SCIENTIFIC AMERICAN

graph by Margaret Bourke-White

Where Stainless Steel is Born (See page 225)

NOVEMBER 1934 VOL. 151 NO. 5 35¢ A COPY

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SCIENTIFIC AMERICAN

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NINETIETH YEAR • ORSON D. MUNN, Editor

The SCIENTIFIC AMERICAN DIGEST

CONTENTS · NOVEMBER · 1934

Cover

STEEL is the backbone of many industries of the world; stainless steel in particular has opened many new fields of endeavor. Important in its manufacture is nickel, the story of which is told in the article starting on page 229.

SCIENTIFIC AMERICAN, November, 1934. Vol. No. 151, No. 5, entered at the New York, N. Y. Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City.

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ACROSS THE EDITOR'S DESK

We Look to the Future

WHEN the young inventor, Thomas A. Edison, gave the first demonstration of his phonograph in our old offices in lower Broadway, SCIENTIFIC AMERICAN had been "selling" scientific and industrial progress to laymen for decades. During those early days, from 1845 onward, the ingenuity, the inventiveness, the vision of progress, and the individual initiative of Americans were in their early ascendency. Like an onrushing flood, the "American idea" swept on and on, slowly gathering momentum until, during the past few years, its growth has been so phenomenal as to set it apart as a model for the world to emulate.

Yet, just three months ago we said editorially: "Progress has only just begun," and the month before that: "... by use of a little imagination, new depths of demand can be reached and new demands created; by use of a little extra energy and courage, products can be sold; and by employing research as never before, progress can be made. Our next and infinitely greatest frontier is the frontier of science and invention, and this frontier extends to the stars!"

Vision, courage, progress—a frontier that extends to the stars! SCIENTIFIC AMERICAN has always appraised this frontier; has interpreted and evaluated (in understandable fashion for the far-sighted, thinking layman) the myriad applications of science that lead toward the better life; has given an authoritative picture of the present that, in turn, gives a vision of the future. Our pages have exhibited, for those with analytical eyes to see, an architect's perspective of the complete tower of science-made civilization pointing to the stars, the stones of which are the advances of science in human affairs.

The tempo now changes. Doubts and uncertainties are in the minds of men, planted there by theorists and dreamers. Isms abound, grow more insidious, and would undermine the foundations of man's tower of achievement. The old order, say the cultists, is all wrong; we must stop making machinery, curtail production, organize for collective control, pay higher wages—in fact, industry suffers on all sides. In spite of its vicissitudes, however, industry takes the long view and marches valiantly ahead, slowly it is true, but none-the-less surely.

Our cue is here. Long the champion of typically American progress and mentor to the layman, SCIENTIFIC AMERICAN adopts a more vigorous editorial policy. If the laissez faire world has gone into the discard, much palaver in abstractions by "economists" are but straws in the wind; they cannot erase the bewilderment from your mind. Hard facts, however, are weather vanes; they not only show the way the wind is blowing, but, their proper significance being adduced, they will also foretell the future hurricane of developments. SCIENTIFIC AMERICAN has always presented such facts for the wise ones to use and numerous letters attest the great profits made thereby. Now, we present them more vigorously, will emphasize them as never before.

SCIENTIFIC AMERICAN will continue to champion the cause of progress for we do not think the principle of individual enterprise is out-moded, will champion it more courageously, fearlessly, with facts that cannot be refuted and which will serve to guide us forward to the better life, to give a vision —a vitally important vision—of the future!

Orson D. Munn

Editor and Publisher

Personalities in Science

FRAULEIN EDITH KROUPA

WITH Nazi bombs exploding and rifles cracking in the most recent Vienna revolution, Fraulein Edith Kroupa, a research chemist at the University of Vienna, sat calmly in the laboratory of Professor A. Franke, conducting a trying micro-chemical analysis of a tiny rock sample sent from near Winnipeg, Canada, to determine the age of the earth. The two activities, revolution and research, are doubtless somewhat incongruous when pursued at the same time in the same city, and one may possibly conclude that the conduct of ultra-precise chemical analysis in the midst of a small war must demand the qualities of a heroine. But the chances are that Fraulein Kroupa, as she worked, was scarcely made aware of the event of lesser importance, that is, the local war, since Vienna is a large city and its average resident is doubtless made little more aware of its average revolution, than the average citizen of an American metropolis is made immediately aware of the bank robberies and gang wars which are somewhat too average in our own "peaceful" land. And so Miss Kroupa determined the age of the earth and found it to be at least 1,725,000,000 years.

What the feminine scientist, who happily does not find it inconsonant with the aims of good science to wear a pretty hat, did in the bit of research in which she participated was to employ special methods of making what chemists call a micro-analysis. These are newer, more refined methods than some others. The aim is to ascertain the ratio of the radioactive material of a rock sample to its radioactivity product, lead. The sample she analyzed microchemically weighed only one hundredth of an ounce, but such a sample is enough for this work.

It will be recalled that the radioactivity method of determining the earth's age has supplanted earlier methods, such as determining the ratio of salt in the ocean to that in the land rocks. This method has given to geologic time a sufficient length to satisfy the biologists, who previously asserted that 100,000,000 years or so was not enough to allow for the whole course of evolution of life on earth. Science now gives the earth an age of at least two billion years.

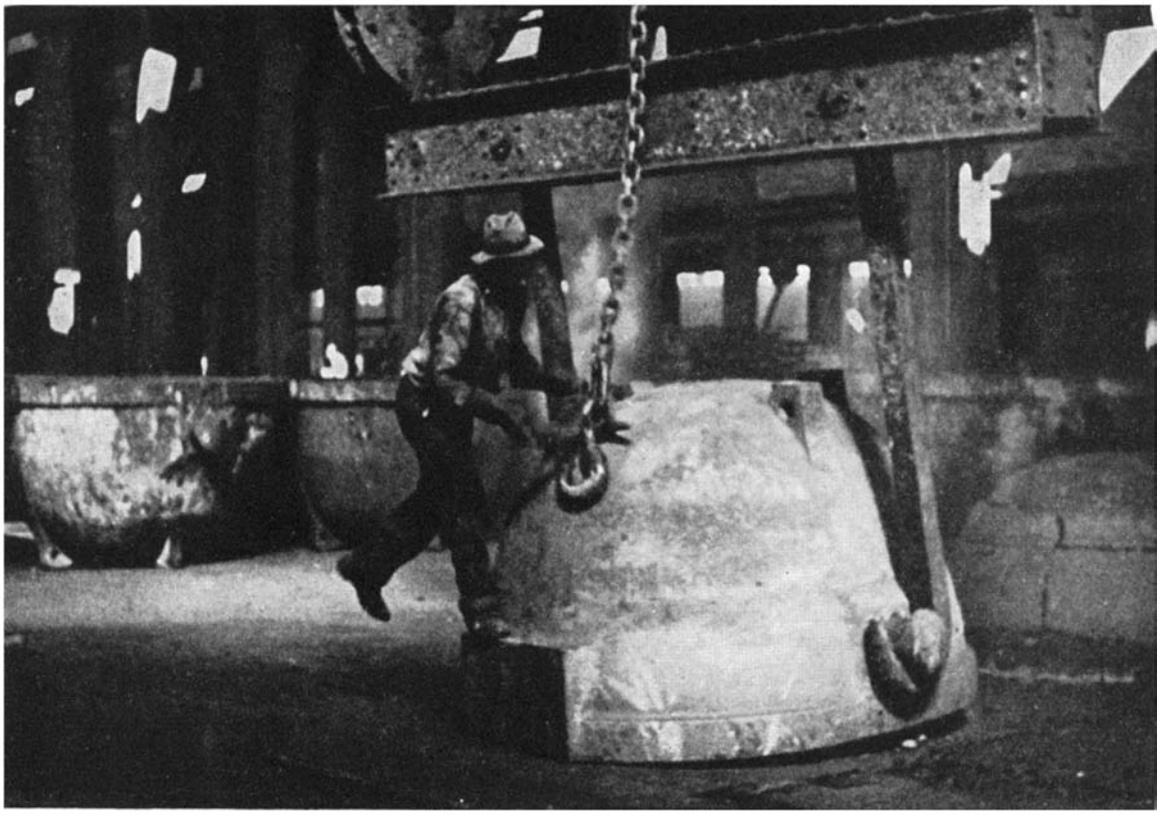
THIS is one way the radioactivity method is figured out: In ancient rocks, and younger rocks as well, geologists long ago found tiny haloes, visible only under strong microscopes because they were so small, which seemed so uniform in diameter and so geometrically perfect that their representing any kind of fossil seemed improbable. Years later it was found that these haloes were merely the exposed cross-sections of spheres, each sphere surrounding a minute particle of a radioactive element, thorium or uranium. These spheres represent the product of the slow breakdown of the central radioactive particle into lead, and the ratio of the radioactive element to the lead present gives a measure of the age of the rock in which the spheres or haloes occur. In rocks known by other kinds of evidence to be younger there is found to be correspondingly less lead. This method has become standard in ascertaining the age of the rocks.

Only by a most delicate micro-analysis can the uranium-lead ratio be determined accurately, and that sort of analysis is what Fraulein Kroupa has become expert in making. It is work that requires painstaking care and precision, for the quantities of each component involved are almost microscopic.

Science Service photo

A RICH NEW DISCOVERY OF DINOSAUR REMAINS

IN Wyoming, Dr. Barnum Brown, paleontologist, on the staff of the American Museum of Natural History, New York, has discovered a fossil dinosaur-wallow 125,000,000 years old, and in it the skeletons of 12 or more large dinosaurs. The significance of this find is not that dinosaurs, as such, have been found, for these have not been especially rare, but mainly the number found in one place, their fine condition, and the fact that parts of the same species found incomplete elsewhere are supplied by this discovery. Another lucky strike was the unique discovery of a piece of petrified dinosaur hide.



Dumping a pot of "nickel bottom" and "copper top" in the Orford separation process

'NEAR NOBLE' NICKEL

By JOHN F. THOMPSON
Vice President, The International Nickel Company of Canada, Limited

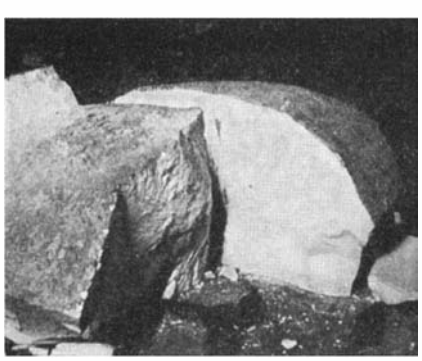
Of Great Industrial Importance . . . Used Daily by Millions . . . Chromium Promotes Nickel Plating . . . 49 Percent Used in United States . . . Vital in Automotive Design

IN the eternal quest of science for better materials with which to meet the demands of modern industry, nickel has found in recent years fertile soil for spreading the roots of a great industry of its own. Its versatility in joining with other metals to effect better properties and performance gives it a near nobility in the modern alchemy of alloys.

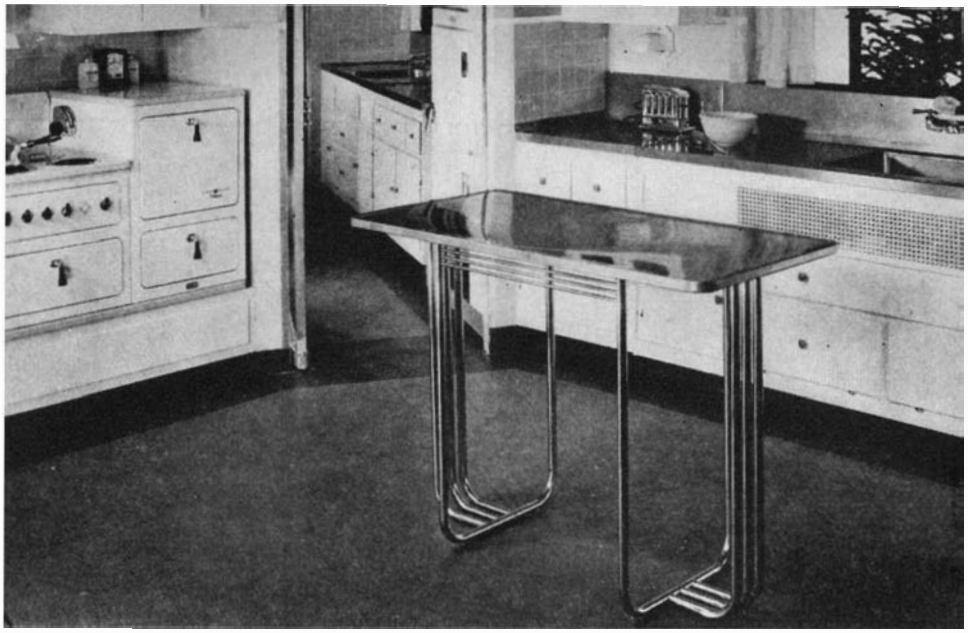
To the average layman, nickel is usually associated with plating; yet the metal is part of his latch-key, of his bathroom fixtures, of his table silver, toaster and percolator, of his radio and of many another product that he uses daily. The association of nickel with plating carries the further thought that chromium plating has largely driven out nickel; the truth is that chromium plating is very generally done over a comparatively heavy underlay of nickel plate, thus contributing to the further use of nickel in plating. Another phase of popular confusion about nickel is that it has supplied the nickname for the American five-cent piece which is only 25 percent nickel and the balance copper, although some 27 other nations, including those as close as Canada and as distant as Abyssinia and Japan, are using coins that really are pure nickel.

DURING the last five years the United States has consumed nearly as much nickel as the rest of the world put together, its share of world deliveries for that period having been 49 percent. In five years American consumption exceeded 100,000 short tons, or an average of more than 40,000,000 pounds a year. As a result, this country is making some of the most spectacular uses of this white metal.

For example, the Empire State Building and the Chrysler Tower are sheathed with stainless steel, the chromium-nickel alloy containing 8 percent nickel; and the same material has been used by the E. G. Budd Manufacturing Company to construct all but the trucks and enginebed of the "Zephyr," the Burlington Railroad's entry in the new competition between trains and airplanes.



Nickle-copper block (see above) is broken by mechanical fracture

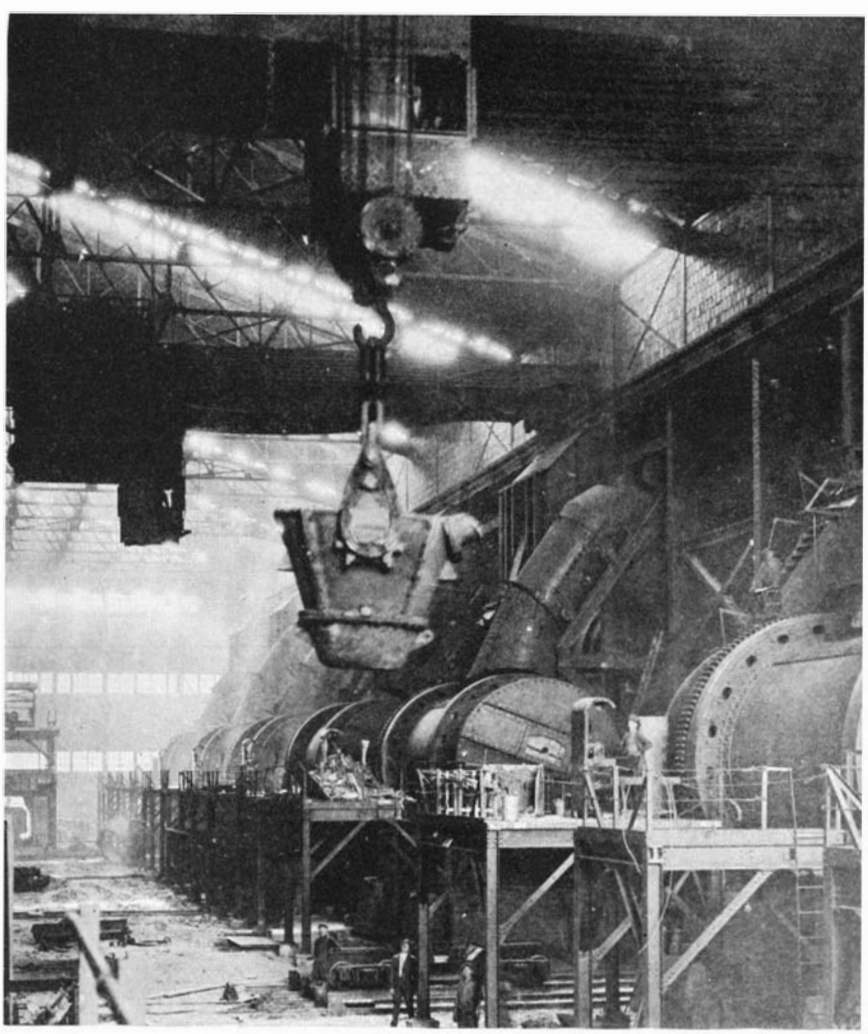


Monel Metal, corrosion resistant, used for working surfaces in a modern kitchen

Monel Metal, the natural alloy reduced directly from ores in which the nickel-copper content maintains the ratio of two parts of nickel to one of copper, is used for the propeller shaft of Gar Wood's record-holding speedboat, for turbine blading on the *Bremen, Rex, Manhattan* and other ocean greyhounds, and for the pontoons of some of the latest seaplanes. It provides the working surfaces for soda fountains, hotel and restaurant kitchens, packing and canning factories as well as for operating rooms in hospitals. At Boulder Dam it not only forms the important valve seats which will control the flow of water, but it is also being imbedded as grout stops (expansion joints) in the massive masonry of the dam itself. According to the present schedule, more than 250,000 pounds of this alloy will go into the dam. Used as the roof for the Pennsylvania Station in New York City, Monel Metal has already had 26 years of exposure to the elements, and a recent test indicates that this roof will last for 100 years more.

ALLOY steels of low nickel content have become the feature of modern automotive design where increased strength and safety are required with no increase in the sections and weight of the main structural parts. And some 3500 tons of these nickel steels are going into the construction of the San Francisco-Oakland Bay Bridge.

At the same time the production and the applications of cast iron, one of the oldest industrial materials, are being revolutionized by the results obtained from including nickel either alone or in combination with other alloying elements. These new cast-iron alloys not only show smaller losses from imperfections and breakage in casting and machining, but they also offer properties and performance through which cast iron is regaining an important place in the modern industrial world. Their greater toughness and wear-resistance are finding uses for them as brake drums for busses and trucks, as manhole covers which must withstand the heavy impacts of modern street traffic, and as parts for rock crushers, dredges, and other machinery subjected to abrasion.



Crane transferring ladle from converter in nickel separation process

In the electrical field nickel demonstrates its greatest versatility. Certain nickel alloys are magnetic; others are non-magnetic. The volume of messages which a transatlantic cable can handle has been multiplied 15 times by the use of Permalloy, an alloy developed by the Bell Telephone Laboratories and containing 78 percent nickel and the balance iron. The telephone companies employ the same nickel alloy to make long-distance conversations clear, and another type in the "boosters" to increase the volume of sound transmitted. The whole development of electric irons, toasters, percolators, and ranges for household use depends largely on a special nickel-chromium alloy for the heating element. Every metal part in the interior of a modern radio tube is either pure nickel or an alloy predominantly nickel.

PERHAPS the most recent finding of science has to do with the development in New York of a nickel-chromium-iron alloy under rigidly controlled heat and quenching conditions to produce a foolproof material for spring scales. As far back as 1678 Robert Hooke, eccentric English experimenter, proclaimed what physicists have since known as Hooke's Law. It is that "the power of any spring is in the same proportion with the tension thereof: That is, if one power stretch or bend it one space, two will bend it two, and three will bend it three,

and so forward." In the many years which have ensued, that law has been observed more in the breach than in the performance, because deviations appeared as the theory was applied in actual practice. A series of "errors" came to be recognized in the spring scale industry — the temperature error, the straight line error, and errors due to creep and hysteresis. Various methods were developed as compensations, but the inherent errors persisted. Spring scales therefore had to be made and assembled by highly skilled manual labor.

DOWN in the shadow of Brooklyn Bridge there is an Old World pocket which has resisted the encroachment of skyscrapers. Known to native New Yorkers as "The Swamp," it is the place where John Chatillon and Sons have been making spring scales for nearly a century. Five years ago Robert B. Wasson, research engineer of the company, began experimenting. Dr. A. V. de Forest and Prof. Mortimer Sayre served as consultants. Now he has perfected the Iso-Elastic Alloy which eliminates the errors due to temperature changes, creep, or hysteresis in helical, or spiral, spring scales; and he has worked out a geometrical form for the spring wire, which automatically corrects the straight line or torsion error.

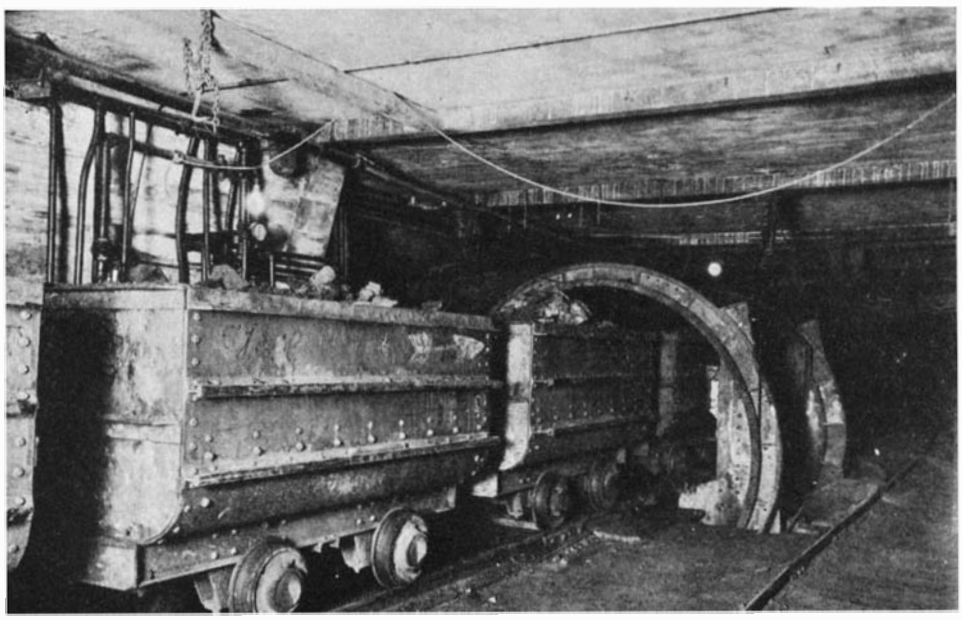
Iso-Elastic Alloy is essentially a modification of Invar, a nickel iron alloy developed years ago by the French metallurgist, Guillaume. Not only does it make possible spring scales on which both butchers and grocers and their customers can place reliance; it also has potential uses wherever a spring operating under wide temperature changes is the activating principle of an instrument. For example, truck manufacturers are already investigating the use of this alloy in the manufacture of governors to set the maximum speed at which trucks can be driven. Heretofore the accuracy of such instruments has been affected by the temperature variations under the engine hood.

Thus research initiated by various industries—and notably by those in the electrical field—supplements the research and development work of the nickel industry itself in finding new uses for nickel and in broadening its older applications.

From the standpoint of weight percentage, nickel occupies sixth place among the 92 components of the earth's crust; yet there are only a handful of known concentrations sufficiently important to justify mining on a commercial basis. Of these the Sudbury Basin, a small area in Ontario, supplies 83.5 percent of the world's consumption; the next most important field is New Caledonia with 10.5 percent. Germany, Norway, Greece, Japan, and Burma together furnish the remaining 6 percent of the world's requirements. The New Caledonian fields were the most outstanding source of the world's nickel supply prior to the development of the Canadian deposits.

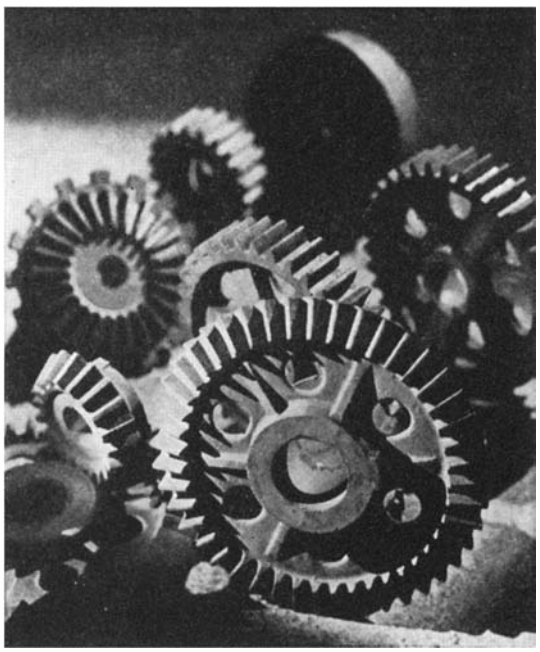
Converters where copper content of nickel ore is blown to "blister"

At the 2800-foot level in the Frood mine: A rotary dump handles six-ton cars



THE dominant factor in this situation is the Frood Mine which is located a few miles from Sudbury. So far, explored to a depth of 3300 feet, it already shows a reserve of some 135,000,000 tons of workable ore; neighboring mines bring the aggregate of proved ore above 200 millions.

These deposits take the form of pyrrhotite-chalcopyrite ores containing copper and nickel in comparatively large quantities, and gold, silver, the platinum metals, and selenium and tellurium in sufficient quantities to make



Industry is geared to nickel steels

their recovery a factor in the economical production of the nickel. Discovered in 1883 when the Canadian Pacific Railway was being pushed westward through Ontario, these ores duplicated the difficulties and exasperation experienced by the Saxon miners of the early 18th Century, who wrestled in vain with similar ore and finally dubbed it *kupfer nickel* on the theory that "Old Nick" and his gnomes had bewitched perfectly good copper ore.

The primary metallurgical problem is one of separating the nickel from the copper on a commercially practical basis. Two successful answers have emerged as standard. One is the Orford separation which depends on the chemical action of sodium sulphate on copper-nickel sulphide in the presence of carbon, the sodium sulphate turning to sulphide and joining with the copper sulphide in a solution which is lighter than the molten nickel sulphide that has been but slightly affected by the presence of the "soda." Thus, when the charge is tapped from the blast furnace into great pots and allowed to cool, the nickel sulphide settles in the bottom and the copper-soda solution floats on top. After the contents have solidified, the pots are dumped, and there is an easy fracture of the two masses. This method of separation is the one used in the Canadian process, and it also has become a basis for the other type of separation.

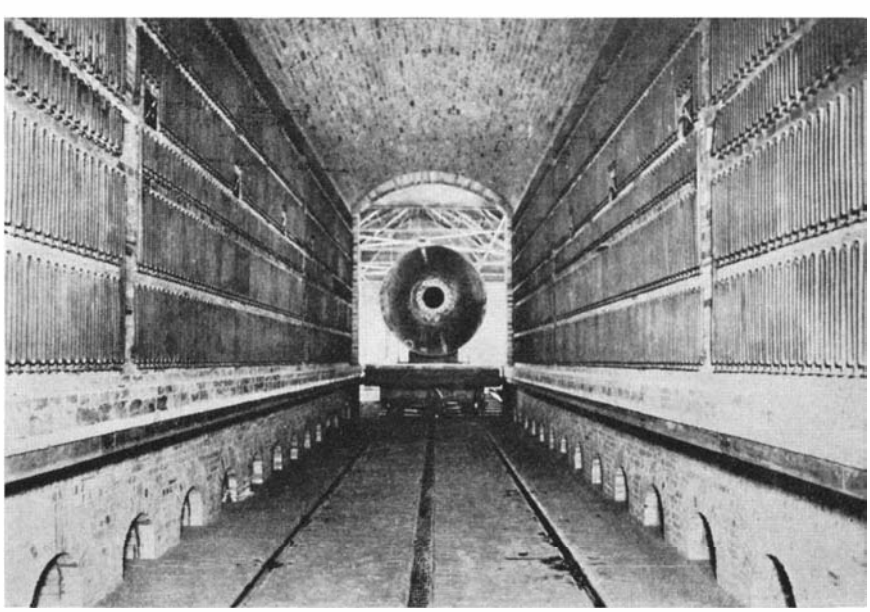
THE other answer to the metallurgical problem is the Carbonyl separation in which finely divided metallic nickel is volatilized with carbon monoxide at one temperature and is deposited out of the gas at a higher degree. Developed by the Mond Nickel Company in the United Kingdom, the process employed has been modified since the amalgamation of that company into The International Nickel Company of Canada, Limited. Originally copper-nickel matte from Canada was the basis of the Mond process, as much as possible of the copper being leached out as a preliminary to volatilization. At the present time, some nickel matte produced by the Orford process is used, thus anticipating much of the copper elimination. At the same time the process developed in Canada around the Orford separation has been improved by the use of selective flotation in the concentrator to effect a rough separation of the copper and nickel contents of the ore prior to the blast-furnace operation with sodium sulphide.

To produce the pure nickel of commerce the Canadian method is to reduce the Orford matte by final elimination of the sulfur and then to cast nickel anodes some 96 percent pure. Placed in electrolytic tanks, these anodes are turned into cathode nickel more than 99 percent pure. The sludge from the tanks is treated for the removal of the gold, silver, selenium, and tellurium; the residue after these treatments is shipped as a concentrate to the company's precious metals refinery at Acton (a suburb of London, England) where the six platinum metals are recovered and separated.

AS for copper, the most important by-product of these nickel operations, most of it is separated out either in the flotation tanks or in the "copper tops" of the Orford separation; and the blister copper thus produced is refined in the electrolytic plant of Ontario Refining Company a few miles from where the ore was mined. Such copper as finds its way to the Mond refinery at Clydach, Wales, in the "nickel bottoms" of the Orford separation, is leached out as copper sulphate. The copper content of the ore—the copper by-product!—is such that International Nickel ranks as the sixth largest of the world's copper producers.

SUPPLEMENTING these various operations is the production of Monel Metal as a natural nickel-copper alloy by direct reduction of ore from the Creighton mine. Situated within a few miles of Frood, this mine produces an ore in which the precious metal content is low and the nickel-copper ratio runs two parts to one. The properties of an alloy containing two-thirds nickel and one-third copper are such that Monel Metal has established itself as standard for many industrial and household uses where both strength and corrosion resistance are required. The reduction of the matte and the production of sheet, rods, bars, tubes, and the other forms in which Monel Metal is used, are carried out in a mill at Huntington, West Virginia, nearly 90 percent of the world's consumption of this alloy being in the United States.

Thus science has come a long way since the early Saxon miners discarded copper-nickel ore as being bewitched. An important field of metallurgy has been developed in learning how to separate these two important metals and how to use them in their natural combination. It is an alchemy based on the recognition that simple metals must make way for the alloys in meeting the demands of modern life.



In the largest electric furnace of its type in the world—73½ feet long, 25 feet high, and 19 feet wide—special nickel alloy heating elements line the walls

OUR POINT OF VIEW

"Glorious Failures"

PERHAPS the critics of the American attitude are right. Perhaps Americans *have been* entirely too optimistic and yet the most unhappy people in the world. Perhaps, as cynical foreigners frequently state, Americans do carry to extremes exaltation of bigness: "the greatest this" or "the greatest that" in the world. Perhaps, moreover, American science does scold the people for improperly utilizing the products and by-products of science, without itself offering a helpful suggestion as to how that may best be done; or too quickly we shrug our impatience at Secretary of Agriculture Wallace's strictures in the June SCIENTIFIC AMERICAN.

Suppose we plead "guilty" to all of this? We are optimistic and we are unhappy. We do glorify bigness, and yet for the most part this is for purposes of symbolizing achievement, and inspiring to further developments. The scolding is merited—we are yet a young people. Well, what then? Shall we adopt lugubrious masks to cover our faces, and sit hopefully awaiting a miracle that will carry us forward through the maze of scientific achievements, without a single mistake? Certainly there shall be no scientific holiday. Shall we turn to the critics for help? So far they've given no constructive criticism but doubtless they *have* a plan or two. Let them advance it; we are open to suggestions—in the scientific method!

Errors we have made in the past. We admit it and as candidly confess that we expect to make more. Only he who stagnates in the placid pool of certainty makes no mistakes—and no progress! Those who dare to forge valiantly ahead, gambling, if you will, with uncertainties, make both!

* * *

By an odd coincidence, just as this issue goes to press, Sir James Jeans, speaking in Scotland at the annual meeting of the British Association for the Advancement of Science, said, while discussing the value of science and invention and the question of technological unemployment:

"Is it not better to press on in our efforts to secure more wealth and leisure and dignity of life for our own and future generations, even though we risk a glorious failure, rather than accept inglorious failure by perpetuating our present conditions, in which these advantages are the exception rather than the rule?

"Shall we not risk the fate of that overambitious scientist, Icarus, rather than resign ourselves without an effort to the fate which has befallen the bees and ants? Such are the questions I would put to those who maintain that science is harmful to the race."

Television—How?

SCANNING disk or cathode-ray tube? This seems to be the burning question in television experimental work today. The scanning disk is being marvelously improved; the cathode-ray tube is proving to have many "bugs" difficult to overcome. Still the public has not been offered a real opportunity to "play around" with television. When will they have this chance, and what form will the equipment take? We await the answer of the televisionists with interest.

100,000 Scientists on Strike. Treason?

TO the human beings who are living in our present era its most important events must often seem to be its great wars and political occurrences, but future historians doubtless will discern that by far the most important events of our times were its scientific discoveries. Neither Alexander nor Caesar nor Napoleon has exerted a fraction of the effect on human history which has been exerted by the scientists Galileo, Newton or Darwin, since their discoveries and similar ones underlie our whole Age of Science. Almost any single invention or discovery—for example, the harvester or the germ nature of disease—puts vastly more wealth into the world than the whole World War took out of it. The most important thing for the human race to keep in sight in our age is, then, that through thick and thin, scientific research must march steadily on. Taking the long view of things, this is the *main bet.*

Now that the world is becoming more and more jittery about the risk of new wars, scientists are trying to think up a formula which will provide that in the event of another such occurrence this "main bet" in human affairs, this invaluable thing called scientific research, shall not be interfered with by so relatively unimportant a sideshow as our last world war, but will proceed unruffled.

At a meeting held in Brussels the International Council of Scientific Unions, premier overhead organization of all scientific organizations of the world, has just been seeking a way to maintain "by all means international co-operation in the domain of science under whatever circumstances may present themselves." This statement may be taken to mean that scientists are serving plain notice to the rest of the people of the world that if the world is ever again so idiotic as to become involved in another disastrous dog fight like the last one, concerning things that are of relatively little importance, these scientists will refuse to stop the much more important things which they are doing, and likewise will refuse to lend their aid to the several participant nations under which they live.

The 100,000 scientists of the world are its best minds. In their thoughts and attitudes they are far in advance of the rest of the population. Among themselves these men, regardless of the accident of nationality, form a brotherhood which is essentially international; more accurately, non-national. Science ignores political boundaries. In the spirit of their commingling and co-operation scientists thus furnish the closest existing approach to practicing internationalism which the world can show today.

But scientists could even do more than to refuse to stop co-operating across national boundaries in time of war or actually engaging in these childish squabbles themselves. They could even refuse to help the politicians and soldiers when war comes. They could go on strike. Without the aid of the scientists and their discoveries (which were never meant for use in war) those who make wars would then be left sadly in the lurch, for war today depends in nearly every aspect on modern science, and the scientists, without at all desiring to be, are its key men. This would reduce war to a far more limited scope than it now has, both in terms of men and of money. As a result of this there might remain in the world enough money for the steady promotion of scientific research—the main bet we have spoken of.

In thus sticking to the logic of cold reason, and steadfastly ignoring human passions, local and temporary, scientists would be placing "patriotism" toward the whole human race, present and future, even above the loftiest existing ideals of patriotism.

And how the scientists could squeeze the politicians and soldiers, merely by sitting down and refusing to be their tools and play their destructive game!

Scientific Methods of Game Breeding Will Make

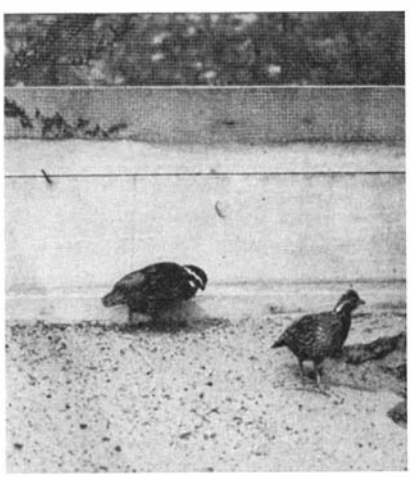
GOOD HUNTING

By GEORGE S. McCARTY
Former member, New Jersey State Fish and Game Commission

Game Raised Artificially . . . Low Cost . . . Game Fed in Natural Haunts . . . Gunner-Farmer Co-operation

ONE of the natural heritages of citizens of the United States is the right to pursue the ancient and honorable sport of the chase, hunting wild game as a recreation and as an outlet for primitive instincts which, perhaps, have been more carefully nurtured here than in other lands. Our forefathers lived by their skill as hunters and fishermen, and it is no wonder that we of the present day have a distinct leaning toward the same pursuits, but for sport rather than from necessity.

But the United States of today is a far different hunting ground than was the case 100 or even 50 or 25 years ago. Rapid increases in population, particularly around centers of business and industry, have steadily wiped out large areas which formerly were favorable to natural breeding of game birds and rabbits. The motor car has done its part by making remote areas easy to reach. The state of New Jersey is an excellent case in point. Dotted with numerous industrial towns, heavily populated, and adjacent to New York City and Philadelphia, the situation for the gunner and fisherman has become acute. Large areas of brush and woodland have been cleared for agriculture, and much of those lands which are available for gunning has been posted against trespassing.



A pair of breeding bob-white quail

What can be done to make good hunting available for the man of average means, under such conditions? The method of expensive game preserves limits shooting to the few, while we in the United States want and can have it for the many. For eight years I have studied the problem and on my farm near Newfields, New Jersey, have reduced to practice a system of game breeding and allied projects that, if properly handled, will provide self-perpetuating sport in densely populated areas.

The author feeding young grouse

While my work has been done in New Jersey, with conditions in that state particularly in mind, the system is applicable in any state in the Union where intensive gunning and improper efforts at restocking have resulted in a dearth of game.

This system may be broadly divided into four parts as follows:

1. Co-operation must be secured between the land owner and the gunner, so that hitherto posted areas will be opened for hunting.
2. Game must be raised artificially at a much lower cost than at present.

Ol' man ruffed grouse broadcasts

3. Food for game must be planted at strategic points.
4. Predators, both winged and four-footed, must be controlled.

It will be noted that these four points are dependent largely upon each other, and that failure of one will rapidly undo any good that might arise from the others.

While point number 1 is perhaps the most vital of the four, it hinges so strongly on number 2 that the latter will be discussed first. I have demonstrated that, with proper care, it is entirely possible for anyone to raise game in a small area. I would set up, under the supervision of the state game commission, or similar body, a plan whereby the farmer or his sons and daughters would be instructed in the raising of game and supplied with the necessary equipment, or told how to build it. Then the game could be purchased by the state when sufficiently grown, and either released at once or held over the winter in state lands.

BIRDS and rabbits so raised can be purchased at a much lower figure than is possible today, and every farmer on whose land the raising is being done will be a fast friend of the gunner. I fully believe that 200,000 dollars a year can be put in the pockets of the

A bantam hen watches over her brood of quail

farmers of New Jersey under this plan, resulting in a situation where the gunner becomes a customer of the farmer, and is directly responsible for the increased income. It follows, then, that the farmer who is being paid to raise game will open his land to controlled gunning.

This brings us back to point 1. Land available for gunning should be posted, informing those who would hunt there that they may do so if they obtain permission of the landowner. Thus the farmer can control the number of gunners on his property at any one time, the net result of the whole procedure being that the farmer will be protected, as he knows how many gunners are on his land, and better hunting will be had as congestion will be relieved and the total number of gunners will be spread over a wider area.

IN the case of point number 3, there are two methods which may be followed. The landowner may plant grain to provide food for game, or the state commission may have the work done on areas designated by the owners. In the first case, the farmer must be paid to do the work and must be supplied with rye and buckwheat for quail or corn and cow-peas for pheasants. If the state undertakes the work, a truck and tractor, with plow and disk harrow will be all the equipment necessary to attend to the work over a large area.

That there is plenty of land available on almost every farm that may be used for raising game feed is well known. Every farmer with such land available will be glad to have it plowed and planted, or to do the work himself if compensated for it.

Control of predators is an essential part of any plan for the preservation of wild life. Weasels, cats, and crows, to mention only three of the many enemies of game, account for more dead birds and rabbits in the state of New Jersey than all the gunners combined. Predators are hunting every day in the year, while the gunning season lasts for a period of only a month or so.

The same persons who raise game for the state can be interested in predator control. I have demonstrated that simple traps, properly placed, will soon reduce both winged and furred predators to a minimum.

It could easily be arranged for the state commission to set aside a fund each year to provide a series of prizes to be awarded to the farmer or farmer's son or daughter who trapped the greatest number of predators. The regular state game wardens could check up monthly on the catches, and the annual prizes awarded on the basis of the wardens' report.

I have also found that the egg-stealing propensities of the crow can be used to good advantage in the control of this black-winged thief. Candled incubator eggs can be filled with poison and distributed by wardens to vantage points on poles and in trees where the crows will find them. No crow can pass up the chance to make a meal of eggs, which is the reason why crows play such havoc with game birds. I have practically rid my farm of crows by the simple method of placing poisoned eggs where only crows can get them.

THOSE who are somewhat familiar with game breeding as it has been practiced will find what appear to be flaws in this system. Quail, for example, cannot be raised in captivity, they will say, except under expert supervision. This was true a few years ago, but I have found by practical experience that it is entirely feasible to set eggs under bantam hens and to raise the baby quail in simply but scientifically constructed coops and runs so that the mortality is reduced to a minimum. Any farmer's boy can, with some instruction, build these coops and runs, and raise quail as successfully as he could raise a brood of chicks. The same thing applies to other game. Instead of trying to multiply the difficulties of game raising, I have found that simplification will yield excellent results. In fact, it is possible, after a little experience, to raise game on a small scale with as little trouble as with any domestic fowl or animal. And who could be better qualified than those who already have this experience?

How does this system fit in with present administrations of game matters? Few if any changes need be made. Present commissions and wardens can adopt this system, if they will only think of game breeding in terms of small units spread over the entire state, instead of as two or three huge game farms that can only inadequately supply game for the gunners.

PRESENT state-owned game farms fit perfectly into the picture. The small game raisers must be supplied with adequate numbers of eggs at proper intervals, and these can be furnished by state owned and operated farms. Thus the efforts of the officials will be concentrated on egg production, and the care of the settings of eggs will be spread over such a large number of raisers that the individual attention needed will be small indeed in comparison with the results.

The whole system briefly outlined here—there are many details that cannot be touched upon at the present time—is not in the least theoretical. Eight years of intensive work have proved each point and demonstrated fully that cooperation between state commissions, the landowner, and the hunter, coupled with the application of scientifically worked-out methods of game raising, will result in better gunning and a greater appreciation of the sport by all concerned.

A fine flock of ring-neck pheasants, artificially raised

OVERTONES AND ATMOSPHERES

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

MANY years ago an old piano tuner showed the writer one of those curious things that most people miss, though the chance to hear it is close to hand. Press down the pedal of the piano, so that the sound of a note may last, and strike one of the lower keys strongly. As the deep bass note dies away its place is gradually taken by the octave, then by the fifth above, followed by the second octave and by a succession of higher tones, each fainter than the last, most though not all of which correspond to higher notes of the keyboard.

The experiment is as pretty as it is simple, and its explanation is easy. Any vibrating system, such as a piano string, can oscillate in many ways. Its principal vibration, with the ends fixed and the whole string moving together, gives the deep fundamental note. But one half may go up while the other goes down, leaving a motionless point in the middle—then we get the octave above. With two fixed points and three vibrating segments comes the next fifth of this octave. With four segments the second octave—and so on. It might be possible by some special device to start the string off in one of these forms and make it give off one note alone. But the blow of the hammer stirs them all up at once, though with unequal intensities. At first the deep fundamental note is so strong that it drowns out the rest. But it dies down rapidly, while the successive higher "overtones" fade out more and more slowly, so that each may be heard for a few moments after its predecessor has died away.

ALL musical instruments produce overtones of this sort—indeed the differences in their intensity are responsible for the varying quality which enables even the novice to tell whether the same musical note has been played on a piano, a violin, or a cornet.

In most instruments, as in the piano, the higher overtones vibrate just two, three, four . . . . . times faster than the fundamental note, and give tones in harmony with it. But in a few, such as bells, this is not the case—which is why a tune has to be played on church chimes one note at a time.

But what have these remarks on the elements of music to do with the heavens, or anything therein? Evidently any parallel must be found in the vibrations of light. But, though physicists sought long for overtones in their spectra, for a long time they found none. We know the reason now: The isolated atoms from which come the spectral lines which are important in the sun and the stars do not behave like elastically vibrating material bodies, but are governed by a quite different set of numerical rules. Molecules give a better chance, for the separate atoms within them may undergo real vibrations about their normal positions. But the band-spectra which are so important in the red stars come from molecules in which an electron "jump" occurs and complicates the effects of the vibrations, which are also present, so that the simple overtones no longer appear.

It is possible, however, for a molecule to absorb or emit light without disturbing the electrons in it, simply altering the state of oscillation of its atoms. In this case there are real overtones oscillating almost, though not quite, as fast as the fundamental vibration. Each of these gives an absorption band in the spectrum of light which has passed through the gas. The main oscillation is very strong and produces powerful absorption. But it is also slow (as such motions go), so that these absorption bands lie far out in the infra-red region and can be studied only with special apparatus and with powerful sources of light. The first two or three overtones also give bands in the infra-red, each much weaker than the last. Higher overtones should give bands in the visible region, but the absorption should be so weak that a very great thickness of gas would be required to produce a perceptible effect.

Till recently, therefore, the investigations of the physicist and the astronomer, though in different parts of the same field, do not overlap. Now the gap has been closed, with notable results. Five years ago (as has already been told in these columns) Adams and Dunham photographed these sharp bands in the infra-red spectrum of Venus. The spacing of the individual lines (which depends on the rotation of the molecule) agreed exactly with that which might be expected from carbon dioxide. But no absorption by this gas had ever been observed in this region, nor could any be found in passing light through 40 meters of the gas, even at three atmospheres pressure.

A FEW months later Adel and Dennison, at the University of Michigan, showed that the strongest of these bands was exactly in the right position for the fifth harmonic (or overtone) of a very strong band which had long been known in the infra-red, while the other two could be equally well explained by a combination overtone involving also another, and slower, known vibration of the molecule. Though the origin of the bands was then proved beyond all doubt, they were not reproduced in the laboratory till the present year. Slipher and Adel have just announced that "by using an absorption cell 45 meters in length, charged with 47 atmospheres of gas," they have been able to detect the strongest of these bands. This corresponds to a layer a mile and a quarter thick, at atmospheric pressure. The

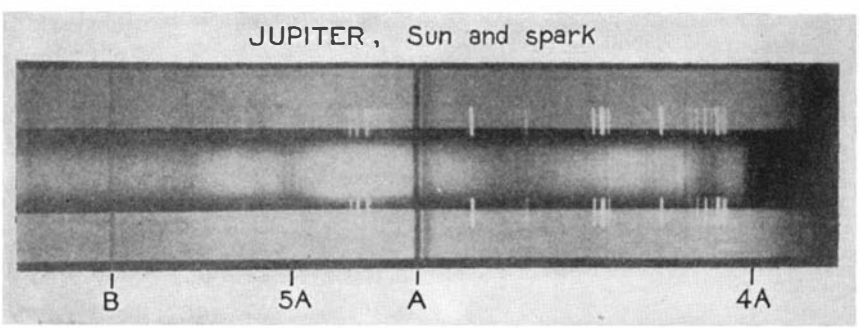


Figure 1: **Spectra of Jupiter and the sun, photographed by V. M. Slipher at the Lowell Observatory. This shows the red and infra-red regions, from about 6500A to 9000A. The bands marked *B* and *A* at bottom are due to terrestrial oxygen. The overtone band marked *4A* is very strong. The weaker one marked *5A* is resolved into numerous lines, which in Figure 2 are blended into one band**

bands in Venus are stronger, and the amount of carbon dioxide above the planet's visible surface must be at least equivalent to a layer two miles thick at standard temperature and pressure, and may be much more. The amount of this gas alone, in Venus' atmosphere, is at least two thirds of the whole mass of the earth's atmosphere. This seems inconsistent with the textbook statements that the planet's atmosphere is less extensive than ours. But the only previous evidence on this subject was the existence of twilight on Venus, which prolongs the horns of her crescent when she is very nearly between us and the sun. The illuminated layer is little over a mile in thickness, but this represents the part of the twilight on Venus which is so bright that it can be seen telescopically through the foreground of our own atmosphere at mid-day, close to the sun. Only the densest and haziest parts of the planet's atmosphere could be seen under these severe conditions. When she is farther from the sun in the heavens, and can be seen on a dark sky, it might be possible to detect more. Observations indicating the existence of such a fainter and more extensive twilight were made about 150 years ago by the German astronomer Schroter and, strangely enough, seem never to have been repeated with modern telescopes.

THE theory of over-tone bands has had another notable success in the spectra of the major planets. From the dawn of astrophysics, it has been known that Jupiter and Saturn showed bands in the orange region of their spectra, which must arise from something in their atmospheres. Early in the present century Dr. V. M. Slipher found that the same bands were present with greater intensity in the spectra of Uranus and Neptune, along with many fainter ones—as is illustrated in the admirable photographs here reproduced, which the writer owes to Dr. Slipher's generosity.

Wildt, in 1932, pointed out that certain of these bands were probably due to ammonia, and others to methane, and this conclusion was finally established a year later by Dunham, who resolved some of the stronger bands into their component lines, and found that these agreed exactly with the lines produced in the laboratory. But the fainter bands in Jupiter and Saturn, and those which appear only in the two outer planets, remained unidentified.

A few months ago Slipher and Adel announced that they, too, were due to methane. Fuller details, now published, reveal an extraordinary sequence of overtones.

Methane has a complicated molecule, which has no less than four independent types of vibration, each with its own period. One of these gives a strong

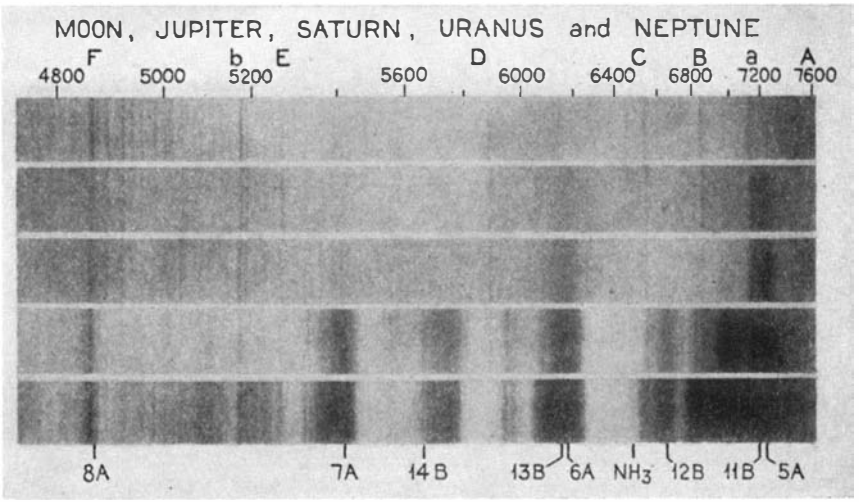


Figure 2: **Spectra of the major planets and the moon, photographed by V. M. Slipher at the Lowell Observatory in 1907. The moon, which has no atmosphere, reproduces the solar spectrum. The band marked *B* is produced by oxygen in the earth's atmosphere, and *a* by water vapor. The band due to ammonia is marked NH_3. It is strongest in Jupiter. The bands of methane increase in intensity for the outer planets. The overtones of the great infra-red bands (see the text) are marked at the bottom. The numerals represent angstrom units (abbreviated A) and this piece of the spectrum extends from about 4700 A, in the blue, to 7600 A, in the red. The letters, capital and small, at the top are designations assigned about 1816 to the most prominent lines of the spectrum, by Fraunhofer and, though arbitrary and somewhat clumsy, are still employed by physicists**

absorption band in the infra-red, near 33,000 angstroms, and its harmonics account for the heaviest of the planetary bands—marked 4A to 8A in the figures. Another band, near 76,000 A (that is, 76,000 angstroms) is so far out that only its high overtones—marked 11B to 14B—are accessible. Some of these are drowned out by stronger bands. The others, as might be expected, are faint bands. The other bands arise from combinations in which two sets of molecular vibrations are simultaneously stirred up.

Practically the whole of this rich system of bands has now been accounted for by a single constituent of the atmospheres. These are faint bands due to ammonia in Jupiter and Saturn (marked NH_3 in Figure 2). These disappear in Uranus and Neptune, presumably because this more easily condensible gas is frozen out by the low temperature.

It is very probable, as Dunham points out, that the clouds which are so conspicuous on Jupiter are composed largely of tiny crystals of frozen ammonia—not drops of liquid; for the measures of planetary radiation indicate a temperature of −132 degrees Centigrade—well below the freezing point of the liquid.

The amount of ammonia necessary to produce the observed bands is estimated by Dunham as equivalent to a layer ten meters thick, at atmospheric pressure. This gives another way of getting at the planet's temperature, for we know what pressure this amount of ammonia would produce by its own weight, under the planet's attraction. The vapor pressure of ammonia has this value at −100 degrees Centigrade. But if, as is probable from other considerations, Jupiter's atmosphere is composed largely of hydrogen, its light, fast-moving molecules help to carry the weight of the heavier ammonia, and the temperature at the cloud level may be as low as −120 degrees Centigrade: in quite as good agreement with the radiometric determination as might be expected.

The great intensity of the methane bands in Uranus and Neptune may perhaps be explained by the freezing out of the ammonia. In Jupiter, and to a less degree in Saturn, there is enough ammonia left to form clouds at a fairly high level and prevent our seeing deeper. If these planets should be cooled down sufficiently, so that no more ammonia vapor was left to form clouds, their atmospheres would become clearer, and we might see much deeper and get stronger bands of methane, as we do in the other planets.

The amount of this gas in the planet's atmosphere must be great. Slipher and Adel find that a layer of methane equivalent to two kilometers, at standard temperature and pressure, produces absorption bands comparable to those in Jupiter and Saturn. The amount in Neptune has not yet been matched in the laboratory, but may be ten times as great, or more.

Since the light we receive from the planets goes twice through their atmospheres—in and out—we may estimate the amount of methane in Jupiter's atmosphere as roughly equivalent to a kilometer, under standard conditions. Under the planet's gravity this would exert a pressure of one-sixth of a stand-

(*Please turn to page* 277)

Construction of the Colorado River

AQUEDUCT SIPHONS

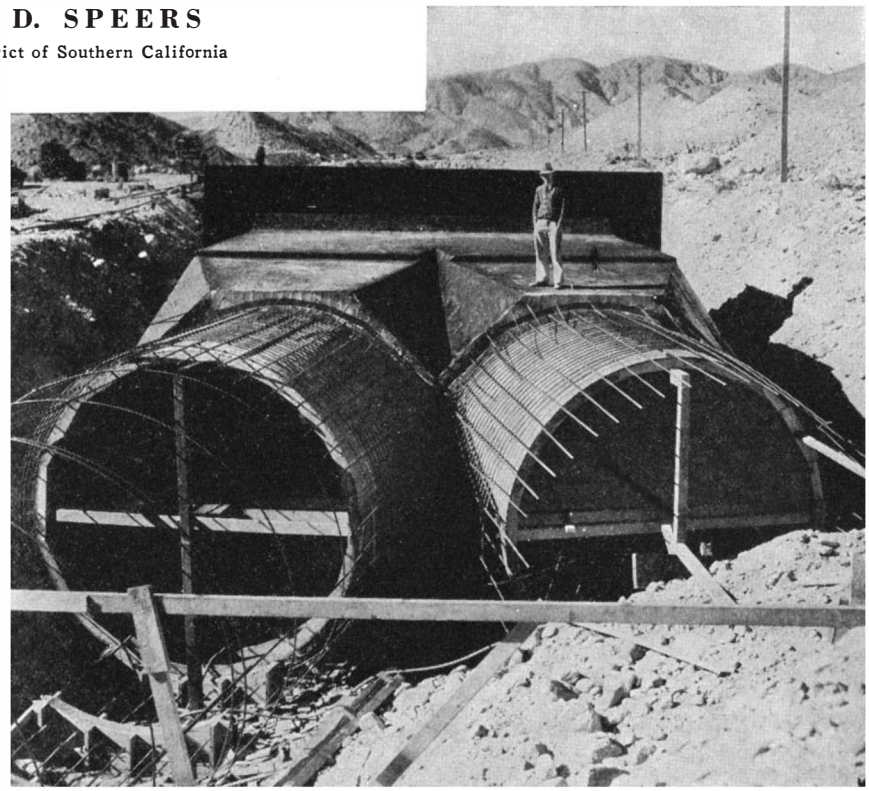
By ROBERT D. SPEERS
Metropolitan Water District of Southern California

WITH underground crews past the one third mark on the largest tunnel excavation program ever carried forward in the history of engineering (see SCIENTIFIC AMERICAN, September, 1934, page 134), construction forces of the Metropolitan Water District of Southern California are now engaged upon still another phase of the Colorado River Aqueduct project—building the huge siphons which will link together the aqueduct's tunnels.

Together, the siphons and tunnels will form important links in the great aqueduct system which will bring Colorado River water more than 300 miles to 13 southern California cities.

In the Little San Bernardino Mountains—in two of the canyons which separate the Coachella tunnels of the aqueduct—an experiment is being conducted to determine the relative merits of the monolithic and pre-cast types of construction for the immense concrete siphon pipes.

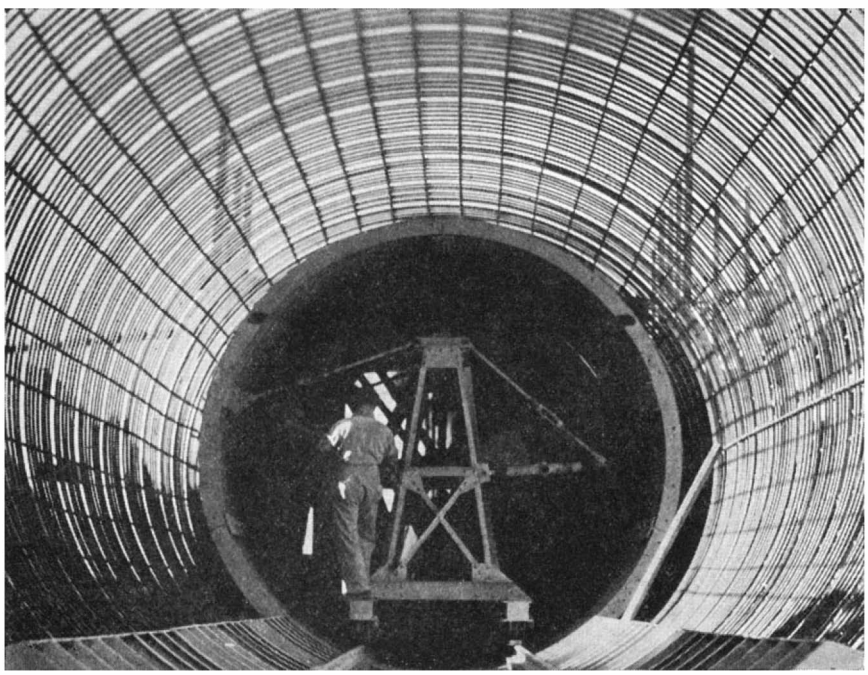
Two inverted siphons are being built. One is the Fan Hill siphon, which is monolithic; that is, it is being poured as one huge piece of masonry. The other structure, the Little Morongo siphon, is pre-cast. It is being poured in 12-foot sections, which are linked together by patented steel joints.



A junction between the siphon tubes and a transition chamber. The chamber extends back for 50 feet, and is constructed of 456 tons of concrete reinforced with 17 tons of steel—a total weight of 473 tons

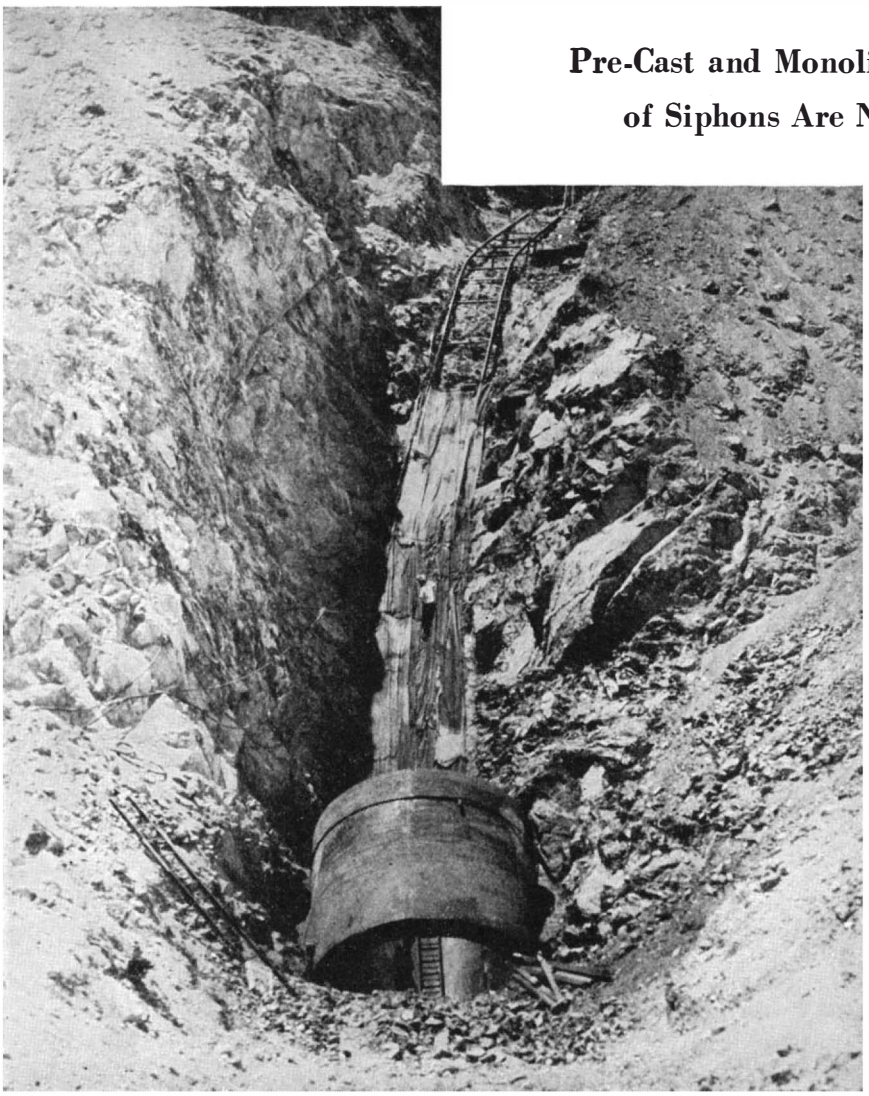
Careful tests are being made to determine which of these two model siphon sections will be best suited to the rigorous desert conditions under which they will operate. On the basis of these tests, under actual conditions, District engineers will decide which method of construction shall be followed in building the remaining siphons, totaling 27 miles in length, which will carry aqueduct water across declivities in the desert terrain between the Colorado River and Cajalco Reservoir, the terminal storage basin of the aqueduct's main line.

At the outset it should be pointed out that the name "siphon" is, in a way, a misnomer insofar as the aqueduct structures are concerned. They do not, in fact, exert any siphonic action. They act merely as pressure pipes in which the water will find its own level after plunging down to the bottom of one of the desert canyons along the aque-



Steel form within reinforcing rods around which concrete is poured. When one section sets, form is moved on rails and another section poured

Pre-Cast and Monolithic Concrete Types of Siphons Are Now Being Tested



One of the 40-ton pre-cast concrete pipe sections in place in the Little Morongo siphon, showing the steep grade of the canyon wall. Note man clinging to a line just above the mouth of the concrete pipe section

duct line and continuing up the other side. The two ends of the siphons are at almost the same level, the down stream end being slightly lower in order to overcome head loss due to friction in the pipe. The name "siphon" has been applied simply because it is a good descriptive word, the pipes resembling in appearance an inverted siphon.

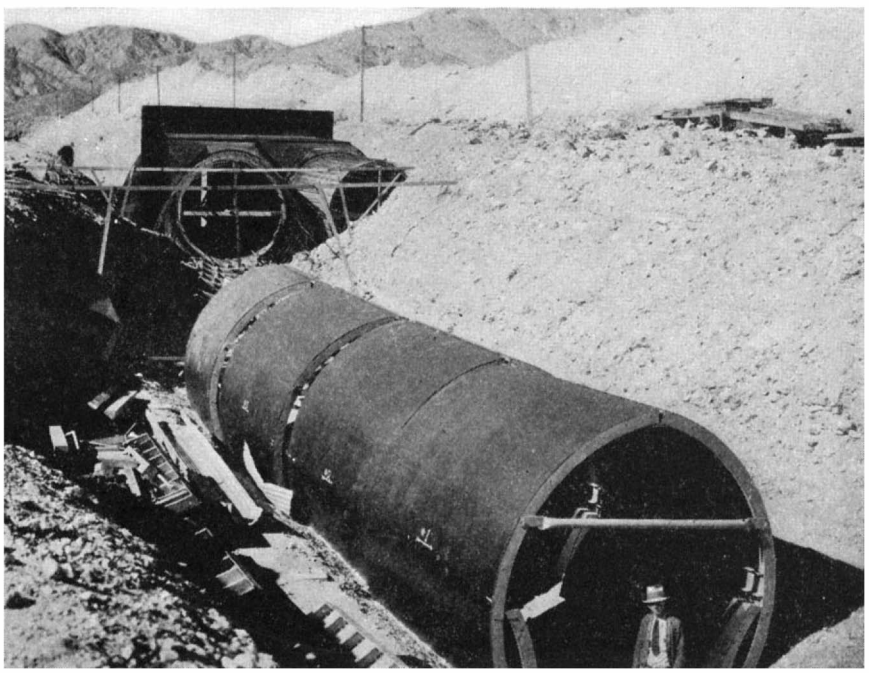
These siphons constitute one of the fundamental differences between modern aqueduct engineering and that practiced by the ancient Romans in the building of their famed water supply systems. Roman engineers drove tunnels and constructed conduits basically similar to those used on the modern aqueducts, but when they came to canyons or valleys which had to be crossed, they were forced to resort to long arcades or trestles to maintain the grade line of their aqueduct. They had no means of building pipes sufficiently strong to withstand the water pressure resulting from a drop into the declivity and the rise on the other side. While highly ornamental, these arcades (in the light of modern construction practice) were uneconomical and poor engineering. They were relatively more costly, and were vulnerable to earthquakes. So the modern aqueduct engineer sacrifices beauty for practicality and safety.

All of the Colorado River Aqueduct's 27 miles of siphons will be built in two separate tubes or barrels, each approximately 12 feet inside diameter. To safeguard the pipes from washouts caused by sudden desert cloudbursts, which are characteristic of the country traversed, they will be laid in large trenches, and buried beneath the bottoms of the washes.

While the tunnels of the Colorado River Aqueduct will be built to full capacity—that is, capable of carrying 1500 cubic feet of water per second—each siphon is being constructed half-capacity, or one barrel at a time. The second barrel will be built whenever demand for water increases beyond half the capacity of the aqueduct. Fifteen hundred cubic feet of water per second amounts to approximately one billion gallons daily.

The construction at Fan Hill includes, as well as the siphon, the construction of the first piece of aqueduct conduit, which links the siphon section with the west portal of the East Coachella tunnel.

Leaving the tunnel, the conduit is in the shape of a gentle arch on top, with a concave bottom inside. Where it joins

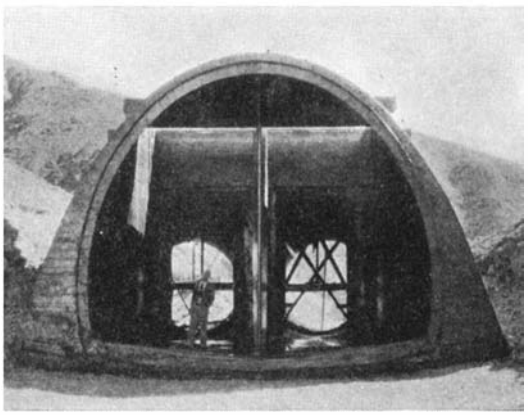


Steel inner forms used in building monolithic concrete siphon tubes. This type of movable form is shown in use in a photograph on the opposite page

the circular siphon, it enters a box-like transition section. The work consists of the construction of about 700 lineal feet of monolithic reinforced concrete siphon designed to operate under a maximum hydraulic head of about 45 feet, with a 50-foot concrete transition section at each end. The west end of the siphon is connected with about 700 feet of the semi-elliptical concrete conduit.

The interior of the siphon section is circular, 12 feet, 4 inches in diameter. The shell is 12 inches thick. The exterior is nearly octagonal. Steel forms are used on the interior and wooden for the exterior. The trench in which the siphon is constructed has a maximum depth of 30 feet. About two cubic yards of concrete are poured for each foot of pipe.

On the conduit, steel forms are used inside and outside. The concrete section is 15 feet high inside, with an overall height of 18 feet, 4 inches. The bottom width is 19 feet inside and 28 feet outside. About four and a quarter cubic yards of concrete are used per foot. Conduit is poured in 70-foot lengths, with contraction joints and water stops each 35 feet.



A view of the end of a transition chamber to which a semi-elliptical conduit will be joined

THE materials excavated from the trench in which the work is being done were tested at the Metropolitan Water District's laboratory at Banning and themselves found to be first class for making concrete. Accordingly a screening and mixing plant has been set up at the site. A unique feature of the job is the placing of the concrete with Pumpcrete equipment, which pumps the mixed concrete into the forms at a rate of 40 cubic yards per hour. (See SCIENTIFIC AMERICAN, November, 1932, page 292.)

An idea of the large size of the transition section may be gained from the following dimensions: 50 feet long; 18 feet, 10 inches high; 28 feet, 6 inches wide across the bottom; contains 456 tons of concrete and 17 tons of reinforcing steel, making a total weight of 473 tons.

Equally interesting is the work on the 720-foot Little Morongo siphon. The word "Little" refers, incidentally, to geography and not to the siphon, which is the largest pre-cast concrete pipe ever made in the United States.

The pre-cast method of construction consists of pouring the siphon in 12-foot sections, each weighing 40 tons, allowing them to cure, and then placing them one by one into the trench.

Ordinarily, pre-cast concrete pipe is manufactured in a factory and shipped to its point of use, there to be assembled. In the case of the Little Morongo siphon, however, the 12-foot concrete sections are so heavy that it is not feasible to ship them even on railway flat cars. Hence, actual pouring and curing of the concrete is done on the ground rather than in the factory. The bar cage reinforcing assemblies which form the cores of the concrete pipe sections are manufactured at Southgate, California, and then shipped into the desert. Also manufactured at Southgate are the huge steel joint rings, 12 feet in diameter and weighing 1000 pounds each, which will link together the 40-ton concrete sections.

After the concrete has been poured around the steel cores of the sections, coal tar is applied to the exterior and water to the interior surfaces. At the end of a seven-day water cure period, a coal-tar coating also is applied to the interiors.

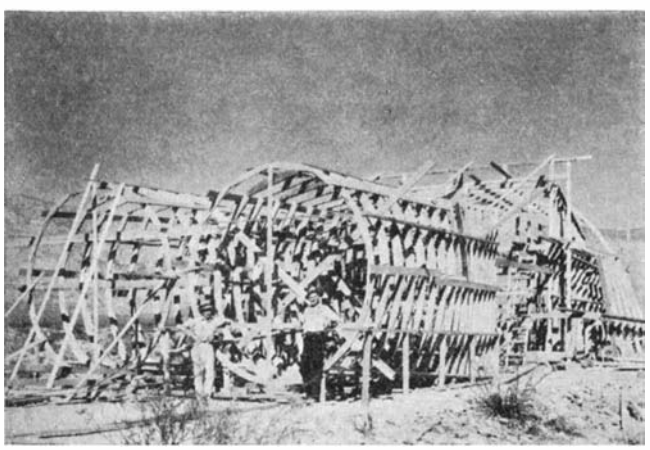
The pipe is laid in a ditch 20 feet wide. Two 60-pound rails are set to line and grade, on concrete ties in the bottom of the ditch. A crane has been erected for placing the heavy pipe sections. The sections are rolled down a ramp to flat cars on the rails in the bottom of the trench, and later lifted from the flat cars into place by the crane.

AS has been pointed out, these two siphon sections are already being subjected to extensive tests to determine which type of construction is best adapted to conditions along the aqueduct line. Several months of study must be devoted to the subject before definite conclusions as to final construction can be reached.

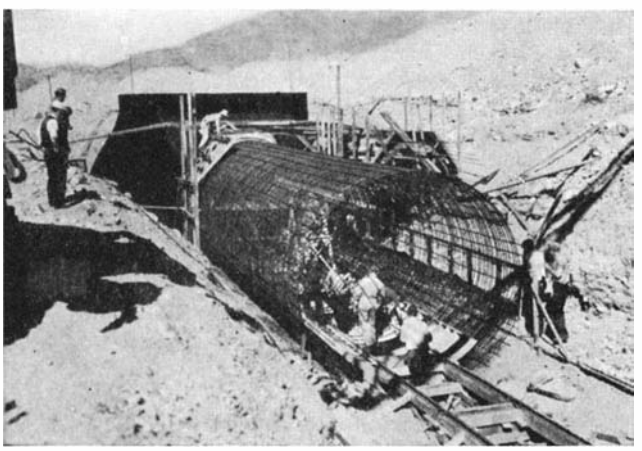
Meanwhile, work goes forward rapidly on the other phases of aqueduct construction. Already more than 30 miles of the aqueduct's 91 miles of 16-foot tunnel has been driven through the mountain barriers lying between the Colorado River and the Coastal Plain on which are situated the 13 southern California cities which make up the Metropolitan Water District.

Soon work is to start on the 13,000,000 dollar Parker Dam, from behind which Colorado River water will be diverted into the aqueduct. This structure, to be constructed by the United States Reclamation Bureau with funds furnished by the Metropolitan Water District, will be located about 150 miles down stream from Boulder Dam.

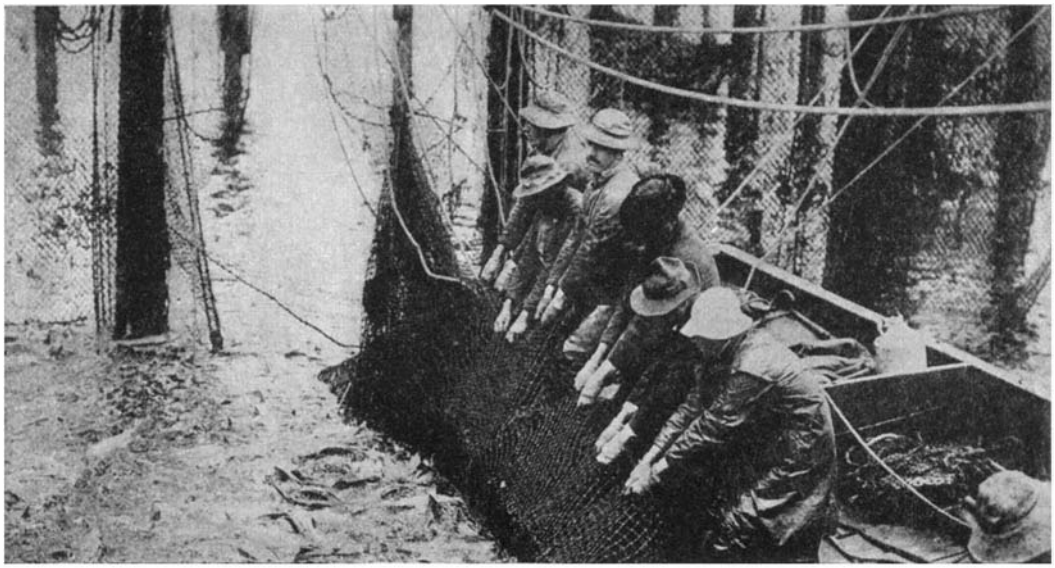
The main aqueduct, from Parker Dam to Cajalco Reservoir, will be 241 miles long, including tunnels, siphons, conduit, and intermediate reservoirs. In addition, 144 miles of huge distributing mains will carry the water from the terminus of the main lines to the 13 cities to be served.



Wood frames used in the first step of building the siphon barrels and transition chamber leading to the conduit



Outside wooden frames and reinforcing steel in place. Within the rods is the form shown on preceding pages



Hauling a net for salmon in Puget Sound

Copper Wire and Fishing Nets

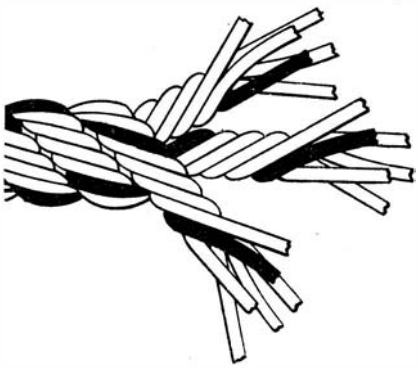
By A. P. PECK

FOR three days a raging northeaster had lashed the surf to a frenzy of pounding white water in which no craft could leave the beach and return safely. At length, a pound net skiff puts out from shore in the cold, dim light of a foggy dawn. The fishing season is well advanced. On setting out, there was no expectancy of a good catch, the sole consideration being the extent of damage which the pound net had sustained. As feared, the net was found badly damaged, in fact almost completely destroyed. The net, incrusted with heavy marine growths and the twine so weakened by the action of micro-organisms, could not withstand the fury of the storm.

Heretofore commercial fishermen on the Atlantic and Pacific Coasts have spent 20 cents for webbing out of every dollar they received for their catch. This high cost of fishing is mainly due to micro-organisms which gather on the nets and not only add to their weight but also digest the fibers of the cotton or hemp strands and therefore progressively weaken them.

FOR years the Bureau of Fisheries has experimented with preservatives and treatments to eliminate or reduce the accumulation of these tiny organisms, but with indifferent success. A coating of tar is helpful but it doubles the weight of the net, makes it difficult to handle, and is, in general, unsatisfactory. Copper and other metallic salts poison the micro-organisms but soon wash out of the strands of the net, leaving the fibers exposed to the destructive agency.

It remained for Philip R. Andrews, of Seattle, Washington, to solve the problem, and the solution is one of those simple things that are so obvious —when explained. Mr. Andrews literally took the ocean into partnership to repel or destroy the animal life and vegetable growths that prey on fishing nets. He hit on the idea of substituting fine copper wires for certain of the cotton yarns which enter into the construction of seine twine and knitting such a twine into a fish net and then letting the ocean do the rest! The natural salts present in sea water react with the copper to form complex metallic salts which completely prevent marine organisms from existing not only on the strands of the net, but also in the water immediately surrounding the webbing.



Copper wire in twine for fishing nets. Black: Wire. White: Cotton

The results gained by Mr. Andrews' invention are manyfold, all of them favorable to the fisherman. "Toxinized" nets, as the copper-fiber combination is called by The Linen Thread Co., Inc., makers of the twine and webbing, are first of all light in weight, being only 25 percent heavier than ordinary untreated nets of the same strength. This compares, to the favor of the fisherman, with a 100 percent increase in weight when tar is applied as a preservative. Then, too, Toxinized nets are clean, easy to handle, need no special care, and at the end of the season are simply dried and stored, ready for instant use when needed. They maintain their strength far beyond the life expectancy of other nets.

THE preservative factor of these nets is always present: As the salts wash out, new ones are generated, keeping the nets free from injurious and weight-increasing growths. It has further been demonstrated that clean nets will yield larger catches, the fish entering Toxinized nets more readily than tarred nets or those heavily incrusted with marine growths.

In the first year after Toxinized nets were made available, many thousands of pounds of webbing have been put into service, with gratifying success. Once more a corner of science has supplied the solution to a problem of industry.

THE ETHER:

RIDDLE OF THE AGES

The Original Concept of the Ether Has Been Altered So Many Times, As a Result of Experimental Evidence Which Has Forced Its Modification, That It Is Now Whittled Down to Next to Nothing. We Still Use the Same Word, "Ether," But the Thing Signified Is Quite Different—Even If An Ether Exists At All.

By CHURCHILL EISENHART
Princeton University. Contributing Editor

THE idea of the possible existence of the ether came of the human need for an explanation of action at a distance. It was not until Newton stated his theory of gravitation that such a need became evident, for in ordinary experience the weight of a body appears to be constant and to be a property dependent only on the body under examination. But Newton showed that weight could be accounted for by considering it as physical evidence of an attraction existing between bodies (that is, masses), and that such considerations, extended to the moon, satisfactorily explained its observed motions. The question now arose as to how this gravitational force acted, since there was no apparent material connection between the earth and the moon through which this force could be propagated, and all actions in daily experience, such as the communication of motion by impact, the transfer of heat, and so on, require material media for their transfer.

The question became: "Can a body act where it is not?" The universal answer in accordance with common experience of natural forces was "No," and therefore in order to unify the nature of forces it was postulated that, although gravitation appeared to act at a distance, it was really conveyed by a genuine medium filling all space, without any breaks or cavities anywhere. No mention was made of the manner in which this medium acted. It was named "the ether," but Newton did not stress its importance, as it was a deduction from, rather than a necessary factor in, the formulation of his gravitational theory.

The next step in the development of the "ether theory" came with the advent of the wave theory of light, as introduced by Huygens and developed by Young. Light was thought to be a wave phenomenon of longitudinal vibration (like sound). Nevertheless, this theory required an omnipresent medium in order to account for the energy received from the sun in the form of light and heat. Light and heat are known to be coming from the sun and stars through interstellar space, and if they are forms of wave motion it was reasoned that there certainly must be something in space which can be thrown into wave movement.

SPECULATION followed as to the nature of this "luminiferous ether," as it was called, terminating in the following description:

It is perfectly transparent—that is, it dissipates no energy; otherwise distant stars and nebulae could not be seen at such distances through space.

There is no friction between matter and the ether; otherwise heavenly bodies (for example, planets) would not continue in their courses undisturbed.

Since it propagates longitudinal wave-motion, it must be fluid-like in nature, and yet it can have no viscosity (fluid friction).

Since it propagates wave motion with such a great velocity (that is, the velocity of light), it must be very elastic.

Such was the state of affairs when Fresnel (1788-1827) announced his researches on polarized light, which proved conclusively that light was a transverse wave motion. This change in the theory of light required a change in the "light bearing ether"; in order to transmit waves of any sort a medium must possess the general property of elasticity, but only the elasticity characteristic of a solid—the elasticity of shape—makes possible the transmission of transverse waves. In other words the ether must be an elastic solid.

The subject of possible relative motions of the parts of the ether was for a while much discussed. It was found, however, that in order to interpret Bradley's discovery (1727) of the aberration of light, and Fizeau's experiment of 1851 (in which it was found that the velocity of light was the same whether going with or against a stream of water), one was obliged to infer that the ether was stationary and did not take part in the movements of bodies, nor was there any relative motion of its parts save the minute deformations corresponding to light waves.

Many were the calculations performed which were to determine the exact magnitudes of the characteristic properties of the ether. Such computations gave to it a density of more than 10,000,000 times that of lead; for, after all, did not the ether fill in the gaps between the most minute of atoms? If so, it must be very dense. Moreover, in order for it to be stationary in the presence of such violent motions as are always going on in it, the inertia (mass) of a cubic centimeter of the ether must be of the order of 10^{12}, that is, one trillion times that of the same volume of water; and, since it transmits a transverse vibration with the velocity of light, it must be a solid of rigidity 10^{33} (for comparison, that of steel is 10^{11}).

Such was the belief of the early 19th Century scientists, who thought they knew the ether as well as they knew matter. This was an excellent dilemma, and there seemed to be no escape. It did not seem possible that light and

heat energy could be propagated everywhere in space without something in which to travel, and yet the necessities of the wave form required imposed the acceptance of a medium which possessed properties totally at variance with everyday experience, and indeed contradictory to sense impressions.

Up to this point physicists had been considering the ether as they would matter, but the results of such a procedure being absolutely at variance with common sense, it was found necessary to conclude that the properties of the ether could not be expressed in terms of units used in the description of matter. Examined from the point of view of mechanical waves the ether had proved intangible, elusive, and "beyond the reach of human intuition." The all-pervading ether had been *postulated* in order to explain gravitation, and in a similar manner it had seemed necessary for the interpretation of light and heat phenomena; but in both of these cases it had been invented in order to aid in a mechanical explanation of these phenomena. It had served its purpose in simplifying theories, but was itself most elusive. Apparently the ether itself could not be truly visualized when viewed in a mechanical way.

MECHANICS having failed, attention was now turned to the field of electricity and magnetism. The introducer of the ether in this branch of physics was none other than the celebrated Michael Faraday. Up to his time a more or less intangible something called a charge had been thought to exist on a charged body, and this something apparently exerted forces on other charged bodies at a distance, in much the same way as gravitation acted on massive bodies. In fact, the mathematical relationship for the force between the charged bodies had been determined. Nevertheless, the idea of action at a distance was distasteful to Faraday. Maxwell, in the preface to his "Treatise on Electricity and Magnetism," says on this subject: "Faraday, in his mind's eye, saw lines of force traversing all space, where mathematicians saw centers of force acting at a distance: Faraday saw a medium where they saw nothing but distance: Faraday sought the seat of the phenomena in real actions going on in this medium."

To Faraday the intervening medium transmitted the electrical force in a way similar to the transmission of an elastic deformation by a rod. Moreover, since electrical forces act through a vacuum, Faraday assumed that the transmitting medium was the ether and considered its properties to be modified by the presence of matter in order to account for the reduction in magnitude of the electric forces acting between charged bodies, when matter such as glass was interposed. In like manner, the ether was thought to account for magnetic phenomena. At this point the miraculous happened: Faraday produced rotation of polarized light with a magnetic field, and a little later Kerr produced a similar rotation with an electrostatic field, thereby suggesting that the phenomena of light, electricity, and magnetism are all propagated by the same medium—the ether.

Inspired by the work of Faraday, Maxwell set to work with mathematical equations and was able to show "that if a medium such as Faraday postulated actually existed, it must be possible to

Hertz, who actually produced the waves that Faraday had postulated

produce in this medium periodic vibrations of the electric and magnetic field intensities having all the characteristics of waves." A short while later Hertz succeeded in producing such electromagnetic waves, and proved that they were identical with light, the only difference being in wavelength. His work seemed firmly to establish the ether, and its purely mechanical aspect was abandoned to one possessing electric and magnetic properties. The reaction against the mechanical was a little too extreme, however, and we find Hertz considering matter and ether as the same—the former being a modification of the latter. He had been led to this belief by the fact that apparently his electromagnetic waves passed through many kinds of matter undisturbed.

Such was the state of affairs when Lorentz stepped into the field. As a result of his calculations the theories then prevailing were brought into accord with experience: the ether was devoid of its mechanical properties as before, and matter was stripped of its electromagnetic characteristics. For example, the electromagnetic properties of matter[1] were not attributed to the atoms themselves but to the ether which surrounds and permeates the atoms. Such a theory admirably accounted for the diminished intensity of light on passing through even the most transparent bodies[2]; also it accounts for the observed increase in absorption of electromagnetic radiation with increase in density (for example, lead is used to absorb X rays). The only remnants of the old mechanical ether left were the property of immobility—a property which seemed to be in accord with the experiment of Fizeau, the phenomena of aberration, and, more recently the experiments in electrodynamics of H. A. Wilson on the force produced by moving an insulator in a magnetic field. (*Proceedings of the Royal Society:* Vol. 73 [1904]; 490.)

Today the ether has ceased to take an active part in electromagnetic theory; a writer on the subject generally postulates its existence and states that "at any point in it there is an electromagnetic quantity having magnitude and direction whose intensity can be measured,"[3] and from that moment on discusses the properties of this quantity, never again mentioning the ether itself. This quantity is supposed to represent some condition of the ether, but "the ether is now only a background and not an active participant in the theory."[3]

SINCE the ether appeared to be stationary it seemed reasonable that one ought to be able to determine the velocity of the earth through it. Now the relative motion of one body with respect to another is all we can ever observe. But how to observe the relative motion of the earth with respect to the stationary ether? Light is supposed to travel in the ether, and therefore a ray of light sent in the direction of the earth's motion through the ether ought to be retarded.

In order to check this, Michelson and Morley constructed an apparatus with two arms perpendicular to each other; by means of reflecting surfaces a single beam of light was broken up and one part sent down one arm of the apparatus, and the other part down the arm perpendicular to the first; after each beam had been reflected back and forth, each in its own arm of the apparatus, the two were brought together in the same observation telescope by means of reflecting surfaces, the distance traveled being the same in each case. In each of the above cases the beam of light was sent over its course and back upon itself and therefore interference must result, giving in the telescope a definite set of interference fringes. Any altera-

[1]Property of transmitting light, electricity, magnetism.

[2]That is, the light which a body transmitted was said to have passed through the ether-filled gaps between the atoms.

[3]A. S. Eddington, in "Space, Time and Gravitation"

tion in the speed of light along either arm must manifest itself in a shifting of these two sets of interference fringes with respect to each other.

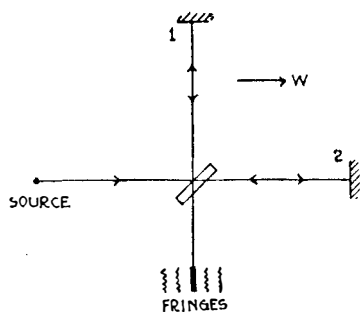
As in the case of a boat rowed upstream and back, or across stream and back, the ray of light which happened to be traveling in the direction of the earth's motion through the ether should be retarded on its trip so that it would return to the telescope later than a ray sent on a trip at right angles to this direction. Of course, it was not known which way was with the earth's motion (and the earth certainly does move, as can be shown by astronomy), and which was transverse, but observations were taken with the apparatus set in all possible directions, and at different times of the year. Hence an effect should have been noted, but no retardation was observed.

What could be the trouble? Naturally the first question asked was: "Had the apparatus sufficient sensitivity?" The universal answer was "Yes," for the apparatus had been constructed in such a manner as to be capable of observing a much smaller motion than the known motion of the earth about the sun. Michelson was led to believe that the ether was carried along with the earth, thus accounting for the absence of an ether breeze.

THIS theory was, however, at variance with the phenomena of aberration, Fizeau's experiment, and the researches of H. A. Wilson. Moreover, Sir Oliver Lodge carried on an equally exact experiment, regarding which he says: "I whirled steel disks at a great rate till they nearly burst, and sent light round and round between them, that way round and this way round, and compared the time taken to go round with the disks with the time required to go against the disks; for, if the ether had been carried around with the disks, the beam one way would have been accelerated and the other way retarded. There would have been an effect. There was no effect. This proved that the ether and matter are mechanically independent of each other; matter moves through the ether without the slightest resistance, and its motion does not affect the velocity of light in the neighborhood."

These experiments, entirely contradictory, presented a difficulty from which it seemed difficult to escape. It was at this point that Einstein stated his Special Theory of Relativity, the kinematics of which was modeled on the Maxwell-Lorentz theory of the electromagnetic field, and hence the Relativity Theory (Restricted Sense) was in agreement with the electro-magnetic theory. The Special Theory of Relativity assumes, on the basis of the above experiments, that the velocity of light is constant regardless of the motion of the observer, and shows that the laws of nature (that is: those of mechanics, light, and so on), are of exactly the same form when referred either to a system of coordinates relative to which the ether is at rest or to a system which is moving uniformly (not accelerated) with respect to the former.

Since by the Special Theory, the equations governing the laws of nature hold equally well for a system which is moving in uniform translation relative to the ether, why give a preferred distinction to the stationary system when all the



The famous Michelson and Morley experiment described in the text

uniformly moving systems are physically equivalent to it in all respects? Therefore, if the ether is still to be considered as existing, which is not at variance with Special Theory, then all its properties which depend on its having a definite state of motion must be given up; in other words, *the ether has now lost the last of the mechanical characteristics that it formerly possessed* —immobility.

The ether has never been proved a reality. It apparently has no properties common to experience, and from the point of view of Special Relativity it seems to be an unnecessary hypothesis.

Therefore, why not do away with the ether? Because "to deny the ether is ultimately to assume that empty space has no physical properties whatever, and the fundamental facts of mechanics do not harmonize with this view."[4]

For example, the mechanical behavior of heavenly bodies depends not only on their relative positions (distance from each other) and relative velocities, but also on the states of their rotation and acceleration, and in order to be able to discuss rotation and acceleration as something real there must be something other than the observable object by which to reckon acceleration or rotation. In reference to real things, Einstein said, in *The New York Times* (February 3, 1929): "Matter is real . . . motion, space, and also time are real forms. Every attempt to deny the physical reality of space collapses in the face of the law of inertia. For if acceleration is to be taken as real, then that space must also be real within which bodies are conceived as accelerated."

Attempts have been made by Mach and others to eliminate the ether by substituting in its place a "mean acceleration with reference to the totality of the masses in the universe."[5] But, in order to have inertia producing an effect on the relative accelerations of distant masses the old action at a distance creeps in again, and in order to account for this, an ether has to be postulated to serve as a medium for the effects of inertia. Such a medium not only determines the behavior of masses, but also has its properties determined by them.

THIS leads directly to the ether or space concept of the General Theory of Relativity. According to this theory the nature of the ether in a *space-time* interval varies at different points in the interval and is subject to influences of matter existing outside the interval under consideration. Since, in accord with this theory, space is neither homogeneous nor isotropic (same physical properties in every direction), its condition in a particular interval being given by ten functions called gravitation potentials, one can no longer consider it as empty. Therefore it contains an ether, it is true, which no longer possesses any mechanical or kinematical properties, but which *helps us to understand* and determine mechanical and electro-magnetic events.

In conclusion, to quote Sir Oliver Lodge: "It is quite true that physical calculations and discoveries can proceed without explicit reference to the ether, but when we come to philosophize and try to formulate the facts physically, it is clear that space must be endowed with physical properties, and is, therefore, entitled to something more than merely a geometric name."

[4]Einstein in "Sidelights on Relativity"

[5]Einstein in "Sidelights on Relativity"

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Astronomical Photography

A Specialty for the More Advanced Amateur Worker

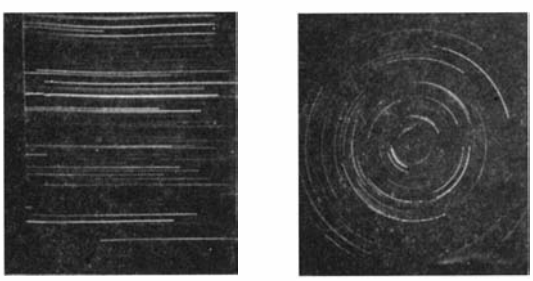
By JAMES STOKLEY
Associate Director, The Franklin Institute Museum, Philadelphia

Photographs courtesy Yerkes Observatory

Meteor trail accidentally caught on plate while exposing for stars

THOUGH astronomical photography forms a vital part of the work of the great observatories, very interesting results can be obtained with simple apparatus. The owner of a small telescope, either a refractor or a reflector, made in accordance with the instructions in "Amateur Telescope Making," can easily make photographs with it of the sun, the moon and the brighter planets and stars. A very valuable guide is "A Manual of Celestial Photography," by the late Edward Skinner King, of the Harvard College Observatory.

Even the owner of an ordinarily good camera can make star photographs without any other equipment. On a clear, dark night, the camera should be set up on a firm support, pointed to the northern sky, and a time exposure of several hours given. When the film is developed, it will show a number of arcs of concentric circles. These are the trails of the stars as they apparently circle around the north pole of the sky. The stars seem to move around the pole in a counter-clockwise direction, and if you mark the ends (or the beginnings) of the trails, you will recognize the familiar constellations of the northern sky. If the camera is pointed toward another part of the sky, the trails will be straighter than those near the pole.



Left: **Star trails at or near the celestial equator.**
Right: **Circumpolar trails at the celestial pole**

When, as may happen, a bright meteor, or "shooting star," happens to go across the sky within range of the camera, it will leave its own trail. At certain times of year, when the earth passes through one of the various swarms of meteors, shooting stars are particularly numerous. Instead of seeing one or two an hour, the average on an ordinary night, you may see them at the rate of one a minute, or even more. Because of the way the earth turns, the meteors that we see before midnight have to catch up to the earth, while those seen between midnight and dawn are met head-on. Consequently, they are always more numerous after midnight, and meteor hunting is a sport that demands late hours. The chief meteor showers are the Perseids, which reach their height each year about August 10 and 11; the Leonids, about November 14; the Geminids, about December 10; and the Lyrids, about April 19. These are named after the constellations from which the shooting stars seem to radiate.

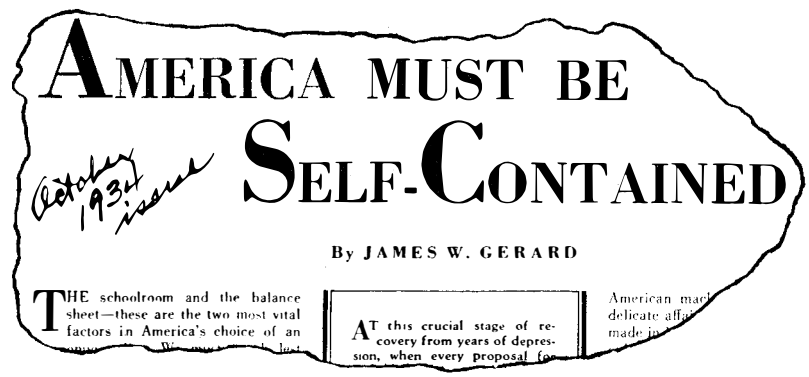
So on these nights, set up your camera about midnight, pointed to the east, in the general direction in which the constellation will rise. Proceed in the same manner as for the polar star trails, but it will be better to take several different exposures, letting each one continue during a half hour period. If any particularly brilliant meteor, especially one bright enough to illuminate the landscape, should appear, note the time, and stop the exposure then. But change the film, or plate, as quickly as possible, in order not to lose any. Of course, the faster the film and the lens, the more faint meteors you will catch. With super-speed panchromatic film, and a modern fast lens, working at an aperture of $f/2.7$ or higher, one should have pretty good results. Such photographs may be of real scientific value, and those astronomers who specialize in the study of meteors will be glad to receive them, and any other amateur meteor observations. Dr. Charles P. Olivier, at the University of Pennsylvania, Philadelphia, is president of the American Meteor Society, an association of amateurs, and Dr. C. C. Wylie, at the University of Iowa, Iowa City, Iowa, is head of the Midwest Meteor Society. These astronomers specialize in meteors.

If the moon is in the direction the camera is pointed, it will also leave a trail, far brighter, probably blotting out all the stars by its glare. The moon is bright enough to permit a snapshot to be made, half a second perhaps, and in this time it will not have moved appreciably. But the image will be very tiny, not more than a twentieth of an inch in diameter, and it will be difficult to find any of the familiar details.

IT is possible to take a larger picture by fastening a pair of binoculars, or even a pair of opera glasses, to the front of the camera, using one side but not the other. In doing this, be sure that the lenses of the glasses are exactly in line with that of the camera, otherwise there will be distortion. The only way to determine the focus is by experiment. Probably it can be found approximately by the use of a ground glass, the camera pointed either at the moon itself, or at some very distant object in the daytime. To get it more exactly, take a series of photographs of the moon, changing the focus ever so slightly between each. The enlargement of the image, by means of the glasses, also has the effect of spreading the light over a larger area, and so the exposure will have to be longer than if the camera were used by itself. However, the moon moves its own diameter across the sky in about two minutes, and if the exposure is longer than about five seconds, the motion will cause a blurring of the lunar details. With fast films an exposure of less than this should be adequate.

RAYMOND B. FOSDICK refutes

MR. GERARD'S DREAM



MY friend, Mr. Gerard, is indulging himself in some wishful thinking. Confronted by a chaotic economic world, he builds a fanciful Utopia in which he finds peace—and escape. It is all so simple as he pictures it. Foreign markets have given us nothing but trouble—why bother with them? Let us sell only to ourselves, producing what we need and consuming it within our own national boundaries. In so far as necessities like coffee, tea and silk are concerned, let us put these minimum requirements on a bookkeeping basis, "so that our dealings with every nation can be perfectly balanced." But otherwise, let us free ourselves from world price fluctuations, retire behind tariff walls, presumably higher than they are now, and live out our days in peace. Thus do children build retreats under a table or in a treetop to escape the realities of an adult world.

Not Organized for Self-Containment.
15,000,000 People in Foreign Trade.
Where "Isolated Prosperity" Leads.
Can Not Live by Slogans Alone.
Spread-Eagleism.
Machines Create Interrelationships.
War and Nationalism.
Nationalism Merely Discouragement.
A Panic Remedy.

The trouble with Mr. Gerard's idea of a self-contained America is that it refuses to face a very stubborn fact. And this fact is that the American economic system is not organized for self-containment. As the result of a long and painful process of evolution our producing interests, both in agriculture and industry, are adapted to world markets. Any attempt to reverse this trend and unscramble this process would result in chaos and human misery on an incalculable scale.

FOR example, suppose we try to reduce American agriculture to a self-contained market. What is involved? We must be prepared to retire permanently from 40 to 100 million acres of crop land. This is the official estimate of the Department of Agriculture of the curtailment necessary to bring our crop production down to the level of our home demand. And what does it mean to take from 40 to 100 million acres out of productive farming? It means that whole populations must be transported out of the farming areas—and where will we take them? It means, as Secretary Wallace points out, government control of marketing, licensing of ploughed land, and base and surplus quotas for every farmer for every product for each month of the year. In the words of Secretary Wallace, "every ploughed field would have its permit sticking up on its post"—and we would be launched on an era of governmental regulation and regimentation as drastic as anything that Russia has dreamed of. It is well that Mr. Wallace asks the question whether the American people have the resolution and staying power to swallow all the traditions and deeds of our robust, individualist past, and submit to a completely army-like, nationalist discipline in peace time.

Or let us suppose that we try to bring American industry within the limits of America's purchasing power. What is involved here? The displacement of labor and loss of capital on an unprecedented scale. In 1928 it was officially calculated that two and a half million families were dependent upon industrial production for export—perhaps ten to fifteen million people altogether. What does Mr. Gerard propose to do with these people? How does he plan to take care of them? Does he really think that home consumption can be increased to meet the needs of this vast army? The present situation is none too happy, but if we throw up our hands in despair and admit that foreign markets are definitely lost and international trade is dead beyond resurrection, we are saddling ourselves and the future with a permanent body of unemployed, a permanent dole system, permanent governmental regimentation, and all the social deterioration and dry rot that accompany an economic order which cannot find work for its people.

THOSE who are dreaming of a self-contained America have not faced the consequences of their proposals. They want to have their cake and eat it too. Mr. Gerard talks about a "return to that security which we sacrificed"—in other words, going back to the good old days, presumably to the days before the federal government began to exercise some measure of control in the management of business. Listen again to Secretary Wallace:

"As yet we have applied to this country only the barest beginnings of the sort of social discipline which a completely determined nationalism requires. . . . Our own maneuvers to date have been mildly persuasive and democratic. . . . If we go on trying to keep things whirling within nationalist limits, it

seems certain that we shall count less on social discipline voluntarily aroused and more on direct compulsion. Under such circumstances the traditional American spirit would soon be, it seems to me, as a spring, tightly coiled, and ready to burst out dangerously in any direction."

Before we start on the path of isolated prosperity, it would be well for Mr. Gerard and his friends to consider where the road leads. Not very far ahead we shall be confronted by the sign posts that point to Fascism or Communism. Are we ready to make the choice?

Quite apart from the consideration of what is involved in getting to where Mr. Gerard wants to go, there is the question of why, on broad grounds, anybody would believe that a self-contained national status represents a good way of living. To be sure there is a patriotic flavor about the slogan "America Self-Contained," just as there is a patriotic flavor about the words, "Buy British," or "France for Frenchmen," or "Deutchland Uber Alles." But men cannot live by slogans alone. Too often these catchphrases are substitutes for thinking. Too many times they are respectable screens for the emotion of the pack.

SO with this idea of a closed national economy, it appeals to the spread-eagleism that is always latent in every country. It easily attracts the applause of the patriotic loud-shouters. Only occasionally does it gain any measure of support from a Keynes, a Donham or a Stuart Chase.

But, assuming that it would be possible to achieve this goal, what kind of human civilization does it imply? Does Mr. Gerard believe that a chromium steel wall one mile high around the boundaries of the United States—to use Stuart Chase's illustration—would make for a better, saner life inside the enclosure? If this were true of the United States why would not happiness and prosperity be increased in California and Louisiana by the same walled-in process? And would it not make for greater satisfaction if we New Yorkers, like Mr. Gerard and myself, could similarly isolate ourselves from the critical judgment of the rest of the country?

These questions are of course fantastic. The groupings of mankind—whether in nations, states, cities, communities or families—are today interrelated and interwoven in a complex pattern that would have seemed incredible a hundred years ago. This is what our machine civilization has done to us. It has reached out with gigantic hands to compress time and space within a small compass, and the process has brought into existence new procedures and institutions and a new principle of human integration. It has developed a high degree of specialization not only between different areas of the same country, but between different nations, each unit contributing to the whole. There is a best place and a second and a third best place in the world for the production of everything that men use—whether it is films, wheat, cotton, copper, coal, oranges, sugar, coffee or what you will. That the present plan is haphazard and faulty no one in his senses will deny. But how can any one in his senses believe that the cure for the present evils lies in a return to the small producing units and the narrow divi-

Raymond B. Fosdick

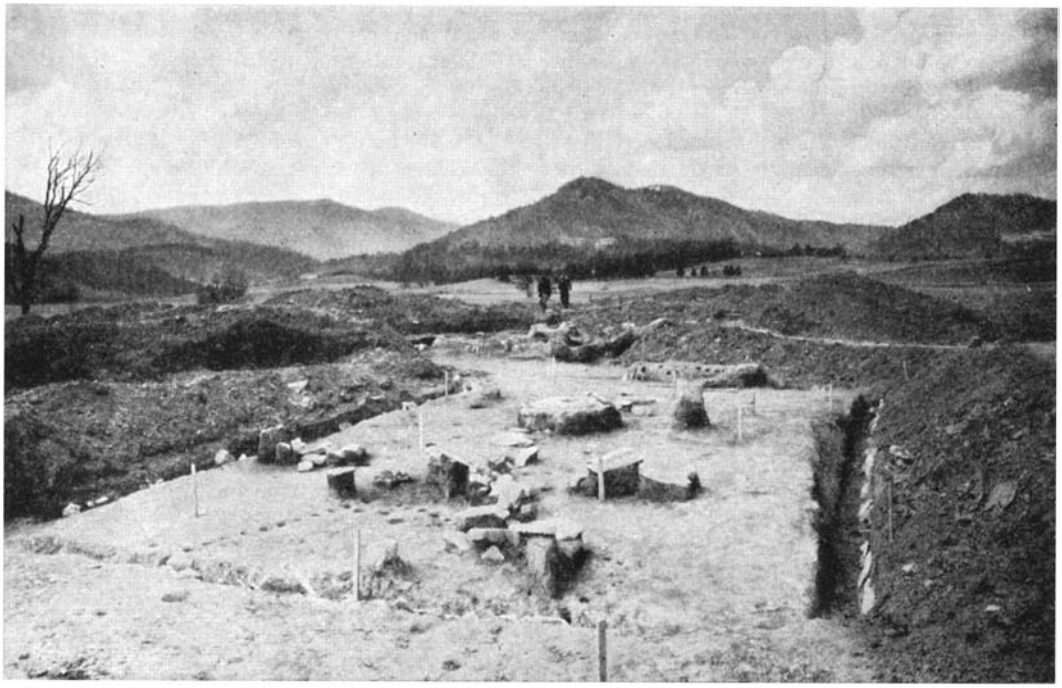
sions that characterized human society before the Industrial Revolution?

For better or for worse here we are—with our machines piled high about us, our airplanes, telegraphs, automobiles, railroads and high-speed productive processes. These new tools involve a new method of living. They have introduced us to our neighbors with whom we must live as best we can. They have broadened our contacts so that our interest and curiosity now range far beyond the parochial limitations of our forefathers. Not only in relation to our physical needs but in relation to our mental needs does this new interrelated civilization play a vital part. Spiritually we cannot go back to the water-tight divisions, to the narrow loyalties, to the little sectarianisms that characterized the old way of life. A new and wider trail has been blazed; and while there will undoubtedly be an occasional loss of direction, as there is at the present moment, the trend toward a world economy and a planetary consciousness is too definitely under way to be permanently reversed. There will be plenty of advisers like Mr. Gerard to bid us return to the old faiths, but humanity is now armed with new tools and has started a march toward a new goal.

One final point in relation to this America Self-Contained movement deserves consideration. Mr. Gerard seems to think it will keep us out of trouble, and that behind our tariff walls we can avoid war. But does anyone seriously believe that peace is the logical result of splitting the world up into intensely nationalistic divisions? In the last few years a fanatic type of nationalism has been bred on the continent of Europe, and countries like France, Germany, Poland and Italy are following its illusive gleam. Not only is the dove of peace conspicuously absent, but Europe is today closer to war than she has been since the signing of the Treaty of Versailles. Nor is this a surprising consequence. It arises from the very doctrine that Mr. Gerard is preaching: the doctrine of economic self-sufficiency. For there are not more than two or three countries in the world today that have either the raw materials or the producing facilities to take even the beginning of a step toward economic isolation. What is to become of the others? Are they to starve to death outside the respective chromium-walled retreats of the favored few? Are the Belgians to eat their lace? Is Ireland to build houses out of bog-peat? Must the Italians burn their fruit trees for lack of coal? Must the Austrians miserably perish wanting everything? The truth is, if denied access to what they need as a means of survival, these less fortunate countries will fight for their existence. There is not a nation in the world today that, if deprived of the right to live, would not bring down the whole house of cards in a last desperate effort to survive. It is the self-sufficient ambitions of those nations that either have "enough," or are determined to get "enough" at the expense of their neighbors, that is arousing jealousy and hatred, and paving the way for violence.

THE way of international understanding and co-operation is a discouraging path to travel. It is an open question whether even by this road we can escape catastrophe. But if the human race is set on bigger and better wars in the future, Mr. Gerard's national self-sufficiency is guaranteed to produce results.

The trouble with Mr. Gerard is that he is discouraged. Because international trade is depressed, he thinks it has disappeared for good. Because the feeble gestures which the nations have made toward a world economy have gotten us nowhere, he believes that nothing in that direction will ever succeed. Because America is hard hit by the depression, he is frankly frightened, and is urging secession from the common interests of the race. But his remedy is a panic remedy. The idea of every nation for itself and the devil take the hindmost is not born of cool-headed judgment. In such a mad stampede for safety the strongest is apt to be trampled down.



The excavated temple foundation. Various objects found have been left in place and standing on the soil beneath them, while the excavation was carried down deeper. Note fire pit in center

Tennessee Valley Authority Aids

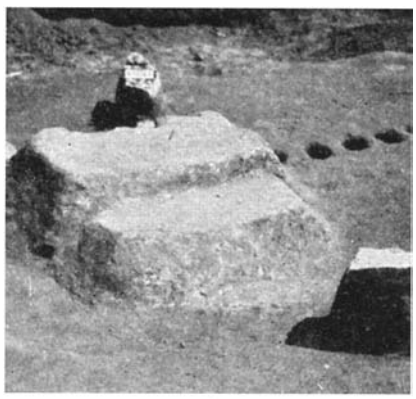
AMERICAN ARCHEOLOGY

By GEORGE O. GILLINGHAM

THE site of one of the early fortified villages of the Cherokees has been discovered just outside of Careyville, Tennessee, by archeologists of the Tennessee Valley Authority, in their examination of Indian remains in the area to be flooded by the waters of the Norris Dam reservoir. Major W. S. Webb, head of the Department of Anthropology and the University of Kentucky, has been "loaned" to the Authority for the work.

The foundations of the village temple, council room, a private dwelling, and a portion of the stockade that surrounded the town, have been brought to light. Further excavation below the level of the hard-packed clay floor of one of these revealed the foundation of another temple, marking an even earlier occupancy of this particular spot by the Cherokees. These are the first temple sites found east of the Mississippi.

The temple foundation measures approximately 30 by 40 feet, and has a raised baked clay altar with a fire pit in the center. The walls of this building were thatched and about 10 feet in height. The roof was formed by bending the tops of the young trees that formed the solid part of the wall inward toward each other and binding them together, thus forming an arched roof. This, too, was thatched. The semi-public building that stood near the temple was of the same construction, but had only a flat



Raised clay bank in private house which probably served as a seat

fire pit in the center, rather than a raised temple altar. The private dwelling house, typical of the dozens that must have formed this village, covered a space 15 by 18 feet and was constructed of much smaller poles. Along the edge of one wall is a raised clay bank which no doubt served as a seat for the tribal head. In the center is a small fire pit.

The post holes marking the location of the stockade indicate that tree trunks at least 10 inches in diameter were used in the fortifications. This huge fence occasionally took abrupt right-angle turns, in order that the face of the stockade could be protected by a cross fire of arrows. The gateway had a protecting wall of poles in front; thus no person entering or leaving would be in a direct line of fire from an enemy. It is thought that this Careyville site may be the Cherokee fortress that Colonel Montgomery saw and thought too strong to attack during his invasion of Cherokee territory in colonial times.

ON the T. B. Walters farm along the Powell River, excavation has brought to light a small burned dwelling, 11 by 11 feet in size, with the customary fire pit in the center. In this site were found four clay vessels still intact, measuring about six inches in diameter, the remains of a larger pot of about 12 inches diameter, and small round stone counters, like checker pieces, which were used in an early Indian game. The pottery, like all early American ceramics, is of the coiled type of manufacture, as the potter's wheel was unknown to the American Indian. It is unpainted and without design, except a serrated ridge around the edge of some of the bowls. The larger pots were no doubt fitted with handles, as several clay handles have been found.

Faceted gems cut by the author. They include topaz, aquamarine, beryl, and tourmaline

Faceted Gems for the

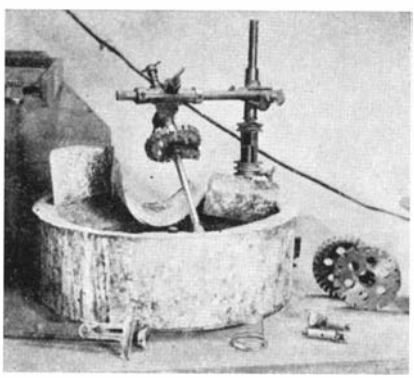
AMATEUR LAPIDARY

By ARTHUR KNAPP

IN the March, 1932, number there was an article by J. H. Howard, entitled "Gem-stone Cutting for the Amateur," which introduced a new hobby to our readers. This hobby attracted a small but select following. In March, 1933, we reproduced photographs of some of the "cabochon," or rounded, gem work done by Mr. Howard's followers. We now show some of the work done by a Philadelphia amateur who has progressed to the more difficult faceted work. The raw materials for this hobby are not expensive when obtained in the rough and the enticing picture at the top of the page should make more of the readers wish to become amateur gem cutters.—*The Editor*.

IT may never have occurred to the reader that it is possible for an amateur to cut and polish worthwhile semi-precious faceted gems. All that is needed is a fair degree of mechanical skill.

It is advisable to learn the fundamentals by cutting and polishing the rounded cabochons first. There is a certain amount of technique which is much easier to learn with a rounded surface, and there is a certain amount of education in looking at and judging wet, polished surfaces, which can be gained only by such experience. The only book on the subject known to the writer is J. H. Howard's "The Working of Semi-Precious Stones." This book contains all the information necessary to get started.



Simple rig for gem-stone cutting, driven by a small electric motor

The machinery required for cutting faceted gems is very simple, and may be constructed in the home. All that is necessary is a motor-driven vertical shaft. The writer uses a one half inch drill rod steel shaft and two self-aligning bearings. On the top of the shaft is a threaded arbor for holding the lap disks.

Cutting is done on a disk or lap of soft gray cast iron, using Number 600 fine Carborundum. Polishing is done on a lap of block tin, oxide of tin being the usual polishing medium.

THE rough gem is attached, by means of a special wax, to a short metal rod which is screwed into the center rod of the index head (see illustration). The index circle has 32 slots, and controls the position of the facets around the gem. The vertical angle is controlled by placing or removing slotted washers on the vertical shaft, to raise or lower the horizontal arm. Since cutting is done on one lap and polishing on another, it is necessary to have exact mechanical control of the position of each facet, in order that they will register precisely on the polishing lap.

The stand, clamps, and bushings of the indexing machine are standard parts. The index plate was cut on a gear-cutting machine, and the shaft and cylinder of the index assembly are the only other machine-shop parts.

The faceted gems in the picture include precious topaz, citrine, green and pink tourmaline, smoky quartz, kunzite, amethyst, aquamarine, golden beryl, and various colored quartz.

SUNDIALS AND THEIR CONSTRUCTION

Part VII—Lines of Declination on Different Types of Dials

By R. NEWTON MAYALL
Landscape Architect
and MARGARET WALTON MAYALL, M.A.
Research Assistant, Harvard College Observatory

THE lines of declination on the equatorial dial are circles; but on other dials, such as those whose planes lie oblique or parallel to the axis of the earth, they take the form of ellipses, hyperbolas, and parabolas. One does not have to understand the theory of conic sections in order to construct these lines, because they may be easily laid out by the same method (graphic) used for the hour lines.

The construction of the lines of declination for the south vertical dial is typical of those dials whose planes lie oblique to the axis of the earth. It will not, therefore, be necessary to describe the construction for each dial of this type, for the description of one may be applied to all. As a guide to the reader, additional diagrams have been included showing the location of the lines on various dials.

THE following example shows the construction of the lines of declination for a south vertical dial in 50° north latitude.

Figure 1 shows the dial completed. The line *C′* 12 is the substyle line; the foot of the perpendicular style is marked at *F′*. On this dial the horizontal line will pass through the foot of the perpendicular style, at right angles to the substyle line.

On any dial whose plane lies oblique to the axis of the earth the equinoctial line will be a straight line, and perpendicular to the substyle line. To find the position of the equinoctial and other lines of declination, another diagram is brought into use, such as that shown in Figure 2. Early diallists called this figure a trigon, and by it many problems of the sphere were solved.

In Figure 2, the horizontal line *PC* represents the style; *CF* the substyle; *P* the nodus; *PF* and *F*, the height and foot of the perpendicular style, respectively.

At the point *P*, draw *PE* perpendicular to *PC*. This line represents the equinoctial.

Draw *PN* and *PS* for the greatest northern and southern declination of the sun. Angles *NPE* and *EPS* will be equal to 23°27′.

Now, produce *CF*, cutting *PS* at *b*, *PE* at *a*, and *PN* at *o*.

In Figure 1, *C′* corresponds to the point *C* of Figure 2. Lay off the distance *Ca*, from *C′* to *a′*, on the substyle line *C′* 12. The equinoctial line will pass through the point *a′*, perpendicular to the substyle, and parallel to *K″C′K′*.

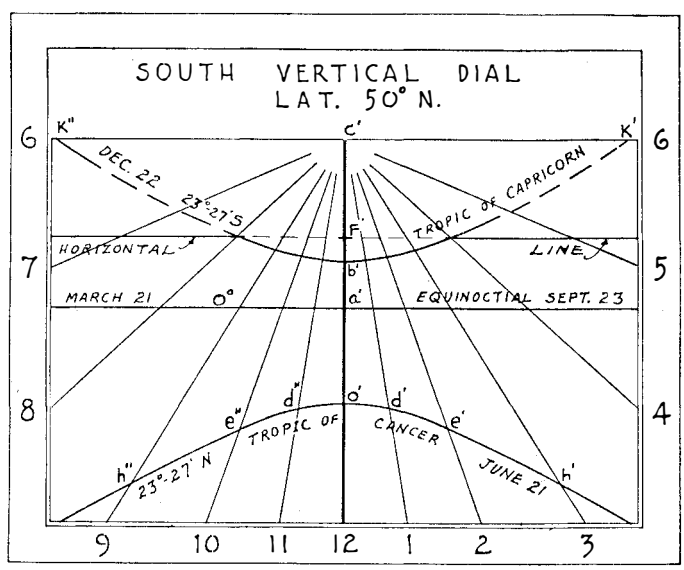


Figure 1: **The south vertical dial—lines of declination**

With *C* (Figure 2) as a center, describe arcs cutting the line *PE*, whose radii are equal to the distances from *C′* (Figure 1) to the points where the equinoctial line cuts the various hour lines. Through the points thus found on *PE*, draw lines from *C* cutting *PS* and terminating in *PN* at *o*, *d*, *e*, and so on. These lines represent the hour lines on the dial plate (*Co*=12; *Cd*=1 and 11; *Ce*=2 and 10; and so on).

If the distances *Co*, *Cd*, *Ce*, and so on (Figure 2) are plotted on the corresponding hour lines (Figure 1) from *C′* to *o′*, *d′*, *e′*, and so on, and to *d″*, *e″*, and so on, a curved line drawn through those points will represent the path of the shadow of the nodus when the sun has a north declination of 23°27′.

Similarly, the line *K″b′K′* (Figure 1), representing the path of the shadow of the nodus when the sun has a south declination of 23°27′, may also be plotted by taking off the distances from *C* (Figure 2) to the various points where the lines *Co*, *Cd*, *Ce*, and so on cross the line *PS*.

A line drawn from *C* (Figure 2) perpendicular to *PC* and cutting the line *PS* at *K*, will give the location of the point where that line of declination intersects the 6 o'clock line, as at *K′* and *K″* (Figure 1). It is not necessary to extend this line beyond the horizontal line.

All other lines of declination will fall between the lines *K″b′K′* and *h″o′h′* (Figure 1); and they may be plotted as shown above, by inserting the desired lines in Figure 2, making angles with *PE* equal to the declination, on either side of that line, as the declination is north or south.

THE position of the lines of declination on an horizontal dial in 40° north latitude is shown in Figure 3. It is evident that the horizontal line cannot be placed on this dial, because the plane of the dial lies parallel to the plane of the horizon.

Note that the Tropic of Cancer, which is the line nearest the center of the horizontal dial, is farthest from the center of the south vertical dial (Figure 1). It will be easier to visualize the position of these lines if they are labelled north or south declination, and the direction of the celestial pole properly indicated, as shown in Figure 2.

FOR the lines of declination on the direct north and south reclining dials the work is done in exactly the same way as that for the south vertical dial. The height of the style is its elevation above the dial plate (Explained

on page 251 of the May, 1934, number).

The location of the horizontal line on these dials is derived in the same manner as for the equatorial dial, described in the September number, and it is perpendicular to the substyle line.

THE position of the lines of declination on a south vertical dial, declining 20° east in 40° north latitude, is shown in Figure 4. In this dial *AF* is the substyle line (not the 12 o'clock line); *AN* is the style; angle *NAF* is the height of the style; *N* is the nodus; *NF* and *F* the height and foot of the perpendicular style, respectively.

In order to construct the lines of declination on this dial, first, with the substyle *AF* as the meridian or 12 o'clock line, lay out the hour lines for an horizontal dial, the height of whose style is equal to the angle *NAF*.

Then, with all the parts of the gnomon for the horizontal dial equal to those of the declining dial, proceed to lay out the lines of declination, as previously described. Thus will the lines for the declining dial be properly constructed.

The horizontal line, on declining dials, will pass through the point where the equinoctial line intersects the 6 o'clock line, as at *K*. From *K* it is drawn through the foot of the perpendicular style, at *F*; and at right angles to the meridian line of 12 (in the figure, *AB* 12).

DURING the short period that the sun shines upon the north vertical dial, it has but a small elevation above the horizon. For this reason, the lines of declination are seldom drawn upon this dial. The lines may be constructed if the work is done in the same manner as for the south vertical dial.

The construction of the lines of declination for the east and west reclining dials is the same as that for the declining dials, where an horizontal dial is described about the substyle line on the reclining dial. The height of the style for the reclining dial is used as the height of the style for the horizontal dial. Then, the lines of declination constructed for the horizontal dial will be the lines for the reclining dial, as shown in Figure 5. The diagram shows the appearance of the lines on a direct east dial, reclining 25° in 37° north latitude. The line *SF* is the substyle; *F* the foot of the perpendicular style; and *N* the nodus.

The horizontal line, *AB*, is drawn through the point where the equinoctial line cuts the 6 o'clock line, and parallel to the 12 o'clock line, which on this dial is parallel to the plane of the horizon.

●

The next installment will describe the construction of the lines of declination for dials whose planes lie parallel to the earth's axis, and another simple method of plotting them.

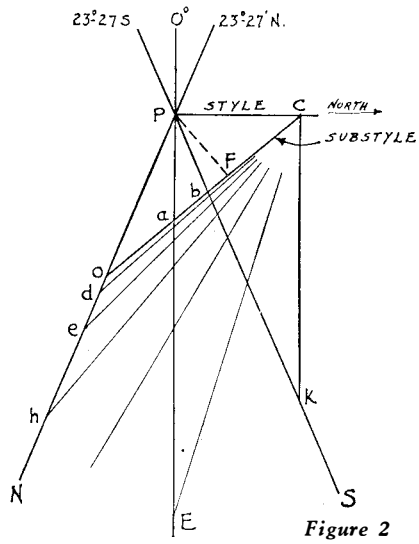


Figure 2

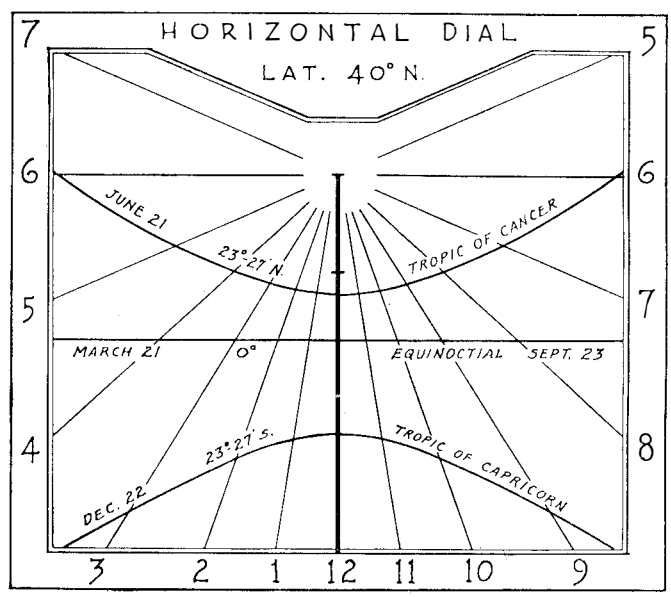


Figure 3: **Lines of declination—horizontal dial**

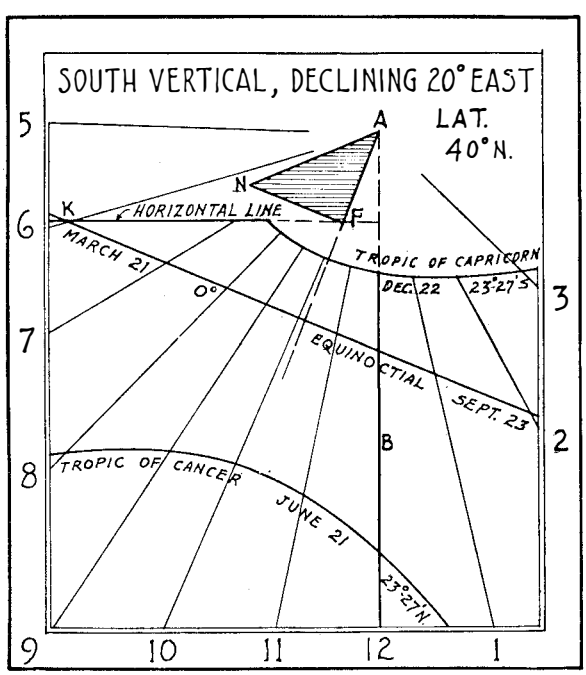


Figure 4: **South vertical, declining 20 degrees east**

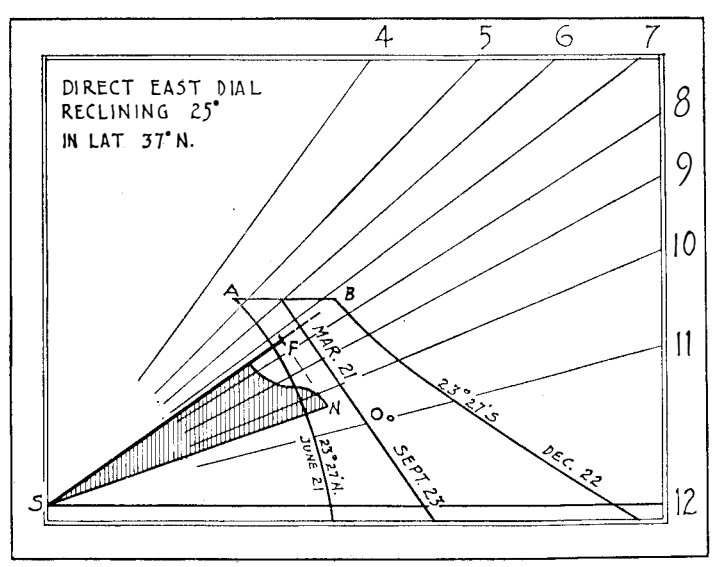
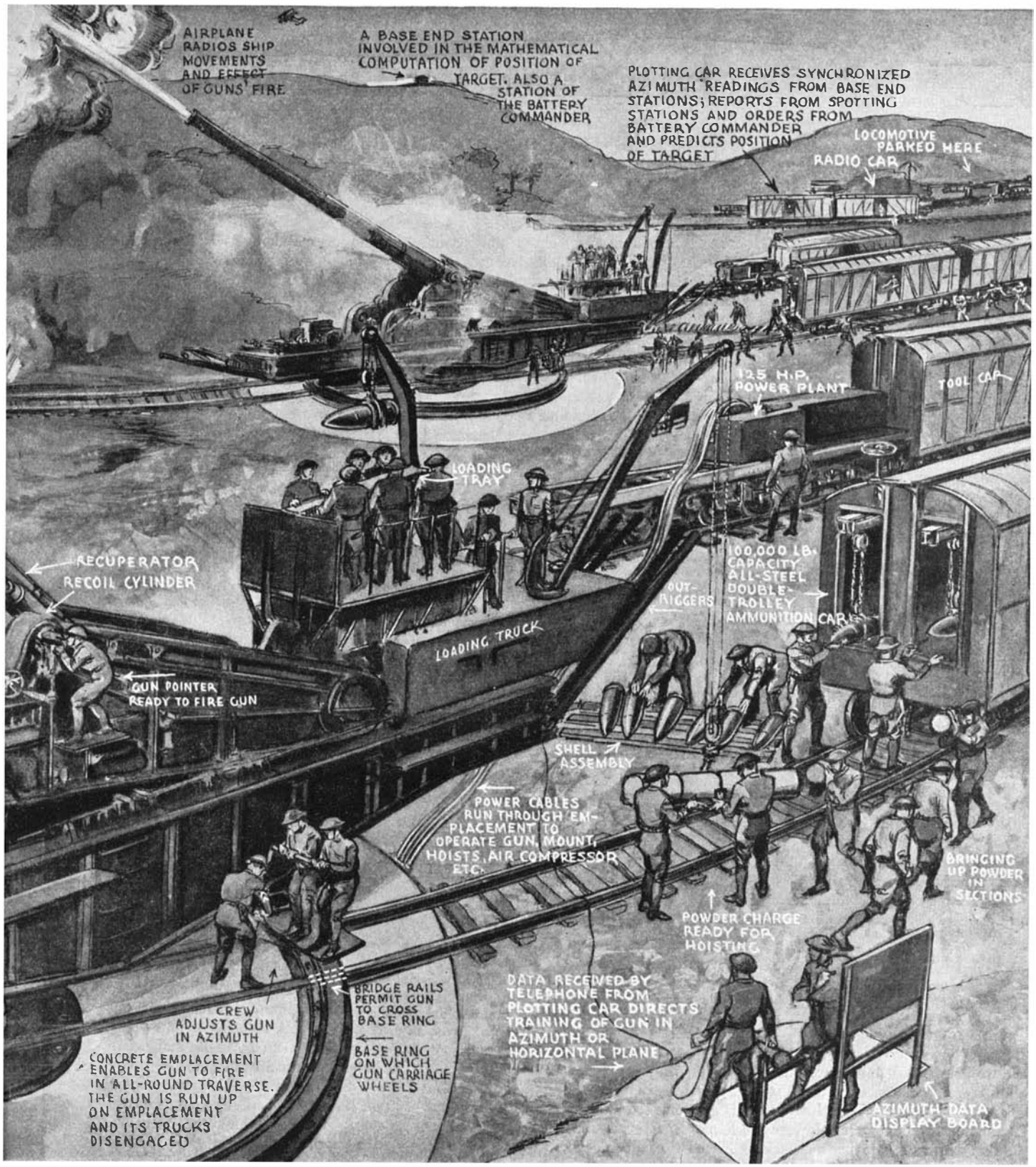


Figure 5: **Direct east dial reclining 25 degrees**

FOR DEFENSE OF T

A DIRECT hit at a distance of 23½ miles on the forward turret of a target simulating the battleship *California*—that is the record made by one of the two guns, shown here in a hypothetical situation, which have been constructed for defense of what is perhaps our most vulnerable shipping lane, the Panama Canal. These two 14-inch guns, the largest of their type except for two others rumored to be on our west coast, represent the peak of development in extraordinary artillery armament devoted expressly to defensive purposes. In ingenuity of construction, mobility, and ease of operation, these guns add spectacular interest to long range measures for land resistance to naval attacks.

At strategic and concealed positions at each end of the canal, emplacements, with necessary turn-tables and side-tracks, have been constructed for these guns. While they are shown here relatively close together, actual emplacements are sufficiently distant from each other to make it impossible for one naval shell to dis-



HE PANAMA CANAL

able both simultaneously. The guns, together with necessary ammunition, tool, and machine shop cars are moved on railway tracks at train speed from one end of the canal to the other as needed. From two to three hours are required to move a gun from traveling position to firing position and about five hours are required before firing can be begun.

With radio-equipped airplanes as spotters of enemy fleet movements, with highly developed mathematical instruments for sighting and control, with carefully plotted artillery maps of waters within range, and with freedom to move in a complete circle, this defense scheme would prove a formidable obstacle for hostile ships to overcome.

Drawing prepared for SCIENTIFIC AMERICAN from data kindly supplied by James T. Campbell, C. A. C., Fortress Monroe, a former commander of this battery, and through the courtesy of the office of the Chief of Coast Artillery.

DOES YOUR SLEEPING ROOM

By DONALD A. LAIRD, Ph.D., Sci.D., F.R.S.A.
Director, Colgate University Psychological Laboratory
Hamilton, New York

ONE thing about the American home makes me snort. It is this: Why are the sleeping rooms invariably bright, cheery and contrived, seemingly, for almost every purpose except sound sleep?

This abruptly posed query may come, gentle reader and home lover, as something of a shock. It may make *you* snort. For at first thought, one may think that nothing could be more desirable than a bright, cheery and pleasant sleeping room. Yet the truth is that nothing is more important than sound sleep, and sound sleep cannot, as a general thing, be had in the bright and cheery rooms so much in vogue among present-day home builders, no matter how much relaxation your bed cushion encourages. On the contrary, if you would sleep well in the new home of your dreams, on which you have spent so much time and thought and good hard dollars —indeed, if you would keep good health and spirits with which to enjoy your home long and well—make the sleeping rooms like the bear's cave—blue and green with shadows, sheltered from outer noise as with woodland leaves and wild boscage, and completely free from vagrant air currents which cause even the gentlest motion of, and therefore sound from, curtains, calendars, lamp shades and other ornaments, as well as from polished metals and glasses which reflect semi-rousing gleams and beams in human bed chambers.

A bed in the sleep laboratory in the author's home. Thermograph at left records the temperatures. Dial of kinetometer to which Dr. Laird is pointing shows the total vertical displacement of top of mattress during the night. Special clock records all turning over in bed

OFF and on, at the Colgate Psychological Laboratory, we have been studying sleep for some ten years. Not only have we obtained definite data on sleep habits from hundreds of persons in all walks of life, but we have had scores of students sleeping under the eyes of scientific observers, on beds especially constructed, hung on springs and equipped with any number of gadgets for measuring and recording the slightest movements, changes in respiration and bodily condition of the sleepers. We have thus watched the effect of light and light beams, of noises gentle and heavy, of short sheets and heavy blankets—indeed, of everything we could think of—on human sleepers. Not only the immediate effect, of course, but the after effect. In other words, the resultant measure of energy and good spirits possessed by the sleepers the next day after sleeping under varying conditions; and, as well, the gain or loss in these desirable things as a result of long periods of sleeping in ideal or non-ideal conditions. That is to say, for brevity's sake, bear-cave rooms or the bright, cheery rooms.

We found that humans sleep soundest and with best results in absolutely dark, silent, still places, and that those who get such sound sleep are vastly happier, more energetic and efficient than those who do not. Indeed, we are convinced that many a man and woman who is ailing around and worrying because he or she cannot sleep—or even doctoring for insomnia, or taking one or another of the countless sleep potions to be had at the druggist's—is really suffering from nothing more serious than the continued attempt to sleep in bright, cheery, pleasant rooms more adapted to wakeful living than to sleeping, or on a cushion that tortures instead of relaxes; and that countless folk who think they do not get enough sleep, or do not get enough hours of sleep, do get in enough sleeping time, and would get enough sleep if in that time they slept under conditions where deep sound sleep were possible. We humans spend, roughly speaking, one third of our lives in sleep, and the Colgate research proves, if proof were needed, that how well we improve and enjoy the other two thirds depends to a truly great extent upon how soundly we sleep. Should we not then plan our sleeping room with as much of an eye on good sleep as we do our kitchens with an eye to the speedy preparation of good food? Or the living room with an eye to comfort and hospitality?

AFTER all, the business of building a sound sleeping room is simple enough, and for the home builder, who has to buy new furnishings anyway, it should cost very little more than any ordinary home "sleeper."

Let us consider first the problem of making a room quiet. Providing vacuum walls with air-tight doors and windows would do the trick, but not for humans. However, that's the ideal, and the puzzle is to approach it as nearly as possible while assuring ventilation and ordinary ease and comfort of living. Sometimes, it is puzzling indeed.

Well, then, how can a sleeping room be made sufficiently noiseless? Naturally, the degree of defense against outside noise must depend upon the location of the room and the amount of noise, and the measures which would suffice in one location might not suffice in another. But let us consider a room such as a friend of mine set up, which was in the end about as quiet as a human sleeping room could be made. First, he lined the ceiling and the upper walls with a thick, blotter-like sound-proofing material which actually absorbs as much as 75 percent of the sound that strikes it. He covered the floor with thick-pile carpets and rugs, hung the windows with heavily shirred velour curtains and put a

Give You Insomnia?

velour spread upon the bed. All of these materials absorb noise as a sponge absorbs water. He fitted the doors with spring-bronze weather stripping, and put silencers—acoustical baffles which block noise but permit ventilation—at the windows. Not content with these, however, he put velour-covered screens before his windows—and when he had done you couldn't hear in his room the radio or the voices in the other parts of the house.

While my friend's home, by reason of its location, was not subjected to the other main aspect of this form of sleep insurance—unwanted light—I have talked with any number of home owners who find it a major difficulty; especially those whose houses are close to the roads or streets where beams from street lamps, passing automobiles or sometimes the glare of downtown sections of cities invade the room through the windows. When you are dog tired from heavy manual labor or a long period of enforced wakefulness you might possibly be able to sleep deeply with your room fully lighted. But this is not often the case, especially for people engaged in what we call, for want of a better term, brain work. By and large, it may be said that light invariably makes sleep lighter and less refreshing—if, in truth, it doesn't rout it altogether. For a nervous person, or one prone to worry, to attempt to sleep soundly in a room where light penetrates, even in a slight degree or only occasionally, is very difficult and often impossible.

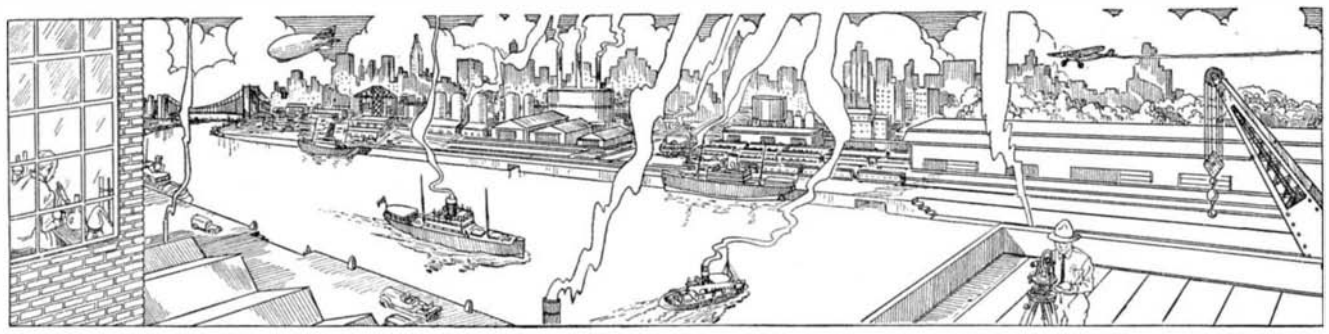
IMMEDIATELY, of course, you think of curtains. Surely, they keep out the light. They do, to an extent, of course, if they are black, dark green or blue, and perfectly opaque, and if their edges travel up and down in grooves at least an inch deep. Ergo, if you want to sleep well, have that type of curtain in your room—rather than the light-colored, translucent ones so often found in "bright, cheery rooms." Yet, even with such curtains, light will come in at the bottom or top, which-ever you choose to leave open for ventilation. Coming in, if such vagrant light finds a nice bright-colored interior, it has a fine and, from the sleeper's viewpoint, a devilish time. It actually expands and multiplies itself when reflected from the white or light-colored walls and curtains and furniture. Then, assuming that it strikes a silver, gilt, or polished metal fixture or toilette array, it concentrates itself and plays in a bright beam through the darkness. Shut your eyes, sometimes, and let a light beam play over them, then you'll have some conception of what a force for poor sleep a light beam is.

Given dark, opaque curtains, what next? Well, in a room perfectly protected against light, the walls must be of some dark, restful color, preferably following the tints of the deeps of shadow, the night sea or sky. Deep blues or greens are best by all odds, though black lightly lined with silver is smart and not bad, scientifically. All points, woodwork or wall paper must be of the dull or frosted type, rather than the glossy, gleaming kind which, even though black, reflect light like a mirror. So, too, must be the case with such ornaments and fixtures as may be necessary. Coverings for mirrors and telephones are, of course, highly satisfactory as defenders from light. Screens before the windows—dark-colored, opaque screens—are essential, too, even where one has the silencers mentioned above at the windows, because light has a fierce penetrative power. If you don't believe it, observe sometime how the rays of automobile lamps will stream through the chinks of a blind or around an ordinary curtain as, say, the car turns before your window and the light sweeps past it.

Not only will such a room keep out or eliminate those twin enemies of sleep—noise and light—but it has a further and tremendous psychological advantage. Suppose now that the general idea of this perfected sleeping room is carried out in other details. The lights are well shaded and soft when turned on; the paintings, portraits or pictures are all of a restful, subdued nature, both in subject and treatment; there are no touches of red, yellow or orange in the many minor things that one must have in sleeping rooms. You enter. You are in a place that literally breathes restful influence, the idea of peace, rest and security. The deep silence itself woos you to slumber, and the restful greens and blues lull you to sleep on the bed cushion with a psychological spell that is, all things being equal, verily overwhelming and in the long run irresistible. You may have come from a highly stimulating and exciting social affair, bridge tournament, a dance or even a business meeting where you have battled to the limit of your resources, but you will find in such a room as we have described a veritable sleep-producing charm. On the other hand, after such stimulation, enter the usual bright, cheery, noisy room, with its light colors—often its red, yellow or orange colors—and you will, in many instances, be playing the bridge games, or fighting the business battles, all through the night; and in the morning be convinced that you have a bad case of insomnia.

Above: **The sleep laboratory, on the floor below the bedroom, is itself walled with absorbing material (a patch shows behind author) and its windows are double—its walls filled with powdered gypsum. Note somno-kinetograph, sleep movement recorder.** ***Left:*** **Sleep record**

I SLEPT in ordinary, bright, cheery rooms for years. Then, awhile back, I built myself a room of the type outlined in this article—and I wouldn't give it up for a fortune; that is, unless I could get another like it. It has paid for itself many, many times over, in dividends of better health, better spirits, and consequently better work.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN

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

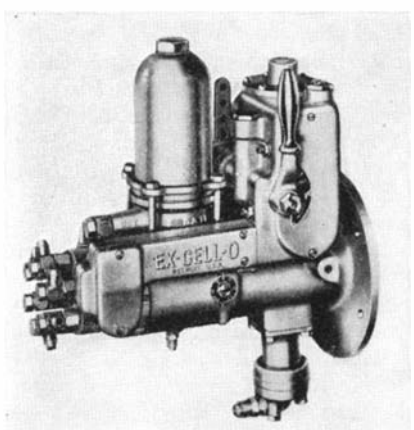
A. E. BUCHANAN, Jr.

Lehigh University

Diesel Fuel Injection Pump

THE long anticipated "made in America" standard fuel injection pump for builders of high-speed Diesel engines, which will challenge what virtually amounts to a foreign monopoly, has been announced by the Ex-Cell-O Aircraft and Tool Corporation. Most engines manufactured heretofore in the United States have used foreign built fuel injection pumps. This significant announcement was made recently by Mr. C. R. Alden, Research Engineer of the corporation.

European countries have been far ahead of the United States in utilizing Diesel



Injection pump for Diesel engines

engines for commercial transportation, perfection having been achieved to such a degree that all trucks of two-ton capacity or over exhibited at the European shows this year were equipped with Diesel power.

The American company has been developing its fuel injection pump for the past seven years and announces it now only after extensive field tests by some of the large engine builders. These tests, it is claimed, have proved the pump completely successful on every count.

One of the difficult problems in the perfection of light, high-speed Diesel engines suitable for motor truck use has been the extreme precision necessary in the manufacture of fuel injection equipment. It must be capable of metering a quantity of fuel as small as 14 millionths of a pound, compressing it, and injecting it in the form of a highly atomized spray into the engine cylinder in a time as short as one two-thousandths of a second.

The pump consists of two major parts: the drive unit and the hydraulic unit. The drive unit is mounted directly on the engine, making it practically a part of the engine structure. This enables the engine builder to eliminate several parts and operations and will not permit misalignment which causes rapid wear.

The hydraulic unit is removable and is furnished as a sealed assembly. This requires a minimum amount of time for servicing, all of the precision or hydraulic parts of the pump being replaced as a unit.

Incorporated as an integral part located on top of the fuel injection pump is a secondary filtering unit. The fuel oil must pass through this filter before entering the hydraulic unit. Foreign material is thus removed that might otherwise damage the system. A two-step filter is employed, the first being a specially woven wool fabric and the next a spirally wound edge filter.

A fuel transfer pump is available for delivering oil to the injection pump if there is not sufficient gravity head.

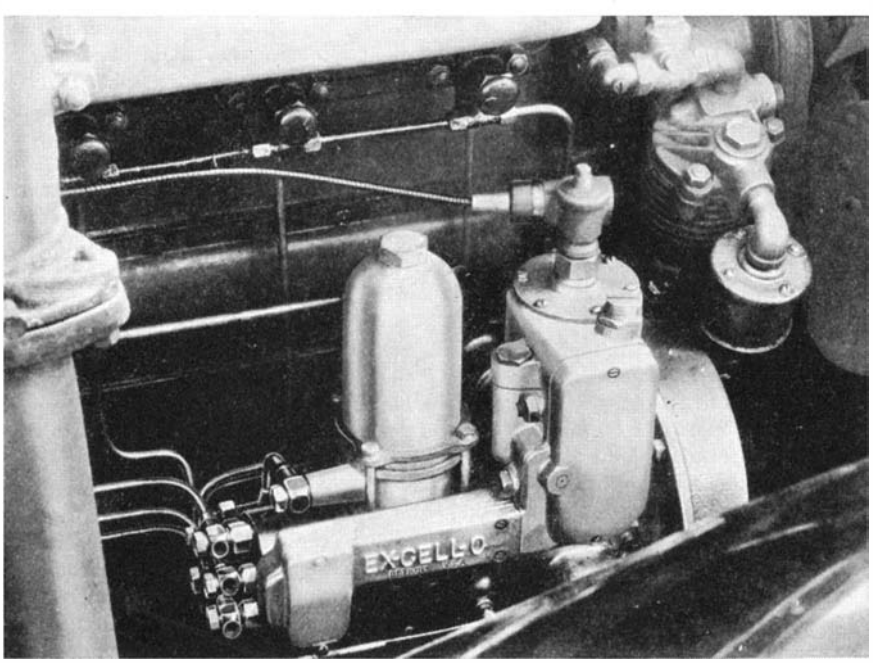
The new fuel pump may be furnished with a governor in which can be incorporated features adapting it to automotive, marine, industrial or constant speed service.

Ceralumin, a New Light Alloy

A NEW light-weight alloy of high strength has been developed by the use of the relatively rare metal cerium, from which the new alloy derives its name, Ceralumin. The composition of the alloy is copper 2.5, nickel 1.5, magnesium 0.8, iron 1.2, silicon 1.2, cerium 0.15 percent, the remainder being aluminum.

Investigations have established the fact that cerium allows the beneficial mechanical effects of a high iron content to be obtained by suppressing the embrittling iron-aluminum constituent which is otherwise liable to be formed. In addition the small amount of cerium also confers on the alloy important advantages in the foundry; Ceralumin has extremely good "running" properties and gives castings having a smooth clean surface and an attractive appearance.

In the heat-treated condition Ceralumin



The new Diesel engine fuel injection pump installed

presents an excellent combination of high tensile strength at ordinary and elevated temperatures, high elastic limit and high Brinell hardness as well as a very high fatigue strength, a quality which should prove of special interest to designers anxious to take the fullest advantage of the properties of available materials. The alloy is suitable for high-duty service in the form of die-castings, chill castings and sand castings, and it is anticipated that it will find a useful field of application in the aeronautical and automobile industries.—*A. E. B.*

Amateur Photomicrography

AN addition to the equipment of the amateur microscopist has recently appeared in the form of an inexpensive photomicrographic outfit for photographing specimens in the field of the microscope. The price of

Taking a photomicrograph

12 dollars is a long jump from the hundred-dollar tag which has dismayed many amateurs who have looked at the professional outfits. This does not imply that professional work cannot be done with this compact little outfit. It is in no sense a toy and the results obtainable with it are limited only to the quality of the microscope and the skill of the operator.

The outfit can be used with any good amateur or professional microscope and the procedure is very simple. The microscope is placed on the base of the stand and held by a forked metal clamp. The camera is adjustable up or down on a vertical rod and can be swung to the left or right. It uses standard 127 roll or cut film in holders. Cut film of flat celluloid is generally used by professionals because results may be checked more easily after each exposure. A good source of illumination is a 100-watt frosted bulb in an ordinary gooseneck desk lamp.

Attached to the side of the camera is a focusing tube with which the object may be seen on a focusing disk. When the exact focus is secured the camera is swung over the microscope ready for the exposure. A light-tight connector fits over the eyepiece of the microscope and into the shutter opening of the camera to keep stray light from reaching the film.

A New Jack-Driven Tunnel Shield

THE accompanying drawing serves to clarify the application and economy of using the T & M Tunnel Shield, now built by Link-Belt Company at Philadelphia, for constructing tunnels underground without disturbing the surface.

This shield is a combination jack-driven shield and block placer which can readily be guided to line and grade and can place 25 feet of precast block lining per eight-hour shift, provided soil conditions are such that the remaining operations can be co-ordinated to meet this pace.

The machine itself requires two men—a trained operator and a block placer. The jacks extrude the completed lining into the earth bore and cause the shield simultaneously to advance and dress the mined hole.

All remaining functions—mining, spoil removal and disposal, and delivery of blocks to the shield—are subject to any modus operandi the experience of the contractor may dictate. As a rule, the expedition with which the contractor prosecutes this part of the job will determine the daily progress of the tunneling machine.

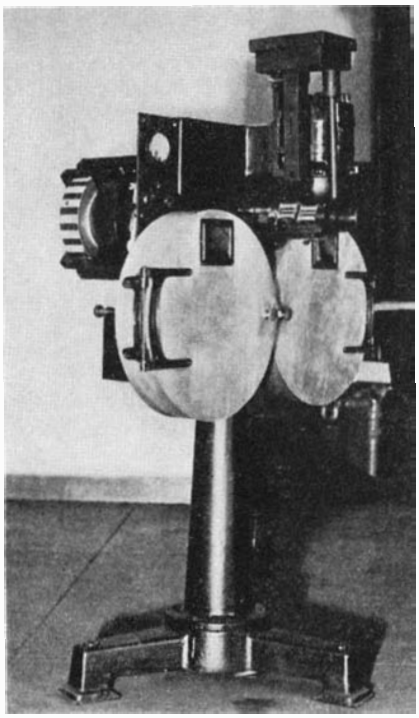
Sound Movies By Television

A FORERUNNER of what may be tomorrow's home entertainment was demonstrated in the laboratories of the Peck Television Corporation in New York, when scenes from current newsreels flashed across a television screen. William Hoyt Peck, president and chief engineer of the company, has devised a new type of film scanner, built entirely without gears and using two automobile headlight bulbs as its only sources of light to actuate the photo-electric cells for both the sight and sound channels.

To pick up the picture, a concentrated beam is projected onto the face of a revolving mirror lens disk, which causes it to scan the film horizontally. Vertical scanning is accomplished by the continuous motion of the film at the rate of twenty-four frames per second.

The receiver likewise makes use of a headlight bulb as its light source, and of reflecting lenses in its scanner. These lenses are each made from a single glass casting, silvered on the back, and are said by the inventor to be as efficient and as highly corrected as a photographic triplet.

Sixty-line images were seen during the demonstration, but although a great amount

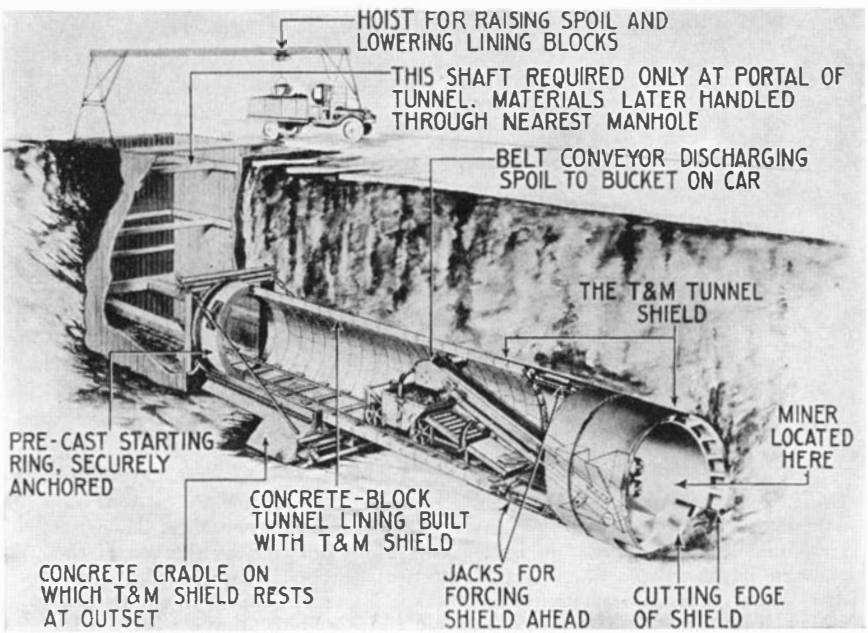


Television pick-up for movie film

of detail is not expected in pictures using this number of lines, observers were able to see the swing of baseball bats even in long shots of the diamond, the motion of hockey sticks as players skimmed over the field of ice, to read the numbers on racing horses, and to recognize Samuel Insull, Premier Mussolini, and Eddie Cantor, close-ups of whom were shown.

"The unusual brilliance of the image," said Mr. Peck, "is explained by the fact that all of the light from the source is concentrated to a point, all of which strikes each lens in turn, as the scanner rotates. When lenses are arranged in spiral form, as is necessary on the ordinary disk, the spot of light must be large enough to cover both lens #1 and lens #60. This means that three-quarters of the light is being wasted at all times."

In Peck's receiver, the light source is on the same side of the disk as is the screen



How the new jack-driven tunnel shield is put to work

upon which the image is projected. He claims that allowing for all losses from reflection and refraction, 83.33 percent of the available light is used. Pinhole disks, he says, make use of only 1/4320th of the light.

The light is modulated by means of a modified Kerr cell, which measures less than one cubic inch over all, contains but fifteen drops of fluid, and has an internal capacity of only 0.000006 mfd. A pair of screen grid tubes are used to actuate this cell, as an output of only 1/20 of a watt is required for its operation.

Salt Bottom on Salt Lake

SALT in the amount of 400,000,000 tons is the estimate of the lake bottom lining of Salt Lake in Utah. At least this is the estimate of three scientists who have made a study of the lake. Beautiful crystals of salt are said to form a lining two inches thick.

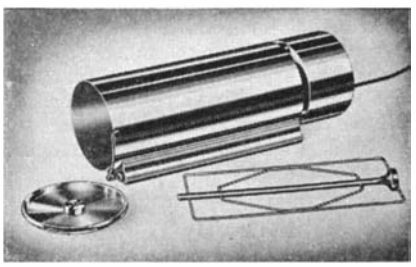
Rubber Cement Improves Bronze Castings

RECENTLY two large bronze plaques, to be used at the entrance to the grounds of the National Bureau of Standards, Washington, D. C., were cast in the experimental foundry of the bureau. These plaques carry the Department of Commerce seal and the inscription, National Bureau of Standards, in raised letters on a matte background.

With regular foundry technique the results were not entirely satisfactory because of a slight washing of the sand and other causes, says *Industrial and Engineering Chemistry*. C. M. Saeger, Jr., chief of the foundry section, overcame the difficulty by spraying the mold surfaces with rubber cement. By this means, firm adhesion of the fine surface particles was secured and accurate reproduction of the details of the plaque face was assured. According to Mr. Saeger, economy in handling of molds, as well as in producing castings of a very excellent quality, is obtained by the use of rubber cement surfacing.—*A. E. B.*

Electric Cream Freezer for Automatic Refrigerator

A NEW electric motor-driven ice cream freezer which fits into the freezing or ice-cube compartment of an automatic refrigerator has just been announced. It enables the housewife to make with simple ingredients—only milk and cream, sugar and flavoring—smooth, firm, velvety ice cream free from objectionable icy crystals.



Ever since the introduction of the automatic refrigerator there has been a demand in the homes for such an idea, and various manufacturers have spent a great deal of time and money endeavoring to perfect such a device. The new freezer is almost absurdly simple. It consists of a cylinder with a motor at one end, equipped with a beater, and fastened to a flat base. The cover to the cylinder is held in place by a spring latch.

The use of the freezer is extremely simple too. All the housewife has to do in order to prepare any frozen dessert is to pour in the ingredients, fasten the cover with the spring latch, attach the cord to any convenient outlet, and place the freezer in the cube compartment. The motor of the freezer automatically stops when the ice cream or dessert is frozen to the proper firmness.

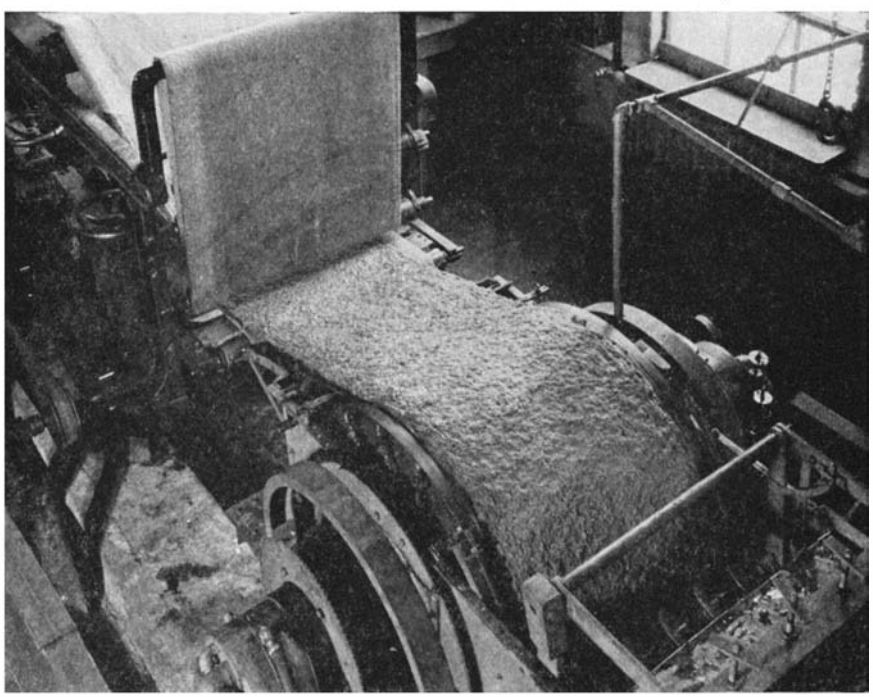
Right: **The parts of the new ice-cream freezer. Motor is in end of tube.** ***Above:*** **Placing the freezer in the automatic home refrigerator**

After the freezer is shut off, the ice cream is sufficiently solid to serve, but if further hardening is desired, the dessert may be left in the freezer or emptied into the trays of the cube compartment.

The new freezer holds three pints, is made of non-staining, highly polished alloy and is very easy to keep clean.

An ingenious feature of the design is the method of getting the electric current supply to the motor of the freezer. The cord is very thin and flexible, and its construction, coupled with the flexibility of the refrigerator door gasket, enables the door to be closed on the cord in such a manner as to keep the refrigerator door tight and at the same time not damage the cord even after long continued use.

Making frozen desserts isn't the only thing that the freezer will do, for it will chill and mix drinks without ice dilution, beat eggs, whip cream and mix batters.



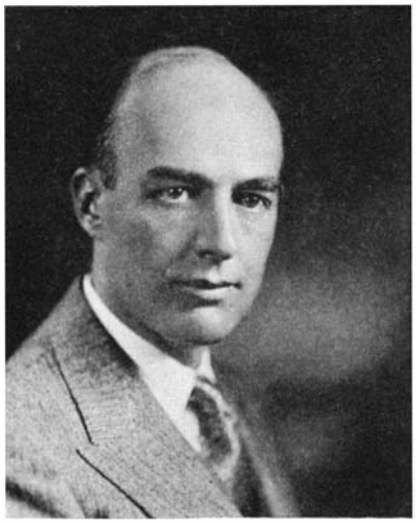
Until recently, scrap leather has been almost useless to industry. Formerly it was used to make prussiate of potash, a process which became obsolete. Then the scrap material was disposed of by burning. Now, however, by the use of the machine illustrated above, continuous sheets of genuine leather board are produced from leather fibers obtained from scraps. Because of the tough and tangled nature of the fibers, it is possible to make a synthetic "hide" that rivals the original form of the leather in both strength and industrial usefulness.—*A. E. B.*

Latex-Lined Fur Coats

IT is reported in *Rubber Age* that latex, the milky sap of the rubber tree, is being used in connection with an inner lining for fur coats. The latex is applied to the skin and the silk lining placed over it. The claim is made that this process not only increases the warmth of the coat but also strengthens the seams where the skins are sewed together.—*A. E. B.*

The Future of the Air Mails

WE have never, in these columns, taken sides in the controversy which followed the annulment of all domestic airmail contracts as of midnight, February 19, 1934. Since then things have more or less settled down. After the disastrous carriage of the mails by the Army, the calling for new bids, and much heated argument, the situation remains substantially as before. The same operating companies are carrying the mail over the same routes, except that the rates are much lower and the companies are losing money. Strange to say, one of the lines



John H. Geisse, who is doing much to promote safety in private flying

is now actually giving passenger service which is some 50 percent faster than the airmail service.

We will leave it to others to determine whether the governmental action has improved the situation or not. It is more refreshing to consider what the future will hold. A book by Paul T. David entitled "The Economics of Air Mail," published under the auspices of The Brookings Institute, sets forth a few guiding principles in its last chapter, and these may be of interest to summarize.

Companies should disassociate themselves from each other in the interests of full and free competition in bidding. This is a splendid theoretical concept; the only difficulty is that over any given line, there are not and never will be, in all likelihood, two competing systems.

Next, Mr. David thinks that the operating companies should be disassociated from the manufacturing companies. This has already been done and seems to be a wise measure. If operating companies purchase in the open market, competition is certain to bring forth greater design efficiency.

Contracts should be awarded, Mr. David thinks, for not longer than a year, owing to the uncertainty of growth on long-term contracts. This again is theoretically reasonable. What it will mean in practice is that the companies will never make a profit on their airmail operations. Whether it is desirable that companies should never make a profit on airmail is not for us to say.

Another point which the author brings up is that new legislation should protect the post-office department against pressure for unjustified extensions of service, this to be done by a statutory requirement that services be withdrawn when the average mail load drops below some stated minimum for three successive months.

For a more permanent program Mr. David advocates a reform in accounting methods, compensation in full for the cost of mail transportation, passenger subsidy contributions on a definite basis, and so on.

In the opinion of this writer and of many authorities, the best way to handle the airmail situation is to place it under the Interstate Commerce Commission, with power to regulate rates, and so on, in much the same manner that this Commission now regulates the railroads.

An unfortunate situation might then arise: the Air Commerce Bureau of the Department of Commerce and the Interstate Commerce Commission would both then have a hand in regulation. Perhaps the Commerce Department would restrict itself to private, non-scheduled flying, and the Interstate Commerce Commission to control of the regular air lines.—*A. K.*

Airplane Safety

THERE has been created by Congressional amendment a Development Section in the Bureau of Air Commerce, Department of Commerce. Prior to the creation of this new Section, the Department was authorized to develop only air navigation aids, such as radio and lighting facilities. Now it has authority to carry on the development of airplanes, airplane engines, and accessories. The Assistant Director in charge of this new work is John H. Geisse, an aeronautical engineer of splendid technical training and experience, a former Army pilot, with several important executive positions in aeronautics to his credit. The first main objective of the Development Section is increased safety in private flying, and we are indebted to Mr. Geisse for an interesting and comprehensive statement on the subject, the substance of which is given below.

Safety for private airplanes has lagged behind other aeronautical developments, and it is this lag which is largely responsible for the lack of interest in private flying. The industry is not to be blamed for its failure to produce more suitable equipment for the private flier. In all lines of business, development is ordinarily paid for out of earnings, and the manufacturers of private airplanes simply have not had the earnings necessary to finance the development of new types.

Another retarding factor has been the expressed opinion of a large group in the aviation industry that airplanes having any safer flying characteristics than those presently available are neither needed nor desired. Another contention of this group is that fliers who have been trained on safe airplanes are almost sure to fly other types of aircraft with disastrous consequences. Still another opinion frequently voiced is that it is impossible to train a pilot on an airplane which flies itself.

Mr. Geisse disagrees with these views, and states definitely that until it is possible to make training for flight a minor item, sales of airplanes for private use will be limited.

Henry Ford once stated that flying was now 90 percent pilot and 10 percent airplane and that until these figures were reversed it could have but a limited scope. This view is reinforced by the fact that over 50 percent of accidents in private flying are charged to errors on the part of the pilot.

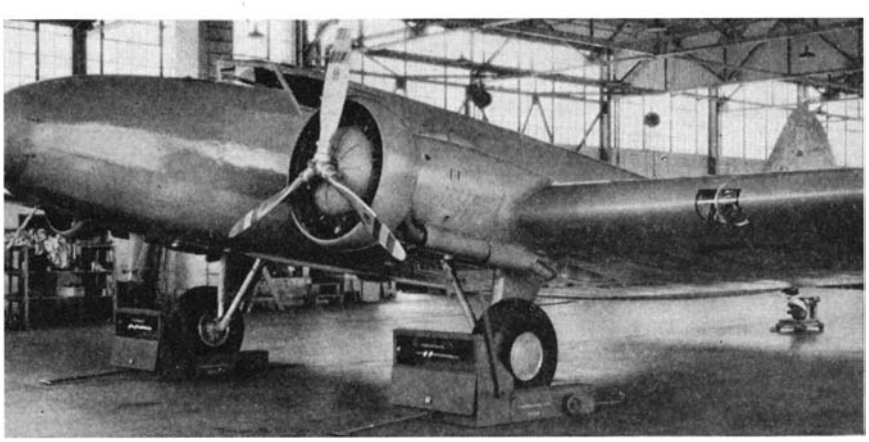
The Air Commerce Bureau believes that it is now possible to produce airplanes which will bring flying much more closely to 90 percent airplane and 10 percent pilot. A first step in its safety program has already been taken by calling for bids on the production of 25 airplanes for the use of the Department of Commerce, to meet specifications which demand unusually safe and easy operation. The Bureau is in hopes that this competition will bring forth an airplane which can be handled successfully by a pilot trained in a fraction of the time now required to learn how to master the more conventional types. At the same time the Bureau has kept in mind a drastic reduction in the cost of flying, which will follow naturally on greater safety and the consequent increase in sales volume.

This program is, of course, a subsidy to aviation. The justification of the expenditure of federal funds on the development of aviation, not only as a means of furthering national defense but also of fostering a new industry, hardly needs comment. This type of subsidy, consisting in the purchase of new equipment is, moreover, not self-perpetuating, and is therefore economically sound.

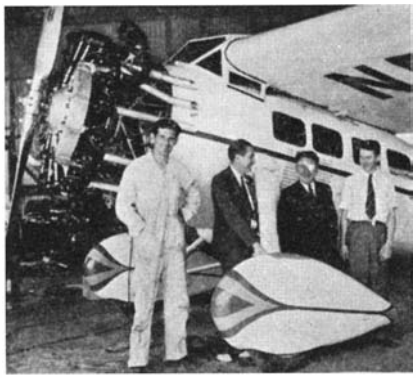
Ensuing steps will depend on the outcome of the competition. At any rate an excellent beginning has been made.—*A. K.*

Weighing In

ALMOST important item in the operation of airplanes lies in securing correct weight and trim. This process is in some respects analogous to the trimming of cargo on board an ocean vessel and in careful hands the airplane is weighed up and its center of gravity is located prior to every trip. One of our photographs shows a Boeing transport plane undergoing this check-up. It is, of course, necessary to use three scales to get the center of gravity. Special types of scales have been devised by Fairbanks, Morse and Company. Although these register weights up to 16,000 pounds, they are easily handled by one man. The point in the design of the scales is that they are only 2¼ inches above the floor, so that no ramps are required. With these instruments the weighing in process has been reduced to one fourth of the previous time.—*A. K.*



Weighing in a transport plane to secure correct "trim"



Wiley Post and some of the men responsible for his ship's equipment

An Interesting Group

IN our last issue we described Wiley Post's altitude suit which he will use in his high-altitude flight in the London to Australia race. One of our present photographs shows Mr. Post standing in front of his Lockheed aircraft *Winnie Mae*. With him are E. G. Molleukopf, his personal mechanic, D. S. Smith, President of the Westport Manufacturing Company which built a special radio set for this flight, and Paul O'Connor, Chief Engineer of the Westport company.

The flight is to be made at 30,000 feet and it is quite a problem to supercharge sufficiently at this altitude to maintain full ground horsepower of the engine. Two superchargers in series are employed, one (shown in the photograph) above and behind the engine. The powerful compression process involves a further difficulty: the air becomes too hot for most efficient use. Hence air coolers are put into the circuit between the two superchargers.—*A. K.*

Two More Electrical "Roofs" Over Earth

TWO new "roofs" of ionized electrical particles far above the earth are suggested by Dr. Harry Rowe Mimno of Harvard University in a letter to the British scientific journal, *Nature*, just published. Experiments on the reflection of radio waves indicate that echo layers "G" and "H" may soon be added to the layers "E" and "F" already known to science.

Electrical "roof" G, Dr. Mimno indicates in his communication, is probably at an altitude of 375 miles above the surface of the earth. Layer "H" seems to be at a height around 725 miles.

The already known layers are at an altitude of 62 miles and 155 miles.

Reflecting layers of ionized, or electrically charged, air molecules high above the earth have been known since 1902 when Professor A. E. Kennelly of Harvard University and Professor O. Heaviside in England independently came to the conclusion that such layers must exist to explain the long-distance transmission of radio waves.

The reflecting layers are now called the Kennelly-Heaviside layers in honor of these two men. Ordinary broadcasting is commonly reflected by the lowest of the reflecting layers, at 62 miles.

Within 50 or 100 miles of a powerful broadcast station the reflecting layers are not needed for reception because the "ground" wave has sufficient intensity. Beyond this range, however, reception is possible only because the radio waves go up to a reflecting layer and are then turned back down to earth as if they had hit some radio mirror.—*Science Service.*

Broad Program of Tin Research

FOLLOWING out an extensive and continuous research program in the world's principal tin-using countries, The International Tin Research and Development Council has announced definite plans for carrying on this work in the United States.

On the recommendation of D. J. Macnaughtan, Director of Research for the International Council, the Battelle Memorial Institute, Columbus, Ohio, has been appointed to conduct research projects on tin in this country. Work is reported to be well under way, following such lines of investigation as will be of the greatest value to American manufacturers who employ tin for various purposes.

Post points to one of the radiators which are to cool supercharged air

As Mr. Macnaughtan pointed out in an address to the American Tin Trade Association not long ago, an analysis of the major applications of tin in industry reveals the fact that its chief use is in conjunction with copper, lead, and steel, and in the production of these metals the United States leads the world. A wide application in the use of tin is also found, in this country, in the form of chemical compounds affecting many industries. Technical problems, covering a number of new uses, will also be studied.

Air Markings for Bridges and Transmission Lines

BRIDGES, causeways, transmission lines and other structures over navigable waters of the United States are now required to be provided with lights and other signals for the protection of air navigation, the Bureau of Air Commerce, Department of Commerce announced recently. Responsibility for installation and maintenance of the lights and signals is charged to owners or operators of the bridges or other structures by an amendment to the Air Commerce Act of 1926, passed in the session of Congress recently adjourned. Types of markings to be used are to be prescribed by the Secretary of Commerce.

The Corps of Engineers, War Department, which issues permits for all structures crossing navigable waters, has stipulated that if the display of lights and signals on any work authorized is not otherwise provided for by law, such lights and signals as may be prescribed by the Bureau of Lighthouses, Department of Commerce, shall be installed and maintained at the expense of the owner.

On this authority, the Department several years ago issued "Recommended Standards for Marking Obstructions to Air Navigation." Clothed with more direct and explicit authority and jurisdiction, the Bureau of Air Commerce now is studying the entire matter with the view to promulgating regulations to carry out the terms of the new law.

Super-Speed in Aviation

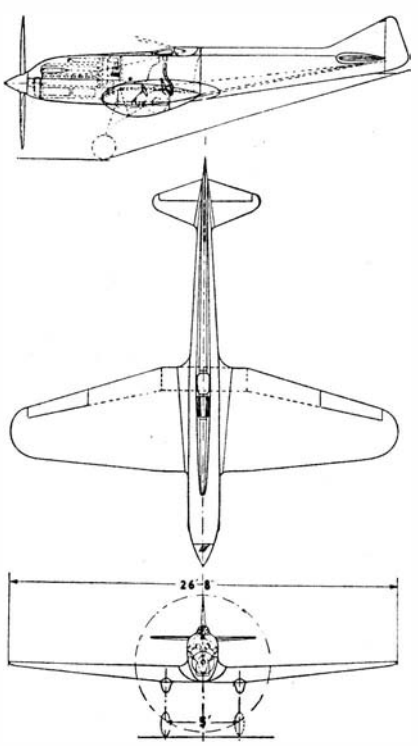
TO date, the world's speed record is held by the Italian Schneider Cup racer, which, while it did not win at the Schneider Cup Races, subsequently flew at 423 miles an hour.

Thanks to the courtesy of *Popular Aviation* we append a three-view photograph of a projected racer designed by Keith Rider, who already has several high-speed machines to his credit.

It is proposed to employ a "V" type, 16-cylinder, 2500-horsepower engine, which is at the drawing-board stage in the hands of Harry Miller, well-known for his racing cars.

Even though both plane and engine are as yet only "on paper," the project is well worth study as showing what may be expected in the line of speed in the near future.

First of all, in spite of the tremendous power of the engine, the dimensions of the machine are very small. The span is only



Three views of a new plane designed especially for "super-speeds"

26 feet, 8 inches, and the overall length is only 27 feet, 9 inches. The approximate weight is given as 3000 pounds. This means, of course, that the engine will have to be exceedingly light and will probably not stand up very long; it will be essentially a racing engine.

The landing speed is given as 85 miles per hour. This will be realized by the aid of flaps. A variable-pitch propeller is to be embodied in the design, so as to facilitate take-off. The fuselage diameter will be only 40 inches—just big enough for a pilot, with no excess room.

Since the engine requires so much cooling surface, a cooling system will be used in which steam will circulate through a heat removing condenser under pressure.

With a 9-inch pitch propeller at wide open throttle, the engine will consume one gallon of gasoline every 15 seconds, and only enough fuel will be carried for a flight lasting 40 minutes. However, in that short period of time, it is estimated that the airplane will travel 300 miles.

While this project may look too ambitious, it is our opinion, based on previous study of this topic, that with careful engineering, both plane and engine can be realized, and that speeds in excess of 465 miles per hour may be attained.—*A. K.*

Aluminum Paint Pigment in Paste Form

PIGMENT for aluminum paint is now available in the form of paste as well as powder, as a result of several years of experimental work in the laboratories of paint manufacturers. Paste offers the advantage of drying to a very smooth finish which does not collect dirt readily and which remains clean and bright, even in industrial atmospheres. Also it is more convenient to mix with the vehicle because it eliminates loose powder flying about during mixing.

Adequate Helium Supply for U. S.

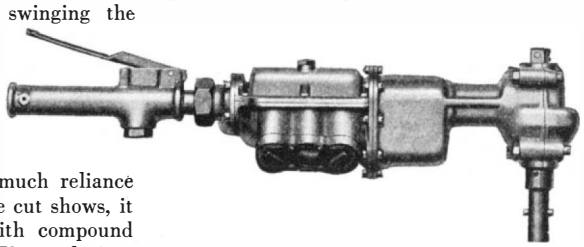
THE acquirement of all gas rights in 50,000 acres comprising the Cliffside helium-bearing gas field near Amarillo, Texas, has been completed by the United States Bureau of Mines. This field supplies the raw material from which all helium used in the nation's military service is extracted. In addition to supplying current requirements, the field provides a large reserve for future lighter-than-air craft operations of the Army and Navy.

With the responsibility of providing helium placed upon it by the Congress, the Bureau of Mines made a thorough study of the Cliffside field and considering all factors, determined that this field was the best reserve of helium-bearing gas then known. No comparable field has ever been discovered.

Production of helium at the Amarillo plant was started in April, 1929. In five years of operation, this plant has produced more than 57,000,000 cubic feet of helium, or about one half of all of that element ever recovered in the world. Operating costs have been less than one third of the lowest cost at which helium was ever obtained by the government from any other source.—*A. E. B.*

A Convenient Airplane Starter

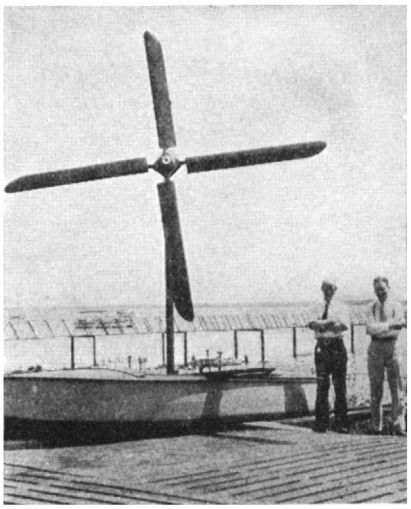
A USEFUL item of equipment around the hangar is a new engine starter developed by the Cleveland Pneumatic Tool Company, and illustrated on this page. This is another device to avoid swinging the propeller, and to avoid too much reliance on the built-in starter. As the cut shows, it is a piston-operated drill with compound gear reduction, driving at 78 revolutions per minute a spindle which is attached directly to the engine crank shaft. The piston operates under a pressure of between 80 and 125 pounds per square inch, and the whole instrument can be conveniently held in the mechanic's hand.—*A. K.*



Compressed-air starter for turning a plane "prop"

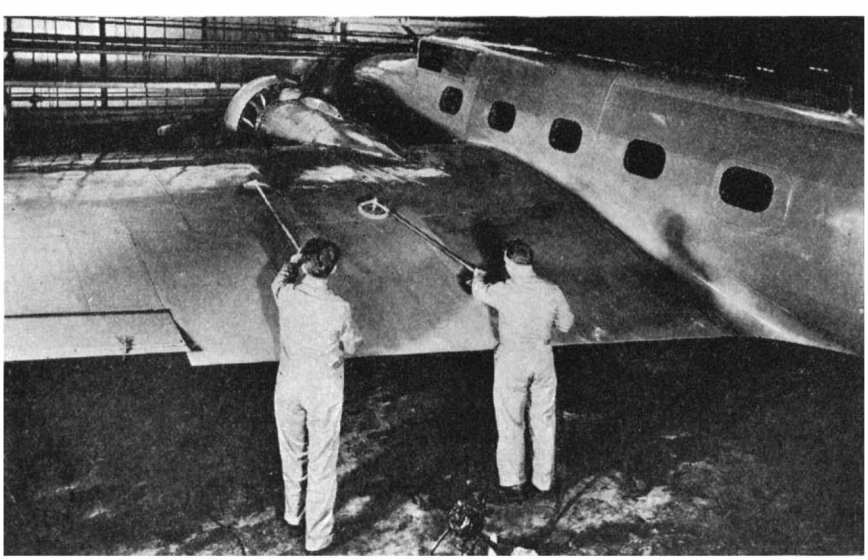
Novel Use for the Wilford Gyroplane

THE Wilford gyroplane is not unlike the autogiro, but its feathering is about the main axis of the blade and not about a transverse axis. It has been pronounced of equal aerodynamic interest by experts of the National Advisory Committee for Aeronautics. In spite of a recent accident, experimentation of real value is proceeding with this type of rotary aircraft. The gyroplane rotor develops lift in a wind without application of power, just as with the stationary airfoil or with a sail. This lift is quite powerful for a given diameter. Therefore the application of the gyroplane to boat propulsion is a logical matter.



An application of the Wilford gyroplane rotor to marine propulsion

One of our photographs shows an outboard motor boat hull equipped with the gyro in lieu of a sail. The rotor is 12 feet in diameter, and tested in 5 and 10 knot breezes gave as much propulsion as a sail of similar projected area. The gyro is mounted on a tubular steel mast, on the top of which is mounted a hub and brake. The plane of rotation of the gyro can be swung to various angles relative to the wind, so that the boat can sail before the wind, on the wind and with wind abeam—just as in a sail boat. Manipulation of the gyro in correct relation to the wind is of course much easier than that of a sail. Instead of reefing the sail, the gyro will be braked, since its lift is so much smaller when rotating slowly or when stationary.—*A. K.*

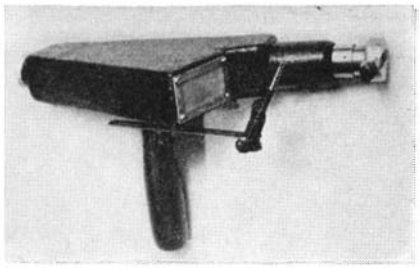


Waxing the wings of an airplane to obtain the maximum possible speed. Mechanics are applying a coating of wax to the wings of a twin-engine Boeing transport ship. The fuselage is similarly treated. Three miles per hour more speed is claimed

Black Lightning

PHOTOGRAPHIC enthusiasts who go in for lightning photography sooner or later find a curious effect in their pictures. "Black lightning" shows up on the prints as one or more streaks of dark hue, sometimes in combination on the same print with the more usual "white" lightning. The following explanation of this phenomenon was prepared for our readers by the Eastman Kodak Company:

"... This effect is well-known as the 'phenomenon of black lightning' and is due to what is known as the Clayden effect. It occurs in general in photographs which are



made of electric spark discharges, of which lightning is an example. It consists of a reversal in the under-exposure portion of the characteristic curve and is usually observed when the photograph of the lightning is followed by a uniform exposure to light. This would occur, for instance, if the camera were pointed out of the window and after one lightning flash had been recorded, a second one occurred in such a way as to give a uniform diffuse exposure over the first one, or if there were a uniform exposure to the light from the night sky after the first flash had been recorded. Very little is known about this effect since it bears no relation at all to ordinary solarization. The fact that some flashes appear white for a distance and change to black, is probably the result of varying exposure along the flash."

Oil Explosion and Fire Test Arc Welding

AN oil explosion followed by fire recently destroyed the arc-welded steel structure of the Spring Perch Company, Lackawanna, New York, without causing failure to any of the welds used in its construction.

Twisted and bent by the terrific explosion and heat of the flames, trusses and bar joists of the one-story mill building formed a contorted mass of steel on the factory floor. Examination of the ruins failed to disclose any welds which had given way.

The structure was built in 1932 with framework entirely of arc-welded steel. Wide span trusses, bar joists, purlins, roof deck, and window sash were welded by the arc process using equipment manufactured by The Lincoln Electric Company. The Buffalo Tank Corporation had the contract for the welding.

The explosion which destroyed the structure proved a rigid test of welded construction and indicated the unusual strength of welds made with the arc.

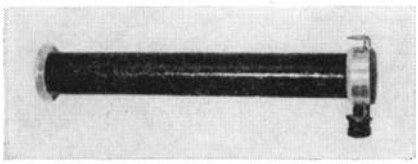
The U. S. Expands!

THE cities of Washington and San Diego seem to be giving each other the cold shoulder. According to Naval Observatory Astronomers, these two cities were about 40 feet farther apart in 1933 than they were in 1926. This is said to be due to a shift in longitude but some doubt has been expressed as to the accuracy of the calculations. It wouldn't do for the country to spread out too much and spill into the oceans!

Inexpensive Spectroscopes

A NUMBER of inexpensive spectroscopes are available for use in the laboratory and by the student and amateur astronomer. These instruments use a celluloid replica of the diffraction grating instead of a prism for dispersion of the light. While such instruments are not as sensitive to faint sources of light as are prism instruments of the same aperture, they have the advantage in that the spectra are not crowded

Left: **A scale type grating spectroscope.** ***Below:*** **A direct vision grating spectroscope. Described in text**



in the red as are the ordinary prismatic spectra.

They are offered in several types, including a type having a wavelength scale, a direct vision type with adjustable slit, and an instrument which fits within the telescope eye-piece tube. This latter instrument will show the prominent absorption lines of the solar spectrum and if used with a fairly large reflector, will show the brighter star spectra as a series of colored dots.

Vitamin C Being Manufactured

SYNTHETIC vitamin C can now be manufactured on a commercial scale. Discovered some months ago, the process for this (the first chemical synthesis of any vitamin) has been so elaborated and improved upon that actual production of vitamin C on a large scale has been achieved. The new synthetic product has been named Redoxon.

This news is of particular interest in connection with the recent discovery that intravenous injection of vitamin C gives promise of proving a cure for a number of diseases which have previously defied the doctors' best efforts. Announcement of this discovery was made by Professor A. Szent-Gyorgy, distinguished Hungarian scientist, to a recent meeting of the British Association for the Advancement of Science. Among cures accomplished he cited cases of purpura, hemorrhages and Werlhoff's disease, which shows itself in dangerous bleeding, chiefly from the nose or mouth; nephritis, and certain non-inheritable forms of haemophilia, a mysterious bleeding disease, which in its hereditary form afflicted the former royal families of Spain and Russia. Addison's disease, with its abnormal bronzing or blotching of the skin, has also been conquered by injections of the vitamin, the professor said. And by a single injection—or three at the most—he asserted, physicians in Hungary and Germany have been able to check and cure pyorrhea.—*A. E. B.*

Good Paper Important in Braille Books

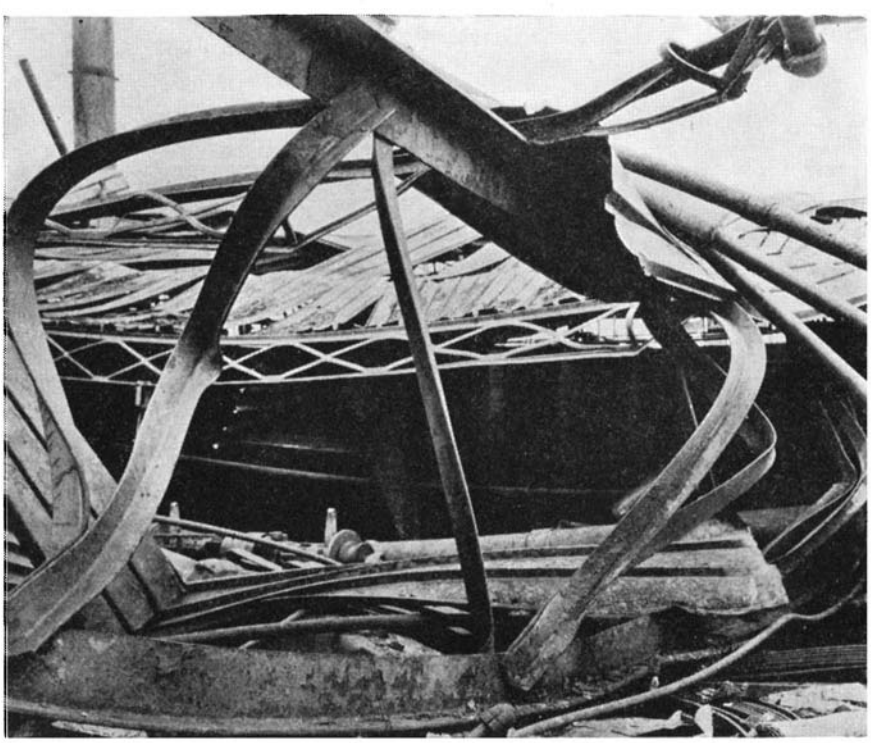
EVEN the blind can notice faults in the paper of their books. The National Bureau of Standards has just completed an investigation of books printed in Braille, the raised-type method of printing which permits deft finger tips to "read."

Paper that is too hard gives the raised dots harsh, cracked surfaces irritating to the reader's fingers, it was found. Some other papers are too soft and the Braille dots on them are not strong enough to prevent being ironed out under the reader's fingers.

Results of the study will be used by the Library of Congress to set up a uniform, high-quality standard of books for blind readers.

Braille process printing is accomplished by two methods, the wet and dry. Dry printing, as the name implies, is done on dry paper and the dots on the surface of the pages are not permanent. The use of this method is limited to magazines and papers of only temporary value.

In the wet method, the paper is moistened uniformly and after printing allowed to dry in racks. This is more permanent if done



Welded joints that resisted the action of an explosion and fire

on the right kind of paper, and the books can be read many times without having the dots become "dim and illegible."

Tests with small weights of about four ounces were used to determine how well the dot-like markings on the paper stood up. It was found that the paper with the greatest tensile or pulling strength was the kind which stood up the best. The dots on strong paper have a long life, and yet there is no tendency for them to crack at the top and form edges irritating to the reader's fingers.—*Science Service.*

Uncle Sam Enters Fertilizer Business

DURING the World War, the United States Government erected two plants at Muscle Shoals, Tennessee, for the manufacture of nitrates to be used in explosives. Since 1918, these plants have lain idle in spite of many proposals for their peace time utilization. Now, however, as a part of the War on Depression, Uncle Sam, through the Tennessee Valley authority, proposes to utilize the Muscle Shoals chemical factories but instead of producing nitrates for explosives, it is planned to manufacture phosphates for fertilizers.

Dr. Harry A. Curtis, chief chemical engineer of the TVA is the man who made the decision to scrap the whole idea of using the Muscle Shoals nitrate plants for their original purpose. "The fact is," he says, "that since these Government factories were built, new processes for the fixation of atmospheric nitrogen have been developed to such a point that the plants built at the time of the World War are now obsolete." America can now manufacture cheap nitrates adequate for any conceivable demand. One of the other essential fertilizer ingredients, however, phosphate, has lagged behind because the conventional method of treating phosphate rock with sulfuric acid is cheap and easy. Dr. Curtis, however, hopes to improve on this process by manufacturing the cheapest phosphoric acid possible as the starting point for the manufacture of the most concentrated fertilizer.

"We are converting two of the carbide furnaces in the nitrate plant at Muscle Shoals into phosphate furnaces," says Dr. Curtis in an interview in *Chemical Industries.* "In the meantime, we are building a plant to produce triple super phosphate fertilizer which will run as high as 54 percent P_2O_5. With important deposits of phosphate rock right in the middle of Tennessee I think we can make concentrated super phosphate cheap enough for fertilizer use." —*A. E. B*

Cooling Motor Truck Tires

NOTWITHSTANDING the fact that all truck and bus operators are only too familiar with the destructive effect of heat in dual tires, little has ever been done about it.

Recently, however, Rogers Brothers Corporation, trailer manufacturers of Albion, Pennsylvania, requested The B. F. Goodrich Company of Akron, Ohio, to test the performance of a new type of cooling fan which they had invented and on which patents are now being taken out.

The actual effectiveness of the fan as tested is shown by the fact that the cooling effect lowered rim temperatures 50 percent more than the plain duals could dissipate under identical conditions. Translated into service performance on the basis of 50 percent more rapid heat dissipation, a wheel equipped with the Rogers fan would experience less temperature rise than the uncooled wheel during brake applications and, in motion, would cool to normal temperatures

Fan to cool truck tires

33 percent more quickly than the latter. Roughly, 50 percent more frequent or 50 percent more severe brake applications would then be possible without raising the rim temperature above that of the plain wheel in normal service. Dangerous tire burning, due to dragging brakes, would be minimized by the extra cooling of the fan.

Amateur Seismology

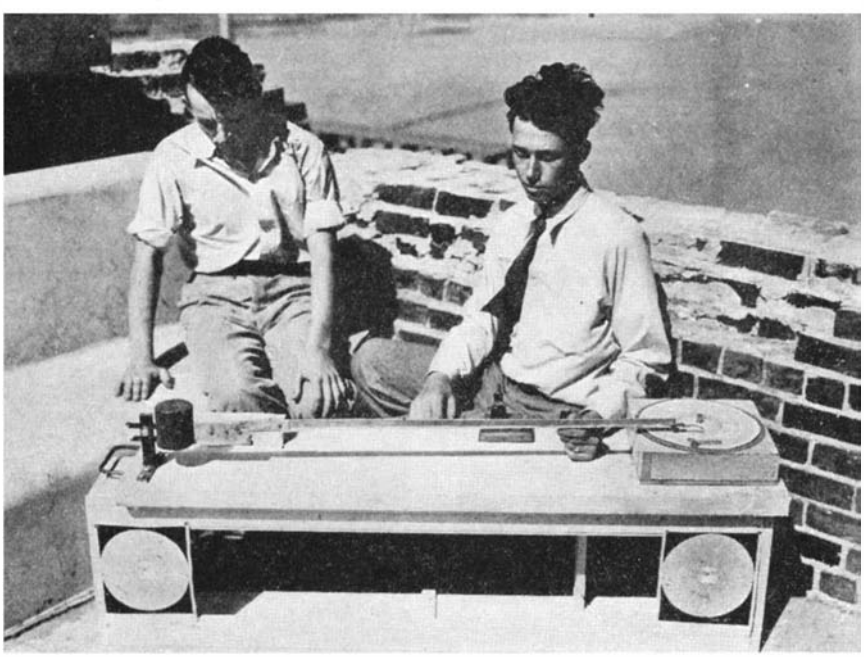
AFTER the earthquake of March, 1933, which shook Los Angeles and her neighboring communities, the study of seismology became more popular than it had ever been before in that locality. On this page is a photograph of two high school students and their local shock recorder, which was made by following drawings published in SCIENTIFIC AMERICAN, November 1929. This photograph was made available by Mr. M. H. Compton, teacher of physics in the Phineas Banning High School at Wilmington, in the Los Angeles City High School District, who writes:

"For rather well known reasons there has been much more interest in and around Long Beach, in earthquake study, since March 10th of last year than heretofore. I am inclosing a snapshot of a seismograph made by the boys in our high school, particularly Norman Thornton and Harold Schiffer, who are shown in the view. In the construction, we followed the plan given in SCIENTIFIC AMERICAN of November, 1929, by Dr. T. A. Jaggar, excepting the clockwork. Our clock was salvaged from a creamery thermograph. It has to be wound and set by hand daily. The protecting top of our device has been removed for the picture and is serving as a support for the heavy two-inch base-board.

"The brickwall background is an entrance wall of our school, the top stones of which were destroyed by falling cornice stones during the March 10th shake. However, with the removal of roof decorations, earthquakes have no terrors for our high school seismologists, several of whom would welcome further opportunities to observe the working of our apparatus under shakes of varying magnitude."

Hoped They Would *Not* Strike Oil

"WHEN a big petroleum company drills a well over 3500 feet down to the granite core of the earth and hopes to goodness that it will not strike oil, that's as much news as when a man bites a dog," says Williams Haynes in *Chemical Industries.* "Yet, that is exactly what the Texas Company did near their large refinery at West Tulsa. That curious wish was fathered by a clever chemical thought worked out by the late Dr. Otto V. Martin. Knowing that there were great reserves of salt brine under the refinery and that the refinery sorely needed more abundant and cheaper supplies of water for cooling, he combined these facts and figured out a method to evaporate salt by chilling in complete reversion of all existing processes. The Martin process . . . is just as simple as that—the brine is pumped up by compressed air and sent through the cooling system of the refinery where it absorbs heat. The heat-



Amateurs with a seismograph made from directions published in *Scientific American*

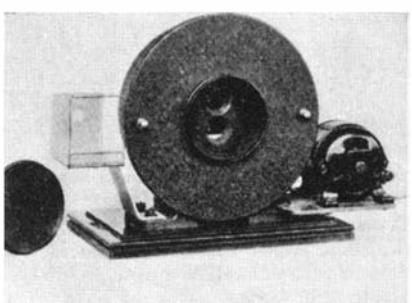
ed brine is sprayed out through a long series of fine nozzles over steel lined tanks and the fine mist in the cool air results in rapid evaporation of the water. The salt drops out and settles to the bottom of the spray ponds. Here it is scraped up and carried by bucket conveyors and rubber belts through a series of dryers, washers, dryers again, and finally to the storage bins."

Salt is the main product of this plant, but bromine, Epsom salts and calcium chloride are also produced in the same process.—*A. E. B.*

Lightning Strikes Twice—And Even Ten Times—In One Place

"LIGHTNING never strikes the same place twice" is another saying that definitely has been disproved. Engineers of General Electric's high-voltage engineering laboratory staff at Pittsfield, Massachusetts, have obtained a series of photographs that prove lightning to be more than a single flash of high-voltage electricity between cloud and earth.

The photographs were obtained with a special type of camera in which the film is



Camera for lightning research

whirled past the lens at a speed in excess of a mile a minute. The result is that there is a time scale along the length of the film, and readings in millionths of a second are possible.

On a recent evening at Pittsfield there was a severe electrical storm. The engineers set up their camera, pointed it toward that part of the sky where the flashes were particularly prominent, started the electric motor which whirled the film past the lenses, and removed the lens cap. In a few moments the men felt sure they had pictures of at least a few flashes; so the lens cap was replaced, the camera removed to the photographic developing room, and the negative processed. The men had been particularly successful, for the film revealed photographs of 10 separate strokes to ground, and one of these strokes was a multiple flash of 10 recurrent discharges over the same path.

Study of the series of 10 recurrent discharges showed that, except in the case of the first one, each discharge had a certain type of "leader" stroke traveling from the cloud to the earth. This stroke, relatively weak on the film, was immediately followed by a brilliant, powerful flow of the energy in the other direction—from earth to cloud—over the path already cut by the "leader." Following this bright flash the film showed illumination for approximately 1/2000th second. Then there was a pause of a matter of a few millionths of a second, whereupon another "leader" discharged from cloud to earth, with another immediate stroke from

Left to right: **Engineers McMorris, McEachron, and Lloyd have taken many high-speed lightning photos**

earth to cloud. In rapid succession there were 10 such discharges, all in general being like the preceding ones. All of them occurred in a small fraction of a second—so rapidly that the human eye or usual camera would be unable to follow them.

Observers frequently notice that strokes of lightning are branched or forked. The film showed that the streamers were confined to the first discharge only; thereafter the flashes followed the main path only.

Knowing the velocity of the film, the focal length of the camera lens, and the size of the photographic image, and being able to determine the distance away of the stroke—either by calculation from the time between the flash and the thunder or by happening to know where the bolt struck—the engineers have been able to determine numerous properties of the recorded strokes. They have calculated, for instance, that the "leader" travels at a rate of from 14 to 38 feet per microsecond (1/1,000,000th second), and the main stroke up from the earth at from 73 to 180 feet in that time (light travels approximately 1000 feet per microsecond).

Since the "leader" appears to have slight illumination when compared with the main stroke, the engineers have interpreted it as existing in the form of a dart—not as continuous from cloud to earth.

The device with which the photographs were obtained is known as a Boys camera. It was recently lent to the General Electric engineers by A. P. Loomis, of Tuxedo Park, New York. A small motor drives a rotating drum 29 inches in circumference, to which the strip of film is attached with its emulsion side toward the center. Near the center are two matched lenses with prisms so that simultaneous photographs are obtained on opposite sides of the drum. The direction of motion, and the images, are reversed. Differences in distances between corresponding parts of pairs of images are used in obtaining the time measurements. The speed of rotation of the drum can be varied according to the requirements of the work; in obtaining the lightning pictures a speed of 3000 revolutions per minute was used.

The photographs were obtained by W. L. Lloyd and W. A. McMorris of the Pittsfield laboratory.

"We believe these pictures to be outstanding," says K. B. McEachron, head of General Electric's high voltage investigations at Pittsfield, "since they so well corroborate the recent work of Dr. B. F. J. Schonland in South Africa. Working with a somewhat similar type of camera (in which the lenses rather than the film were rotated) he also obtained a photograph of a multiple discharge. The pictures now obtained at Pittsfield, with different equipment, prove that lightning discharges are the same throughout the world. Work with the Boys camera is to be continued at Pittsfield, in the hope of obtaining further interesting data regarding lightning, its characteristics, and methods to reduce its destructiveness."

Skating on Water

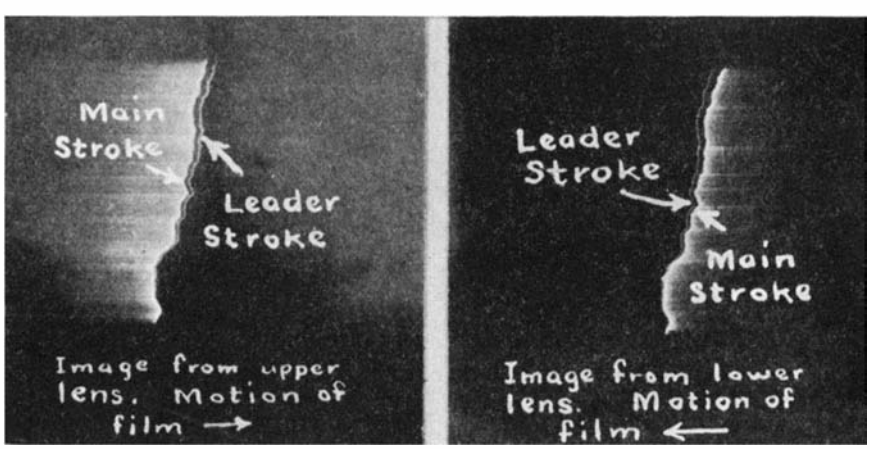
A SKATER on a frozen lake does not skate on ice but on a thin film of water. This is simply elementary physics. Under pressure the freezing point of water is lowered; and on a frozen lake the skate runners provide the pressure.

Anesthesia Aided by New Drugs

NEW investigations in hypnotic drugs producing a degree of insensibility between normal sleep and complete surgical anesthesia have recently been reported to the American Chemical Society by Drs. E. H. Volwiler and D. L. Tabern, of the Abbott Laboratories, Chicago.

Previous work with derivatives of barbituric acid has produced drugs of the neobutal type, now widely used in hospitals for patients before an operation and prior to the administration of a total anesthetic.

Such drugs, when given by mouth in prop-



Two lightning photographs taken simultaneously with the Boys camera

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ONCE more revised and greatly enlarged—more than 50 percent larger than the previous edition. Many new contributions, new notes, new illustrations. A mine of practical, definite, concrete, working instructions and information—a real shop book. From it thousands of SCIENTIFIC AMERICAN readers have already made their own astronomical telescopes —real instruments, not toys. By doing all of the constructional work—making the mounting, grinding and polishing the concave glass mirror disk and silvering it—the amateur may create his own telescope. A six-inch diameter (beginner's size) magnifies 50 to 200 diameters. Will read a watch at a mile and reveal many wonders of the heavens. Cost about $25; value about $250. The constructional work is real *fun*. No special tools required—just your two hands.

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TO PRESENT OWNERS OF "AMATEUR TELESCOPE MAKING":

THE new edition contains what was in the old, plus the following: A new ten-chapter part entitled "Contributions by Advanced Amateurs," which contains the Hindle monograph (Cassegrainian and Gregorian), and chapters on flotation systems for larger sized mirrors; flat making; solar spectroscope making; celestial photography; accuracy in parabolizing; new Ronchi test (clearly explained); new test for Gregorians; simple clock drive. In Part IX, Dr. Hale's instructions for making a solar observatory (spectroheliograph) have been included. The Miscellany has been greatly extended by notes both short and long, based on actual difficulties reported by workers—especially on lap making and silvering. The new detailed instructions and digest of scattered literature on silvering represent an attempt to cover all of the fine details of the process and anticipate all of the pitfalls, and are the longest ever published anywhere. Other notes cover: the diffraction ring tests (long); slit test; test for strain (polarized light); new strokes in grinding; whipping pits; Hindle's method of testing at zonal foci; calculating size of diagonal; conic sections; binocular telescopes; turret telescopes; eyepieces; finders—these are only a few. Many new drawings by Porter, and selected photographs of telescopes already made, are included. Errata in earlier editions corrected. New book lists, new materials list, new directory. This edition must run to nearly 500 pages (not yet paged at time of writing), but the price remains the same three dollars. Keep up with the advances in the art —Possess this new edition! It now covers the field exhaustively.

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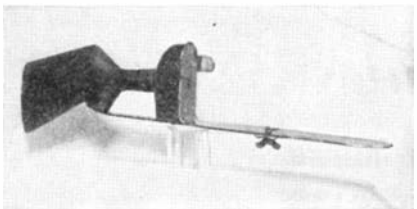
er doses, produce a relaxed condition in the patient, without causing complete insensibility. While under their influence the patient could be given ether or other anesthetics, and could co-operate with the physician in the process. The desired insensibility came quickly and lasted only a little longer than the operative period; hence decreased possibilities of post-operative complications.

Another major improvement in the barbiturate drugs was to increase the margin of



The "gun" stock made for a movie camera, as described on this page

safety between an effective dose causing insensibility and a fatal dose. Drs. Volwiler and Tabern observed that these specific effects of the barbiturates were associated with a certain arrangement of the atom groups within the molecules of the compounds. They determined to study the properties of other substances into which these groups might be incorporated.

Substituted acetyl ureas, acetamides, and brom analogs were employed. In all, 27 different drugs were prepared. Some of these new preparations had unusually wide margins of safety. However, while their study may aid in increasing the knowledge of what factors are needed to raise the safety margin in hypnotic drugs, the scientists feel that the newest compounds described by them are not yet ready for clinical application.—*Science Service.*

"Gas" by the Dollar's Worth

NEW pumps now being introduced make it easy to sell "gas" by money's worth or tank capacity rather than by the gallon. Dials indicate cash as well as gasoline. One type of pump has a small dial for the gallons, a large one for the cash and the price; another type features a dual-dial recorder in which the price clip controls the cash recorder; and a third type has figure instead of clock type dials to avoid any error when the hand type is viewed from one side.

A Movie Camera "Gun" Stock

WHEN the depression hit the Army, writes Major F. T. Chamberlin, in *Field and Stream*, heart balm—or something—was given in the form of a month's leave, without pay. With time on his hands, he decided on a hunting and fishing trip, together with his movie camera and three companions. Some time previous to this, Major Chamberlin had discussed with Dr. Louis B. Wilson, Director of the Mayo Foundation, a "gun" stock for use with a motion picture camera, and Dr. Wilson had sent him photographs of such a contraption.

"The night before we left," writes Major Chamberlin, "when I should have been packing, I suddenly became obsessed with the idea of 'stocking' my camera and proceeded to develop the ideas on the stock that had been lying dormant for two years, stealing, I'm afraid, more than a few from Dr. Wilson's photos.

"I have a fairly well-equipped workshop in the way of tools, but that night, when time was at a premium, I found I was mighty short on material. However, I dug up a piece of yellow pine, 1¾″ by 10″ and started hysterically to hack out a stock. This was accomplished in a very short time, as can probably be judged from its appearance in the photo.

"The method of attaching the stock to the camera was not so easy and, besides, I didn't care about drilling holes in the camera case as Dr. Wilson had done with his.

"I cut a strip of ⅛ inch brass two inches wide, bent it at a right angle and fastened it to the stock with four brass screws. A strip four inches long and one inch wide was then annealed, bent to grip the rear end of the camera, and held in place with two screws. A ¼ inch hole was then drilled through the bottom of the long strap under the screw hole for the tripod in the camera and a screw having the same thread as that for the tripod was turned out on the lathe and a pair of wings soldered on.

"To mount the camera it was only necessary to push the rear end into the jaws on the stock and fasten it by the one screw in the tripod hole.

"As the brass had a little too much spring for the weight of the camera, a piece of ¾ by ⅛ inch steel was riveted under the brass strap and fastened to the end of the pistol grip by a screw. This made an absolutely rigid stock that could be mounted or dismounted in half a minute without changing the camera in any way.

"As I was not using a telephoto lens, there was no reason to use a peep sight as on Dr. Wilson's job.

"The work was completed in less than two hours, including the cussing. It wasn't a thing of beauty and I didn't feel like taking time out to checker the grip and put on a recoil pad, but it filled the bill.

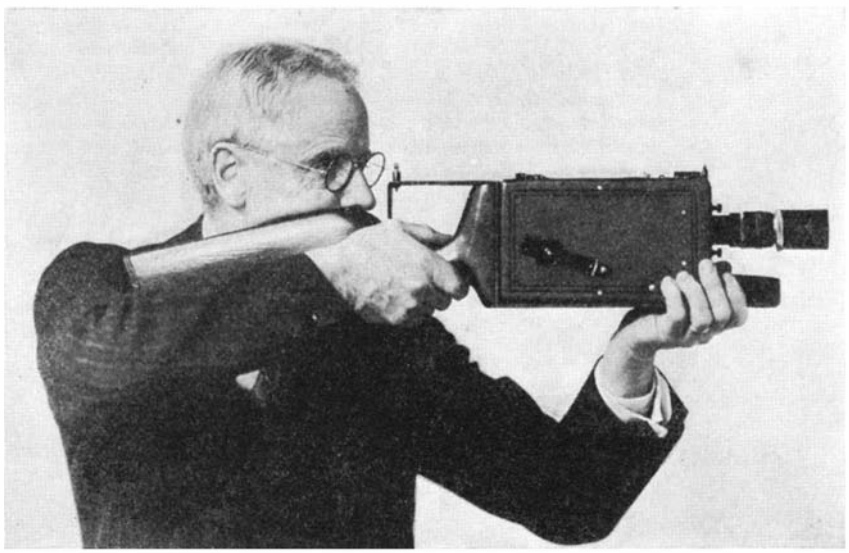
"We arrived at our destination two days later on one of the old south Georgia plantations in the middle of the state, near the Florida line.

"Early the next morning, after one of those southern breakfasts that remain long in your memory, we started out chiefly to 'shoot the camera.' One of the darkies from the plantation carried the contraption and we alternated with the shots, after the formality of flipping a nickel to see who got the first shot with the gun or camera. Later, when we dropped down to the Gulf for fishing, the same system obtained.

"Aside from the pleasant memories of a most enjoyable trip, we brought back 500 feet of as fine hunting and fishing pictures as I have ever seen.

"This stock was as easy to handle as a gun and, although three of the party had never had a movie camera in their hands, let alone work one, there was not a blurred picture in the bunch. In no case were there pictures without the subjects in the field.

"In passing, I would say for the benefit of the brother who may decide to rig himself one of these stocks: Use it in the wide open spaces, where men are men, etc., and not in the wicked cities, as some cop, well-meaning citizen or gangster might decide that you are on the verge of starting a little one-man revolution or about to 'bump off' a friend. It sure looks like one of 'them double-actin' machine guns in the paper', as one old darky said after watching us take some pictures about the plantation."



Dr. Louis B. Wilson with his camera in action

Tonsil Removal

CHILDREN subject to tonsilitis, enlarged glands of the neck and ear troubles are most benefited by removal of the tonsils, Dr. Albert D. Kaiser of the University of Rochester School of Medicine found from a study of a large group of children for a period of ten years. Head colds and infections in the chest, on the other hand, were not benefited by removal of the tonsils. Tonsils may be large without causing any trouble and mere size is no reason for removing them.—*Science Service.*

Food-Stuffs Field Beckons Chemists

CONSIDERING the billions of dollars that America spends for food, we really have pathetically little definite scientific knowledge about food-stuffs. Says Arthur D. Little's *Industrial Bulletin:*

"Many dietitians still evaluate foods on the calory (heat-producing) basis, and may or may not go so far as to recognize the need of providing the calories from foods of various types, including protein. Some recognize the functions of the various vita-

mins, and occasionally, the need for mineral constituents. Certain individuals seem to need much bulk in their food, whereas others may be irritated by bran and even spinach and other bulk-producers, but, if the fad of the moment is to have bulk, it will go into many diets. While a few progressive investigators now distinguish between the various kinds of proteins and their relative importance to the person or animal, there is still a long way to go in understanding the chemistry of foods, even without regard to the peculiarities of the needs of individuals.

"Butter fat, for instance, is not at all simple, for one investigator was able to separate it into some 37 fractions. Some of these parts may be of far greater importance than others. Further, the composition must vary greatly with the feed of the animal, as is known to be true of other fats. Recently, milk is being 'softened' as water is softened, to remove some of the excess lime, which is apparently of more utility to the calf than to human babies. Thus we still know very little about such an important food as milk, and the situation is hardly, if any, better in the cases of grains and various other foodstuffs.

"It is still necessary to use rats and other laboratory animals to measure the vitamin values of foods, for adequate routine chemical determinations have not been developed. Relatively little is yet known about the hormones or chemical regulators of the body, although a salutary and determined assault is being made on this field by some splendid workers. Some of these hormones undoubtedly enter our bodies by way of food. By their intelligent use we may secure more control over our activities than we now can realize.

"Important and promising studies are under way pertaining to the nutrition and welfare of the human body. Enough has already been found to suggest great benefits to come, but also to suggest conservatism in making or accepting claims for universal beneficial effect for any one food product or ingredient. In this branch of human knowledge, we are still in a state of great ignorance."—*A. E. B.*

Blindness Due to Detached Retina is Curable

BLINDNESS caused by loosening of the retina, the actual seeing part of the eye, can be cured or at least benefited by operation in nearly 50 percent of all cases. So Drs. J. H. Dunnington and J. P. Macnie of New York City have reported before the meeting of the American Academy of Ophthalmology and Otolaryngology. The New York surgeons described their results in operations on a series of 150 patients.

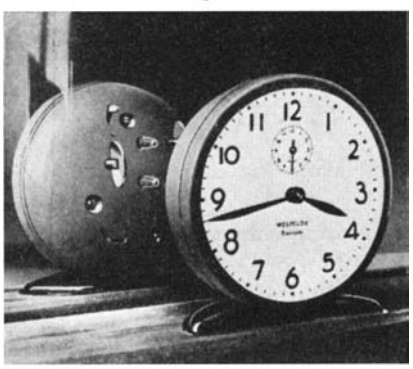
The retina, the light-sensitive lining of the eye, is an exceedingly thin, delicate film of living tissue. It may be compared with the photographic film or plate in a camera. It rests on a tissue called the choroid, which contains many blood vessels. From this the retina gets its blood supply.

Sometimes the retina becomes detached from the choroid, peeling off as wallpaper does from a wall. When this happens, the retina fails to get enough nourishment and cannot function properly. The patient feels as if a curtain were falling over part of his eyes and he has increased difficulty in seeing. The retina may not become wholly de-

tached, but if not treated it will as a rule eventually all peel off.

Modern treatment of detached retina is based on a method first proposed by a Swiss surgeon, Dr. Gonin. It is analogous to spot welding, the idea being to seal the retina back onto the choroid by cauterization, which produces an adhesive inflammation between them. One modern method of doing this is by driving tiny platinum-iridium needles into the choroid. These needles carry an electric current of from 30 to 50 milliamperes, which does the cauterizing. In early cases this method gives as high as 70 to 80 percent of cures. If the retina has been detached from the choroid too long, however, it loses its power to function, and the patient cannot see even after the retina has been re-attached. Consequently the greatest percentage of cures are among early cases.

The operation for treating detached retina is now being performed in all the major clinics in this country.—*Science Service.*



While an alarm clock is not usually "going somewhere" that it need be streamlined, this "air-flow" Westclox reflects a distinct refinement of design which follows the trend of modern transportation

Gas Attack Protects Oranges

IF oranges are subjected to a new kind of protective gas attack, storage damage from decay is reduced to a half or quarter of the usual losses.

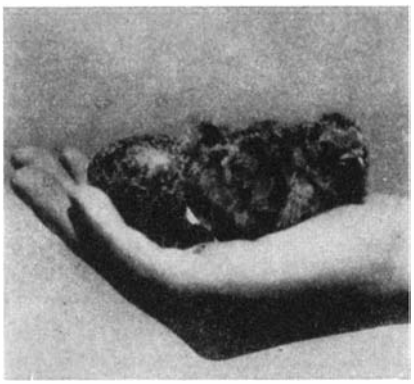
The gas used by Dr. L. J. Klotz of the University of California's Citrus Experiment Station at Riverside is nitrogen trichloride. It promises to combat decay-causing fungi upon citrus fruits in storage rooms or in loaded cars of packed fruit.

Very small concentrations of this gas do the work satisfactorily. Equivalent concentrations of chlorine gas, while more toxic to the fungi, injure the fruit rind and open the door to greater losses later.—*Science Service.*

First Northern Grouse to Hatch in Captivity

NESTLING in a human hand, the little ptarmigan or northern grouse shown in the accompanying illustration is the first baby of its kind to be hatched in captivity.

Dr. A. A. Allen, head of Cornell's ornithology department, collected freshly laid ptarmigan eggs on an expedition to the Canadian outpost, Churchill on Hudson Bay. Bantam hens were persuaded to act as foster mothers in hatching the eggs which he rushed from Churchill to Ithaca. Out of 18 eggs set, only one hatched.



Just a handful of fluff, this grouse is the first to hatch in captivity

"Strong and doing well" is the nursery bulletin on this first captive ptarmigan baby.

The ptarmigan study is being made because of the similarity of this bird to the common ruffed grouse which has been studied by Dr. Allen for the past 10 years under the sponsorship of the American Game Association.

Scientists left by Dr. Allen at Churchill to continue the study of Canadian birds have sent back another set of 20 eggs which are now being hatched. Several eggs have already been broken by the foster hen mother, but it is expected that there will soon be more hungry mouths in Cornell's ptarmigan nursery.—*Science Service.*

United States Has Most Telephones

THE five countries of the world having the largest number of telephones are the United States, Germany, Great Britain and Northern Ireland, France, and Canada. These are the only countries having a total of more than one million telephones each.

A review of telephone facilities recently completed by the American Telephone and Telegraph Company shows that on January, 1933, the last date for which comparable figures are available, there were in use approximately 33,000,000 telephones. Of these, 17,424,406 or nearly 53 percent were located in the United States. Germany held second place with 2,960,401; third place Great Britain and Northern Ireland with over 2,146,409; France had 1,292,254; and Canada 1,261,245. Sixth place goes to the other side of the globe, for Japan had 965,390.

Besides having by far the greatest total of telephones of any country in the world, the United States also leads in ratio to population. This country had almost 14 telephones to each 100 of its population, and in this classification Canada jumped to second place with 12 telephones per 100 of population. New Zealand is third with 10 for each 100 of its people. Denmark is fourth with just under 10, and Sweden is in fifth position with almost nine and one half.

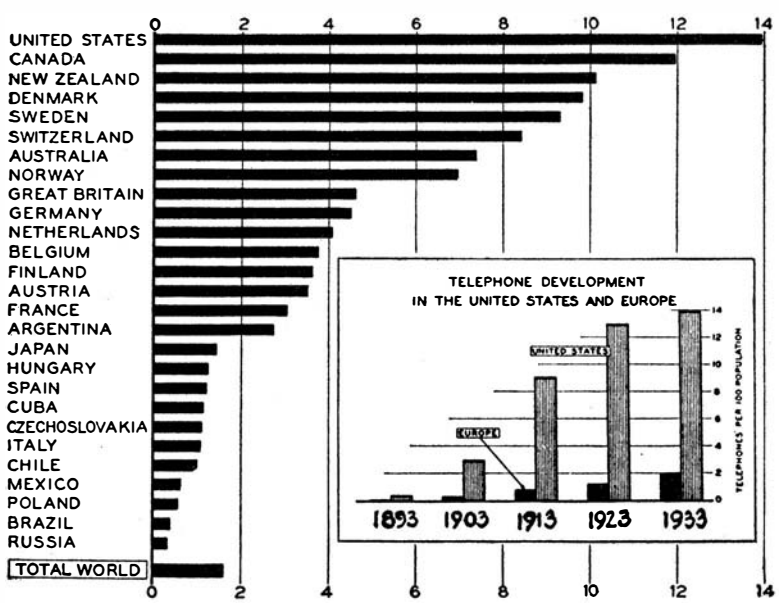
Rubber Putty

"PLASTIKON" putty, a compound similar in appearance and consistency to ordinary painter's putty, with the important exception that it is combined with rubber, is a new product being marketed by the B. F. Goodrich Rubber Company. Not only are most of the advantages of ordinary putty claimed for the new compound but the use of rubber is said to yield additional benefits. Of unusual interest is the fact that this putty requires no mixing, since it contains practically no oil. It effectively resists corrosive chemicals and fumes and, because of its rubber content, offers very high resistance to moisture. Another property, peculiar to this putty, is its high degree of adherence to steel surfaces.—*A. E. B.*

Medicine Given Through Skin

CERTAIN medicine is more effective in treating diseases of the blood vessels when induced to enter the body by the aid of an electric current than when given by mouth or by hypodermic injection under the skin, a group of New York physicians has found. These men, who recently demonstrated their method to the American Medical Association, are Drs. Irving S. Wright, A. Wilbur Duryee, Joseph Kovacs, Dean Moffat, and Joseph Wiener of the New York Post-Graduate Medical School and Hospital of Columbia University.

The medicine they use has the long name of acetyl-beta-methyl choline hydrochloride.



The number of telephones per 100 population throughout the world

It has been found useful in treating Raynaud's disease and certain other ailments, including chronic arthritis, because it improves the local circulation of blood.

When this medicine or similar ones are given by mouth they have little or no effect. When given by injection under the skin or into the muscles, the action is very transient because the medicine is quickly destroyed by the blood. When injected directly into the veins it is highly poisonous. But given by what the doctors call galvanic induction through the skin its effects are more prolonged and hence more satisfactory, they found.

While the treatment is not a "cure" for rheumatism or chronic arthritis, it gives striking results, reducing the swelling, increasing the general activity of the joints without pain and making the patient more comfortable.

An asbestos bandage soaked in the medicine is wrapped around the affected limb or joint. Over this is placed a flexible metal plate which is connected to the positive pole of a galvanic generator. A moist pad electrode placed on the back is connected to the negative electrode and the current turned on and slowly increased.

The electric current breaks the medicine down into ions which are carried, according to the principle of ionization, into the skin.

Because the medicine is slowly absorbed through the skin it does not have a poisonous effect as it does when injected directly into blood stream, Dr. Wright explained. But it does have a very striking effect on the circulation and other body functions. The blood pressure decreases and the pulse rate increases slightly. There is flushing and sweating and an enormous output of saliva. The basal metabolic rate, indicator of the rate at which the body is converting food into energy and tissue, also increases enormously. The temperature of the skin at the finger tips increases five or ten degrees.

As a result of all this, the rheumatic patients are more comfortable and can move their limbs more easily and freely. The patients suffering from Raynaud's disease or similar disturbance of the blood vessels have less pain, better circulation and rapid healing of the ulcers which are sometimes a feature of their ailments.—*Science Service.*

Engineering Construction Uses Refrigeration

DETAILS of an interesting use of refrigeration in foundation work has just come to our attention in connection with a complete report of the building of the vehicle and pedestrian tunnels under the Schelde River at Antwerp, Belgium. These two tunnels, of which that for vehicles is 5801 feet between portals and that for pedestrians 1750 feet, were begun in January 1931 and were officially opened in the fall of 1933.

It was necessary to sink the ventilation shafts at each end of these tunnels through water-bearing soil. To sink these shafts 70 feet in diameter and 87 feet deep, free from internal bracing, the ground was first frozen in a circle by a unique method. First, 116 holes were bored in two sets, one in a circle 86 feet in diameter and the second in a smaller circle of 78 feet, the holes being spaced on the circumference at distances of 4½ feet. In each of these holes, six-inch pipes, sealed at the bottom, were

sunk to a depth of 90 feet. Inside each outer pipe a two-inch open-ended pipe was inserted. Through this inner pipe a brine refrigerating solution was pumped downward. Reaching the closed bottom of the larger pipe, this brine escaped upward in the space between the smaller and larger pipes.

Four months of pumping brine through these pipes sufficed to create a solidly frozen wall surrounding the circular space which was to be excavated.

Our readers will remember that other instances of refrigeration in construction have recently been described in SCIENTIFIC AMERICAN. The most notable, perhaps, is the process of refrigerating the concrete of Boulder Dam as fast as it is poured in order to remove the heat generated by setting.

Ice Cream While You Wait

WHAT is probably the most rapid commercial ice-cream freezer in the world has been put on the market by a Los Angeles inventor. Ice cream and frozen novelties are produced in from 15 to 45 seconds.

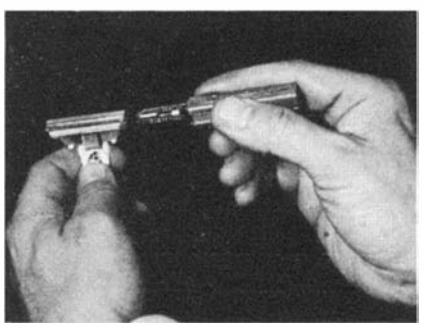
To make ice cream the mix is simply poured down a central hollow shaft where it is atomized by a spray spindle driven by a 1/64 horsepower motor, being sprayed against the walls of the chamber which are refrigerated to −20 degrees, Fahrenheit, with methyl chloride. The shaft head travels up and down, driven by a 1/15 horsepower motor, and as soon as the material has frozen sufficiently, a cutter head automatically removes it from the walls, molding and discharging it. This operation requires 30 to 45 seconds.

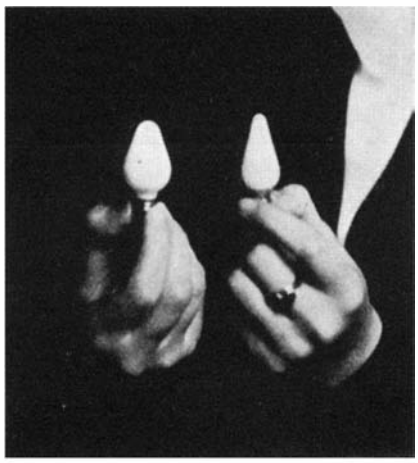
Frozen novelty confections can be produced almost as quickly. If the mix is poured in first and followed by fruit juice or fruit pulp, the finished product will be ice cream with a fruit core. These confections are free of disagreeable ice crystals and smooth in texture, because of atomization and instantaneous freezing.—*A. E. B.*

Multiple-Burning Christmas Tree Lamp

A NEW small multiple-burning Christmas tree lamp which, unlike the series type, does not affect the other lamps in a string when it burns out, has been developed by the Incandescent Lamp Department of General Electric Company at Nela Park, Cleveland, Ohio.

Slightly larger in size and using only a little more electricity than the well-known series-burning variety, the new lamp does not cut out the others of a string when it burns out. This eliminates the time and trouble always experienced with the series-burning string in finding the burned-out lamp





The multiple-burning Christmas tree light (left) compared with old

among eight that have become extinguished. Its longer burning life of 500 hours offers another advantage to the user. The new lamp has a candelabra screw base, and is designed for use on circuits from 110- to 125-volts.

How Ear Canals Control Body's Balance

CONCLUSIVE evidence showing exactly how the semi-circular canals inside the ears maintain the balance of our bodies was presented by Dr. J. W. McNally of McGill University, Montreal, at a meeting of the American Academy of Ophthalmology and Otolaryngology. The experiments he reported are said to be the first conclusive evidence for the theory scientists have held concerning the function of the labyrinth in maintaining balance.

On each side one of the semi-circular canals is horizontal and the other two are vertical. The horizontal canals are the ones having to do with turning movements from side to side. The vertical semi-circular canals and chambers called utricles keep the head level and steady and maintain the body's position once it is established.

The three semi-circular canals together are called the labyrinth of the ear, and Dr. McNally found from investigations on frogs that this labyrinth is essential for normal behavior and that even the simplest movement may stimulate all of the labyrinth.—*Science Service.*

A real novelty in razors—a magazine type in which the sealed package of blades is a separate unit. *Left:* The key of the sealed magazine is inserted in a slot in the razor. *Above:* A slide on the magazine is pulled and pushed, ejecting the old blade from the razor and inserting a new one. When the key of the magazine is withdrawn, the new blade is automatically aligned. *Right:* For periodical thorough cleaning, the handle of the Schick razor is separated, scissors-like, releasing the upper blade-holding parts

Diesel Engine Cylinders Built By Arc Welding

BLAZING new trails in the construction of Diesel engines, F. B. Stearns, Cleveland, Ohio, is building an experimental Diesel embodying arc-welded cylinders for use in marine type engines. Since both weight and space are at a premium, castings were discarded and arc-welded steel used for the cylinders and other parts.

The design and arc welding of these cylinders was a difficult problem since some 16 pieces are required for each cylinder and the tolerance on the finished work was exceedingly small. The inner sleeve is of case-hardened steel and the outer portions of mild steel.

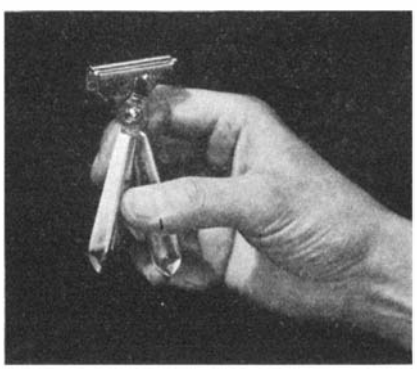
The arc welding was done by The Thornton Company, using welding machines and Fleetweld electrodes manufactured by The Lincoln Electric Company, Cleveland, Ohio. These are said to be the first arc-welded Diesel engine cylinders ever built.

Cod-Liver Oil for Industrial Workers

STUDIES by sick benefit associations, the Metropolitan Life Insurance Company, and the United States Department of Public Health show that over 40 percent of the lost time by wage earners is caused by colds and respiratory diseases.

During the past winter a study was conducted to determine the value of cod-liver oil for reducing lost time of wage earners caused by colds and similar troubles. Three hundred and eighty-nine men and women employed at a variety of tasks such as office work, light machine work and heavier machine work were fed five tablespoonfuls of cod-liver oil per week at their forenoon rest period. Three hundred and nine men and women of corresponding age, weight, general living conditions and employed at identical tasks did not receive cod-liver oil and thus served as controls. The experimental period was 20 weeks long.

The experiment showed that by feeding vitamin-rich cod-liver oil to average industrial employees the number of severe



colds can be materially reduced, the number of persons having no colds may be increased, and the amount of lost time from work may be very significantly decreased.

Air Conditioning May Increase Gold Supply

THE famous Robinson gold mine, in the Rand, near Johannesburg, has contracted for an installation of air conditioning equipment that is expected to make it possible for men to work at depths previously uninhabitable. Says *Industrial and Engineering Chemistry:* "The Rand produces about half the world's gold with the amount definitely limited by conditions in the deep mines, some of which already extend to 8000 feet below the surface. Here temperatures from 100 to 120 degrees, Fahrenheit, combined with a humidity from 90 to 100 percent, definitely limit operation, and while there is reason to believe that the richest deposits of gold lie at still greater depths, it has been humanly impossible to work them.

"The plan is to force dry, cold air, traveling at a rate of approximately 30 miles an hour, to the lowest parts of the mine. This will cool and dehumidify, as well as thoroughly ventilate, these remote depths where men strive for the precious metal. This first installation in the Robinson mine must be regarded as something of an experiment on which a half million dollars is being risked, but the chances for success are large and the return on the operation promises to be most gratifying. There are doubtless other instances where air-conditioning will allow further production of gold. We are told that in Nevada, for example, some mining operations were abandoned because of working conditions in the mines, even though not so deep as those in the Rand, rather than because of lack of ore.

"A great increase in the production of gold, according to the economists, would support amply any possible trade revival, enable the world to return to the gold standard, greatly restore confidence, and cause commodity prices to rise. In fact, it would quickly change the present world economic situation and multiply the number of those who can smile."—*A. E. B.*

Fooling the Fish

AFTER reading the article "Angling Has Scientific Angles," in our July number, Mr. Paul L. Rittenhouse of the United States Printing and Lithograph Company, Chicago, obtained some nickel chrome wire from the Gilby Wire Company, and used it as a fishing line during a recent trip. A report of the results obtained follows:

"Its advantages over silk line for deep trolling (as well as for shallow trolling) are quite interesting. The sensitivity to nibbles is an entirely new sensation—just exactly as though one were connected with the fish by a telephone line. It is obvious that because of the absolute lack of stretch in this wire, a very flexible rod must be used for sizable game fish from three to ten pounds weight, as the danger of pulling the bait out of the mouth of a game fish, which is usually lightly hooked, is much greater. . . .

"I not only failed to lose a single fish, but actually hooked every fish that struck, with perhaps one exception.

(*Please turn to page* 274)

THE AMATEUR ASTRONOMER

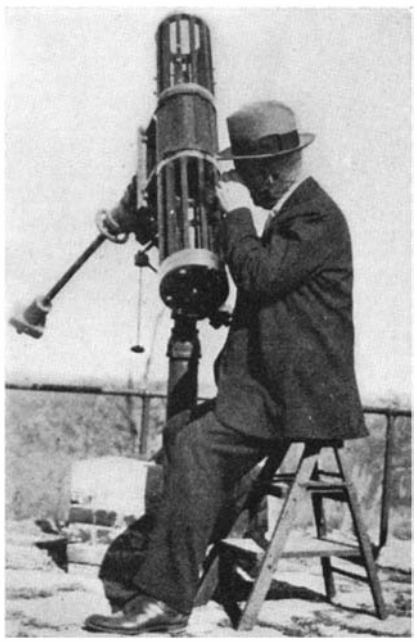
Conducted by ALBERT G. INGALLS

EXTREMELY few have made Gregorian telescopes, but Mr. W. F. Decker, whose romantic address is Mizzentop, Christmas Lake, Excelsior, Minnesota, has made one having an added reflection and a side-door eyepiece (non-perforated type). He describes it thus:

"The difficulty of making an optical flat or an accurate spherical mirror for testing purposes only, need no longer deter the amateur who has the ambition to make a compound telescope; these accessories are not absolutely necessary, as once believed. Kirkham's method of testing Gregorians from foci is entirely practical and within the capacity of anyone who can make a good Newtonian telescope.

"My first telescope, illustrated in the December, 1933, number of SCIENTIFIC AMERICAN, was a six-inch Newtonian. I afterward made an eight-inch, *f*/9, Newtonian which proved so much better than the first that I had no further use for the six-inch. It then occurred to me that I might use the six-inch tube for a small Gregorian.

"I decided, in the first instance, on a 6-inch *f*/5 primary, with a 1.75-inch secondary, making p=7.5 inches. These values are in proportion to Hindle's example in 'Amateur Telescope Making' and fit into my 54-inch tube as though it were made for them. It took just one month of my spare time to make the change, and I now have a good compound telescope of convenient dimensions and considerable magnifying power. Because of the small size of my primary, which was limited by the size of my old tube, I did not seek a very high magnifying power; but the new telescope is very satisfactory, and I feel amply repaid for the effort.



Mr. Decker and his Gregorian

"My Gregorian is of the non-perforated type. (See drawing.) I use a one-inch prism located about a foot from the primary mirror. This comes near enough to the declination axis to make the eyepiece always convenient. Instead of an adjustable adapter tube, I slide the block which carries the eyepiece tube between two of the strips of my wooden telescope tube, and pick up the focus wherever it may be. I have a thumb screw adjustment for accurate focusing.

"While it is necessary to keep rather closely to the values of *f*, *p* and *p'* employed in determining the RC of the secondary, the latter can easily be figured by Kirkham's method, even though *f* and *p'* vary slightly from assumed values. This is fortunate, for it is extremely difficult to keep these dimensions from varying slightly during final polishing and figuring.

"It is better, in this case, to keep the value of *p* constant, and absolutely necessary to figure the mirrors accurately.

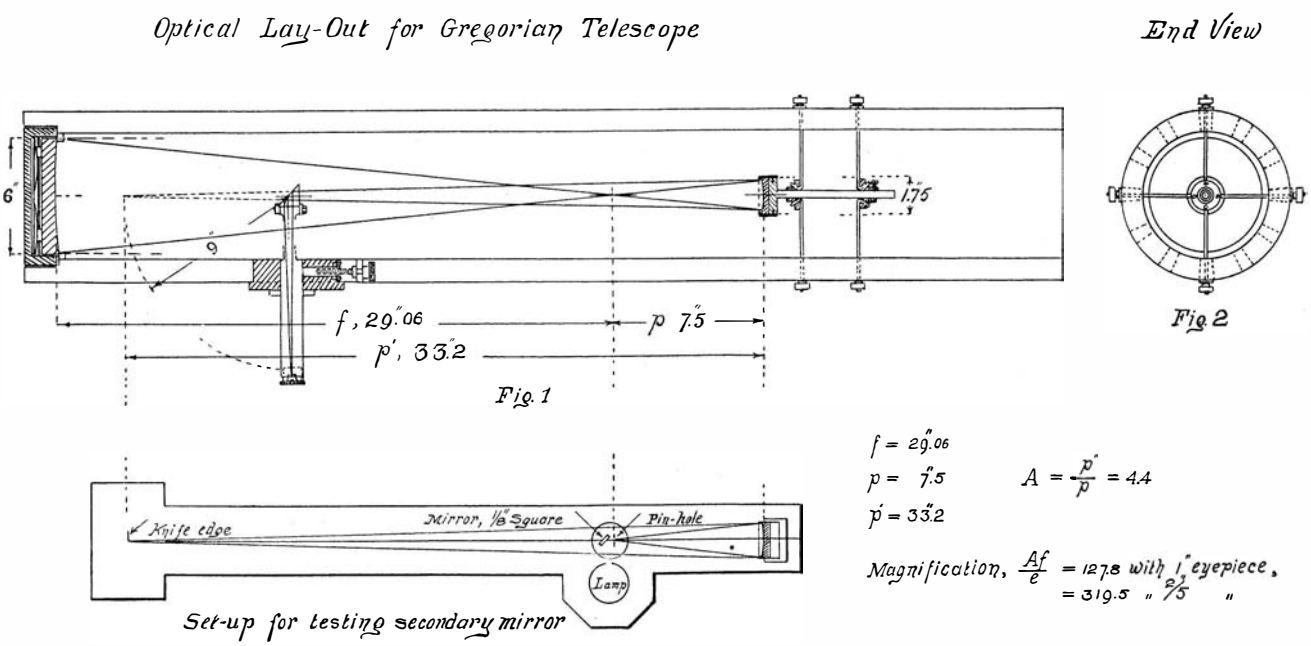
"The primary must be a true paraboloid and the secondary a true ellipsoid. It bothered me at first to know how I was to determine when the secondary was correctly figured; but I found it was only necessary to apply the test for a perfect spherical surface; in other words, an *apparently* flat surface, with the pin hole at one focus and the knife edge at the other. In such a test an ellipsoidal surface will appear perfectly flat at the outer focus. This test is really more delicate than Foucault's center of curvature test, for the reason that conditions are precisely the same as when a star is under observation—which is not true in the other case.

"Any variation of *f*, *p* or *p'*, of course, varies the amplifying power slightly, but this is relatively unimportant.

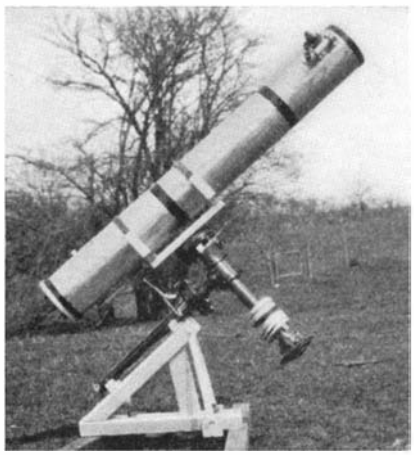
"It took me several hours to line up the optical elements properly, as this is tedious, but only slight adjustments were afterwards necessary.

"I secure the telescope to the saddle by means of leather straps, and take it into the house when not in use. My long focus Newtonian fits into the same saddle."

Figures 1, 2, and 3, show the optical layout and details.



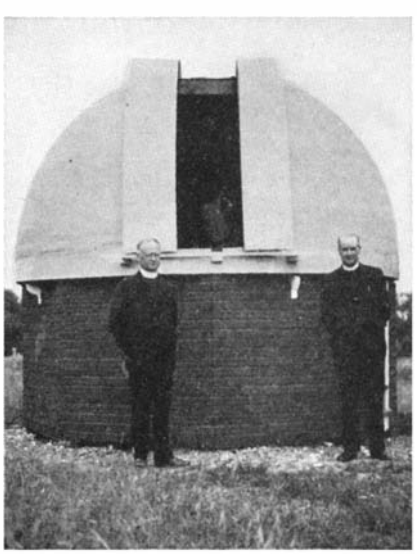
Mr. Decker's drawing of the optical layout and details of his Gregorian



A 9-inch reflecting telescope. The mounting was made by the Rev. John J. Goergen of the Marist Novitiate, Prince Bay, Staten Island, N. Y. and Father McKenna, a fellow-professor at the same institution, with the assistance of two students, as was the observatory below

SO much for Mr. Decker's Gregorian. From another worker who is making a Greg we have received the following comments, suggesting that the Greg is not a suitable job for a beginner (we constantly receive inquiries from beginners who want to tackle one as their maiden job):

"The biggest job about the Gregorian is the mounting. I find that the positions of the Greg mirrors are very critical. Unless they are exactly right, you get blurred images with tails. It is a tough job to line up a system of this sort, and it is highly important that provision be made for adjustment in every direction—lengthwise, crosswise, tilting, and so on—and for locking the parts firmly after they are once set correctly. A Greg is not a job for a beginner—it's a difficult job for any one. The high magnification of the Greg results in a small field, and it is hard to keep objects in view. Jupiter sails across it like an airplane."



The observatory made by Fathers McKenna and Goergen. Its radius is six feet. The roof is made of wainscoating covered with canvas, and revolves on eight two-inch ball bearing casters. The main part of the building is octagonal in shape

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 271)

"The SCIENTIFIC AMERICAN article suggested fine gage wire chiefly for its low visibility. I do not know the mental process of the fish well enough to know whether this is actually a fact, but it is a fact that this fine wire actually disappears as soon as it strikes the water.

"I expected to have trouble with kinks, but found no such trouble except when landing a fish, which I always do with my hand over the side of the canoe.

"Accurate casting for bass is obviously impractical with this line, but I found that short casting under rapids where the large fish come, supposedly to get an easy meal, is entirely practical.

"An additional important advantage is that this wire line seems to free itself entirely from water when reeled in, which avoids the awful bore of drying silk line.

"Having caught lake trout and wall-eyed pike exclusively on this trip, it is evident I was not dealing with fish that swallow the bait. In fact, almost every fish I caught was extremely lightly hooked."

More About Fire Walking

CAN a human being walk barefooted over red-hot stones? A note on this question, published on page 260 of the May number, has brought the following comment from "T.N.S.R." of Madras, India, a medical worker.

"I was an eye-witness to at least two fire-walking ceremonies and was indeed struck by the remarkable freedom from injuries which characterised the ritual. At one of these which I saw at Pallavaram, in the Chingleput District, there were 18 men of ages from 18 to 65, who participated in the ritual. The fire was about 16 feet by 12 feet by 4 feet deep and was made up of huge logs of wood which were allowed to burn for over six hours before the men went into it barefooted and with only a wet loin cloth on their person.

"These men took a bath immediately before they got into the fire, and with the wet loin cloths on their person, freely walked over the red-hot embers, chanting some weird religious songs.

"The only rational—at all events, what appeared to me to be rational—explanation was that these fire-walkers smeared their bodies with the juice of some leaves, which had the remarkable property of desensitizing the skin to fire. Other explanations ascribe the freedom from injury to mystic and occult powers, and to religious fervor in the walkers, which transcended all physical feelings.

"In the second instance 55 men took part in the ceremony but only one was hurt. If the whole thing was a fake, how can we explain this observed fact of one man being injured?

"I honestly feel it is not a stunt. But, at the same time, I cannot for one moment reconcile myself to the idea that fervor, however deep, can save the victim from physiological injury. It must therefore be some sort of cocaine effect that is induced

in the walkers by the previous application for some days or hours or even perhaps minutes, of some powerful juice which, while producing this effect, is not washed away by the bathing to which the walker subjects himself before the assembled audience—apparently to show them that they had nothing on their bodies to protect them from the fire.

"I would like that you invite a free expression of opinion on this matter from your readers over the globe."

Tail of White Rat is Mexican Medicine

WEIRD medical prescriptions that savor of the long-ago are faithfully followed by Zapotec Indians, it appears from an unpublished report by Dr. Luis G. Cabrera, formerly of the Mexican Department of Anthropology.

The tail of a white rat placed against the heart will cure St. Vitus' Dance, these Indians of the Monte Alban region believe. Blood of frogs or snakes mixed with lard forms a pomade to stop bleeding. Surgery is unknown among the modern Zapotecs. Broken bones are set in rigid leaves of maguey.

Powdered frog is the remedy for dropsy. River sand is taken for intestinal obstruction. Scorpion bites are treated on the principle that like cures like. To heal the bites, scorpions are mashed up in mezcal, an alcoholic drink which Mexicans also use to prime gasoline stoves when they refuse to burn.

These Indians are innocent of ordinary facts of anatomy, such as circulation of the blood.

Except in cities, Mexico has few doctors. Only in the large towns are there modern drug stores, with druggists who understand modern remedies. Medicine is largely in the hands of native curanderos, and these are no longer skilled as they were in pre-Spanish times, when Indian science was better regulated.

However, in the past few years, state health departments have grown up. The federal government sends trained health squads to scenes of epidemics, and uses the rural schools to instill health propaganda.

The writer just witnessed vaccination of Mixtec Indians against smallpox during the weekly market day in Tlaxiaco, when thousands come in from the hills. Local troops pushed the first unwilling subjects into the tax collector's office where one visiting government doctor and five school teachers made inoculations. The first Indians vaccinated, resentful of their companions who had thus far escaped, caught the others and brought them in themselves. Indians are not afraid of being hurt by vaccination. In fact, they are likely to have faith only in treatments which hurt or draw blood.—*Science Service.*

Photoelectric Relay for A. C.

A NEW photoelectric relay, designed to operate on 110 volt 60 cycle A.C., is normally supplied with contacts having 2 amperes, A.C. non-inductive load capacity. A speed of 600 operations per minute can be consistently maintained. The circuit can be so arranged that no plate current is drawn from the amplifier tube except while the light beam is interrupted, thus increasing

the life of the amplifier tube at slow or medium speeds.

G-M Laboratories, Inc., makers of the photoelectric relay, state that it will operate reliably on changes in illumination as small as one foot-candle or less, and when used in conjunction with the proper light source can be operated at distances as great as 90 feet with white light and up to 40 feet with an infra-red invisible beam.

Naval Aircraft

APPROVED by the Navy Department and passed on to the Budget Bureau, a new program calls for naval aircraft construction of upwards of 500 planes. Half of these are intended as replacements and the other as expansion planes. The new aircraft carriers *Enterprise* and *Yorktown* will be taken care of by this program with 108 planes each.

Forest Plantings Trebled

TREE planting in the national forests was nearly trebled last year, the United States Forest Service reports. And the plantings for the calendar year, aggregating 69,215 acres, were well over three times the annual average for the five preceding years.

The regular forces of the Forest Service planted 13,236 acres. Civilian Conservation Corps' plantings amounted to 45,843 acres, and N.I.R.A. planting crews accounted for 10,136. Forest Service crews operated in six of the forest regions. Ninety percent of the C.C.C. plantings were in the Lake States region.

CURRENT BULLETIN BRIEFS

THE PROGRESS OF BRONZE-WELDING describes correct practice for this work, and its advantages in joining the more common metals. *Write to Scientific American, 24 West 40th Street, New York City, for Bulletin 11 B.—3 cents postage.*

ELEMENTARY PLACER MINING IN CALIFORNIA AND NOTES ON THE MILLING OF GOLD ORES. (The April and July 1934 quarterly chapters [combined] of the *California Journal of Mines and Geology.*) This is a bulletin of 200 pages, well illustrated. There is a selected bibliography on both ore milling and placer mining. *State of California, Division of Mines, Ferry Building, San Francisco, Calif.—90 cents, postpaid (remit by money order).*

THE TESTING AND QUALIFICATION OF WELDERS deals with oxy-acetylene welding, the purpose of the booklet being to outline simple tests for measuring the ability of welders. *Write to Scientific American, 24 West 40th Street, New York City, for Bulletin 11 A.—3 cents postage.*

PLANT PROPAGATION is a well-illustrated pamphlet dealing with the methods of propagating fruits and ornamentals such as roses and evergreens. It has been prepared by Dr. H. B. Tukey, and is sent free of charge on application to the *New York State Agricultural Experiment Station, Geneva, N. Y.*

TELLS HOW TREES AND SHRUBS ARE GRAFTED (Circular No. 138, Experiment Station), by Dr. H. B. Tukey, describes each step in cleft, bridge, bark, and side grafting, and bud grafting or "budding" as it is generally called. *New York State Agricultural Experiment Station, Geneva, New York—Gratis.*

ARMAMENT MANUFACTURE AND TRADE (*International Conciliation No. 295*, December, 1933), by Constance Drexel. Several former issues of this periodical have been devoted to this subject, which has been admirably brought down to date by Miss Drexel. *Carnegie Endowment for International Peace. 44 Portland St., Worcester, Mass.—5 cents.*

NEWS: THE STORY OF HOW IT IS GATHERED AND PRINTED. This is the story of the news—an account of that complex and astonishing process which within the span of 24 hours brings the record of events from the far corners of the world to the reader at the breakfast table. It is a story, beautifully illustrated, of a newspaper organization in action. *New York Times Company, 229 West 43rd Street, New York City.—Gratis.*

OVERTONES AND ATMOSPHERES

(*Continued from page 237*)

ard atmosphere. This is less than one-sixteenth part of the vapor pressure of methane boiling at the planet's probable surface temperature of –120 degrees Centigrade, and methane must therefore be a "permanent" or non-condensable constituent of its atmosphere.

On Neptune, the situation may be different. Ten kilometers of methane, with the planet's smaller surface gravity, would exert a pressure of about two-thirds of an atmosphere, corresponding to a boiling point of –160 degrees Centigrade. Dilution of the gas with hydrogen might lower the temperature of cloud formation to –180 degrees.

This is certainly cold enough, but a planet at Neptune's distance, receiving its heat solely from the sun, would have an average temperature of –220 degrees Centigrade. The sunlit side would be somewhat hotter, but would not get up to –200 degrees unless the escape of heat from the surface into space were obstructed. But it is very probable that this happens; for the atmosphere, which absorbs strongly in the visible, must do so far more powerfully in the infra-red, where the principal bands replace their overtones. The influx of heat from the sun to the visible surface is somewhat hindered, but its escape by radiation into space must be much more so; and this, of course, tends to make the surface warmer.

A very similar situation occurs on Jupiter, for which the theoretical temperature (disregarding the effects of atmospheric "blanketing") is –170 degrees, and the actual temperature probably about –120 degrees.

Whether the whole difference for either planet is due to atmospheric influences, or a part of it comes from a slow escape of heat from the interior of the body, is a problem for future investigation.—*Lowell Observatory, Flagstaff, August 30, 1934.*

Books SELECTED BY THE EDITORS

WHAT ABOUT ALCOHOL?

By Emil Bogen, M.D., and Lehmann W. S. Hisey

THIS book is aimed mainly at young people and it is full of scientific facts about alcohol, plainly and clearly stated. Many middle-aged readers will recall certain sticky, stuffy, goody-goody textbooks of physiology largely devoted to the horrors of the Demon Rum, which the law required their schools to use in teaching. This book is an attempt to avoid that kind of extreme fanaticism. —$1.65 postpaid.—*A. G. I.*

THE NEW INTERNATIONAL YEAR BOOK

By Frank H. Vizetelly, L.D., LL.D.

THE events of 1933 will long be studied and frequently referred to by those who have an interest in the world's progress. The New International Year Book is a sure source of factual material and it is interestingly presented. The year of 1933 showed a remarkable progress in evolving sound fundamentals upon which a workable economical system has been based. The editor of the New International Year Book is to be complimented on condensing such a huge mass of material in a compact volume of 856 pages of ample size.—$6.50 postpaid.—*A. A. H.*

FIRST AID FOR THE AILING HOUSE

By Roger B. Whitman

EVERY house owner will find this an invaluable handbook as it tells how to keep a house in good condition at the lowest possible cost. Its practical advice is based on the questions of 6000 home owners who have written to the author's column in *The New York Sun* to ask what to do about household troubles.—$2.15 postpaid.

CREATION'S DOOM

By Desiderius Papp

IN this book, which is an excellent translation from the German, the author has fused into one long drama the various scientific theories of the earth's past, present, and future, finishing with an account of the end of the world according to science. We see the fate of the human race and meet the future rulers of the world—ants. Then comes the end, when the sun becomes a "nova" and the little earth is licked up in the flames like a leaf in a holocaust. This book contains good science all through, is good reading and, in fact, is rather dramatic.—$3.15 postpaid.—*A. G. I.*

HEROES OF THE AIR

By Chelsea Fraser

EITHER as a running story, to be read for entertainment and information, or as a reference book to be used to settle arguments as to "When was such-and-such a flight accomplished?" this book will find an ever-widening group of readers. Now in its twelfth printing, the present edition has been brought up-to-date to the early flights of 1934. After a short chapter on the history of flying, the author plunges directly into a recitation of aviation events from 1919 to 1934. A chronology furnishes an excellent summation of all important flights during that period.—$2.70 postpaid.—*A. P. P.*

MAN'S PLACE AMONG THE ANTHROPOIDS

By W. K. Gregory, Ph.D., Prof. Paleontology, Columbia University

A REFUTATION of the argument, advanced by a small minority of scientists, that man is but distantly related to the anthropoid apes, and a demonstration of his close relationship to the same animals, as believed by the majority. The author's thesis is based on a comparative study of the anatomy of man and apes, and is rather technical in spots though mainly semi-popular.—$2.65 postpaid.—*A. G. I.*

IDENTIFICATION OF THE COMMERCIAL TIMBERS OF THE UNITED STATES

By Harry P. Brown and Alexis J. Panshin

THIS book was written by professors at the New York State College of Forestry, for the use of those dealing in wood, and it is a very solid, businesslike, unromantic treatise and reference book —not a book about the "pretty trees." It tells how to identify commercial woods positively, not by the old earmarks but by a close study of the minute anatomy, with the naked eye and with a ten-power lens. To assist in this method the book contains 274 excellent, large photomicrographs. After close comparison of these with the samples of wood, and with the keys and descriptions in the book, there should no longer be any chance for argument. Thus a sort of "finger print identification" of wood is made possible, and misrepresentation impossible.—$3.20 postpaid.—*A. G. I.*

ATOMIC THEORY AND THE DESCRIPTION OF NATURE

By Niels Bohr

THIS book of 119 pages contains four reprinted papers by the famous originator of the planetary atom concept. These papers were originally published respectively in 1925, 1927, 1929, and 1931. As they have to do with problems of the quantum theory, their implications will be fully graspable to teachers of physics and to those of equal background.—$2.15 postpaid.—*A. G. I.*

BEFORE THE DAWN

By John Taine

MOST persons of scientific leaning, except those who take all things with deadly seriousness, enjoy scientific romances, even though these are not scientifically true or possible. This book is a piece of pure scientific fiction. By means of the "electric analyzer" it proves possible to review the whole geological and historical past as clearly as we see present events. On the stage walk fighting dinosaurs and other monsters of past geologic eras, shown life size by means of television applied to emanations from ancient rocks. The author is professor of mathematics at the California Institute of Technology, a past president of the Mathematical Society of America, and a member of the National Academy of Sciences. Thus this book reveals the serious scientist at play —writing a yarn—and it makes good reading.—$2.15 postpaid.—*A. G. I.*

COMMERCIAL PROPERTY NEWS

Conducted by SYLVESTER J. LIDDY

Foreign Patent Licensing Corporations

A METHOD by which revenues may be obtained by American concerns owning foreign patents was recently developed in connection with the operation of corporations under the Webb-Pomerene Act which permits of combining for export. In more than one instance, groups of U. S. concerns which were in competition in this country nevertheless pooled their foreign patents and licensed the European industry under this pool of patents. This represents a distinctly new departure and may suggest uses by which concerns which are competing in this country, but have mutual interests abroad, may be able to regulate foreign competition, especially in the industrial countries.—*Journal of the Patent Office Society.*

"Vapex" Mark Upheld

IN a recent decision of the United States Patent Office, First Assistant Commissioner Spencer refused to cancel the registration of the trade mark "Vapex," of Thomas Kerfoot & Co., Ltd., of England, issued March 18, 1924, for an inhalent for the relief of cold in the head, notwithstanding the previous adoption and use of the trade marks "Vicks" and "Vaporub" by Vick Chemical Company, of Philadelphia, Pennsylvania, on similar goods.

The ground of the decision is that the petitioner has failed to establish such likelihood of confusion as would warrant the cancellation of respondent's registration. The First Assistant Commissioner noted that considerable evidence had been adduced by the petitioner in an attempt to show not only that confusion was likely, but that it had actually occurred, and held that in view of the entire record such evidence was totally insufficient to overcome the conviction produced by an inspection of the marks themselves that they possessed no deceptive similarity.

"The First Plant Patents"

UNDER the above title a book by Robert Starr Allyn is now available, containing a discussion of the plant patent law and patent office practice. The volume should be of great benefit to any one interested in obtaining a patent on a plant, or in any phase of the legal aspect of protecting a new form of plant by means of a patent.

The book opens with a reproduction of plant patent No. 63, including the illustration (not in color) of the rose which is the subject of the patent, and the two pages of specification. This particular patent is said by the author to be perhaps the most complete and carefully drawn of any. Contained in the volume are abstracts of 84 patents as well as several chapters covering the history of the plant patent bills and law.

Mr. Allyn presents in this little book a well-rounded discussion of the whole situation, covering not only the legal aspects of the actual patents but the effect which the Plant Patent Act of 1930 may have on those for whom it was originally intended to benefit. Since this act is a legislative attempt to recognize the plant breeder as an inventor, the implications and the results may have far-reaching effects in patent office procedure.

The book is very thorough in its systematic arrangement and is provided with a comprehensive table of contents and index.

Patents in India

THE official date of a patent issued in India is the sealing date. A patent cannot be sealed before four months after the publication of the acceptance of the application in the *Gazette of India* and not after eighteen months from date of application.

Patents are in force in British India only, and are granted for sixteen years from date of application, or from priority date under reciprocal agreement with the United Kingdom, etc. Extension may be granted for five years and in some cases for ten years.

Patents of addition are granted for the unexpired term of the original patent.

Opposition may be made to the grant of a patent in four months from date of publication of acceptance of the application.—*Journal of the Patent Office Society.*

"Beaver-Penn" Mark Not Registrable

IN *ex parte* The Freedom Oil Works Company, First Assistant Commissioner Spencer held that the company, of Freedom, Pennsylvania, is not entitled to register, under the Act of 1905, a trademark for lubricating oils consisting of the hyphenated word "Beaver-Penn" together with the representation of a beaver, all within a rectangular border, without disclaimer of the word "Beaver-Penn."

The ground of the decision is that that notation is merely geographical.

In his decision the Assistant Commissioner noted the decision of the Court of Customs and Patent Appeals in in re Plymouth Motor Corporation, and pointed out the difference between the facts there and the facts in this case and said:

"The town of Beaver is located in the western part of Pennsylvania in the region that is justly famous for its production of hydrocarbon oils. Many of the finest lubricating oils are obtained from this vicinity and, indeed, Pennsylvania motor oils have acquired a high reputation in the motor world. That 'Penn' is an abbreviation of the state name of Pennsylvania is clear beyond reasonable contradiction and this obviously holds despite the two communications submitted by the applicant, one from the United States Government Printing Office and one from the Commonwealth of Pennsylvania, Department of State, both to the effect that the proper *official* abbreviation for Pennsylvania is 'Pa.' No matter what the official abbreviation is, the fact remains that any number of members of the public write the abbreviation of 'Penn.' as standing for Pennsylvania. It would accordingly seem that the mark is no more, no less descriptive than Boston, Mass., and it is therefore held that without disclaimer of the word 'Beaver-Penn' registration cannot be obtained."

F. T. C. Stipulations

STIPULATIONS recently announced by the Federal Trade Commission include the following:

National Rabbit Institute

Monroe Green, successor to National Rabbit Institute of Arcadia, Calif., selling courses of instruction in raising and breeding rabbits, asserted that rabbits could be raised for profit. "Earn $1,000 to $5,000 a year," he advertised, alleging that "proved successful methods show you quickly and easily how to make $1 to $3 every hour of spare time." Green agreed to cease advertising that probable earnings of prospective students would be in excess of the average amount earned by competent rabbit raisers devoting their entire time to the business.

Charm Laboratories

Charm Laboratories, Inc., 521 Fifth Avenue, New York City, selling a medicinal herb compound designated "Charm Tea," is said to have represented as follows: "Reduce with charm tea safely, sensibly, surely." The respondent agrees to cease advertising that its tea is of itself a competent treatment for obesity or excess weight.

Nature Herb Company

The Nature Herb Company, Seattle, advertising a laxative medicine made of roots, barks and herbs designated "Sen-Gen-Ma," agrees to cease labeling its product as a tonic and from representing it as a preventive, a competent treatment or an effective remedy for any of 20 ailments listed including stomach disorders, pneumonia and heart disease.

Schuyler Preparations

George Schwager, trading as Schuyler Preparations, New York City, advertised "Schuy-Tone Tablets" for the treatment of shyness, bashfulness, blushing, stammering, lack of personality and other defects. "Bashfulness is a disease," the respondent advertised; a disease "to be diagnosed as carefully as any other malady." The respondent informs the Commission he has discontinued advertising his commodity and does not intend to resume.

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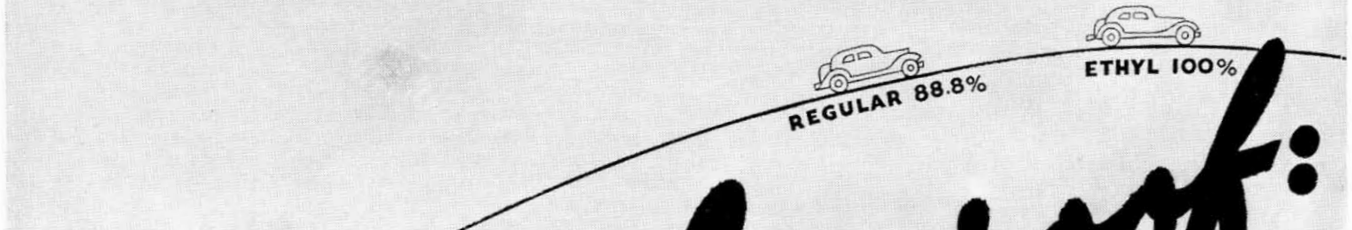

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Ten new automobiles, of makes representing every price class and more than 80% of all cars sold so far this year, recently were taken to an automotive testing ground, by qualified engineers.

Performance tests were run on the same measured hill; first with Ethyl, next with regular gasolines, and then with third grade gasolines. The gasolines used included 17 brands representative of the three grades (Ethyl, regular and third grade) generally distributed throughout the United States and Canada.

Adjustable sparks were set to the car manufacturers' recommendations for bringing out the best possible car performance with each of the three grades of fuel.

Taking the performances of the cars with Ethyl Gasoline as 100%, the averaged performances with the two other grades of fuel used showed the following *losses*:

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100%	88.8%	65.9%
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* **PERFORMANCE** means *speed* at top of the test hill in the case of those cars that were able to reach the top in high gear; in the case of those cars which had to shift to second, *distance* on hill made in high gear.

Study these figures in terms of your own car. Consider also another point these tests brought out: objectionable knocking and higher radiator (cooling water) temperatures accompanied the power losses when regular and third grade gasolines were used.

Now ask yourself: "Is it economy to 'save' a few pennies per gallon when I buy gasoline and *lose* from a tenth to a third in car performance? Is it economy to invest from $500 to $5000 in an automobile and then get only *part* of the power I paid for?"

Ethyl Gasoline Corporation, New York City.

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