetic acid (same as used for stop-bath purposes) and the soldering accomplished over this in the usual manner; Geko solder can also be used to make the work easier. After the soldering has been finished, which includes soldering the copper tubing to the bottom and in the holes of the tray, clean up the whole assembly with a wire brush and scouring powder, then paint everything, inside and out, with Kodacoat acid-proof black paint, which dries in about 15 minutes.

—*Herbert E. Hayden.*

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WHAT'S NEW

In Photographic Equipment

VICTOR MIDGETFLASH No. 64 ($1): Adapter-reflector to convert medium base receptacles for most effective use of midget lamps. Unit has 4½-inch parabolic, polished aluminum reflector clipped to plain bayonet socket Edison base adapter.

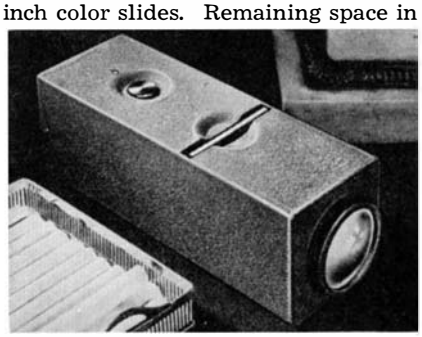
KODAK FARMER'S REDUCER (75 cents for carton of five tubes): Each tube makes 16 ounces of working solution. Farmer's Reducer is two-solution corrective reducer designed for correction of over-exposed and over-developed negatives, and for limited print reduction.

PRINCETON COMBINATION SUNSHADE AND FILTER HOLDER (75 cents): Adapter ring of screw-type replaced by new adapter ring of semi-flexible rubber. Will cover all lens barrels 24mm to 42mm. Available sizes: four adapter rings to be used with 29mm sunshade; two with 39mm sunshade; two with 42mm sunshade; one with 45mm sunshade.

INCRE-LIGHT 2½-inch *f*/1.65 and four-inch *f*/2.5 BELL AND HOWELL PROJECTION LENSES ($30, $17.50): *f*/1.65 lens 40 percent faster than *f*/1.9, especially adapted to take advantage of violet and ultra-violet end of spectrum available in arc-generated light of Filmoarc. Equally efficient mounted on any Filmo projector. Four-inch *f*/2.5 replaces *f*/2.8 model, giving 25 percent greater brilliance.

ALBERT and ROYAL MIDGET TRIPODS ($3.50 and $1.95): Both designed for short range work. Albert is constructed strong enough to hold heavy cameras; has long-handled tilt-top that locks securely in any desired position and holds cameras at all levels from table top to 13 inches. Royal Midget similar in design except for tilt top, which is simplified.

VUESCOPE COLOR VIEWER ($3.95): Compact, lightweight rectangular steel box, about 2⅛ inches square, 6¼ inches long. One end of Vuescope equipped with large, clear viewing lens. Two and one-half inches behind lens is slot for insertion of 2 by 2 inch color slides. Remaining space in



box occupied by two small dry cells, small bulb, ground glass diffuser, and switch. Slide appears large as 5 by 7 inches. Slot accommodates all popular 2 by 2-inch slides. Equipped with spring tension clips to keep slides from falling out.

PHOTO-COMPACT COMBINATION ENLARGER, PRINTER, AND SAFELIGHT ($34.50): Designed for use with all cameras from 35mm to 3¼ by 4¼ inches. By attaching ordinary camera to Photo-Compact, user has complete enlarger with built-in dodger and combination safelight switch. By attaching platen and masks supplied, Photo-Compact can be converted into contact printer.

KEMP TRAY THERMOMETER (35 cents, three for $1): Entirely encased in white rubber, making it shock-proof, acid resistant, and non-corrosive. Designed for tray use by immersion in solution. Legible in darkroom as figures on rubber sheath are highly embossed and darkroom lamp throws distinct shadow of figures and gradations.

ROYAL TRIPOD, 1941 MODEL: Features new plastic cap on head. "Quick-Lock" leg adjustment improved with new leg locking nut. Tilt head now provided with adjustable camera screw which can be lengthened or shortened to accommodate camera screw sockets of various lengths.

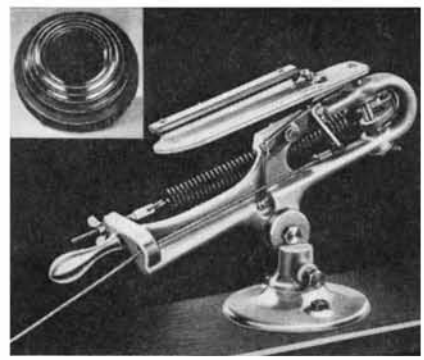
YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

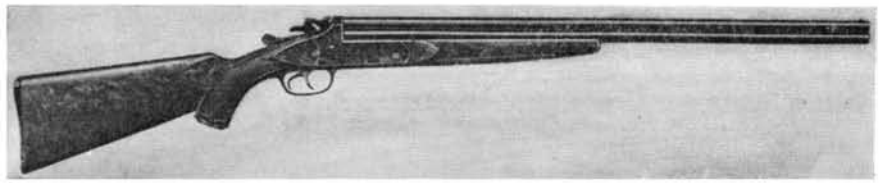
INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

Wing-Shooting Practice

IF there is one goal toward which we average shotgunners aim, it is reasonable proficiency in wing-shooting. Not many of us go afield more than six times during bird season and the total number of shells fired at flying targets can't be regarded as wing-shooting practice. Then, likely as not, we put the gun away until next season. True, many of us hunt crows, shoot skeet or trap, thereby keeping eyes, muscles, and hand in training, and despite all arguments that none of these truly approximates grouse or pheasant shooting, the more frequent the use of the shotgun on moving targets, the more the gunner will have confidence, assurance, and familiarity with distances and target leads. In other words, trite though it may be, practice still tends toward perfection.



Hand operated "Skeeter Trap"



Stevens, model 240, .410 bore, over/under. Ideal for "Skeeter Trap"

Two difficulties that have long faced the bird hunter who desires to practice are a place to shoot and, regretably, the matter of expense. Justifiably popular as skeet shooting has become, skeet fields are still too infrequent throughout the nation to accommodate our army of shotgun users. Moreover, not all of us can afford to belong to clubs or associations, and as the crows can't always be depended on to be present when we desire shooting practice, many of us shrug our shoulders resignedly and let the matter drop.

Shooter's foot releases trap

Not long ago, however, we found a solution to this problem. It has materially helped to improve our shooting, it has cost us very little money, and it has the distinct advantage of portable equipment. In a few minutes we can set up our "Skeeter Trap" in a convenient field. Using our little .410 bore over/under Stevens shotgun, we can burn up four boxes of shells blasting away to our heart's content at miniature clay targets, in singles or doubles, thrown from our "Skeeter Trap," and we've had a couple of hours good fun and practice. The cost? The trap is either $14 or $15, depending on the model, and that is our permanent investment, good for years to come. The miniature clay targets run about a half-cent each, and shells for the .410 shotgun range from 50 cents upward for the 2½ inch length in case lots.

As we said, the "Skeeter Trap" will throw singles or doubles, and, as illustrated, the shooter may release his own targets by foot pressure, or the trap may be sprung by a cord in the hands of a companion. The "Skeeter Trap" will throw any of the little 2⅝-inch clay birds a distance

of 70 to 80 feet, so it requires snappy action to score doubles. It isn't, of course, necessary to use a .410, but we specified that size shell because of its low cost. Larger sizes are entirely acceptable, and you can, if you like, be very sporting and use a .22-caliber smooth bore gun with the .22 long-rifle scatter-shot shell. However, as we are trying to approximate hunting conditions as closely as possible, we suggest the .410 as being the nearest approach to sporting conditions and, at the same time, the least expensive in the shotgun class.

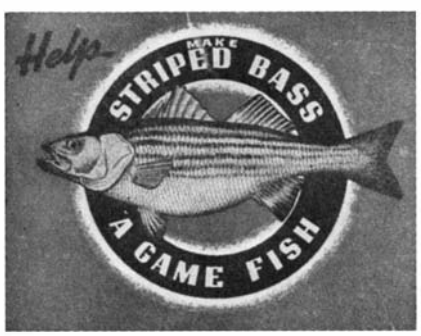
There are also several possible variations to "Skeeter Trap" shooting. The trap, or traps, can be arranged in the proper terrain to simulate quail shooting, a brush walk, a grouse range, or a covey rise, in all of which the "birds" take off with startling suddeness from unexpected places to offer extremely sporting shots and splendid practice. We have folders on the "Skeeter Trap" which detail all these ideas and more, provide suggestions for your spring and summer shooting practice, and they're free.

What About the Striper?

SHALL the striped bass of the eastern coastal waters legally be made a game fish (as is the imported striper of the West Coast), or shall we go along as we are today, letting the commercial fisherman decimate the ranks of this "gentleman of the surf"? From Massachusetts to Virginia this is a question that is being heatedly argued by all those who have the least interest in salt water fishing in general, and in surf fishing in particular.

Only some forty years ago, striped bass on the East Coast were present in such numbers that commercial fishermen would take tons of them in a single haul of a net. Today a commercial boat is lucky if it can account for as many stripers in a whole season. And the situation is even worse for the surfman. He has seen one of the finest game fish of the surf gradually disappear from its former haunts, decreasing in numbers to a point where the surfman is lucky if a dozen days and nights on the beach yield even one striper.

What is to be done about it? Make the striper a game fish, removing it from the list of fish that can legally be taken by commercial fishing methods, is one answer, and probably the only logical one. This would preserve *Roccus lineatus* for future generations; at the same time it would work no hardship on the commercial fishermen who, today, would starve if they had to depend entirely on the striper for their livelihood.



"Gentleman of the surf"

There is definite foundation for the belief that making the striper a game fish would have beneficial results. Experience on the West Coast proves the point. There the striper was introduced from eastern waters and completely protected. Today the striper on the West Coast furnishes sport for a vast number of surfmen and other salt-water anglers.

It is still not too late to build for a similar future on the East Coast. Maine and Louisiana have passed laws that make it legal to take stripers only by rod and line. But the other states on the eastern seaboard must do the same before results can be obtained. There is only one way in which this can be accomplished. Interested sportsmen must get up on their hind legs and holler—holler long and loudly, individually and collectively, until the furore is heard in the legislative halls and a realization is reached by the powers-that-be that this is the voice of a majority that must be obeyed.—*A.P.P.*

Defense and Sporting Arms

IT ISN'T news that national defense requirements are demanding practically the full facilities of American manufacturers of sporting arms, but perhaps it is news that military necessities in small arms are not the only defense reason for the bustling production lines. The military requirements come first, of course, but we still have the needs of civil officers, who must be armed, and now there is a third group that has to be considered. It is composed of armed guards and plant police for the industries producing defense materials. This latter group is a large one that has sprung up almost over night, for under normal circumstances such guards are not armed. After the needs of all these are cared for, come the sportsmen.

Worth waiting for; K-22

This is an unfortunate situation, because with war no longer being confined to well-drawn battle lines, there was never, in our opinion, a time when the training of civilians in the art of shooting was quite so important as now. Certainly, in the recent tragic history of European countries, it has been proved that a well armed and well trained citizenry is a powerful asset. There is little that can be

done about the situation at the moment, but rest assured that in the hurly-burly of defense the small arms makers have not forgotten their sportsmen friends. At every opportunity sporting rifles, shotguns, and target pistols are shoved through the crowded production lines.

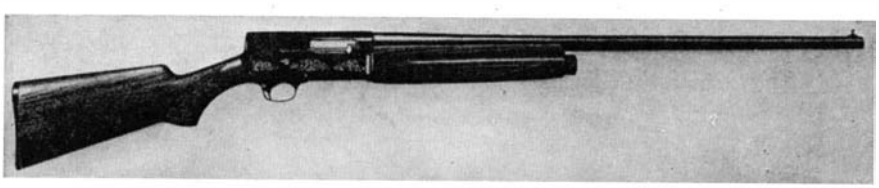
Not long ago we visited Cy Bassett, of Smith & Wesson, who explained some of the present-day trials and tribulations of a concern normally busy manufacturing revolvers for peace officers and target pistols for range shooting. Smith & Wesson, you'll recall, brought out that smart, new .22-caliber revolver, the K-22 Masterpiece, just a year ago. Since then, wartime work has occupied every hour at the Smith & Wesson plant with the result that the K-22's were woefully side-tracked. However, Bassett explained, every now and then there is a minor hitch in production of guns demanded for the military, the peace officers, the special plant police. When that happens, jigs and dies are quickly changed and a batch of K-22's moves on toward completion until the hitch in defense gun manufacture has been eliminated, after which the K-22's are again necessarily shoved aside. By such heroic efforts are Smith & Wesson and other makers of sporting arms desperately endeavoring to care for the desires of their sportsmen customers.

• • •

POT-SHOTS

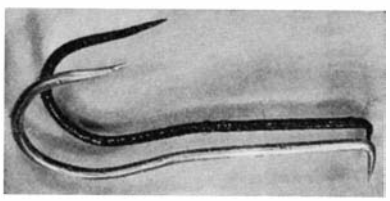
At Things New

SAVAGE ARMS CORPORATION has ended the long search by upland game hunters for a light weight *automatic* shotgun by producing a new 12-gage automatic weighing about 6¾ pounds. In this newest of Savage shotguns, Model 745, ready for delivery May 1st, the use of Alcon, an astonishingly light but tough metal, in constructing the receiver of the gun decreases its weight by a full pound. This means that now, for the first time, hunters may own a 12-gage automatic, hammerless, takedown shotgun that is about as light and easy to handle as many 20-gage guns. Model 745 has a plain, round barrel of special alloy steel, 28 inches long. It is chambered for 2¾ inch shells, with improved cylinder, modified, or full choke boring. Stock and fore-end are of selected walnut, checkered. Stock has full pistol grip, is 14 inches in length, has drop at heel of 2¾ inches, and is equipped with hard-rubber butt plate. Breech is solid; top of receiver is matted; there is a friction ring adjustment for light and heavy loads; a cross bolt safety at rear of trigger guard, and a three-shot magazine plug is furnished at no extra cost. We have Savage, Fox, and Stevens catalogs. Want one?



New Savage 12-gage automatic shotgun; weight only 6¾ pounds

BILL DEWITT BAITS, makers of fly boxes, lures, and many other fishing necessities, and who last year introduced absolutely rust-proof hooks of "Z" Nickel to salt water fishermen, have again earned the praise of the ocean angling fraternity, this time by announcing a Bill DeWitt gaff hook of "Z" Nickel with steel-like strength and which, because of the rust-inhibiting properties of "Z" Nickel, should be good for unlimited service. Due to corrosion by salt water, ordinary steel gaff hooks have relatively short lives, must frequently be cleaned and oiled for preservation, are often replaced several times before the handle wears out. Through use of "Z" Nickel it is expected the hook will outlast several handles and cleaning will be unnecessary because of properties of the metal.



"Z" Nickel gaff won't corrode

BEVIN-WILCOX LINE COMPANY'S catalog depicts trout lines of Nylon or enameled silk; double water-proofed silk casting lines for all manner of fresh water work; an unsurpassed Cuttyhunk selection. Also phosphor bronze leaders and a splendid article on "The Use and Care of Fishing Lines." Want a copy?

RICHARDSON ROD & REEL COMPANY'S 1941 catalog presents a complete line of seamless tubular and solid steel bait casting, trolling, and fly rods with strength, flexibility and balance more than adequate to meet the most gruelling challenge of "fightingest" fish. We'll send you one, free.

"HYSTERICAL LEGISLATION," an editorial on page 259 of this issue, has to do with proposed laws requiring registration of privately owned firearms and is a matter of importance to every American gun owner.

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FLIGHT

"First Principles"
"Construction and Maintenance"

By Wright, Smiley, and Martin and a staff of aviation experts.

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In the second volume—"Construction and Maintenance"—stress is laid upon manufacture and repair. Here again a large number of illustrations serve to make the text more complete.

Quiz questions at the end of each book enable the reader to check up on the completeness with which he absorbed the text material. ("First Principles," 283 pages, 6¼ by 9½ inches. "Construction and Maintenance," 259 pages, same size.)—Each volume $2.60 postpaid.—*A. P. P.*

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HANDBOOK OF COLOR PHOTOGRAPHY

Edited by Jack Hevesh

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By Arnold Gesell, M.D.

INDIA'S wolf children, two human infants reared by wolves, were the subject of an outstanding article in the March Scientific American. In the present book the Yale psychologist, Gesell, presents the account in somewhat greater detail and interprets it from the angle of the science of psychology, explaining many things that have puzzled readers of the bare uninterpreted account. (107 pages, 7 by 10 inches, 10 illustrations.)—$2.10 postpaid.—*A. G. I.*

AMERICAN VAUDEVILLE

By Douglas Gilbert

BRINGING back nostalgic memories to those of us who can recall the days of Lew Dockstader, McIntyre and Heath, Eva Tanguay, Weber and Fields, and other bright stars of their day, this book will likewise prove a revelation to this generation of radio-entertained youngsters. For back of today's air-wave shows and movies lies the birth, growth, and development of that amazing phase of our na-

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tional character, American vaudeville. The author, feature writer and former drama critic of the New York *World Telegram,* spent years interviewing the greats and once-greats, poring over old magazines, prowling around newspaper morgues. The result is an authentic document, rollicking in anecdote, racy in style, and revealing as to history. (428 pages, 6 by 9 inches, 35 illustrations.)—$3.60 postpaid.—*A. D. R., IV.*

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PLAYING WITH LIGHTNING

By K. B. McEachron in collaboration with Kenneth G. Patrick

EXTRACT from the mind of General Electric's artificial and natural lightning expert that part of his knowledge of this subject which will interest, but not bore, or swamp the average reader having scientific leanings, and you have this informative, but readable and entertaining book. Facts about lightning; analyzing natural lightning with the moving lens camera and oscillograph; antics of lightning on transmission lines and on high buildings (experiments on the Empire State Building); science in lightning rods, which reduce house risk to 5 percent and are by no means relics of a by-gone day; personal risks from lightning, some old-fashioned ideas being not so crazy after all—this is the scope of the book. (231 pages, 6 x 8½ inches, 16 illustrations.) $2.60 postpaid.—*A. G. I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

TO MAKE your own telescope, a lathe isn't necessary; a mounting can be devised from parts picked up here and there and adapted. Yet if you do own a lathe you can have a really neat telescope—provided you also were born with a feeling for clean design. John Marshall, of Philadelphia, has such a feeling, as the 4", f/8 reflecting telescope shown with him in Figure 1 clearly proves. His friend, L. F. Wiler, 2502 South 75th Street, also of Philadelphia, sends in the following description of the telescope.

"The tube is made from 16-gage sheet metal and turns in supporting rings, so that the eyepiece is always in the most comfortable position. Originally, the mirror was mounted in a wooden cell, but the wood shrank, causing a pronounced astigmatic image, so a new brass cell was made.

"The polar and declination axes are of 1⅝-inch cold-rolled steel tubing turned true, and ground into the four bearings. These were cut from scrap bronze, bored to fit the tubing. Turning friction can be adjusted by tightening the capscrews on the split side of the bearings. Thrust is taken up by steel collars on the axes. An adjustment atop the hollow tripod allows an azimuth change to be made without moving the legs around.

"The legs are 2½-inch bar channel, bolted to the base. They have leveling screws at the bottom. This seemed to be the most logical way of supporting the instrument, since it is used in the city, standing on concrete walks.

"Motions in right ascension and declination are made by two slow-motion thumbscrews. The worm and worm-gear ratio is about 20 to 1. Worms and worm gears also were made by Mr. Marshall. The thin, split extensions of the hubs of the worm gears are tapered and threaded on the outside. The worm gears are locked in position on the axes by turning up the threaded collars on these extensions. Quick adjustment through large arcs can be made when the collars are turned back. The axes then turn freely in the bores of the worm gears.

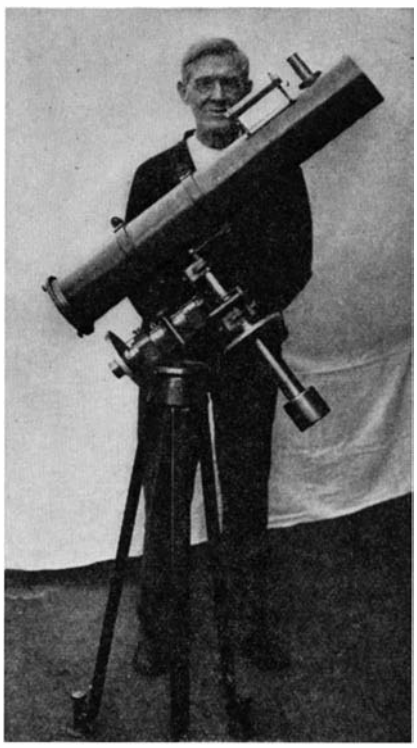

Figure 1: **Marshall and reflector**

Figure 2: **Hough's 16" telescope**

"The telescope is further glorified with two circles graduated in degrees. The finder was made from a piece of brass tubing. Its optical system is from the lenses of an old box camera. It serves the purpose well, in spite of the chromatic aberration.

"The total cost of material, including the prism and aluminizing the mirror, was $5.75. The man-hours that went into this telescope are astronomical."

IF YOU are flirting with the idea of building a telescope, and have been reading this department of the magazine for months or years, as we know many do before actually making the pick-up, do not be frightened off by the large size of some of the instruments described here from time to time, since these are not first telescopes. Most amateurs start with a 6" size, make an 8", perhaps a 10" or a 12½", and by that time have gained enough experience to tackle something larger, if they wish to go that far. Unusual—probably unique—is the 16" reflector of Springfield type (Figure 2) described below, made by a user of the handbook, "Amateur Telescope Making," C. W. Hough, Box 145, Route 1, Pasadena, California. Actually this is three telescopes on one mounting, the "other two" being 3" refractors mounted beneath the tube of the main reflector. By moving a simple slide the same eyepiece may instantly be applied to any one of the three. Hough writes:

"The 16" mirror for the reflecting telescope was ground and polished by hand on an HCF lap. Its short focus —48", or f/3—required the removal of about 1/3" of glass at the center of the curve. [When asked why he chose this great focal ratio, instead of the more usual f/8, Hough replied that he was attracted by the difficulties promised in "ATM" in hand-working a mirror larger than 12" in diameter, and in figuring one of great focal ratio; he also wanted large light-gathering power.—*Ed.*]

"The equatorial mounting was made from an old Dodge rear axle and drive shaft. On the upper end of that axle is mounted a wheel hub and brake drum, and to this unit is bolted a forged yoke which supports a 200-pound lead counterweight.

"Sliding around the outside of the drum is a setting circle, which may be clamped wherever desired for settings in right ascension.

"On the brake drum on the end of the sloping polar axis shaft and bolted to it at right angles, is the end of the propeller shaft housing from the same old Dodge car. This unit consists of the housing, ball-bearing cage, and drive shaft. This drive shaft was bored out and serves as the light-channel from the diagonal to the prism beneath the eyepiece.

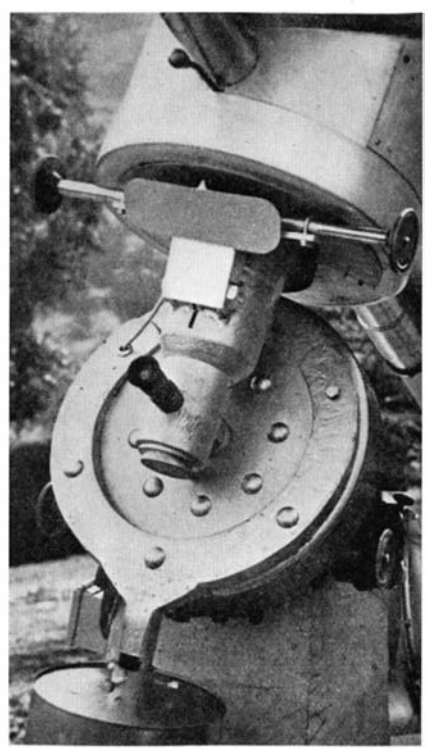

Figure 3: **Hough, close-up**

"The second wheel hub is mounted on this drive shaft, and on the hub part is mounted a second brake drum through a plate friction clutch. This is driven in slow motion by a worm and right and left hand-wheels. A similar friction clutch is built inside the first or polar axis brake drum, and, like the other, is turned in slow motion by double hand-wheels, or else may be driven by an electric motor back-geared to the handwheel shaft (Figure 3). The declination circle is screwed to the flat face of the second brake drum and is dimly lighted by a 6-volt lamp, the hour circle being similarly lighted.

"The main tube is 17" in diameter and 100" long, hence the telescope's pet name, 'The "100-inch-Long".' The tube's four internal stiffening rings were made by spinning a 19" diameter steel plate, turning the edge at right angles and cutting out the center.

"Between the tube and brake drum is a short stub, or T, of metal tubing welded to the tube, and through holes in this stub piece two 3" refracting telescopes, pointing in opposite direc-

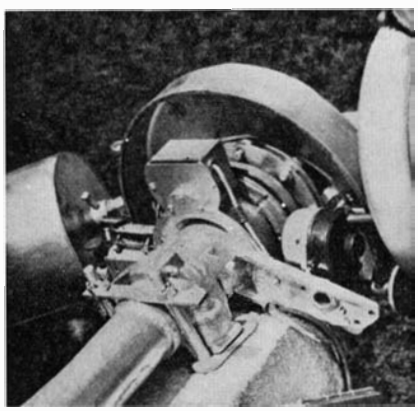

Figure 4: **Hough, back side**

tions, one an f/12, the other an f/18, are inserted, their outer ends bolted to the big tube.

"The 1" diagonal prism for the 16" reflector is mounted on an adjustable unit attached to the side of the big tube.

"The mirror rests in a spun steel cell on felt pads and has the usual three adjustments, plus radial adjustments.

"Inside the T stub mentioned above is a brass slide parallel with the three telescopes, and on it are mounted two prisms, also a 1" achromatic negative lens in the center. Handles (Figure 3) for sliding this slide project through the T, a detent holding the slide in the selected position. The prisms and slides are mounted on micrometer adjustments and the three telescopes are adjusted for identical focus and center at infinity. The 1" negative, achromatic Barlow lens mentioned above is 11" from the main diagonal, and focuses 15" farther along at the eyepiece, the cone of rays first passing through the ½" hole in the declination axis and being reflected by the second prism below

the eyepiece. The eyepiece mounting is fixed in position.

"The telescope may be swung by hand by slight pressure, against friction of the clutches. Fine adjustments then are made by means of the handwheels. The drive motor is thrown in gear by a milled screw seen silhouetted above the lower handwheel in Figure 3. Motor speed is controlled by a variable resistance. While not synchronous, it keeps a star in the field of the 16" mirror for an hour or more without adjustment.

"I live on a hill overlooking Pasadena and Altadena, and with Mt. Wilson in the northeast, and I use the 3" f/12 as a terrestrial unit, then reverse the telescope and use the refractor and reflector interchangeably, without leaving my seat or taking my eye from the eyepiece. I believe this assembly of three different telescopes on one universal mounting, with a single, stationary eyepiece, is a new idea.

"The telescope is waterproof, the large tube having a spun cover seen hanging on the southern pier in Figure 2.

"Figure 4 shows the rear, with transformer in center, motor rheostat at right, motor holding clamp at left, polar axis clutch in center, and the worm screw rings shown in part.

"All the auxiliary equipment is mounted on the original brake band support. The foundation bolts are the ½" U-bolts once used for bolting the rear axle to the springs of the Dodge car. Two of these were fitted with washers and nuts and placed nuts down, one in each of the two foundation forms parallel with the axle. The other two were interlaced with the first two, with the threaded ends projecting through the form to straddle the car axle. The latter bolts were wound with clothesline, over which was wound two layers of rubber tape. Concrete was then poured and, after it was thoroughly set, the clothesline and tape were pulled out. This provided about ¾" space for movement of the bolts for polar adjustment.

"Originally I mounted the 200-pound lead counterweight on an arm at the lower end of the polar axis shaft, but the torsion twisted the 1⅛" shaft so much that the unit was out of balance in both east and west directions, and this is the reason for the rather heavy forged yoke which now supports the counterweight. The telescope is now perfectly balanced in all directions and extremely rigid.

"On top of the main tube, and in line with the declination axis, is an 8" by 8" manhole which gives access to the prism, and this hole normally is covered by a curved plate. My camera is attached to an identical plate which fits on the same projecting studs. This plate mounts a prism positioned in the axis of the mirror but between the mirror and main prism. Thus the two prisms do not interfere with one another. The light is turned upward, through a high-grade shutter with remote control. When making photographs, the telescope is guided by the refractor.

"I did not do any of the small optical work. Some years ago I picked up from a Third Avenue, New York, junk dealer a large assortment of lenses and eyepieces; two 3" fixed position theodolites; a 2" Throughton and Simms repeating theodolite with 12" scales, a beautiful instrument; World War I trench periscopes. The dealer had bought this for the brass! This material has been very useful. I think it came from some of the early Coast and Geodetic Survey stations. The telescope is largely made up of junk and odds and ends."

NEAT little gadget for mounting a diagonal in a Newtonian reflector is shown in Figure 5, which is self-explanatory ("*Hua-i neng ta ch'ien yen*," or, picture's meaning can express a thousand words, in case your Chinese has become rusty). Developed by Max Burgdorf, Natchitoches, Louisiana, and made by Lorane Brittain and Sherwood Burgdorf, it takes the place of the more customary

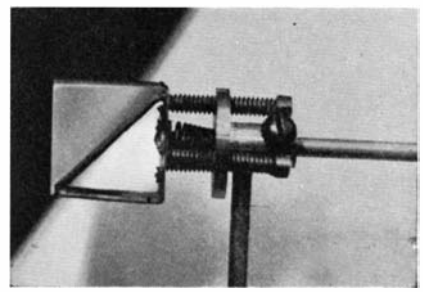

Figure 5: **B, B and B support**

spider support for diagonals and would cause a less complicated diffraction pattern than the latter. They embodied it in their 8" reflector.

The trio, the first-named an ice manufacturer, the second an associate professor of music (teacher of counterpoint and composition) at the Louisiana State Normal College, experienced an amusing variation on the old theme supplied by professional looking-glass silverers (not telescope mirror silverers) in which they stubbornly silver the back of the mirror disk unless kept under duress; *their* silverer silvered the face, just as requested—and then smeared on a coat of paint to protect it!

SOCIAL item: Annual report of the Director of Mt. Wilson Observatory says the 72" spherical f/2.5 mirror for the 48" Schmidt telescope on Palomar Mountain has been figured at the Observatory optical shop; the entire work of grinding and polishing having been completed by Hendrix and Dietz in 21 weeks. Dietz, only a few years ago, was a beginner, reading the present department and starting in by making the orthodox 6" reflector, following the directions in "ATM." Now he is a professional with

his name bracketed with that of D. O. Hendrix, Mt. Wilson's head optician. Home-town boy makes good.

MEDAL — the Coffin Foundation award—has been handed by the General Electric Company to A. W. Everest, Pittsfield, Massachusetts, employee, for his research in the measurement of steel when magnetized. Everest, with his usual modesty, won't tell exactly what he did but we hear he developed a thing actually called a magnetostrictoscope. Not to be outdone by a mere $300,000,000 corporation, your scribe, on August second, at next summer's convention of amateur telescopticians in Vermont, will hand to the same Wally Everest a much larger medal, for his research on a close technic in working optical surfaces on glass, and for developing a thing called, with much greater economy of syllables, the "spit test" for radius of curvature.

NO SECOND *edition* of "ATMA" has been published or is contemplated, but whenever a *printing* of the existing edition, which is the first, runs out we try to correct those errors which our readers have kindly pointed out to us. In the second printing, made August 20, 1939, the following errors were corrected and owners of "ATMA" may change their copies as follows:

Page 71, Fig. 2: Cross off top lettering, which is reversed (and unessential).

Page 131, line 7: Delete from "assumed" to end of paragraph and substitute: "Plane mirrors used in the testing of paraboloids and of completed telescopes at their foci must be of high quality as regards smoothness of figure (± 0.1 wave maximum), but uniform sphericity of the order of ± 1 to 10 waves can be tolerated, depending upon the application."

Page 201, line 4 of legend under Fig. 6, for first nine words substitute "print. The bottom cylinder is cast solid."

Page 227, near top, change 16620 to 1662.0.

Page 348, line 11, change "remaining" to "ramming."

Page 404, line 5, change 2.8 to 3.2.

Page 633, footnote, third line from bottom, delete decimal points.

Page 635, last paragraph, change each M to m.

Page 637, line 2, change M to m; line 3, delete m.

Those who purchased "ATMA" between August 20, 1939 and February 1941 (third printing) need change only the following:

Page 253, fifth line above bottom, 16 to 15.

Page 266, in Fig. 5, lower, right-hand part, r_1, r_2, r_3 to r_7, r_8, r_9.

Page 404, first line below cut, half to quarter.

In addition to these errors of fact, a number of slips in diction were found and many of them corrected. What real errors have you found?

CURRENT BULLETIN BRIEFS

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

HERE'S A PROBLEM YOU SHOULD LICK is a 12-page illustrated booklet that gives reasons why costly dust conditions in an industrial plant should be controlled, and how this control can be brought about by the proper installation of dust collecting equipment. *American Foundry Equipment Company, Mishawaka, Indiana. —Gratis.*

NEW TERMITOPHILOUS DIPTERA FROM THE NEOTROPICS, by Charles H. Seevers, concerns the subfamily Metopinae of the Phoridae, and describes the new species Syntermorphora microphthalma, Crytophora colombiae, Ecitomyia termitoxena, Holalophora gutiquiae, Homalophora metae, and Pulciphora termitophila. *Field Museum of Natural History, Chicago, Illinois.—15 cents.*

KODAK DATA BOOK — SLIDES AND TRANSPARENCIES, the latest Kodak Data Book, contains extensive information on making of Kodachrome as well as black-and-white slides. Included are recommendations on making Kodaslides, methods of printing films and plates, developing technique, information on tinting, toning, finishing slides, masking and binding, storage and projection. *Eastman Kodak Company, Rochester, New York.—25 cents.*

HYCAR is an eight-page illustrated booklet that tells the story of the new Hycar group of synthetic rubbers. The book is written in non-technical language. *Hydrocarbon Chemical and Rubber Company, 335 S. Main Street, Akron, Ohio.—Gratis.*

ELECTRIC MOTORS FOR THE FARM is a bulletin prepared by Engineers of the Bureau of Agricultural Chemistry and Engineering. It presents facts about the types of motors, purposes of various sizes, installing and connecting them, and their care. These fundamentals are essential to the farmer who would become well informed on this mechanical contrivance that can be of great assistance in farm operations. Request F. B. 1858. *Office of Information, U. S. Dept. of Agriculture, Washington, D. C. — Gratis.*

FACTS YOU SHOULD KNOW ABOUT COSMETICS is a 16-page booklet that deals with the whole range of cosmetics from powders to reducing creams, from acne treatments to X-ray machines. It points out that while the cosmetic industry in general is a legitimate one, there are some unethical operators who may even employ poisonous and dangerous substances in their products. This booklet sounds warnings where warnings are needed. *National Better Business Bureau, Chrysler Bldg., New York City.—Three cents.*

INDUSTRIAL RESEARCH INSTITUTE is a 15-page booklet which outlines the nature of this organization, the need for it, its working methods, its value, and membership requirements. Details of this institute will be of interest to all those concerned with industrial research. *Industrial Research Institute, 8 South Michigan Avenue, Chicago, Illinois.—Gratis.*

ESSOLUBE HD is a 16-page fully illustrated pamphlet which gives a complete description of the properties of this high-viscosity detergent type of oil for heavy-duty gasoline and diesel engines. *Standard Oil Company of New Jersey, Room 1569, 26 Broadway, New York City.—Gratis.*

TORFLEX FLEXIBLE BEARINGS is a four-page illustrated pamphlet which describes typical applications of these bearings which are specifically recommended for the elimination of noise, vibration, and lubrication; for impact and shock absorption; and for parallel and angular misalignment compensation. *Harris Products Co., 5474 Commonwealth Avenue, Detroit, Michigan.—Gratis.*

TOP NOTCH SHOCK RESISTING TOOL STEEL is a folder of special interest to makers and users of tools and dies for cold work or semi-hot work applications where resistance to severe and repeated impact is important. Contains complete information on heat treatment of the steel. *Jessup Steel Company, 680 Green Street, Washington, Pennsylvania.—Gratis.*

PLANTS AND CHEMICALS, by W. E. Bott, is a 32-page booklet containing instructions for amateur experimentation to obtain plant mutations by means of the chemical, colchicine, also for the use of hormones and vitamins in plant experimentation. *W. E. Bott, Box 2648, Lakewood, Ohio.—25 cents.*

TABER ABRASER RESEARCH MODEL, bulletin 4012, is a six-page illustrated folder which describes the uses of an efficient testing machine for evaluating resistance of surface finishes, as well as textile fabrics, to rubbing abrasion. This equipment can find a definite place for itself in all modern laboratories where abrasion resistance must be determined. *Taber Instrument Company, North Tonawanda, New York.—Gratis.*

IT SANDS, SAWS, HONES, FILES is a four-page bulletin that describes several models of reciprocating multipurpose hand tools. It tells of the many operations that can be accomplished with these tools, as outlined in the title. *H and H Research Company, 12540 - 12th Street, Detroit, Michigan.—Gratis.*

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

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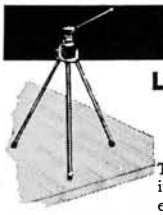

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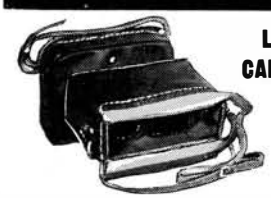

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