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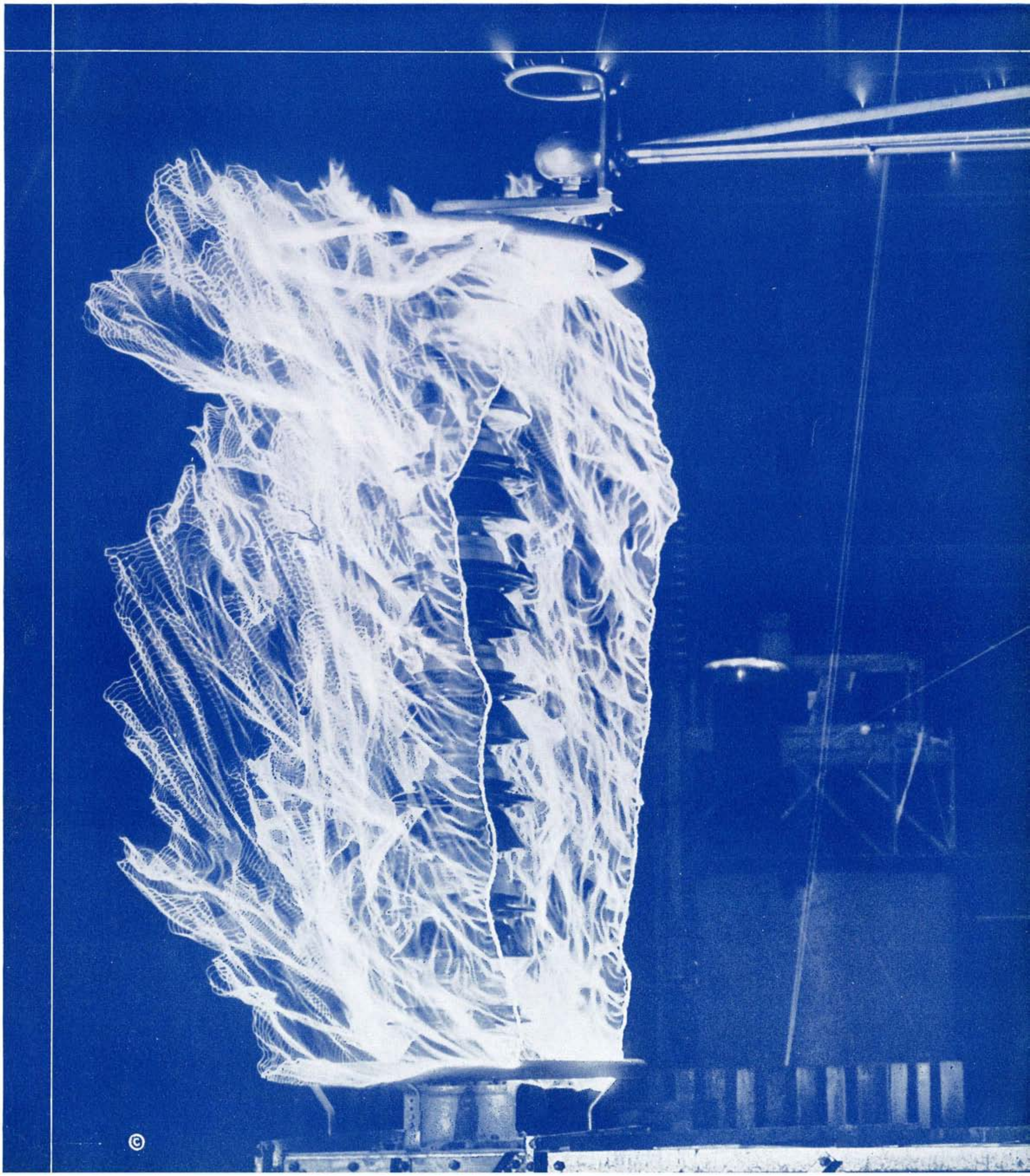
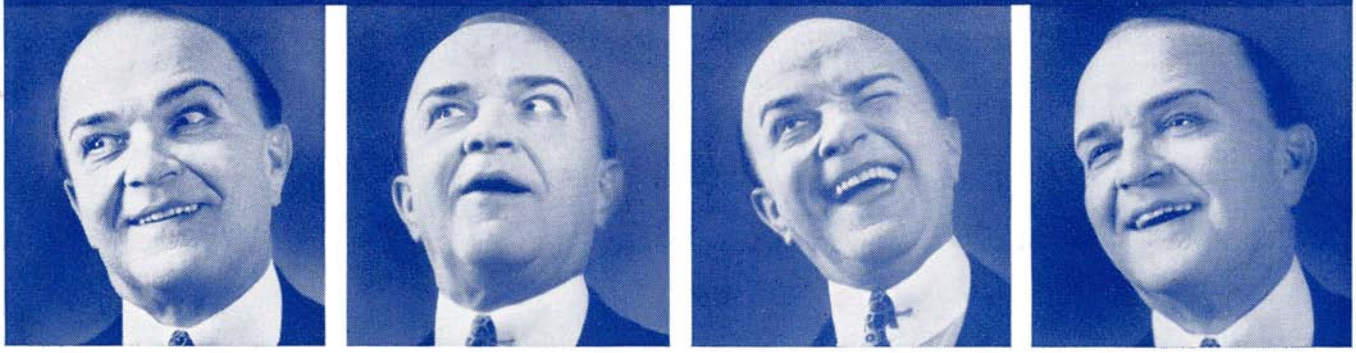


"It's the Money-Saving Car" SAYS VICTOR MOORE STAR OF "ANYTHING GOES"



My big, money-saving Dodge certainly breaks all the records I ever heard of for economy.

It gives me 22 to 23 miles to the gallon of gas and saves me easily 20% on oil.

At the rate it's saving it will cost me less than a small car in the long run.

And it's the safest, sweetest-running car ever . . . in fact that Dodge is "The Top."

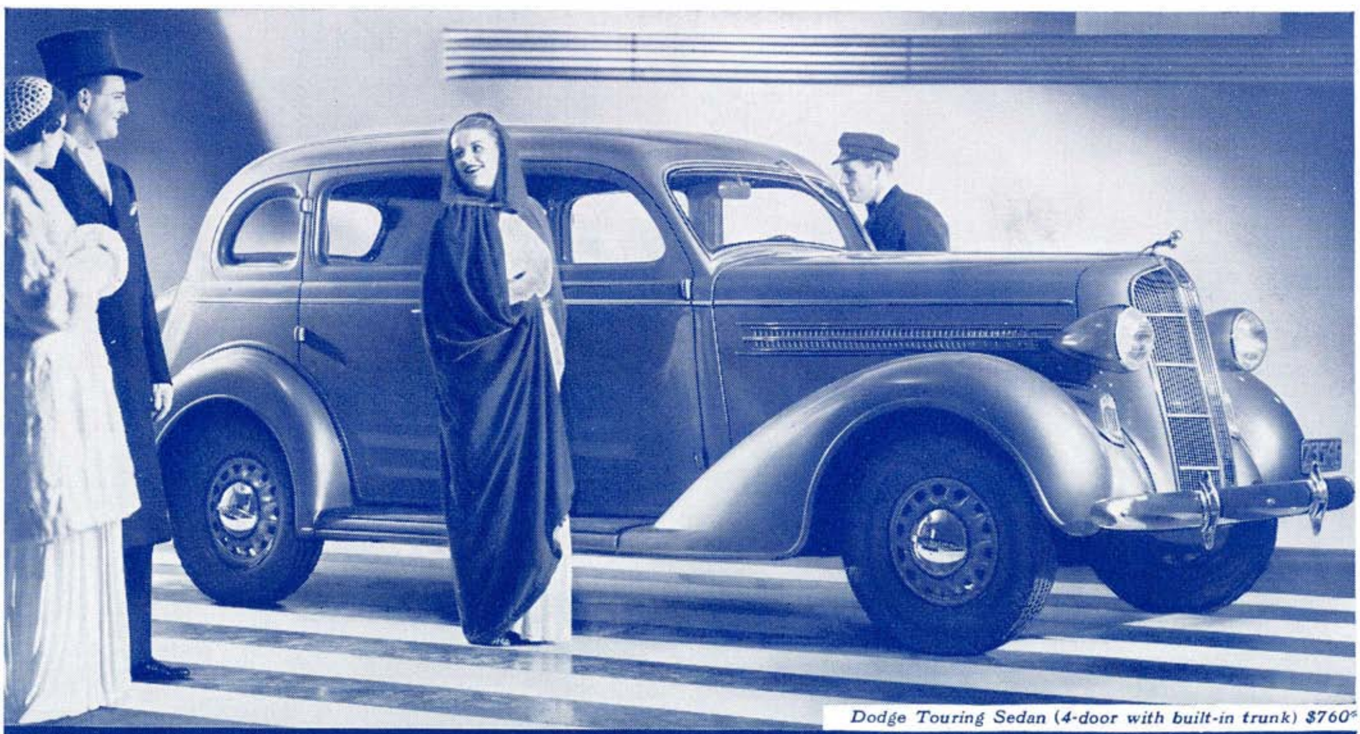
"It's the 'Beauty Winner' of 1936" SAYS BENAY VENUTA STAR OF "ANYTHING GOES"

That magnificent new Dodge is truly the "Beauty Winner" of 1936 . . . it's an eyeful!

You should see the youthful swagger and sophistication to its striking Air-Style lines!

It's not only gorgeous-looking but its interior appointments are positively fascinating.

The moment you see this "Beauty Winner" you'll itch to get at the wheel . . .



*Dodge Touring Sedan (4-door with built-in trunk) $760**

The Big Money-Saving DODGE *at new low price — only* $640*

Coupe $640, Rumble Seat Coupe $695, 2-door Sedan $695, Touring Sedan (2-door with built-in trunk) $720, Sedan $735, Touring Sedan (4-door with built-in trunk) $760. *List prices at factory, Detroit, subject to change without notice. Special equipment extra. Through the Official Chrysler Motors Credit Company New 6% Time Payment Plan you will find it easy and less costly to arrange time payments to fit your budget.

SCIENTIFIC AMERICAN

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NINETY-SECOND YEAR • ORSON D. MUNN, Editor

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COVER

OUR cover illustration this month, copyrighted by Berton Crandall, shows an 830,000 volt sustained arc-over on a huge disconnect switch being tested in the Ryan Laboratory described on page 84 of this issue. Three seconds were required to form the 10-foot long lace-like arc which contains at least 120 separate parts.

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN, February, 1936. Vol. No. 154, No. 2, 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. Copyrighted 1936 by Munn & Company, Inc. Great Britain rights reserved. Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 Years Ago in . . .

Scientific American

*I*T IS *frequently the case that present-day advances in science and industry can be more fully appreciated when there is available some knowledge of what has gone before. The accompanying excerpts from Scientific American for February 1886 were selected from our files for their inherent interest and significance. If you would like to see this page continued as a regular feature of Scientific American, won't you write us a note to that effect?*

ORSON D. MUNN, *Editor and Publisher*

CASTINGS—"The presence of occluded oxygen and of oxides in metals has long been recognized as the cause of deterioration of quality which appears as flaws in casting or in reduced strains. The removal of oxides is generally accomplished by adding more readily oxidized substances, like manganese in steel, phosphorus in copper and bronze, and magnesium in nickel."

TRAIN TELEGRAPHY—"The Edison railroad telegraphy apparatus on board the train is all attached to a compact operator's desk, occupying no more room than an ordinary car seat. The apparatus consists of an ordinary Morse key, phonetic receivers, an electro-magnet, a vibrating reed, an induction coil, and a battery. The car roofs are covered with tin and connected electrically by copper wire. As the induction takes place between telegraph wires and the tin roof, it is desirable to have as large a metallic surface as possible. The Morse alphabet of dash and dot is employed, and consequently any operator can work the system. When the key is pressed down to form a letter, the short circuit is closed and the current passes through the primary coil. But the vibrating reed breaks the current each second into five hundred waves, and these electrical waves induce corresponding ones in the secondary coil. The function of this induction coil is to transform the intermittent current into one of high electrical tension."

DEPRESSION—"On all hands the cause of the recent stagnation in trade is assigned, by business men, to overproduction. . . . It has been pertinently remarked that 'putting aside the wealthy classes, there never was a time in which more people could wear silk and broadcloth, have vacations, take journeys, eat ice cream, provide pianos and organs for their families, go to the races, the theater, and the polo ground, than at the present time.' "

WATER—"The Holly Manufacturing Company, of Lockport, N. Y., have just completed the water works at Fond du Lac, Wis. The engines are two compound Gaskill engines, of 3,000,000 gallons each per 24 hours, and pump through 14 miles of pipe to 140 hydrants, etc."

CANALS—"An examination of the relative merits of canal and railway transportation, as illustrated in the case of the Erie, shows that in addition to its want of speed and the inconvenience arising from the winter's deadlock, the canal, all things considered, is the more expensive carrier."

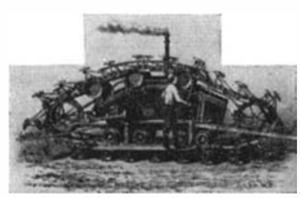
GAS—"It has only been within the past few years that natural gas has been utilized to any extent in either Pennsylvania or New York."

OTTO GAS ENGINE—"The important case of Otto *vs.* Steel, which had been fought for sixteen days before Mr. Justice Pearson, in the chancery division of the High Court of Justice, London, England, ended on December 19, with judgment for the plaintiff. The point at issue was the validity of Dr. Otto's patent of 1876, which was strongly contended for already in Otto *vs.* Linford some years ago, and then decided in favor of the well-known inventor."

SHELLS—"A novel departure in the line of gunnery is a shell or projectile, the principle of which is to fill the two compartments of the shell with chemicals which, in themselves, are harmless and non-explosive, and to manufacture an explosive compound—nitroglycerine—by combining these ingredients during the flight of the projectile."

FUEL—"The house of the near future, the *Boston Journal of Commerce* thinks, will have no fireplace, steam pipes, chimneys, or flues. Wood, coal, oil, and other forms of fuel are about to disappear altogether in places having factories. Gas has become so cheap that already it is supplanting fuels."

FARM TRACTOR—"The novel locomotive herewith illustrated carries and lays its own track, which consists of an endless chain passing around two sprocket wheels, one at each end of the locomotive, feet for resting upon the ground, and jointed side rail sections forming the track. The rear sprocket wheel is driven by a suitably arranged steam engine. One man can manage the locomotive and a gang of ten plows."



ELECTRICAL PATENTS—"Prior to the year 1881, electrical apparatus was only a Patent Office sub-department under the general classification of philosophical instruments. In that year, it was made into a separate class. Since then, the number of inventions has multiplied so rapidly that during the past year the electrical department was given nine classes in place of one. The greatest epoch in the history of the art was in 1876. Before that time, there had been but 1973 patents . . . for electrical inventions. Since then . . . 8000 new patents."

CO_2—"Carbonic acid gas was proposed years ago for use as a fire extinguisher, but though it possesses many of the best qualities for such a purpose, it has never come into general use. It is readily procured, and cheap. It is heavier than air, and can therefore be poured over a fire very much as one would pour water. Even when diluted with three volumes of air it will still extinguish fire."

AND NOW FOR THE FUTURE

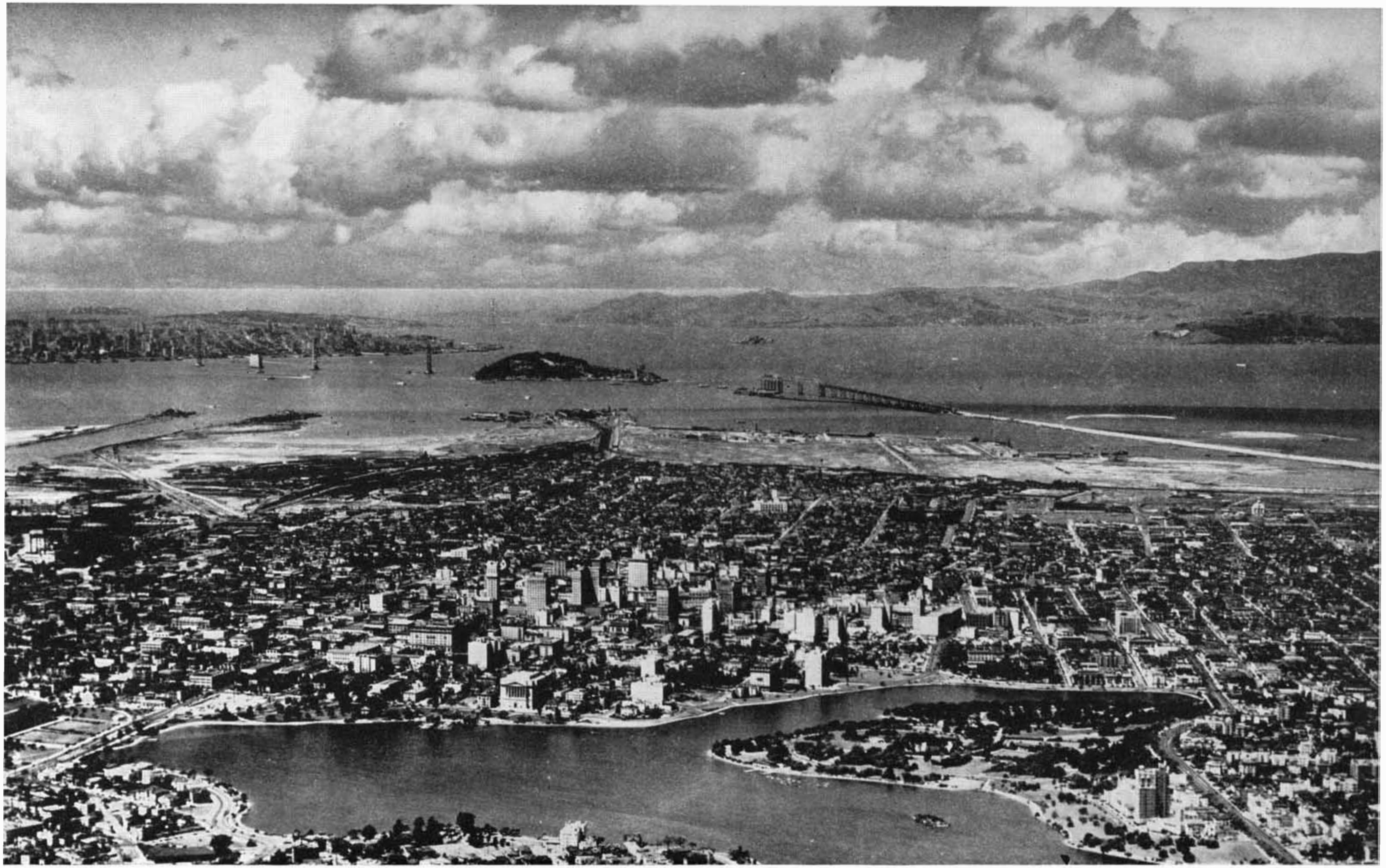
¶Vitamins: Facts and Fancies About These Important Factors in Human Diet, by T. Swann Harding.

¶The Attack by Modern Science on the Motor-Car Accident Problem, by John Henshaw Crider.

¶Hypnosis: The Present Status of this Interesting Phase of Psychology, by Professor G. H. Estabrooks.

¶The Nation's Dependence on Imports of Essential Raw Materials, by Philip H. Smith.

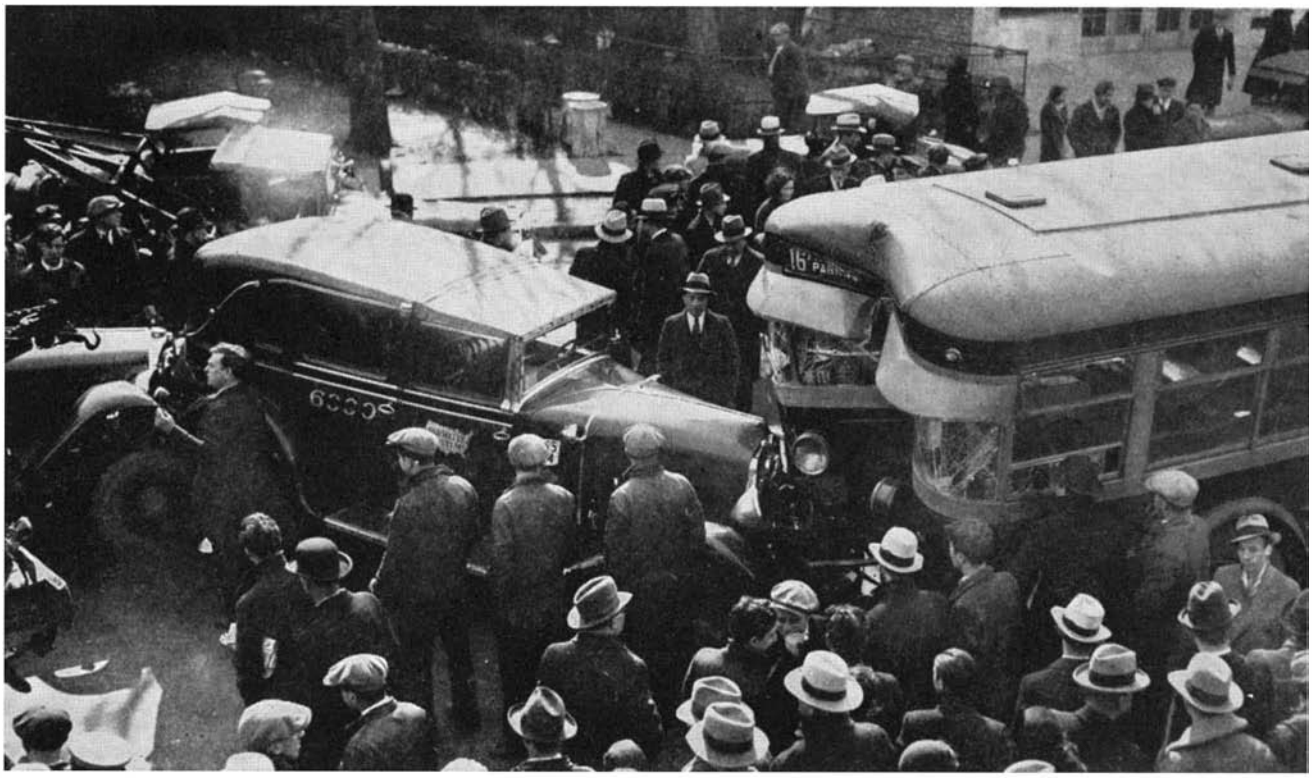
¶How Engineers are Combating Beach Erosion on Our Sea Coast, by R. G. Skerrett.



© Associated Oil Co.

TO END SAN FRANCISCO'S ISOLATION

NOT content with half-way measures, San Francisco, isolated on the peninsula at the left center near the Pacific Ocean horizon, is being connected to the mainland by two important bridges. Stretching from Oakland, in the foreground, is the San Francisco-Oakland Bay bridge which has one foot (or, rather, two anchorages and a tunnel) on Yerba Buena Island. Close scrutiny shows in the distance two piers of the famous Golden Gate Bridge, the great cables of which are now being spun.



Dangerous concentrations of carbon monoxide may frequently be the cause of accidents such as this one

DEATH AND CO

Unexplained Accidents . . . Asleep at the Wheel . . . Carbon Monoxide (CO) Responsible . . . How to Avoid Dangerous Concentrations of the Gas

By LAWRENCE A. CLOUSING
School of Engineering, Northwestern University

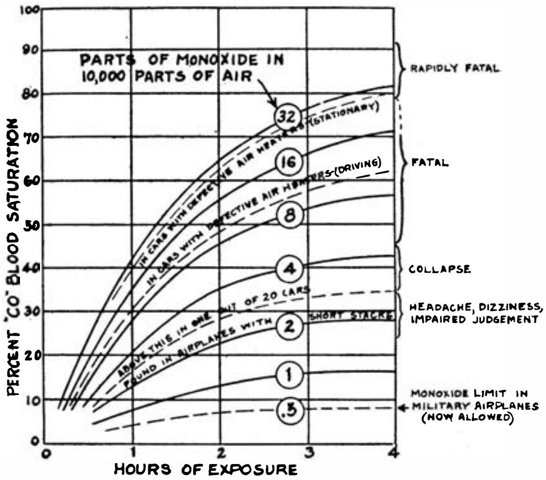
ONE of the definite causes of motor-car accidents that has not received sufficient attention in the past is the presence of carbon monoxide in closed cars and in the closed cabs of trucks. Particularly vicious is this menace in winter time when the windows are often tightly closed. The accompanying article deals specifically with the results of an investigation of the carbon monoxide content in cars as found in a survey of motor vehicles picked at random on public highways. From these findings it is possible to draw a complete picture of the situation and to recommend remedies for it. Every motor-car driver will be protecting his own life and property, as well as those of others, if he will read carefully and be guided accordingly.—*The Editor*

WHEN, each year, there are 500,000 unexplained highway accidents, and when the prevalence of accidents from sleeping at the wheel is on the increase, something must be wrong. Liquor and high speed cannot be totally to blame. There must be other causes. There are! One cause, insidious in effect and heretofore unsuspected, has recently been brought to light as a result of a thorough investigation of the automobiles now operating on our highways.

It is carbon monoxide—CO. Not that carbon monoxide actually kills people by asphyxiation while they are driving; it is rather the drug effect of this gas —producing sleepiness and inalertness —which is the great danger to drivers. Unbelievably small concentrations in the car's interior, breathed for an hour or two, can produce sleepiness, headache, and impaired judgment, yet the driver will not be fully aware of his condition.

It is alarming to note, therefore, that one car in 20, including trucks, contains dangerous quantities of carbon monoxide in the driver's compartment. Winter, with its closed window driving, makes it all the more important that drivers have a thorough understanding of the carbon monoxide danger.

NOT long ago, for example, a truck driver was found dead at the wheel in his truck parked along a road. A report on the case stated: "While dead men tell no tales, a half-empty box of headache tablets, and footprints in the snow around the car, bore mute evidence that the driver had suffered headaches before the tragedy. Apparently the driver, realizing he was 'groggy,' had pulled off the pavement for the purpose of taking a nap. He was found several hours later seated at the wheel with the engine still running. Later, when a carbon monoxide detector was placed within the cab and the engine started, the detector showed a concentration of carbon monoxide which would cause the death of any normal person



CO concentrations. See the text

after only a brief exposure. It was not feasible to test the car on the highway, but there is little doubt that the concentration then would have been sufficient to result in drowsiness, if not complete collapse."

An examination of the exhaust system of the death truck disclosed the fact that the seam of the muffler contained a rip which permitted exhaust gases to be blown inwardly against the floor boards. Openings around the floor boards then permitted the deadly gas to filter into the car. There were also leaks in the flange connecting the exhaust manifold and exhaust pipe. Furthermore, the carbureter of the engine was in such poor adjustment that five to ten times the ordinary percentage of carbon monoxide existed in the exhaust gases.

THE effect of carbon monoxide on human beings depends on the concentration of the gas and the length of time breathed. Chemically it reacts with the hemoglobin of human blood in nearly the same way that oxygen reacts. Normally the blood absorbs oxygen from the lungs and carries it to the various parts of the body in a constantly circulating process. If, however, carbon monoxide is in the atmosphere, the hemoglobin combines with it instead of with oxygen. In fact, the affinity of hemoglobin for the deadly gas is about 300 times as great as it is for life-sustaining oxygen. Therefore, in an atmosphere in which there is one part of carbon monoxide to 300 parts of oxygen —or 1500 parts of air, since only 20 percent of the air is oxygen—or, restating: seven parts carbon monoxide to 10,000 parts air—50 percent of the blood would in time become saturated with carbon monoxide. This is sufficient in most cases to cause death. Hemoglobin which has combined with carbon monoxide is no longer capable of carrying oxygen. Since the number of oxygen-carriers is now reduced, the body suffers because of lack of oxygen and for no other reason. Thus, in time, a form of suffocation takes place, even though the victim may breathe.

The exact degree in which this reaction takes place is illustrated in the curves shown at the left, where percentage of carbon monoxide saturation of the blood is plotted against time of exposure, and the attendant physical effect is indicated at various blood saturations. When from 25 to 35 percent of the blood is carrying carbon monoxide, the person may suffer headache, dizziness, or nausea as a result of oxygen deficiency. A person in such a state can not make the necessary instantaneous decisions required in driving a car; his mental processes are too sluggish.

For example, a truck driver, after being on the highway for several hours, drove at moderate speed into the rear of a parked truck, and was killed. Examination of the dead driver's blood very readily showed a carbon monoxide content which would seem to account for his poor driving judgment and lack of alertness, although the damage to the truck prevented examination of it for the sources of carbon monoxide content in the driver's compartment.

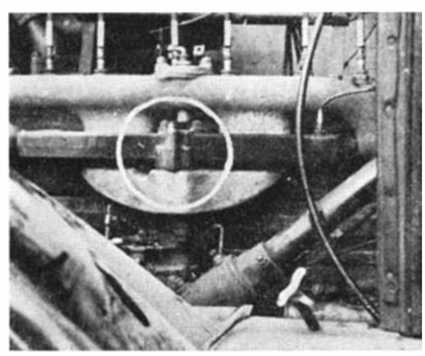
IN another case, a driver in a pleasure car, after several hours at the wheel, drove into a street car safety loading zone. He struck and killed one person, while two others escaped injury by jumping clear. He acted drunk. Police took him in hand and charged him with driving while intoxicated. However, the police physician discovered no alcohol in the man's blood but, instead, discovered the presence of carbon monoxide.

It is seen from the chart that it is less harmful to breathe a relatively high concentration for a very short time, than it is to breathe a small concentration for a long time. As low a quantity as two parts in 10,000 is sufficient to cause headache, dizziness, and impaired judgment, if breathed for three to four hours, while four parts in 10,000 may even produce collapse, and may be fatal. These are the effects upon an average person. A person small in stature, or a child, is more readily affected.

In the investigation which was previously mentioned and which was carried out by the Cities Service Oil Company in co-operation with the highway officials of seven eastern states, 200 cars were stopped at random along the public highways, and were thoroughly investigated for carbon monoxide content, exhaust leaks, and reactions of passengers to long drives. These tests revealed that one car in 20 contained a dangerous concentration of carbon monoxide, and about one out of two cars contained traces of the gas, indicating, thereby, a potential danger.

Carbon monoxide may get into the closed interior of cars in many ways. It has been found that exhaust gases may come in through an open rear window. In any car not streamlined, the vortices behind the car—air current whirlpools—may catch the exhaust gases and fling some of them back into the car through a rear window. In cars such as station wagons, having only a curtain in the rear, carbon monoxide from this source may be bad.

IT is possible to pick up quantities of this dangerous gas from a car ahead in traffic. Some cars have ventilators or heaters which draw air from the front end of the car. With such an installation, the pick up of exhaust gases from a car ahead is accentuated. Large quantities of the gases are given off by buses or trucks on heavy pulls or at high speed. There is on record an actual case of a car having a front ventilator installation which, although in perfect condition itself, drew in enough carbon monoxide, while stalled in traffic behind a heavy vehicle, to affect the alertness of the individuals in the car and cause several headaches. The concentration was high enough to have caused collapse and fatality in two hours. Although this was an extreme case, it no doubt happens frequently, and may be the cause of many highway accidents.

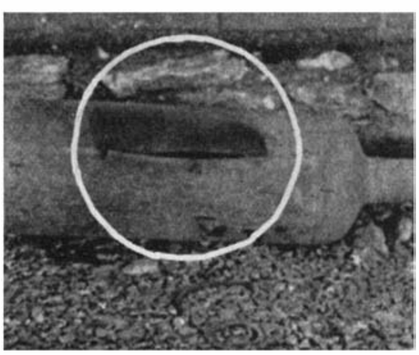

Exhaust gasket leaks should always be repaired immediately for safety

In the case where the heating of the car is accomplished by hot air taken over the exhaust manifold, the carbon monoxide content of a car is invariably high. In many such cars tested, it was found that they were lethal chambers, as much so as those used by the state of Colorado to impose the death penalty on convicts. Any gas leaking through the exhaust gaskets is forced into the car. Asphyxiation of many motorists has been traced to this cause.

In one case, two people were asphyxiated while the car was parked. A gas analysis of the atmosphere of the car showed that within five minutes after the engine was started a lethal atmosphere existed. The car had an exhaust manifold heater, yet it was disclosed on examination that the leak of exhaust gases from the exhaust manifold into this heater was not sufficient even to cause an audible sound. Even the air in the car, though of fatal concentration, contained no warning odors. The windshield of the car bore a sticker certifying that the car had satisfactorily passed the state examination for safety devices only a few weeks before the tragedy. Such is the insidious nature of carbon monoxide.

THE crankcase breather may be another source of carbon monoxide. This vent of the crankcase is sometimes under the hood. In such cases the gases which blow by the piston rings in an engine during the combustion stroke are released under the engine hood. Thence they may work into the interior of the car, where, added to gases from other sources, they may cause trouble. It takes but a "glassful" of carbon monoxide in the ordinary car to give it a dangerous concentration of the "poisonous" gas. This much is contained in a "hatful" of exhaust gases.

Last year carbon monoxide killed 500 to 700 persons who operated their automobile engines in garages with closed doors either intentionally or unintentionally. A small car can render the atmosphere of a single-car garage deadly within five minutes with the engine running and the doors closed. Breathed, it will produce asphyxiation in a short time. These facts are fairly well known, but it is against the effects of low concentrations of carbon monoxide which



A broken muffler discharged exhaust gases against the floor boards

are insufficient to cause death that the driver must guard.

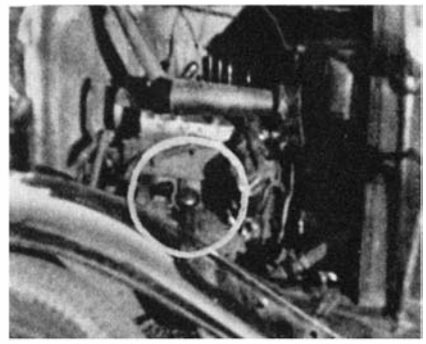
The driver's best safeguard against carbon monoxide is good upkeep of his car. The exhaust system of the car should be kept tight. Leaky gaskets or connections should be replaced immediately, and the entire exhaust system checked at intervals. The floor boards should be kept tight and properly covered. There should be no opening, by means of which gas can seep in, connecting the engine with the driver's compartment of a car.

It is very important to see that the engine combustion is proper, and that the carbureter is properly adjusted. The ignition system should be kept in good condition. Proper adjustment of the carbureter not only prevents large concentrations of carbon monoxide in the exhaust gases, it saves fuel as well.

Another common-sense rule proposed by the National Safety Council, a body which has made considerable study of automobile accidents, is this: "If you drive long hours on the highway, stop occasionally for a 'breathing spell.' An occasional pause to exercise in fresh air not only tends to replace with oxygen any carbon monoxide you might have breathed during the preceding couple of hours, but the resulting relief from muscular and mental tension will make you a safer driver." This is proposed because the union of carbon monoxide and hemoglobin is not permanent. If fresh air is breathed, the carbon monoxide is displaced by the oxygen, and the blood returns to normal, absolutely unharmed by its contact.

IN airplanes at high altitudes, the effect of carbon monoxide is even more dangerous than in motor cars. Doctor David A. Myers of the Medical Division of the Army Air Corps states: "The ability of the blood hemoglobin to absorb oxygen depends largely on the percentage of available oxygen in the air, which decreases as altitudes are reached. Exposure to carbon monoxide decreases the ability of the blood to absorb and carry oxygen; therefore the degree of anoxemia (lack of oxygen) produced by breathing a given concentration of carbon monoxide at 14,000 feet should be much greater than that from breathing the same concentration of carbon monoxide at sea level. There are no data available on this phase of carbon monoxide and its effects on man in the literature. Research along this line should produce much useful information. At the present time whenever a casualty occurs in the Air Corps, blood specimens are obtained and examined for carbon monoxide. Efforts are being made to check frequently all cockpits and cabins for carbon monoxide."

The Army and Navy Air services have specified that one half of one part in 10,000 parts air is the limit of carbon monoxide content they will allow in airplanes. This figure was arrived at as a result of many tests and much research. It was known for some time that in military airplanes with short stack radial engines the exhaust gas was breathed by the pilot to a certain extent. Tests showed that sometimes the pilot breathed air of three parts carbon monoxide in 10,000 parts air. When it was learned by Army Air Corps authorities that three parts in 10,000 caused dizziness and very nearly collapse if breathed for three to four hours, there was a change in the design of those airplanes, much to the pleasure of the pilots. Much of the disagreeableness and air sickness of flight in airplanes of older design and perhaps many of the



Crankcase breather pipes may be a source of fatal carbon monoxide

unexplained accidents were due to carbon monoxide.

While we are concerned here primarily with carbon monoxide (CO), the effect of other constituents of exhaust gases from automobile engines may be of interest. Other products present in gasoline engine exhaust gases are carbon dioxide, oxygen, methane, hydrogen, and nitrogen. There are indications of the presence of small quantities of various aldehydes, but in concentrations too low to produce any toxic effect. When tetraethyl lead is added to gasoline, it is thrown out of the exhaust in particles of lead sulfate, lead oxide, and metallic lead, all of these compounds being solids at ordinary temperatures. In airplanes, some of these particles may reach the cockpit in fine dust.

However, it has been found that this lead dust has no deleterious effect on humans in small quantities. Lead retained in the lungs after inhaling dust in an exposure chamber averaged but 15 percent of the total inhaled, showing that considerable amounts are exhaled or deposited in the nasal passages or throat, where they are swallowed or expectorated. This behavior of the lead that remains in the air as suspended matter greatly reduces the danger of lead poisoning. In cases where animals have been exposed to lead dust air for 188 days, no lead poisoning resulted.

SOME of the other constituents present in engine exhaust gases, while not necessarily harmless if breathed in large quantities, are really harmless in practice because in the concentration in which they would be breathed the effect compared with that of carbon monoxide would be negligible.

OUR POINT OF VIEW

Pacifistic Piffle

"THERE is still hope for China if the Chinese will keep up their resistance long enough for Great Britain and the United States to realize the inevitable implications of Japan's further encroachments on China. Given this realization, the opportunity will soon arise for successful and comparatively easy intervention by the two great sea powers, and the grandiose plans of the Japanese war lords will tumble like a house of cards about their Chauvinistic heads." This statement quoted from "The Problem of the Far East," by the Editor and published in our November Navy Number, judged against the background of the context of the complete article and of the numerous expressions of this magazine's hope for lasting, honorable peace, means just what it says. It means, as our regular readers know, that America is honest enough to observe the letter and spirit of its treaties and believes that, when others are not so honest, displeasure should be expressed by the two nations mentioned, acting in concert in the cause of peace and justice for all mankind. Precisely that has happened, though without premeditation, for a recent newspaper headline reads: "U. S. and Britain warn Japan on North China activities; Hull cites treaty rights."

Apparently, however, Scientific American did wrong in suggesting "honesty" and "honorable peace" and in dragging in that opprobrious word "patriotism" to disturb the peace-cultists. Frederick J. Libby, writing in *Peace Action*, of which he is Editor, quotes the single paragraph at the head of this discussion, with the unequivocal headline: "Editor of Scientific American wants war!"

Droll! Droll and ridiculously naïve!

That is not all. Like a bad rumor, passed over backyard fences and expanded with each reiteration, that yarn has grown to the point where this journal is said to advocate extreme measures in the Orient. Mr. Warren D. Mullin, head of the labor department of the National Council for the Prevention of War, was recently quoted by the *Sheboygan Press* as saying at a peace meeting in that city that "A magazine, Scientific American, suggested running out the Japanese and then ministering to the Chinese ourselves, and taking a nice profit doing so."

Droll! Very, very droll!

We will not argue. There is no argument. We answer both of the quoted statements with one categorical denial. Both are untrue, misleading, and libelous. They exemplify the methods of the myopic tribe of pacifists. These gentry seem incapable of making a logical evaluation of a whole subject but rely upon innuendo and misstatement to gain their ends. Their vocabulary abounds in catchwords and cant. Theirs is wishful thinking; through an emotional approach to the war problem—citation of the blood and horror *results* rather than the inept, stupid diplomacy *causes*—they would banish war and assure permanent peace.

On the other hand, Scientific American, as a magazine, and its staff as individuals, are pacifists of the Realist school. Never in modern times have we advocated, even suggested, military action against another nation. We *have* urged attainment of adequate national defense, and will continue to do so—in the cause of peace; for we face the facts of history. This country has been drawn, *unprepared*, into at least three foreign wars. On August 3, 1842, a Congressman announced that "we have no prospects of war. . . ." In April, 1896, Representative (Uncle Joe) Cannon said, "I want to say that I do not believe we will have war during the coming year. . . . I doubt if there will be any during this century or perhaps the early years of the next century." The late Dr. David Starr Jordan said in 1914, ". . . Humanly speaking, it (the ever-impending great war of Europe) is impossible. There is too much at stake." A few months later the war flame was ignited in Europe, with consequences to ourselves unpredictable and beyond our power to avert. Our wars with Mexico in 1846, with Spain in 1898, and with Germany in 1917 might have been prevented, or at least our ghastly losses in men and money would have been held to a minimum, had we been prepared.

Scientific American is in the thick of the fight for peace. This we have stated time and time again. But it must be peace with honor—no grovelling peace in which we bend the knee at the whim of any nation that wishes to command us.

In fighting this cause for honorable peace through a preparedness that forces other nations to respect our peaceful national policies and refrain from attacking us, Scientific American listens not to emotional, vociferous minorities; to radicals who care not for peace but make a pretense of doing so to cloak their subversive activities; nor to defeatists who see only the blood of war and not the education and diplomacy that can prevent the horror. Scientific American knows that no amount of wishing can stop war, nor can quotation of half-truths or millions of names on an I-won't-fight pledge. Education will, but it must be sane, logical education. And while the world is getting a proper understanding of the disease and working out the remedy, the nation must not be spineless. Preparedness will be our finest peace insurance during those long years. Being a non-aggressor nation, the United States will never use its forces of national defense unjustly. Being, nevertheless, a dynamic nation, a nation of widespread and active interests throughout the world, we can not afford to risk attack by some nation jealous of our wealth, our prestige, our progress, and our peace.

When the emotional fever of the peace-at-any-price propagandists has burned itself out, we shall, perhaps, enter an era of permanent, honorable peace.

Game Increase

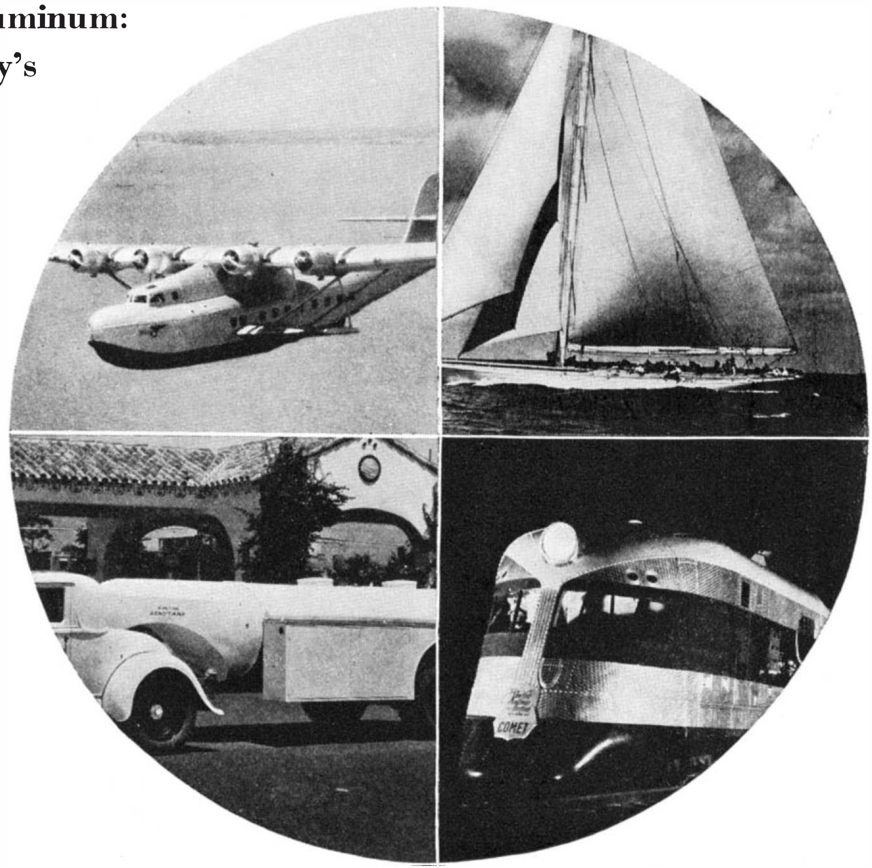
ANTELOPES, deer, elk, moose and mountain sheep, long threatened with extinction, have been staging a come-back. In our National Forests there has been a general increase in the past several years in the numbers of these game animals, according to a report from the Forest Service.

The last estimate shows an increase of about 600 in the number of antelopes in western National Forests during the preceding twelve-month. This brought the total to about 15,000. Deer increased by about 100,000, bringing the total to 1,040,000. Elk increased from 115,000 to 120,000; and the count of moose went up to more than 8000. Mountain sheep increased to 13,000; but mountain goats decreased slightly to 17,900.

The Forest Service, in practicing game management, observes the principle of "sustained yield" of all forest resources. The aim is to develop and maintain as much wild-life—in coordination with other forest values—as the forests can support. Judging from the results quoted above, the Service is doing a fine job preserving the larger species of game animals.

Aluminum's Future

The Next Fifty Years of Aluminum: In the Light of Yesterday's Progress and Tomorrow's Research Possibilities



Aluminum's present: Lightweight alloys of great strength are used in the *China Clipper,* in yachts and ocean liners, in large-capacity motor trailer units, in streamlined railroad trains, and elsewhere. What does the future hold in store?

By W. S. McARDLE

ON the eve of aluminum's second half-century of commercial service, it is interesting to pause for a moment to consider the past and the future.

In the early eighties, aluminum was an expensive metal with few uses and a dubious outlook. Charles Martin Hall, 50 years ago this February, revolutionized the entire aluminum industry through the development of a process for electrolytically producing the metal from its oxide. Almost overnight, the price of aluminum dropped; and 50 years have seen the creation of many diversified markets. Today, aluminum ranks fifth in point of tonnage among the world's metals, being surpassed only by iron (and steel), copper, lead, and zinc. Dreams of the eighties have come true; aluminum trains, bridges, and buildings are actualities! What the next 50 years will hold for the metal is largely a matter of conjecture, tempered by yesterday's records and tomorrow's conditions.

In its struggle for a place in industry, aluminum was endowed with a number of outstanding characteristics which, when taken collectively, were possessed by no other single metal. Briefly summarized, these included lightness, resistance to corrosion, good electrical and heat conductivity, excellent workability, non-toxic properties, and attractive appearance. These properties, either individually or in combination, have accounted for practically all of aluminum's uses, and it is reasonable to assume that future applications will likewise be based on them.

THE growth and development of the aluminum industry have been closely intertwined with research. Most of the major events in the aluminum world have been preceded by months of patient endeavor in laboratories. Quite naturally, then, we turn to research for our first clue as to what the future may hold for the metal.

From the discovery of the electrolytic process in 1886 down through the World War, practically all work with aluminum was confined to about three alloys. While the German metallurgist, Wilm, had worked out methods of heat-treatment designed to strengthen and improve the working characteristics of the metal, the development of the strong, wrought alloys of aluminum in the United States came almost entirely after 1920.

Between 1920 and 1935, there were astonishing strides in the development of aluminum. Scores of new alloys appeared with characteristics far better fitted to cope with the conditions surrounding their use. Tensile strength was increased to a point equalling that of structural steel, and rapid strides were made in the development of corrosion-resisting alloys.

But the ultimate is by no means in sight; the future will see aluminum alloys with still better properties. While it is true that for present needs the aluminum alloys used are adequate, tomorrow's needs will be even greater and it will be necessary to create new aluminum alloys to cope with them.

At present, the alloying elements or "hardeners" commonly employed with aluminum are copper, magnesium, manganese, silicon, and nickel. Occasionally, tin, titanium, and chromium are added. In many cases, the addition of a minute quantity of one of these is sufficient to change the properties of the alloy. By shifting the proportions, an almost limitless variety of properties is achieved.

Commercial application of known alloys must be co-ordinated with known process development, such as jointing, plating, and surface finishing. Add this effort to the rapid strides that will be made in all industries, many of which will need aluminum, and a half-century is too short a period for a slowing up in aluminum progress.

Photographs courtesy Aluminum Company of America

Husky aluminum-bodied trucks at Boulder Dam haul 25 tons of rock and earth per load

One of the chief problems with all metals in the past has been that of corrosion. This single item has accounted for the destruction of millions of dollars' worth of property annually. Aluminum is better fitted than many metals to resist corrosion attack, in that it has a protective oxide coating on its surface which halts further oxidation. This coating, which nature has given the metal, may be built up by means of an anodic treatment, which materially improves its resistance.

Toward a complete solution of the corrosion problem, aluminum research facilities have been directed for several years. While the anodic treatment is a step nearer the goal, even greater progress may be made in the development of new aluminum alloys, designed to resist corrosion more completely. Eventually, then, corrosion-proof aluminum alloys may become a reality and the metal will be employable in countless places where even the advanced treating processes of today have proved inadequate.

ACCURATE as is the present system of manufacturing controls, the future will see greater improvement, and the various processes may in time be controlled almost entirely mechanically, thus eliminating the chances for error which the personal element presents.

Scientific progress will naturally be reflected in improved metal properties. But how will tomorrow's industry be able to utilize the advanced alloys of aluminum?

Undoubtedly, one of the first industries to take advantage of aluminum progress will be the transportation industry. Today, aluminum alloys are used in the manufacture of railroad trains and electric street cars, automobiles, buses, and trucks, airplanes and dirigibles, and marine vessels. Common to all are four objectives: speed, safety, comfort, and economy. The light alloys of aluminum have done much to foster these aims. Union Pacific's streamlined train shattered all records by crossing the continent in 56 hours, 55 minutes, with a fuel cost about equal to that of an expensive automobile. Diesel-powered, and fashioned almost entirely of strong aluminum alloys, it set a new mark in railroad efficiency. With 13 years of experience in railroad rolling stock construction, the experimental stage has passed and the era of aluminum in railroad construction is becoming a definite reality.

Contemporary air-liners are constructed almost entirely of aluminum—wings, motor, and fuselage. With ever-increasing pressure being brought to bear on aviation companies for ships that will fly farther and faster, materials must keep pace with design. Super alloys of aluminum will provide airships for the future that may hurtle through the stratosphere at a thousand miles or more an hour, bringing New York and London within a scant three hours' journey of each other, and permitting travelers to circle the globe with the sun.

Aluminum table service is undimmed by time, food, or fingerprints

Applications for the metal on shipboard in the past have been comparatively few. Aluminum has been used on occasion as a material for masts on racing yachts. Vanderbilt's *Rainbow* scudded to victory in 1934 under a mast constructed of aluminum alloys. Notable among boats built chiefly of aluminum have been the British-owned luxury cruiser, *Diana II*, and the *Interceptor* of the Royal Canadian Mounted Police. In *Diana II* strong aluminum alloys were utilized for such applications as shell plating, deck stringer plates, tie plates, and deck bolts. Ice box, cooker, lockers, and cupboards in the galley are aluminum, as are the water-tight doors between the bulkheads. Both stem and keel are formed of aluminum alloy plate, while other incidentals such as screws, roves, and nails are made of the same metal. The boat carries an aluminum mast and an aluminum motor dinghy.

The argument of light weight is quite as important at sea as elsewhere. Eventually, ocean liners will be streamlined above the waterline as well as below, as a practical aid to speed and efficiency. Weight economy will play a big factor in the choice of materials.

To take a single example of weight saving made possible through strategic selection of materials, consider insulation. In the past, refrigerator rooms, bulkheads, and so on, have been insulated chiefly with cork or magnesia. Roughly, cork weighs 10 pounds per cubic foot; magnesia, 18 pounds. A newer material now used in liners and warships is crumpled aluminum foil, which is equal to cork or magnesia in insulating value, but weighs three ounces per cubic foot!

Even the weight-saving possibilities of the use of aluminum in paint are somewhat startling. In one instance, use of aluminum paint for a cruiser permitted a weight reduction of over 100,000 pounds. This paint, incidentally, has won an important place in many industries because of its appearance, durability, and covering qualities.

To attempt to list the probable applications of aluminum in tomorrow's vessels is a matter of guesswork. Highly resistant to corrosion at present, and likely to be more so, aluminum is a logical choice for exposed metal work. Should the time arrive when we shall have aluminum alloys that are completely resistant to corrosion, applications for the metal on shipboard will be practically unlimited.

Turning again to land, we examine another field for aluminum—the automobile industry. Aluminum and the automobile were "kids together." Naturally, automobile manufacturers quickly took advantage of the light weight of

Aluminum's progress in art exemplified by Laurent's "Goose Girl" aluminum. As early as 1902, cars had aluminum bodies and numerous engine parts of the metal.

Unfortunately for aluminum, price competition changed the entire picture, and cheaper materials were employed for many parts. More aluminum, however, is being used today by the automobile industry than ever before, although its applications are limited to

Escalators use aluminum for efficiency and attractive appearance

such vital parts of the power plant as the pistons and cylinder heads. It remains for the future to create a need for a car in which the inherent lightness of aluminum will make possible a saving in operating costs sufficient to overbalance the high initial cost.

Further demands for economy will undoubtedly result in a more general adoption of the Diesel engine in the motor car of the future. Since engines of this type require more space and more metal than present motor car engines, they will be lightened by the use of metals such as aluminum. Many of today's Diesels have aluminum bedplates, crankcases, and aluminum cylinders. Tomorrow's applications will likely be even more numerous.

In the truck and bus, aluminum is rapidly regaining the market it has lost in the automobile. Economy of operation requires a reduction in dead weight, and both truck and bus operators have found that, although aluminum costs more initially than the materials formerly used, over a period of time the saving in non-productive weight resulting from aluminum construction will make possible an ultimate saving in operating cost sufficient to compensate for the metal's greater first cost. As a result, aluminum is used almost exclusively in bus body construction.

Three years ago, engineers completed the reconditioning of an important highway and electric street railway bridge in Pittsburgh with a strong aluminum alloy floor system. A total of 750 tons was saved in the weight of the bridge, and the useful life of the structure was increased at least 25 years. This important event will undoubtedly have an influence on bridge construction all over the country. Engineers have watched the work with keen interest and plans are already under way to employ aluminum in similar long-span bridges in other cities.

ONE of the earliest uses for aluminum was in the architectural field. A cap placed on the top of Washington Monument in 1884 was probably the first architectural application for the metal. Since then, millions of pounds of aluminum have found their way into buildings in the form of spandrels, decorative trim and, in some cases, actual structural parts. The Empire State Building's "mooring mast" is fashioned of aluminum and glass. In Rockefeller Center, more than 3,000,000 pounds of aluminum is utilized.

Some theorists claim that the trend toward higher buildings will necessitate the use of light alloy beams and girders in the construction of upper stories to obtain a better distribution of weight.

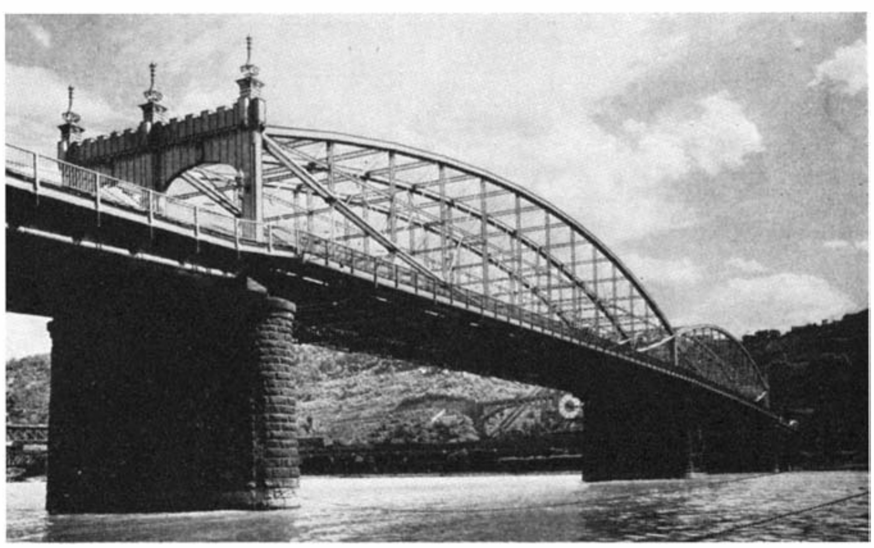
There is reasonable proof that the present trends in utilitarian architecture will continue—and this means an increasing use of metal and glass. Scientific engineering will create office buildings which are heated in the winter and cooled in the summer—t• maintain ideal weather independent of outdoor conditions. Wall thickness will be a matter of inches rather than feet. Proper insulation, such as that provided by aluminum foil, will save fuel in January and keep out the July sun's heat.

One of the first commercial uses for aluminum was in the form of cooking utensils, and its success in that field has been so successful as to warrant no further discussion. The canning industry, however, is keenly interested at present in the development of the aluminum can as a substitute for tin. One of the early investigators along this line was the Point Loma Tuna Packers, of Point Loma, California, which placed on the market in 1933 its "Luxury Brand" tuna packed in attractive aluminum cans. Experiments are being carried on with other types of food and it is entirely possible that the next few years will see the aluminum can as a definite factor in packaging. Advantages of aluminum cans, of course, include attractive appearance and safety (food may be left in opened cans if necessary).

Aluminum is highly resistant to the attack of many chemicals, and it is probable that the future will witness a marked increase in the use of aluminum in the chemical industry. Chemical tanks and tank cars are today fabricated of aluminum. Tomorrow's uses will probably be more extensive, including not only transportation equipment but considerable apparatus used in the actual preparation of the chemicals.

Only a few of the countless other applications of aluminum that appear to have an attractive future may be pointed out by way of illustration. Aluminum alloys are used more and more for steam shovel dippers and dragline booms. Aluminum ink is making its place in the printing industry. Aluminum bars are used for lion cages at the circus, while the man on the flying trapeze entrusts his life to an aluminum platform. The symphony player performs on an aluminum violin, and modern dance orchestras vibrate to the rhythm of an aluminum bass.

Aluminum is the most abundant of all the metals found in the earth's crust—twice as plentiful as iron. Perhaps tomorrow will bring forth another Charles Martin Hall who will again revolutionize the industry to magnify aluminum's usefulness a million-fold.



Bridges will be lighter and stronger as aluminum alloys gain wider use in this field. Here is the aluminum floored Smithfield Street Bridge at Pittsburgh, Pa.

A RIVAL OF THE

The Electron Multiplier . . . Bombarded Surfaces Become Electron Emitters . . . Uses in Photo-Electricity and Television . . . May Open New Fields

By VLADIMIR K. ZWORYKIN

Director, Electronics Research
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IN the past, the thermionic vacuum tube has held an undisputed supremacy in the field of amplification of small currents. Recently, a rival has appeared which may supplant it in many of its applications. This rival is the electronic device known as the "secondary emission multiplier."

The electron multiplier depends for its operation upon the fact that when certain sensitized surfaces are bombarded with a stream of electrons moving at fairly high velocities, they become emitters, the current emitted being proportional to the bombarding current but many times greater. The factor of proportionality is known as the secondary emission ratio, and for cesiated silver surfaces will range from R=3 at 50 volts to R=9 at 500 volts. It is evident that if a primary beam of electrons is allowed to fall on a first target, and the secondary electrons from it directed onto a second target, producing further secondary electrons, which are in turn directed against another target, the process being repeated n times, the original primary current will be multiplied by a factor

$$I_{output} = I_{input} \times R^n$$

It is obvious that since R will in general be considerably greater than unity and n may be 12 or higher, the overall gain will be very large. The curves shown in Figure 1 are for multipliers of various numbers of stages, showing the overall gain plotted against overall

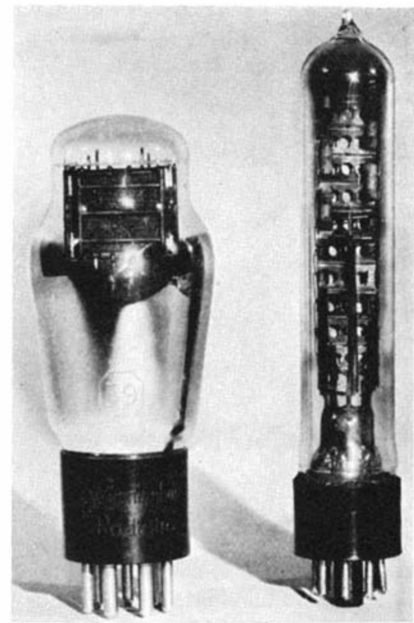

Figure 3: **A nine-stage photo-electric amplifier shown in comparison with ordinary vacuum tube, type 59**

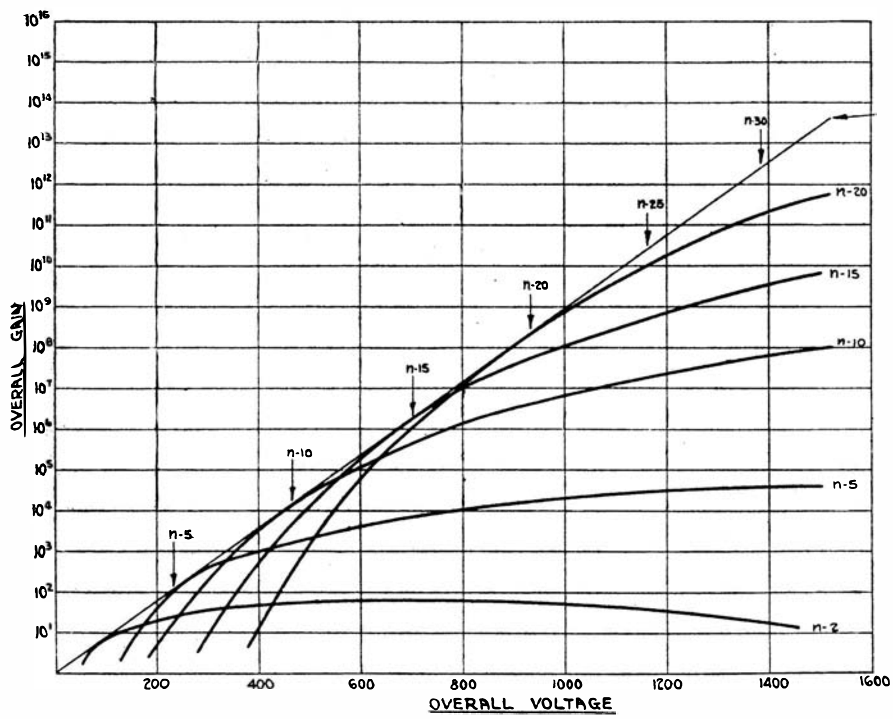

Figure 1: **The curves given are for electron multipliers with various numbers of stages, and show overall gain as plotted against the overall voltage**

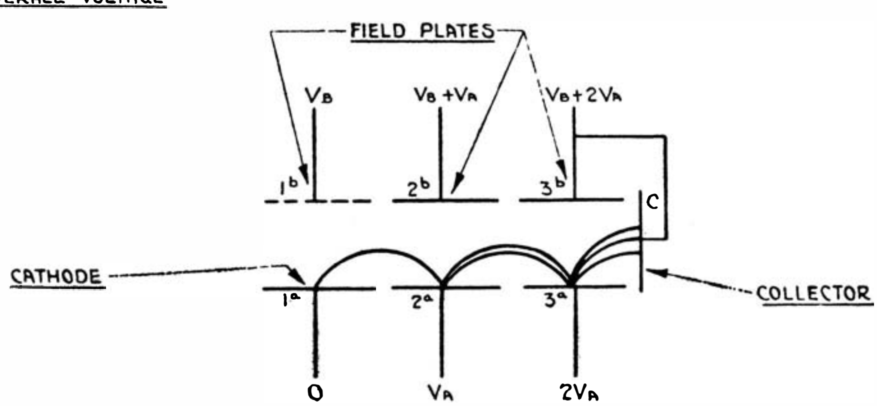

Figure 2: **Diagram of the action in an electron multiplier of the type using a combination of electrostatic and electromagnetic fields. Paths of the electrons are shown as curves above plates marked 1a, 2a, and 3a**

VACUUM TUBE

OUT of the research laboratory steps another result of research in pure science—the electron multiplier — with a bright future ahead of it. Just as the vacuum tube opened many avenues of application as it developed, so may the electron multiplier find places for itself in science and industry. It holds great possibilities for furthering developments in which the vacuum tube as we know it today has reached its electrical limits. The accompanying article describing this new device was written by its inventor, Dr. Vladimir K. Zworykin, a member of our staff of contributing editors, who clearly yet succinctly describes the multiplier, its operation, and gives a hint as to its possible applications.—*The Editor.*

Dr. Zworykin is shown at the right holding one of the new multi-stage electronic multipliers, the action of which is described in the text

voltage. For example, if we have a ten-stage multiplier operating at 800 volts, the overall gain, as indicated by the curve n=10, is a little over a million times the initial current.

There are two principal types of fixed field multipliers, one using the combination of electrostatic and electromagnetic fields; the other an electrostatic field. Both have a number of secondary emissive targets, the electrons going successively from one to the next, not striking any one target more than once, but differ in the means used to direct the electrons along their paths between the targets. Due to the fact that these tubes make use of a fixed number of multiplying impacts or stages, the stability is very great; furthermore, since the power needed to operate the device is a small direct current, it can be very simply supplied.

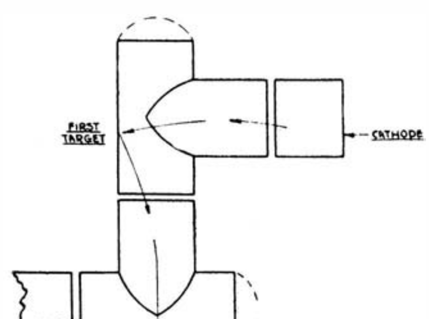

***Figure 4:* Multiplying the electronic stream from a cathode-ray tube**

An example of the first type is shown in Figure 2. The lower row of plates, 1a, 2a, 3a, and so on, are the secondary emissive targets, and are at successively higher positive potentials. The top row of plates, 1b, 2b, 3b, serve only to produce an electrostatic field in the tube at right angles to the axis of the tube. Furthermore, a magnetic field is established at right angles to the axis of the tube and the field between the upper and lower plates (that is, perpendicular to the plane of the paper in Figure 2). Electrons leaving any one of the targets are bent around by the magnetic field in such a way that they strike the next successive target, their paths being sections of a trochoid. These paths are shown as curved lines in Figure 2. The initial source of electrons, of course, depends upon the use to which the tube is to be put.

A FREQUENT application of this type of tube is as a photo-electric amplifier. For this purpose, the first plate of the lower row is made photo-sensitive and photo-electrons emitted when light strikes this electrode are multiplied as described. Secondary electrons from the last target are collected by the electrode C and appear as an output current thousands or even millions of times stronger than the initial photo-electric current. Such a photo-electric multiplier having nine stages and a gain of 1,500,000, is shown in comparison with an ordinary 59 type thermionic amplifier, in Figure 3. This multiplier serves to replace not only the photo-cell but also its associated amplifier.

Its use in photo-electricity is only one of the many applications of this tube. In general, the multiplier can be used wherever it is desired to intensify a small electron current.

Where the multiplier is used to amplify the output of a cathode-ray tube such as the television transmitting tube, the "Iconoscope," the presence of a magnetic field may be undesirable. In this case, an electrostatic multiplier is used. Figure 4 shows diagrammatically how electrons from the cathode-ray device strike the first target, the secondary electrons from the latter being directed onto the second target, and so on through the tube, for as many stages as is desired.

The greater compactness and simplicity of this type of amplifier as compared with the conventional thermionic amplifier is immediately evident. Even more important than this is the fact that these tubes have extremely low inherent noise and can therefore be used to amplify very small electron streams, in general much smaller than can successfully be amplified with an ordinary thermionic vacuum tube. Lastly, these tubes have a perfectly uniform frequency response from the lowest frequency up to many megacycles.

It is too early as yet to try to predict the eventual extent of the application of these tubes, but it seems very possible that they may open up new fields in the realm of the electronics of weak currents.

When Dust Goes Up in Smoke

A Vital Problem in Many Industries . . . Dust Explosion Control Explained . . . Fatalities Reduced . . . New Industries—New Factors

By DAVID J. PRICE, Ph.D.
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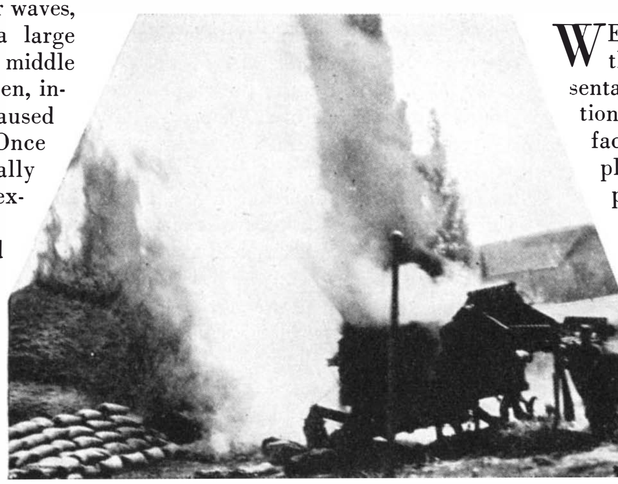
Bureau of Chemistry and Soils, U. S. Department of Agriculture

As part of a recent Farm and Home Hour radio program, the United States Department of Agriculture broadcast a demonstration of an explosion of grain dust from the dust explosion testing station of the Bureau of Chemistry and Soils at Arlington, Virginia, a short distance across the Potomac River from Washington. Just a few minutes before the experimental dust explosion demonstration went over the country by means of the ether waves, a real explosion occurred in a large soybean processing plant in the middle west. This explosion killed 11 men, injured a number of others, and caused extensive property damage. Once again attention was dramatically directed to industrial plant explosions.

What is a dust explosion and how can dust from grain and food products explode? The rapid passage or spreading of fire through a very finely divided dust cloud builds up considerable pressure and produces what we call a dust explosion. It is difficult to realize that when finely divided particles of starch, flour, powdered milk, chocolate, and many other food products are mixed with air in proper proportions, the mixture is as highly explosive as many gases. When this mixture is ignited, however, a violent explosion follows, in many cases causing heavy loss of life and destruction of property and foodstuffs. In fact, more than 28,000 industrial plants in the United States, normally employing more than 1,325,000 persons, may have a dust explosion any moment if the conditions are favorable.

Department of Agriculture records show that during the last 19 years there have been at least 385 dust explosions in connection with the handling, milling, and processing of products largely of agricultural origin. As the result of these explosions 311 persons lost their lives and more than 693 workmen were injured. The property and stock losses amounted to more than 35,000,000 dollars, or an average loss of more than 90,000 dollars for each explosion.

These explosions have occurred in practically all kinds of grain-handling operations—for example: grain elevators, flour and feed mills, and starch factories—and in many industries associated with the processing of agricultural products—sugar refining, and the preparation of powdered milk and other food products, insecticides, fertilizers, wood pulp, wood dust, soap powder, paper dust, and many others.



One of the "mysterious" explosions in a threshing machine, found by the application of research to be due to static electricity generated within the machine

Some years ago the Pacific northwest was startled by the large number of explosions in grain-threshing machines in eastern Washington, northern Idaho, and northeastern Oregon. Although local opinion was inclined to attribute these explosions to malicious activity and incendiarism, it has been pretty well established that the majority of the explosions were accidental and made possible primarily by the very favorable climatic conditions in that territory.

To intimate that a stationary machine threshing wheat in the intermountain country between the Rocky and Cascade Ranges is capable of producing sufficient static electricity to ignite explosive mixtures of wheat smut dust and air may seem to be going pretty far. But that is what occurred; the friction produced by the rubbing of the straw on the cylinder teeth of the thrashing machine was responsible for the sparks of static electricity that jumped from the cylinder to the metal concaves, igniting the dust in suspension and causing the explosion. The installation of a suction fan on the deck or top of the threshing machine and the application of ground wires for the removal of static charges prevented further explosions. It was an indication of how the results of scientific research could be applied to prevent losses of agricultural products during threshing operations.

We can go still further and point to the fine progress made by representative food industries in the reduction of losses from dust explosions. In fact, the investigations on dust explosion prevention in industrial plants now being conducted by the Federal Department of Agriculture were brought about by the interest manifested by grain millers of the country, more particularly of western New York, following the disastrous explosion at the Husted Milling Company plant in Buffalo in 1913. The Millers' Committee, consisting of L. E. Harmon, then President of the Buffalo Cereal Company; F. F. Henry, Manager of the Washburn-Crosby Company; and George P. Urban, of the Urban Milling Company, made it possible for the Federal Government to co-operate with the grain-milling industries in a thorough study of the causes of dust explosions in industrial plants, with a view to the development of methods of prevention. The active interest manifested by the Millers' Committee and the early provisions made by them for conducting both the necessary engineering and chemical research investigations have been of inestimable value to all American industries.

The food industries, where dust explosions were very frequent, have made practical application of the results of the scientific research work on dust explosion prevention. As a result there has been a marked reduction in losses from dust explosions in these industries during the five-year period from 1930 to 1934, inclusive. In flour mills, for example, there have been only five explosions during that period. One man was killed and ten were injured, and the total property loss reported as the result of the explosions and the fires which followed amounted to 131,600 dollars.

In starch and corn products plants, where heavy losses of life and property have occurred as the result of dust explosions, only two explosions were reported during the last five-year period. In one of these cases there were no fatalities or injuries and practically no property damage. In the other case, six lives were lost and ten employees were injured, and a property loss of 7500 dollars was incurred. This explosion took place on September 20, 1930, and an explosion involving loss of life in a starch factory has not occurred since that time. This remarkable record for the starch and corn products industry is a significant indication of the value of the work of the safety organizations in this industry.

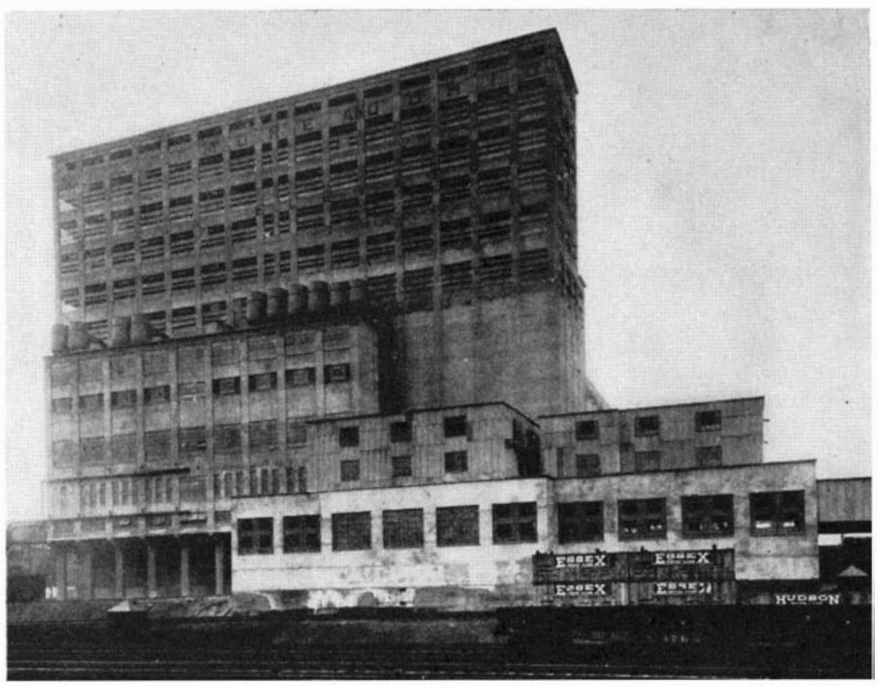
THE sugar industry also had a remarkable record during this five-year period. The last recorded ignition of sugar dust occurred in a pulverizer on January 31, 1930. Not a life has been lost in an explosion of sugar dust since June 13, 1917.

Only one explosion occurred in a cocoa and chocolate plant during this period. That explosion resulted in the loss of three lives, injuries to three others, and property damage of about 15,000 dollars. Not one explosion has occurred in connection with the grinding of coffee or spice during the five-year period.

The significance of the reduction of dust explosion losses in this group of food industries can be more fully appreciated when we realize that in this same five-year period under consideration (1930-1934) a total of 105 dust explosions in industrial plants have been reported, resulting in a loss of 61 lives, injuries to 190 others, and property damage of 5,038,160 dollars.

While the losses from dust explosions in the principal food industries have decreased, 39 grain elevator explosions were reported from 1930 to 1934. In these explosions 26 people were killed, 87 were injured, and the property losses amounted to 3,481,930 dollars. These 39 explosions in grain elevators were more than 34 percent of the total number of 114 explosions on record. These dust explosions in grain elevators show that more definite attention must be given to the application of methods for the control and prevention of dust explosions in these plants.

Above: **An experimental dust explosion in the testing station at Arlington, Virginia. Note flying glass. Adequate venting area has prevented damage to the structure.** ***Below:*** **A modern grain elevator showing application of glass vents**



Progress in the control of dust explosions in industrial plants is based on our knowledge of the causes of these explosions. The research work in the Bureau of Chemistry and Soils of the United States Department of Agriculture has shown that lighted matches, open flames, electric and metallic sparks, and similar sources will readily ignite explosive mixtures of dust and air.

With an understanding of the causes of dust explosions, it is possible to apply effective methods for their prevention. A dust explosion cannot occur unless combustible dust is present. For this reason cleanliness, or good housekeeping in the plant, is, after all, about the easiest and most effective method for preventing dust explosions. Suction systems are helpful in catching the dust particles at their points of origin and removing them. Of course it is equally important to remove all possible sources of ignition. All open flames, electrical apparatus likely to produce sparks, cutting or welding torches, and other heating devices should be eliminated from sections of an industrial plant where explosive dust is present. This will greatly reduce the dust explosion hazard.

Explosions have occurred from the breaking of incandescent lamp bulbs in dust clouds. Electric light bulbs should be provided with double globes and

The damage that can be caused by a dust explosion is shown by the remains of this terminal grain elevator. Six lives were lost in this disastrous explosion

outer guards to prevent breakage. It is important to prevent the accumulation of static electricity on machines to avoid ignition of the dust by static sparks. Special care should also be exercised to prevent hot bearings, friction of belts, and moving machinery from causing a fire or an explosion. A dust explosion can "force" its way out of the building. The opening through which the explosion is released, whether it be a swinging door, a window sash, or a break in a concrete wall, is commonly referred to as an explosion "vent." This word vent must not be confused with ventilation systems.

In order to devise ways and means for letting a dust explosion escape from an industrial plant without damage, the chemical engineers in the United States Department of Agriculture have erected a special dust explosion testing station at Arlington, Virginia. Dust explosions are staged "to order" and, as the result of this experimental work, a new protective measure has been developed for the control of dust explosions. This method consists of automatic or self-opening windows designed to release the dust explosion pressure in the plant before serious damage can be done to the building. The practical value of these vents has been shown in dust explosions in grain-handling plants, particularly in grain elevators.

THE effectiveness of glass vents as a means of explosion control has confirmed the results of the tests by the Chemical Engineering Division of the Bureau of Chemistry and Soils. Hylton R. Brown and Richard L. Hanson, the engineers in charge of the tests, recommend that for satisfactory venting of dust explosions in grain elevators not less than 1.25 square feet of venting area be provided for each 100 cubic feet of space, or one square foot to 80 cubic feet. For proper venting of starch dust explosions at least three square feet for each 100 cubic feet of space should be provided.

Sometimes the question is asked: How can the results of technical and scientific research studies be applied in such a manner as to be of real practical value? A fine example of this application is the splendid work done by the Dust Explosion Hazards Committee of the National Fire Protection Association. This committee, composed of representatives of industrial companies, insurance organizations, fire prevention and safety associations, State and Federal bodies, and other agencies interested in dust explosion prevention, has formulated a number of safety codes for the principal industries subject to the dust explosion hazard. These codes embody the results of the experimental research work of the Bureau of Chemistry and Soils, and this committee affords a very practical means of putting into actual plant practice the prevention methods that have proved effective.

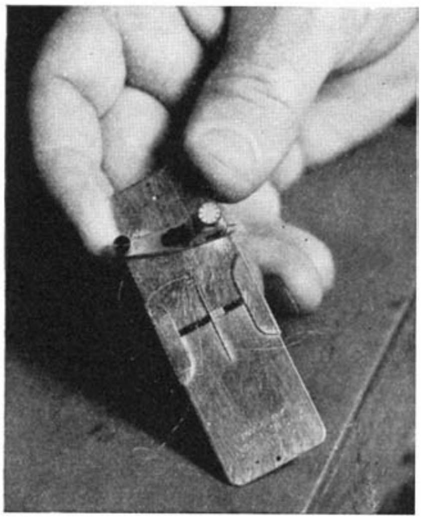
THIS committee, since its organization in 1922, has developed safety codes for dust explosion prevention in the following industries: Flour and feed mills; sugar and cocoa pulverizing systems; pulverized fuel establishments; terminal grain elevators; starch factories; coal pneumatic cleaning plants; wood flour manufacturing establishments; spice-grinding plants; woodworking plants; and a code for inert gas systems for fire and explosion prevention developed in co-operation with the N.F.P.A. Committee on Manufacturing Risks and Special Hazards.

All these safety codes have been adopted by the National Fire Protection Association and the National Board of Fire Underwriters, and have been approved as "American Standard" by the American Standards Association. They have been published by the Bureau of Labor Statistics of the United States Department of Labor in Bulletin No. 562 entitled "Safety Codes for the Prevention of Dust Explosions."

Although we are making progress in controlling dust explosions, all the causes of these explosions are far from being fully explored. Dust explosions may occur in any plant as a result of some newly developed process, or they may follow the installation of some new types of mechanical or electrical equipment. Many explosions in industrial plants have been directly associated with the introduction of new manufacturing processes which have provided additional sources of ignition, and therefore resulted in conditions favorable to explosions. The expansion of large-scale industrial operations and the utilization of by-products and waste materials have greatly increased the hazards from dust explosions. Research studies on dust explosions in industrial plants are directed toward the saving of human life, property, and foodstuffs. They will result in measures for protecting employees in our industrial plants from disastrous explosions and resulting fires.

SECTION SLICER

Aids Study of Wool, Hair, and Other Fibers



Sample of hair in thin metal slot of the new device ready to be cut

AN invention which promises to be of great value in the manufacture of textiles, to the fur industry, to several branches of agriculture, and possibly in the detection of crime, has been announced by the United States Department of Agriculture. Invented by Dr. J. I. Hardy, senior fiber technologist of the Bureau of Animal Industry, a small mechanical device makes possible the rapid cross sectioning and clear study of the structure of hair, wool, mohair, fur, silk, cotton, and other fibers, both natural and artificial. Former methods of study involved laborious laboratory procedures and the results were often disappointing.

With this simple new slicer very thin cross sections can be prepared ready for examination within 10 minutes, whereas in the past it required several hours to obtain them. The new device makes it possible to cut them to one ten-thousandth of an inch without injury to the delicate internal structure. Moreover, such thin cross sections, even of seemingly opaque fibers, are sufficiently transparent for microscopic study.

Doctor Hardy has applied for a public patent on the device, which is about three inches in length and consists of three metal parts. A thin piece of metal contains a slot 0.0085 of an inch wide. A second thin flat piece of metal slides parallel to the first and pushes a short metal guide down the slot, pressing the fibers tightly together in a vertical position. The third part contains a small metal plunger on the end of a supporting screw for pushing the fibers ever so slightly through the slot.

After the fibers are inserted in the slot and secured firmly in it, they are cut off on both sides of the holder with a safety razor blade. The plunger is then swung into place and used to push the fibers from one side to the other according to the thickness of the cross section desired. A drop of liquid Celluloid is put on the projecting ends which are then sliced off with the blade. The Celluloid solution dries quickly without soaking into the fibers. The thin Celluloid slice carrying the tiny disks of fibers is then ready to be mounted on the microscope slide.

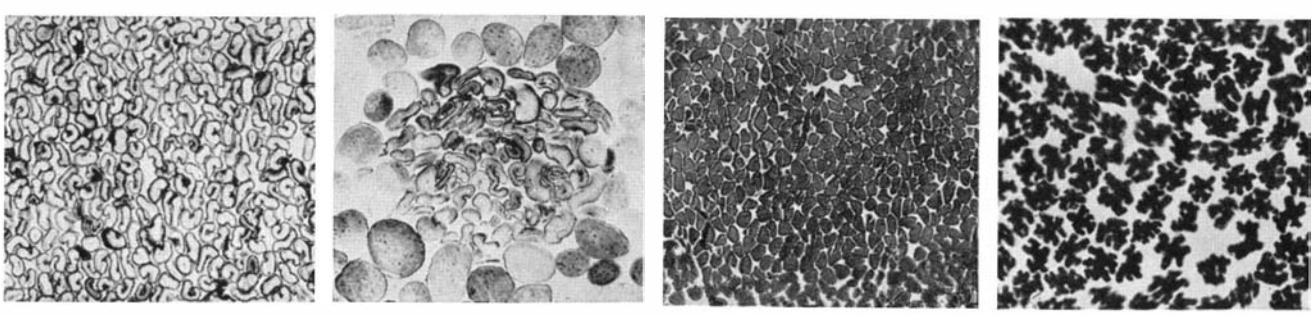
IN contrast to former methods, which involved the laborious work of embedding material in paraffin and difficulty in aligning the fibers, Dr. Hardy's device holds hair and other fibers firmly without crushing and keeps them in proper alignment for accurate cross sectioning.

Information on the types of hair and fibers in various furs, fabrics, and industrial products can be supplied quickly and accurately through the use of the device. It promises to be especially valuable in detecting questionable or fraudulent practices or misrepresentation of quality.

Forcing out a small part of fiber, about 2.5 microns thick, for slicing

Use of the device should be valuable in livestock breeding, Department specialists assert, by aiding stockmen in the development of animals with a hair, wool, mohair, etc., of a kind in greatest demand in industry. The device should facilitate the study of cotton and other plant fibers. It is believed to have far-reaching possibilities also in the detection of crime. With the device it is possible to examine closely and quickly the cross-section characteristics of a tuft of clothing fibers such as a burglar might leave behind on a nail or splinter. Experts, by comparing the cross-sectional appearance of the fibers with that of a sample from a suspect's clothing, might find evidence to link him with the crime that had been committed.

The cross sections may be studied directly through a microscope or by making photomicrographs which may be filed away for further reference or sent to any part of the world for comparative study.



Cross sections, from left to right, of cotton, cotton and worsted, silk, and viscose rayon fibers—approximately X175

More About Nova Herculis

Transformation of a Stellar Atmosphere into an Expanding Nebula . . . Outer Layers Blown into Space . . . Energized by a Hot Neighboring Star

By HENRY NORRIS RUSSELL Ph. D.

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IT is nearly a year since the great new star in Hercules appeared, and it is again getting low in the evening sky—which makes it reasonable to review what has so far been learned about it. No other star has ever been so well observed. Its fortunate position, nearly 80 degrees north of the ecliptic, made it easily observable, both after sunset and before sunrise, even when it was in conjunction with the sun, and a star farther south would have been lost in daylight. Its great brightness permitted the use of the most powerful instruments, especially of the great spectroscopes which reveal such a wealth of detail, and which had not been constructed when the last bright nova appeared 16 years earlier.

Moreover, the changes in this star have been relatively slow, so that the inevitable interruptions of observation by bad weather and so on have left less serious gaps in the record. The mass of data which has been gathered by the united efforts of the world's observers is so great that its full utilization will occupy years to come: but a good general account of what was observed may already be given, and an explanation in general terms is possible.

WHEN Mr. Prentice, the English amateur, first saw the star on the morning of December 13th, 1934, it was of the third magnitude. It decreased by half a magnitude, and then brightened until, on the 23rd, it was of magnitude 1.5—equal to Alpha Cygni, and one of the most conspicuous stars in the sky.

For three months after this it fluctuated irregularly in brightness, with a slow general downward trend; then on April 1 began a precipitate drop which took it from magnitude 4.5 to 10 in nine days. A steady, though slower decline took it almost to the 13th magnitude in a fortnight more, and it might have been supposed that it would soon vanish altogether. But, early in May, began a steady rise in brightness, which brought it back to the 8th magnitude by the end of June. Since then it has varied but little.

To complete the record of the light changes, the "Harvard Library" of celestial photographs showed that the star had been visible for the past 40 years as a very faint object of magnitude 14.6. A month before the great outburst it was still faint. What happened in the meantime we shall never know, for Hercules had got so far down in the evening sky that it was out of range of the nightly "patrol" cameras.

Reduced to ordinary language, this means that the star shot up in less than a month, and probably in a much shorter time, to 50,000 times its original brightness. Ten days later, its light had increased to nearly 200,000 of the same units. It took more than three months to drop to 10,000; then, in hardly more than three weeks it went down to five times its original light: but it is now 200 times brighter than this.

Next in order (keeping together the observations which were made directly, rather than with the spectroscope) it should be recorded that, on July 1st, Kuiper, at the Lick Observatory, observed the star to be a close double. The components were 0.″21 apart, differed little in brightness, and were quite stellar in appearance—even sharper than ordinary stars. Later observations with other large telescopes have fully confirmed this, and show very little evidence of change.

Remarkable as these things are, not one of them is without precedent. Nova Aurigae, of 1892, faded away and came back, to remain visible for months. Nova Pictoris (1925) also remained bright for months (though without a second appearance) and while beginning to fade appeared to be divided into three or four components—too close, alas, to be clearly resolved with the most powerful telescopes available in the southern hemisphere.

To interpret these facts would be an almost hopeless task, were it not for the aid of the spectroscope—and here we have an abundance of new and important detail. When first observed, within a few hours after its discovery, the nova showed a spectrum of the type which we have learned to expect from these stars. Superposed on the ordinary continuous spectrum were wide bright bands, extending far on each side of the usual positions of the lines of the elements (such as hydrogen) to which they apparently belonged, and numerous dark lines, much narrower than the others, though not sharp, and displaced strongly to the violet.

Before going on with the tale it will pay us to recall the simple explanation of this type of spectrum suggested by Adams and fully confirmed by his observations of Nova Aquilae in 1919. Suppose that, in the first paroxysm, the star throws off the outer skin with high velocity—so great that all the force of its attraction cannot bring it back. An expanding shell of gas will then surround the intensely hot central core.

THE first observations of the present nova appear to represent a stage where this shell had already become thin enough to be fairly transparent and give out a spectrum consisting of bright lines.

The gas on the far side of the shell was receding from us: even the bright lines which it emitted appear to be shifted toward the red. The nearer part is approaching, and its lines are shifted toward the violet. The intermediate regions on each side of the star are moving crosswise and give lines in the normal position. As every intermediate between these extremes exists, the observed bright lines will be wide smears, extending far on each side of the normal positions. Right in front of the central star, however, this shell is in a position to absorb its light, and will give dark lines. But this part is coming toward us at maximum speed, and so all the dark lines will be strongly shifted toward the violet.

We need only recall briefly here how the expanding shell surrounding Nova Aquilae finally became large enough to be distinctly visible with large telescopes as a nebula surrounding the star, and still expanding year by year.

In Nova Herculis, the rate of expansion of the shell, measured by the shift of the absorption lines, was 250 kilometers per second on December 15th, and dropped to 180 in less than three days. This might naturally be attributed to the attraction of the central star, pulling the ejected matter back, though not strong enough to keep it from escaping. Calculation shows that if the star's mass was a little larger than the sun's such an effect might actually be produced, while the shell was expanding to a radius of 40 or 50 million miles. As it grew larger the attraction became weaker, and would produce little future change.

As the star rose to its main maximum of brightness the bright bands faded out and a new set of dark lines, displaced much more than the others, made their appearance. This suggests that a second paroxysm had expelled another mass of material from the star, at a higher speed than the first.

The original set of dark lines persisted, since the outer, more slowly moving shell was still there: but the wide bright lines were swallowed up by the internal intensity of the general continuous background.

After a few days, the first set of dark lines disappeared. It is tempting to think that the faster-moving inner shell reached the outer one and literally swept it up.

This second shell appears to have been a big affair. Its absorption lines persisted for three months, showing a gradually increasing shift, as if the gas was still being repelled by the star. This is puzzling, as, with their average speed of 320 kilometers per second, the ejected gases must have reached a distance of 500,000,000 miles in a month's time. The strongest lines—of hydrogen and calcium—showed several other components with larger displacement, suggesting that smaller masses of gas had been expelled with greater speeds—up to 1150 kilometers per second!

THE main shell, judging by its spectrum, was composed of much the usual material of a stellar atmosphere. The familiar metals—iron, calcium, titanium—were present, also hydrogen, oxygen and carbon. For a few days, just after maximum, the bands of hydrogen appeared strongly. This is the first evidence of the presence of compounds in such a case, and suggests that the flying mass of gas must have been of at least moderately high density at the time.

As the shell expanded, these bands soon disappeared, indicating that the lower density had led to the dissociation of the compound. As time went on, the green auroral line of oxygen, and the related pair in the red, made their appearance. These are forbidden lines, which are produced only when the gas is so rarefied that the separate atoms have a long free time between collisions with others; but they do not demand so very low a density as many other lines of this sort.

When the great drop in the star's brightness occurred, the absorption lines disappeared—probably because there was not a strong enough background for them to show upon. The bright lines, which had been visible for a long time past, remained. The resulting spectrum was full of bright lines of iron, both of the ordinary and the forbidden sort (coming from the ionized atoms). Once again, though very peculiar, it was not unprecedented.

The southern star Eta Carinae shows a similar spectrum, and has done so for many years. It is of great interest that, during the first half of the 20th Century, this was a very bright star, sometimes reaching the first magnitude. For the past 50 years it has been of the seventh but, from the little we know about it, it seems to have been rather like a nova, except for the very slow tempo of its changes, which required years when days are usual.

The bright lines in Nova Herculis, at this stage, were fairly sharp, and strongly displaced toward the violet, by an amount corresponding to the velocity of the nearer side of the main shell of gas. The hydrogen lines, and others at times, showed faint components shifted toward the red by the same amount. This apparently strange behavior may be simply accounted for by assuming that the nearer side of the shell was shining strongly, while, for some reason or other, the hinder side sent in but little light. As the brightness dropped to the great minimum, the familiar lines characteristic of gaseous nebulae made their appearance; and the subsequent increase of light came almost entirely from this part of the spectrum. These are strongly "forbidden" lines, whose production demands that the atoms shall have long undisturbed intervals in which to emit them, and hence that their density shall be very low. As the nebular lines (due to oxygen atoms minus two electrons) strengthened, the auroral line (due to oxygen atoms with all their electrons on) weakened, so that the process of electron-stripping could almost be seen.

The whole process of transformation of a stellar atmosphere into a nebula has therefore again been followed, and more completely than in previous novae. In the present case, the ejected gases evidently did not form a nearly uniform shell, as in Nova Aquilae, but were distributed in irregular patches. The spectroscope showed (as has already been told) that the brightest patches were on our side of the star: the telescope has revealed two separate patches, and (if the whole thing does not fade out) may in time show more detail.

When the expanding shell is fairly uniform, a very good determination of the distance of the nova can be made by comparing its apparent size, measured at the telescope, with its real diameter in miles, found from the spectroscopic velocities. With such an irregular affair as this one, the method fails. Probably the best indication of distance is found in the strength of the "interstellar" lines, which show no trace of the rapid motions present in the star and its envelopes, but are absorbed by scattered atoms distributed thinly throughout interstellar space. In this way, a preliminary estimate of about 1200 light-years distance has been made; but other investigators find a somewhat larger distance.

ASSUMING 1500 light years, we find that, before its outbreak, the nova was about a quarter as bright as the sun (photographically); at maximum, some 40,000 times as bright; at its deep minimum a little brighter than the sun; and, when it appeared to have turned into a nebula, it gave out more than 200 times the sun's light.

Now an isolated mass of very rarefied gas cannot (in any known way) produce within itself such a flood of energy. It must act as a transformer, receiving energy from some other source, and converting it into visible light. For the original source, we must look to an excessively hot star in the near neighborhood—in this case, obviously the one from which the gas was ejected. The second rise in brightness must have resulted from an enormous emission of ultra-violet light from this star—very likely much more than was transformed into visible radiation in the patches of nebulosity outside.

What happened to the central star we can only conjecture, but, to give out so much ultra-violet, and so little visible light, its surface must have been intensely hot—perhaps at a temperature of 50,000 degrees or more. Had it remained of the same size as before the catastrophe—when we very reasonably guess that it was a bit smaller than the sun—it would have shone brilliantly. However, it is highly probable that, while the gas-masses were driven off, the central body shrank to a small fraction of its original size. There is good reason to believe that, nevertheless, only a small fraction of the total mass was expelled, and that the surviving nucleus has become a dense body like a white dwarf. All this supports a suggestion of Milne's, that, under certain conditions, the interior of a star may become unstable. The main mass may suddenly contract to a small size, heating itself excessively, but the outer layers, blown away into space, form the expanding nebula. But we must know more about atoms, and how energy is normally furnished to keep the stars shining, before such a hypothesis can be fully tested.—*Mount Wilson Observatory, November 30, 1935.*

THE HEEL OF THE CONQUEROR

Ancient City Mound in Palestine . . . Evidences of Several Conquests Revealed to Excavators

By JOTHAM JOHNSON
University Museum, Philadelphia

FROM the Sea of Galilee the valley of the Jordan drops steadily toward the Dead Sea. Fifteen miles below its source a lateral valley cuts into it from the west, drained by the swift Jalud and dominated by three ancient caravan cities, Megiddo, Esdrael or Jezreel, and Beth-shan (Figure 1).

Town-names are many in a land so often overrun by amateur linguists. Just as Galilee is known as Chinnereth, Gennesaret, and Tiberias, and Megiddo becomes Maximianopolis and Armageddon at a speaker's whim, so Beth-shan became Ba-ti-san to the Egyptians and Bit-Sani in the Amarna letters. Today the nearby Arab town is Beisan; the inhabitants call the ancient mound Tell el-Hosn. The Greeks dodged the issue entirely; they called it Skythopolis, and Nysa. Bashan ('the Bull of Bashan') is different; it is a cattle-raising district in Trans-jordan.

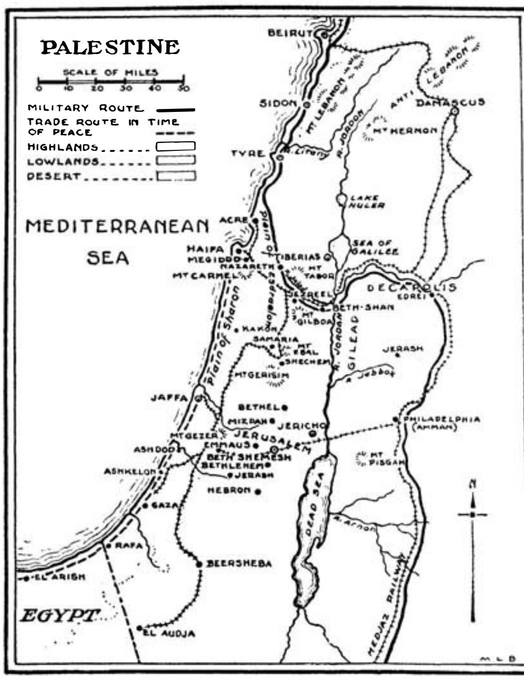

Figure 1: **Map showing places named in text**

Old Stone Age men were hunters. Heedless of the dramatic events destined there for future centuries, they ignored the low natural mound (Beth-shan) which rose from the south bank of the Jalud, four miles above the Jordan. But Neolithic men were farmers who required rich soil and copious water for their poor seed. They thought the mound ideal, and long before 3000 B.C. they built a little village there, the most primitive yet excavated in Palestine, in order to be near their fields. Their houses were squalid pits dug three or four feet deep in the damp red soil, roofed with matting or brushwood. Their tools were of flint; their pottery was crudely made by hand, and some of the bowls were decorated with red paint. To find them we have sunk a great shaft through the mound (Figure 2), from the floor of Level IX through nine earlier strata (Figure 3).

Presently, invaders superseded the pit-dwellers. We have learned that they introduced copper at Beth-shan and built real houses of sun-baked brick; this is Level XVIII, the oldest of nine Bronze Age cultures before Palestine's destinies became merged with those of Egypt. Life in northern Palestine was peaceful throughout this time; the country was inhabited by Canaanites, distant kinfolk of the Israelites, speaking a dialect of Aramaic also spoken by the Habiru; eventually it was known as Hebrew. None of the early levels was closed over by the blanket of ashes that at many ancient sites tells bluntly of the invader's torch, and none was defended by city walls.

PALESTINE was made to be conquered. In the early 17th Century before Christ the bustling market-towns and the sleepy agricultural communities were quietly subjugated by a mysterious Asiatic people, the illiterate Hyksos, known

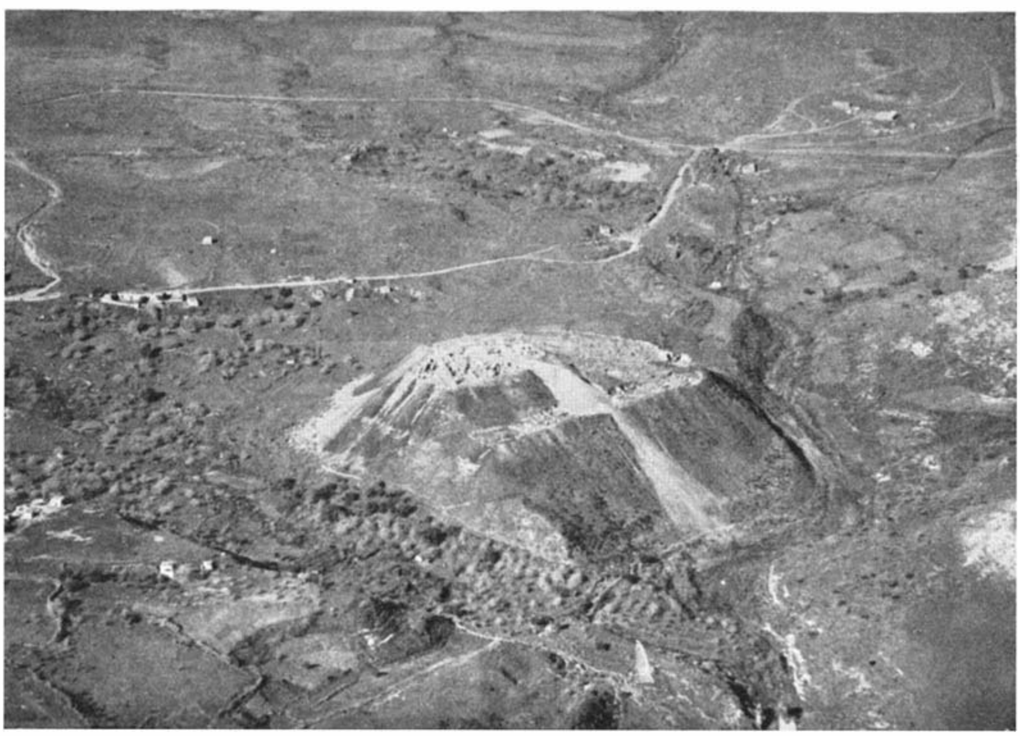

Figure 2: **The great mound of Beth-shan, showing the dump of the excavations**

to archeologists only by the disparaging comments of their unwilling hosts and by a few potsherds of rare type.

Unimpressed by the might of the Pharaohs, the Hyksos presently wrote themselves into history by forging into Egypt, which they captured in 1675 B.C. A century later Ahmose I drove them back across Suez, and his successors' repeated raids into Palestine weakened and disheartened them. In 1479 B.C. the last remnant of their union with the Syrians and Canaanites was wiped out by one of Egypt's greatest kings, Tuthmosis III (alias Thothmes), in the famous battle of Megiddo.

Tuthmosis took over their captured provinces, and Beth-shan appears on the walls of the Karnak temples on the boastful lists of towns he won. Off the record he might have admitted the true motives of his conquest: to guard against a reawakening of the sore and smarting Hyksos, or against an invasion by that newly-risen northern power, the Hittites, to secure spoil and tribute, and to tax the profitable commerce of the age-old caravan trails; but if he had felt called upon to justify his conduct in public he would surely have declared it his divine mission to enlighten these miserably backward peoples. Ancient history is not bunk; it is merely the school of dictators.

CERTAIN it is that under Tuthmosis the ninth level was built and Beth-shan's prosperity began. The excavations of the University Museum, begun in 1921 under C. S. Fisher and later directed by Alan Rowe and by G. M. Fitzgerald, have revealed a vast temple, divided into two sanctuaries (Figure 4). In the southern part lay an inscription recording its dedication to Mekal, the local Baal; the northern sanctuary we think was built for Antit who as Ashtoreth, Astarte or Ishtar was known to the furthest limits of the ancient world.

BETH-SHAN

Level			
Iron Age	I	Arabic	636 A. D. to modern times
	II	Byzantine	330 A. D. to 636 A. D.
	III	Roman Jewish Hellenistic Greek	301 B. C. to 329 A. D.
		Mound deserted	*c. 1000 B. C. to 301 B. C.*
	IV	Israelite Philistine	*c.* 1150 B. C. to *c.* 1000 B. C.
	V	Egyptian (Rameses III)	1198 B. C. to *c.* 1150 B. C.
Late Bronze Age	VI	Egyptian (Seti I and Rameses II)	1313 B. C. to 1198 B. C.
	VII	Egyptian (Amenophis III)	1411 B. C. to 1314 B. C.
	VIII	Canaanite peasants	1447 B. C. to 1412 B. C.
	IX	Egyptian (XVIII dynasty; Tuthmosis III)	1479 B. C. to 1447 B. C.
Middle and Early Bronze Ages	X to XVIII	Canaanites and others	
Neolithic	and Pits		

Figure 3: **A table of levels or strata in the mound. Read from the bottom up**

In the temple stood several altars, one provided with a channel for draining off the blood; beside it lay a ritual dagger of bronze and the bones of a young bull, the last animal to be sacrificed before the temple was destroyed.

The temple, dedicated to Canaanite gods, is thoroughly a product of local architecture; plan and materials alike conform to local prejudices to make this the finest as well as the earliest example of Canaanite public architecture yet discovered. Only for details—cornices, door-mouldings, column capitals and bases, stepped altars—did the builders rely on Egyptian inspiration, no doubt because optional decorations were unknown to the native art.

Just outside the temple the excavators came upon a bas-relief in basalt (Figure 5). The upper scene shows a fight between a lion and a dog; in the lower the lion's tail is between his legs, and we judge him to be in retreat, however stiff and dignified. As he goes, the dog slavers at his back. This inaccurate sculpture has vigor and a lucid symbolism, if we identify the dog as guardian of the temple and the lion as Nergal, god of pestilence and death: the guardian has driven plague from the communicants. You will find it one of the proudest possessions of the new museum in Jerusalem.

Figure 5: **A bas-relief in basalt**

Also in Level IX was found broken pottery from Cyprus and Crete. It is with some apprehension, nowadays, that we turn up Mediterranean wares in such closely-dated strata, because the lifework of a hundred scholars who have synchronized Aegean pottery with that of Asia Minor and Egypt might be wiped out by a new stratification; the Beth-shan types happily agree with the dates expected of them.

This much we know about Beth-shan under Tuthmosis' rule, because we have

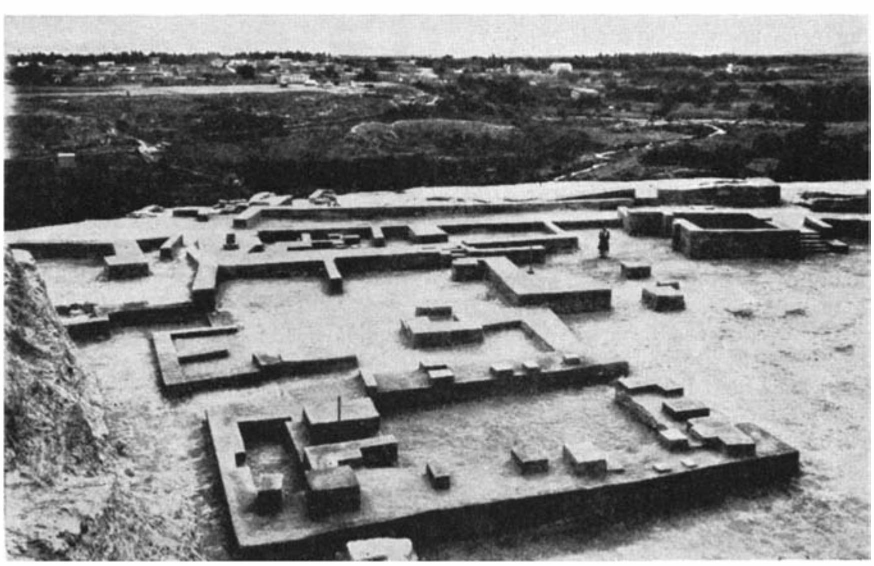

Figure 4: **The temple excavated in Level IX, where ancient rites took place**

seen the evidence resurrected from its long burial. To digress a moment, we may borrow further details from the pages of general history.

The community living isolated from the trading world, producing all its own goods without surplus, has never existed except in the imaginations of economic theorists. Fifty thousand years back, paleolithic man must have bartered the

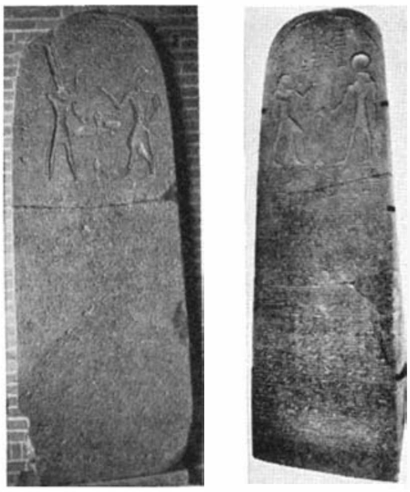

Figure 6: **Two stelae found in the 6th Level of the Beth-shan mound**

chestnuts of the hills against the salt of the coastal flats. At Tepe Gawra (Articles on Tepe Gawra appeared in Scientific American, Oct., 1935, pages 178-179 and Dec., 1935, pages 310-313. It does not appear on the map, Figure 1, being 500 miles northeast.—*Ed.*), closer to the elements than any other organized community which we can study in detail, gold, copper, lapis lazuli and carnelian are found (and these merely head the list), none of them produced locally and some imported from great distances. As soon as one Tepe Gawran raised a few extra bushels of grain, to trade for a gem for his fiancée, the rest were sure to follow suit next year. The story of civilization can be followed in the rise of man's appetite for luxuries, spices and perfumes, rare cloths and precious stones.

The big towns of the interior, Aleppo, Hama, Homs, Palmyra, Damascus (the most admired if not the oldest of all), Beth-shan, Amman and Petra were—most of them still are—natural foci; Beth-shan, for example, received much of the traffic south-bound from Damascus for Jerusalem and beyond to Egypt and return, and a large share of the products of the Transjordan desert fringe, bound west to the coast. On this commerce the government exacted as many taxes as possible—one of the reasons why the Egyptians wanted Beth-shan; and the caravan track was a military route as well. In return the government was supposed to police the desert trails and to keep the water-holes open and clean. It rarely did.

The heel of the conqueror seldom trod too heavily, however; these imposts might bite deep into the profits of the middlemen, but it could have made little difference to them or to the farmers if the yearly tribute in precious metal (by weight; coinage was yet to be introduced), labor or materials was paid to the local agent of distant Egypt's king or to some local sheikh, except that in the long run the stronger rule made for longer peace and more lasting prosperity. The modern argument that war will cure an economic crisis may yet prove fallacious. None the less, Palestine reserved the right to revolt at every opportunity.

Archeology brings home with deadly clarity the extent of Egyptian aims in Palestine. The Egyptians who manned the garrisons and customs-houses and law-courts, who erected stone slabs with hieroglyphic messages and lost their scarabs in Beth-shan's dusty streets, were the lone representatives of the conquering power. Egypt was interested only in farming the land's taxes, and the whole provincial administration was designed to keep the tax-gatherers alive and active.

LEVEL IX was destroyed after a generation; we do not know how, by whom or why. Upon its ruins was built a rude mud village without temples or other public buildings. The finds are poor, too, although we are grateful for a little Mediterranean pottery, some cylinder seals, and a few Hittite objects, welcome to the diggers of Beth-shan as tell-tales of contact with the outer world.

With Level VII (Figure 3) Beth-shan became once more a great city. A new Canaanite temple was built, and beneath its altar steps were placed a scarab, a ring, and other objects bearing the name of Amenophis III who came to the throne in 1411 B.C. Near the temple were erected a fort-tower and a house which may have been the residence of the commandant, and a silo capable of holding a thousand bushels of grain.

In 1375 Amenophis died and was succeeded by his son Akhnaten, effeminate and mystic, husband of the charming queen Nefertiti. He was far too concerned in forcing Egypt's religion into the mold of his monotheism to care about the wider Empire, and through his and his glittering nephew Tutankhamun's reigns Palestine and Syria gradually dropped from Egyptian control until the time of Seti I who won them back and built a new Beth-shan, Level VI.

In the foundation deposits of his new temple we found the rings and scarabs of his father Rameses I and of himself, which he thoughtfully placed there. In the sanctuary he also set up a great stela of basalt (Figure 6, at left) engraved in hieroglyphics and dated in the year he began to reign, so that his first thought must have been to regain Egypt's lost Palestinian tributes. His successor, Rameses II, set up a second stela (Figure 6, at right) to commemorate his prowess in suppressing new revolts in Palestine; this stela has been brought to Philadelphia and erected in the University Museum. From this period date the curious pottery coffins whose lids resemble human features (Figure 7) made for mercenary soldiers of Mediterranean origin.

About 1350 B.C. arrived the first apostles of a new order. The Israelites crossed the Jordan some distance below Beth-shan and captured Jericho. Later they attacked Beth-shan, but were thrown out.

The fifth and last Egyptian level at Beth-shan was founded by Rameses III about 1195 B.C. Rameses had to fight the Philistines who pressed down from their spawning-grounds in the vague north and attacked Egypt; he drove them back, and defeated them in Palestine, but they remained to settle in the fertile coastal plain, and to give the country its name.

After his death in 1167 B.C. the mercenaries sold out to the Philistines. Beth-shan passed forever from Egyptian control, and became a stronghold of Philistine power. About 1020 B.C. they won a battle from the Israelites, led by Saul and his sons, on nearby Mt. Gilboa.

Figure 7: **The large pottery lid of a mercenary soldier's curious coffin**

Saul, defeated and wounded, killed himself, and his conquerors exhibited his body and his armor in public triumph at Beth-shan. A few years later David, or someone else, avenged this outrage and destroyed the town. It was not occupied as a city again until the Greeks of Alexander came in; from then on Beth-shan's history is the story of the Greek and Roman worlds.

PATENTS AND INDUSTRY

THE accompanying summation of a report submitted at the request of the Secretary of Commerce as a part of the Second Report of the President's Science Advisory Board, is important in that, if the recommendations should be adopted, the radical changes would tremendously affect not only the inventor holding a single patent and the corporation holding hundreds but also the general public which benefits by every new development. What the effect might be, we leave to the judgment of our readers. We present the recommendations embodied in the report, together with some of the advantages and disadvantages of each suggested change; and ask that, after careful study, you write us your opinion. Should you and other readers supply us with sufficient and convincing evidence of the general feeling regarding these recommendations, it is our plan to appear before official hearings and assist in clearing up any quirks which may be present. Please address your letter to The Editor.

"THE patent system of the United States was set up originally to benefit the public by advancing the useful arts. It does this by creating a temporary monopoly, thereby rendering possible the hazardous development of untried inventions, which would not otherwise come to fruition to add to the general well-being and increase the standard of living of the people. By its substantial rewards, it stimulates invention and the assiduous study and persistent effort on which invention is based. That it has been successful needs no demonstration, for its results are all about us."

This statement, together with further discussion anent technical advances which result in the creation of new and extensive industries for the well-being and prosperity of the country as a whole, comprises the introduction to the report of the Science Advisory Board's committee on the "Patent System and Stimulation of Industries." As the quotation indicates, the Committee was concerned in its study, not with any question of abandonment of the system, but with the development of "a broad policy and program for the stimulation of new industries in this country." Quoting further: "The inquiry is directed to the stimulation of new non-competitive industries, using 'non-competitive' in the sense that they should not merely replace an existing industry or product by a substitute of no greater social value; but rather should increase the potential aggregate of gainful employment, increase the comfort and safety of living, or confer other important social benefits."

Having explored the subject of patents fully, the committee recommended:

1. *". . . that, when an application is ready for allowance, it be published in the Official Gazette, and the submission of pertinent facts by interested parties invited."*
2. *". . . that there be established a single Court for Patent Appeals, in order to establish and maintain harmony and accuracy in judicial interpretation of patent questions, by confining the appellate jurisdiction in civil patent causes to one court, composed of permanent judges having the necessary scientific or technical background."*
3. *". . . that there be provided scientific or technical advisors or juries to furnish adequate scientific or technical assistance to courts of first instance in equity patent causes."*
4. *An annual tax upon all patents.*

The argument of the committee on Recommendation No. 1 cites the complexity of our patent system with 90,000 patents issued in a year. This is an error, for the annual average for 1932, 1933, 1934, and 1935 has been substantially less than 50,000. Even so, without an increase in the corps of examiners, it is impossible to review adequately all prior art. French patents are issued with little or no examination while the British and German systems provide for publication of an application before issuance. Our patent system is better than the French, says the Committee, but a modification of the system to permit publication before issuance will increase the presumption of validity and tend to lower the probability of expensive litigation.

In favor of this may be cited the fact that the Patent Office does not have at this time adequate facilities for making a complete search with respect to any invention outside of the field of the patented art. The result is that patents are often granted for inventions which have been in use for many years but which for some reason or another have never been patented. Pre-publication would prevent such patents from issuing. Also, it would tend to remove from the Government the burden of making an adequate search and place it upon the persons whose interests are really affected, with the final result that the cost to the Government might be reduced.

One disadvantage of this scheme would be that large and unscrupulous organizations could effectually prevent the inventor from securing a patent on any important invention by simply opposing the grant of his patent and subjecting him to a greater expense than he could afford to pay in his efforts to secure his patent. Also, any departure from the present custom of the Patent Office to maintain applications in strict confidence, except in certain well defined cases, would lead to fraud. Persons other than the true inventor, having seen published accounts of a patent application, could make fraudulent application for a patent on the same invention.

The American Bar Association has rejected several times in recent years the suggestion (Recommendation 2) that a single court of patent appeals be established. The expense which would be incurred by litigants in travelling from all over the country to the location of the court seems to be the main objection to this scheme. Or, if this single court should move to various parts of the country, appeals could be argued only in specific periods in any particular locality, thus making for delay. Furthermore, it would set a precedent for the formation of other special courts of appeal to handle admiralty cases and other cases involving special branches of the law.

ONE strong argument in favor of this proposal is the fact that it would tend to produce uniformity of decisions in patent cases. There are 10 Circuit Courts of Appeal in the country and often there is a conflict in opinions between circuits, which opinions often cannot be made uniform because of the difficulty or expense of reaching the Supreme Court. It would also tend to create a court of experts over a period of years, both in patent law and various branches of science.

The Committee's Number 3 was based on the fact that patent litigation is concerned with both the law and the technical facts. No amount of evidence, voluminous though it may be, can quali-

(Please turn to page 109)

WHY DOES THE ATOM

Family Rows Rare Within the Atom . . . Peculiar Behavior of Electric Forces Prevents Nucleus From Flying Apart . . . Scientists Seek Solution

By JEAN HARRINGTON

THE worthy gentlemen who write dime-thrillers frequently amuse themselves by imagining what may happen "when somebody makes a machine to blow up atoms and let their energy loose." But scientists are not much troubled about such a possibility; they have, in fact, blown up many an atom already, with no dire results. What bothers them more is why the atom does not more often blow up by itself; why, indeed, it sticks together at all.

If the laws of the world of normal sizes held down in the region of atomic dimensions, there would be reason to expect that the pieces which join to form the core or nucleus of an atom would almost never approach each other closely, let alone stick permanently together, for under ordinary circumstances, electrical charges of like sign repel each other with a force which grows larger the nearer they come together. This is according to the classical electrostatic law which every student of elementary physics knows: The force between two charged bodies varies directly as the product of their charges and inversely as the square of their distance apart.

Thus, when two similarly charged particles touch or collide, the force tending to separate them should be infinitely great. But this cannot be actually the case, for within the nucleus of an atom dozens of positively charged protons may exist together in peace and harmony, with no tendency whatever to explode and fly off into space, except when tampered with from the outside.

HERE scientists are confronted with another phase of the same problem which faced Einstein before he presented the world with relativity. The classical mechanics of Newton, which for several centuries had dealt successfully with the more ordinary phenomena of earth and sky, were known to fail occasionally within the depths of the universe. Einstein took Newton's laws and extended them to fit a cosmic scale. Classical laws must now be adjusted again, to fit and to express the behavior of the infinitely small.

The Rutherford-Bohr nuclear atom has been the standard atomic model since Bohr's work in 1913. Naturally the nucleus is not its only part. It is the massive, positively charged core, around which sweep negative electrons in fixed orbits of various sizes. But our problem of atomic stability does not arise in connection with these extra-nuclear electrons. They seem to obey the laws of the universe better than their brother protons within the nucleus. They are held in their courses by the attraction of opposite charges, and there they stay, spinning and revolving, as stable as the solar system, and we may cease to worry about them. It is the nucleus which gives us trouble.

Figure 1: **Heisenberg, the brilliant German physicist who originated the neutron-proton nuclear theory**

From studies of radioactive disintegration and from other experiments in breaking up atoms, it soon became apparent that protons, alpha particles, and perhaps electrons originate within the nucleus. How could these building blocks be stacked to fill the two chief requirements: atomic weight and atomic number?

Until the neutron was discovered in 1931, it appeared that the proton was the most important construction unit, both of weight and charge, for it forms the nucleus of the simplest and lightest element known, hydrogen. It was thought, for example, that the oxygen atom must contain 16 protons, for it has an atomic weight of 16. Its atomic number (that is, its positive electric charge) is only 8, so, in order to neutralize half the charge of the 16 protons, it was necessary to put eight additional electrons into the nucleus itself. Moreover, every four protons were supposed to combine with two electrons to form a kind of sub-unit of structure, the alpha particle.

This conception was very hard to swallow, for the electron, although it weighs far less than the proton, compares with it in size as a cathedral to a pea. How to get eight cathedrals into a pea-pod? This disgruntled the physicists no end. And here, again, was the question of stability. Why should the protons left without electron mates stick together as they did? Theoretically, they should still be repelling each other in opposite directions just as hard as ever before. This problem was shelved for the time by supposing that the electrons formed a kind of cement which held them all together.

THE appearance of the neutron on the atomic scene helped to clear things up. To all practical intents and purposes it has the same weight and size as the proton, and fits into the nuclear pea-pod much more comfortably than the electron. It has no electric charge at all, and thus its inclusion in a nucleus affects only the weight and not the atomic number. Now the oxygen nucleus becomes a huddle of eight protons and eight neutrons.

But in a breath, the convenient electron cement idea was swept away. Then it was that the scientists began to juggle with the laws of the universe. The inverse square law of repulsion between protons, they said, must fail at distances as tiny as these we are dealing with inside the nucleus. There must be another force acting, of nature unknown, but strong enough to hold the nucleus together.

STICK TOGETHER?

This force the German physicist Heisenberg (Figure 1) assumed to be a strong attraction between proton and neutron, and there are various and sundry reasons to justify the assumption. Foremost is the tendency for the formation of neutron-proton pairs within the nucleus. Long before the existence of either particle was known, it was noted that for most elements, and particularly the lighter ones, the atomic number was roughly half the atomic weight. The formation of pairs with a charge of 1 and a weight of 2 gives a plausible physical explanation of the phenomenon.

It is true that the heavy elements, such as lead and mercury, have a preponderance of neutrons in their nuclei, and this we will attempt to explain later. But it is also true that the most stable and most abundant elements are those which contain equal numbers of protons and neutrons. Thus silicon, with 14 pairs, and oxygen, with eight, together make up 75 per cent of the earth's crust, and are equally abundant in the stars.

The mathematical expression of the behavior of the nucleus is given by a curve (Figure 2), which, because of its shape, is known as the potential barrier. It shows how the strength of the electric forces varies within and around the nucleus. Along the horizontal line, the distances are marked off in trillionths (10^{-12}) of centimeters. Along the vertical axis, the electric force or potential is plotted in millions of electron volts. The zero point at the crossing of the axes represents the center of the nucleus.

What does the curve tell us? Suppose, for example, that we have a proton which we would like to shoot into the nucleus from the outside. As it approaches along the horizontal axis, it encounters a repelling force which grows stronger and stronger as the distance grows less. It is as if we were trying to roll a ball up a hill which grows steeper the higher we climb. This effect is shown by the rising portions of the curve, and it is just what we would expect from the classical electrostatic law.

But suddenly the curve stops going up and drops abruptly to zero and below. This phenomenon occurs at a point about one trillionth of a centimeter away from the center of the nucleus. If we have given our proton enough energy to overcome the growing force up to this point, it suddenly ceases to be repelled, and is attracted straight into the heart of the nucleus.

If, however, we have failed to shoot our projectile with enough force to scale the potential barrier, it will simply graze the nucleus and be repelled in another direction. Cloud chamber photographs of the tracks of such projectiles have been taken (Figure 3). We can control and measure the energy of the projectile, and we can measure on the photograph the angle through which it has been deflected; thus we can calculate the strength of the electric field which has given it the deflection. This is our chief clue to the shape of the potential barrier.

The existence of the pit in the middle of the curve, the so-called "potential hole," is very significant. It shows how the classical electrostatic law fails within the nucleus. It shows that some force other than electrostatic repulsion must exist to hold the particles together. And it shows that the strong electric field surrounding the nucleus, the potential barrier represented by the peaks of our curve, serves not only to keep other charged particles out, but to hold the protons within. If a proton coming from the outside needs six or seven million electron-volts of energy to cross the barrier and get inside, then a proton which is already inside needs the same amount of energy to leap over the barrier and escape.

But this is a statement which, as usual, when we are dealing with atoms, must be modified. Nowadays, according to wave mechanics, everything is based on the principle of probability. Because a body usually obeys a certain law no longer means that it always does. Our old laws are no longer absolute; they are expressions of *average* behavior.

We need to introduce this idea here to show that the potential barrier is not an absolute quantity. If we have a proton with a given amount of energy outside the nucleus, there is a certain probability that it will penetrate therein. The more energy it has, the better its chances of doing so; and if its energy is equal to that of the potential barrier, it is fairly certain of success. But the fact remains that a particle has a chance of getting into the nucleus, and conversely, of escaping from it, with an energy less than that represented by the potential barrier. Experiment shows that such a case frequently occurs.

It must be quite clear that the potential barrier applies only to charged particles, such as protons, alpha particles, or the bare nuclei of other elements. An electric field has no effect on an uncharged body; hence for neutrons there is no repulsion and no potential barrier to cross. They can penetrate quite easily into the nucleus; the fact that they are held there so tightly is so far unaccountable unless one accepts Heisenberg's theory of strong proton-neutron forces.

It must also be understood that the potential barrier is harder to cross for

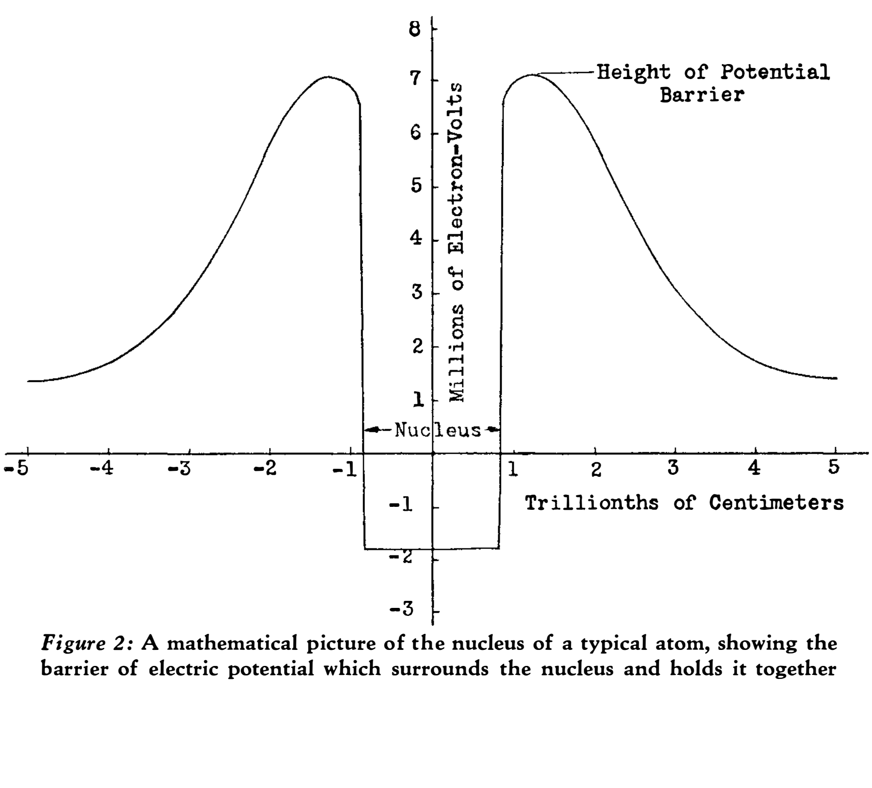

Figure 2: **A mathematical picture of the nucleus of a typical atom, showing the barrier of electric potential which surrounds the nucleus and holds it together**

some particles than for others. A proton, for example, experiences less repulsion from a nucleus than an alpha particle with its double charge. The latter must have more energy than the proton in order to penetrate a given nucleus. A further complication is that the barrier annoyingly changes height whenever a charged particle is added or subtracted; for obviously a change in the concentration of electricity within the nucleus alters the strength of the field around it.

Illustrating, as it does, by a sudden drop from positive to negative potential, the attractive forces operating within the nucleus, the potential barrier answers the question of why the atom sticks together at all. It does not explain how the nucleus is actually composed, nor the nature, the cause, and the behavior of the forces holding it together; these are still matters of conjecture—problems ready and waiting for the Einstein of the atom.

But there is still another check on our belief that, whatever their nature, the forces within the nucleus are real and tangible. The check is the odd fact that the nucleus always weighs less than the sum of its parts. If, for example, we add up the free weights of two protons and two neutrons, we should, theoretically, get the weight of an alpha particle. Actually, the alpha particle weighs slightly less than this total. What has happened?

THE solution of the mystery lies in the fact that mass and energy are in reality two different forms of the same thing. Mass can be changed into energy, and conversely, energy can be transformed into mass. Energy was needed to bring the particles together and hold them there, and so some of their mass obligingly transformed itself, and was used up in the process of forming the nucleus. If we should ever wish to restore the particles to their original mass we must give them back the same amount of energy that was transformed from mass into the cementing forces.

All nuclei have undergone a loss of mass, some more than others. The difference between the theoretical and the actual weight is called the mass defect, and it represents in every case an equivalent energy loss, which is known as the binding energy. A nucleus which has a high binding energy relative to its weight is more stable than one of low binding energy. This is the first factor in our last problem, of why some nuclei stick together so much better than others.

An unstable nucleus is one in which the forces trying to preserve its unity are in some way unbalanced. The balance of forces depends upon the ratio of neutrons to protons, and this in turn is dependent upon the energy levels within the nucleus.

The idea of energy levels is a familiar one, for the electrons revolving outside the nucleus have long been known to possess only certain fixed amounts of energy, represented by the size of their orbits, or, in more up-to-date terms, by their wave lengths. But that levels also occur within the nucleus is a fact only recently acknowledged. A study of the velocity of alpha particles emitted from radioactive elements showed that they could be classed into various speed groups, indicating that they started from a series of different energy states within the nucleus itself. (These states, incidentally, give a further clue to the shape of the potential barrier.)

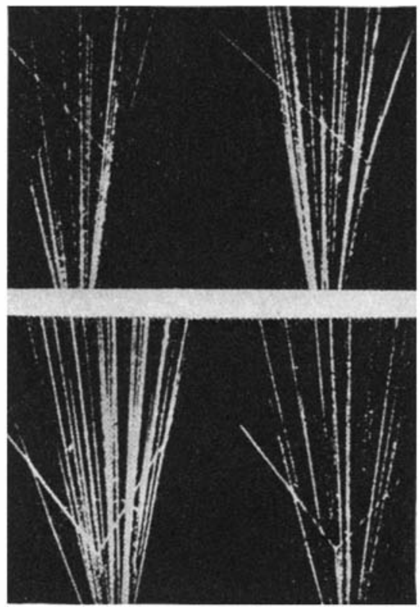

Figure 3: **Alpha particles deflected from their paths by passing through the electric fields of light nuclei. From such photographs the shape and size of the potential barrier can be determined for many elements**

This means that as each successive proton or neutron is added to the nucleus, it falls into a fixed energy state, the lowest one still unoccupied. There are two sets of levels, one for each kind of particle; for the proton, the levels are farther apart, to make room for the additional energy it has because of its electrical charge. We might compare them to two ladders, the proton ladder having rungs spaced wider than the neutron rungs.

For the nucleus to be stable, the topmost neutron and proton must be at approximately the same height on their respective ladders. As the elements increase in atomic weight, the proton gains in height on the neutron, and hence we must put extra neutrons on the upper rungs to catch up. Thus, in the heavy elements, there may be as many as 30 or 40 percent more neutrons than protons.

When the nucleus acquires too many neutrons or too many protons, the balance of forces between them is upset. It cannot stay as it is, and sooner or later it tries to right itself by shooting off some particle or other, and changing itself into a nucleus of a quite different kind.

Strangely enough, it does not emit its extra protons or neutrons; not, at least, if the disintegration is spontaneous and unforced. It may give off an alpha particle, an electron, or a positron. But, you cry, then do all these things exist in the nucleus too? Probably not. It is more likely that they are created at the instant of emission.

An extra neutron, for instance, may split into a proton and an electron, the latter flying off into space as soon as it is created. This is a common type of disintegration among the unstable, radioactive elements. Similarly, a proton may change itself into a neutron by emitting a positron, the positive analogue of the electron. With the emission of an alpha particle, the nucleus rids itself of two neutrons and two protons at one fell swoop. Although it is still argued by some that the alpha particle must pre-exist in the nucleus, the present tendency is to consider that it, too, is created, as it were, on the wing.

IN the foregoing discussion we have tried to show how stability depends on the ratio of protons and neutrons present. For a given number of protons, there may be anywhere from two to nine possible neutron combinations without unbalancing the energy levels too radically. This accounts for chemical isotopes, elements which have the same atomic number and identical chemical properties but differ in the weight of their nuclei. The most abundant and the most stable isotopes, however, are in general those whose energy levels are most nearly balanced.

We have compared the nucleus, now, to a crowded peapod, to a hole surrounded by a potential barrier, and to a set of ladders; but of course these are not accurate pictures of the true nucleus. We have used them only as convenient ways of trying to explain why the nucleus clings together at all, and why some nuclei stick together better than others. Even the ultimate particles of matter—electrons, protons, and neutrons—can no longer be thought of as little round balls; they are too ambiguous in their nature, behaving at one time like wave radiations, and again like actual particles. The thinking man, when once he is accustomed to the facts, discards all models and pictures as mental crutches, and accepts the atom and its nucleus as entities which he knows to exist, but which he cannot visualize as similar to anything he knows from everyday experience.

Nobel Prize Radioactivators

Irène Curie Joliot

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Prof. F. Joliot

JUST before last month's number of this magazine went to press, the Nobel Prizes for Physics and Chemistry were awarded to three scientists whose outstanding researches had already been described in it, and at that late date it proved possible only to insert in the proofs brief mentions of the awards. The article in question was entitled "Artificial 'Radium'" and was by Professor E. U. Condon of Princeton University. In it Professor Condon explained, almost prophetically of the prize awards as it later turned out, the remarkable recent work of Dr. James Chadwick of Cambridge University who has won the Physics Prize for discovering the neutron, and of the two Joliots of the Radium Institute of the University of Paris who won the Chemistry Prize. Photographs of the Joliots are reproduced above. The Joliots received the Prize jointly because they work as a team. Madame Joliot, however, signs her research papers Irène Curie. She is the daughter of the famous Marie Sklodowska Curie, a Pole who removed to Paris. The Prize was awarded to the Joliots for the discovery of induced or artificial radioactivity and the creation of new elements by atomic bombardment.

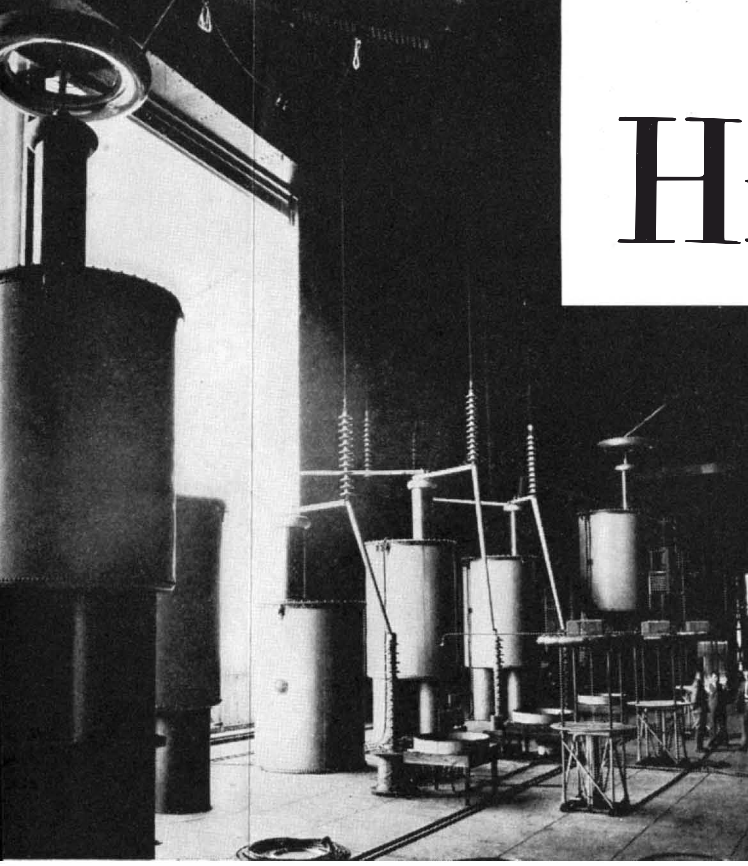
TODAY, as Professor Condon recently said, there is no depression in research in fundamental physics. Advances have come thick and fast and, at that, right on the heels of much shaking of the head by older men of science who had feared that the immense current of discovery which followed on the awakening of a stagnant science by the discovery of the X rays in 1895 was now drawing to a close. It has been young men, mainly in their thirties, who have made many of the recent advances.

It is becoming increasingly difficult, though most fascinating, to keep up with the world's current advances in physics. A year or two ago the Bishop of Ripon, in England, told a scientific gathering that science ought to take a vacation for a while. This remark soon became famous. Many commentators interpreted it to mean that the bishop felt we had already learned enough for our own good. What the bishop meant was probably half whimsical: the feeling, which many of us doubtless share, that the physicists have been making major hits faster than the average mere mortal could keep up with them, and that a breathing spell would permit those of us who were not geniuses to catch up with the trailers in the race and perhaps to keep the leaders at least within sight. But it is not merely laymen who have experienced this difficulty. Scientists themselves also feel it. Thus we find, for example, a biologist here and a chemist there, stating perhaps a bit sheepishly that they have had all they could do to keep abreast of developments in their own field of science and so, like non-professional persons, attending popular lectures on other branches of science in order to get some idea of what is going on in them.

We may go still further: Even among the physicists themselves the research has become so specialized that those who are working in different branches often cannot wholly understand what physicists working in other fields mean.

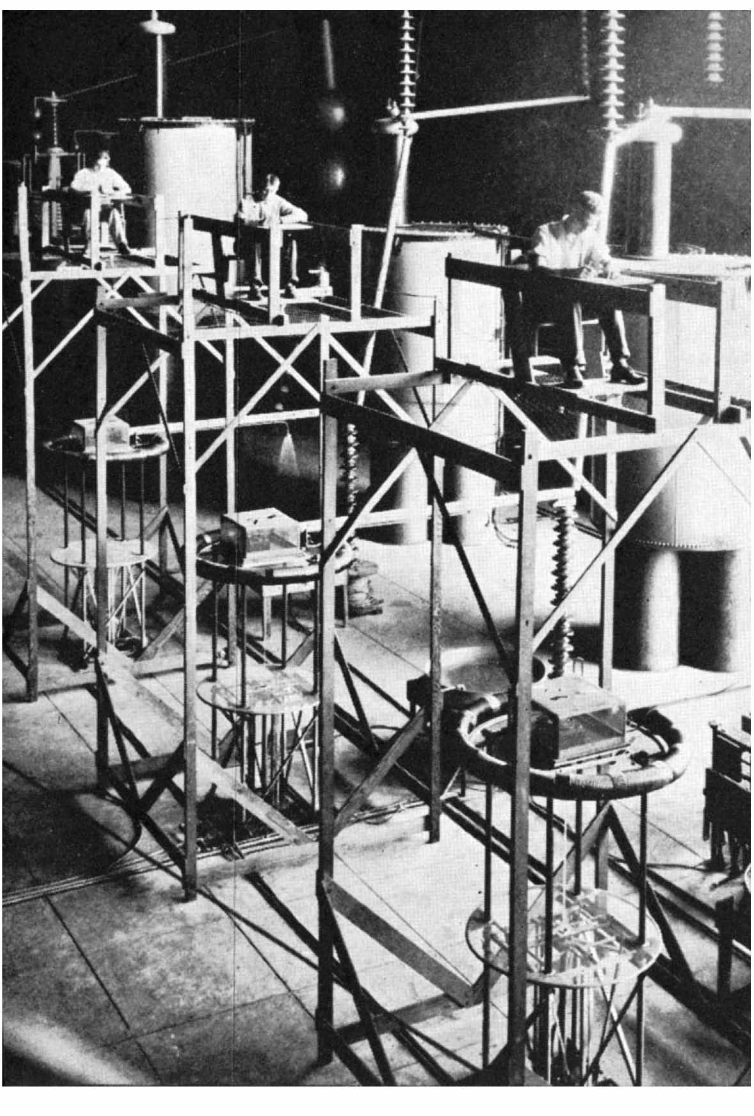
WHAT practical good are all these discoveries? Perhaps none—who knows? Yet few of those thus far made have failed before long to present big business with big bonuses. The physicist himself is interested solely in finding what this world is and just how it works—pure curiosity. But far-seeing business men are turning back to the physicists some of the millions realized. Seed.—*A. G. I.*

HIGH VOLTAGE R



ttery of huge transformers which are capable of producing a voltage 2,400,000. Note the comparative size of the men shown at the lower right

The wattmeter set-up, showing three engineers and the equipment with which they measure the power of strokes of man-made lightning



WITHIN the black walls of the Harris J. Ryan High-Voltage Laboratory, standing alone in an open field at Leland Stanford Jr. University, California, a crackling, blinding flash of lightning 10 feet long burst around the insulators supporting an automatic disconnect switch. Again and again chain lightning was poured into the circuit until, by delicate measurements, the engineers learned the insulators would withstand a lightning bolt carrying 830,000 volts under normal operating conditions.

Three decades ago, when the late Dr. Harris J. Ryan started his experiments with man-made lightning at Stanford, commercial voltages higher than 15,000 were not known. Within the next few months, conductors strung across a 275-mile expanse of desert from Boulder Dam to Los Angeles will carry the then undreamed-of power of 287,000 volts. It was to meet this and other like demands for long-distance transmission of power in the West that experiments by electrical engineers at Stanford have worked toward the safe handling of higher and higher voltages.

Here electrical engineers are playing with man-made lightning, erratic and destructive when untamed, but a valuable servant to humanity when controlled. How much voltage the lightning of nature carries is only guesswork, although engineers' estimates of that voltage range from 20,000,000 to 1,000,000,000. In the black room of the Ryan Laboratory, 30-foot bolts of man-made lightning, with 2,400,000 volts behind them, whip between gaps at the turn of a switch. While this does not compare with the fury of natural lightning, tests with this great power have resulted in development, for example, of circuit breakers which switch power off in 1/1000 of a second when lightning strikes.

A visit to the black high-voltage room carries you behind the scenes of many high-voltage projects, for there Dr. Joseph S. Carroll, the director, and his associates, have whipped baffling problems of power transmission. Inside the door of the lofty laboratory you find yourself facing a table covered with sections of cable cut to cord-wood lengths. Some are aluminum, others copper; some are bundles of wire, others are pipes almost 1½ inches in diameter. Nearby is more cable, wound on reels high as a man.

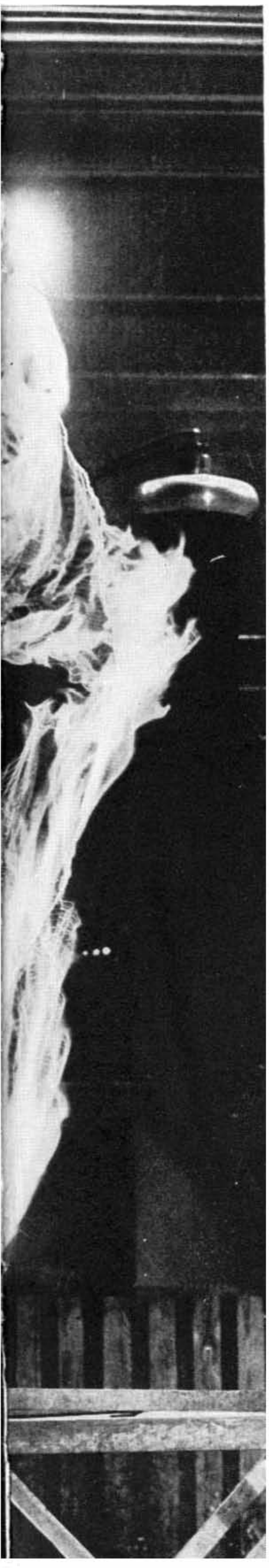
Since high voltage is like high water pressure, it pours electrical energy over a cable at such pressure that there is

Photographs by Berton Crandall

Artificial lightning at length of a ten-foot

ESEARCH FOR COMMERCIAL USE

By ANDREW R. BOONE



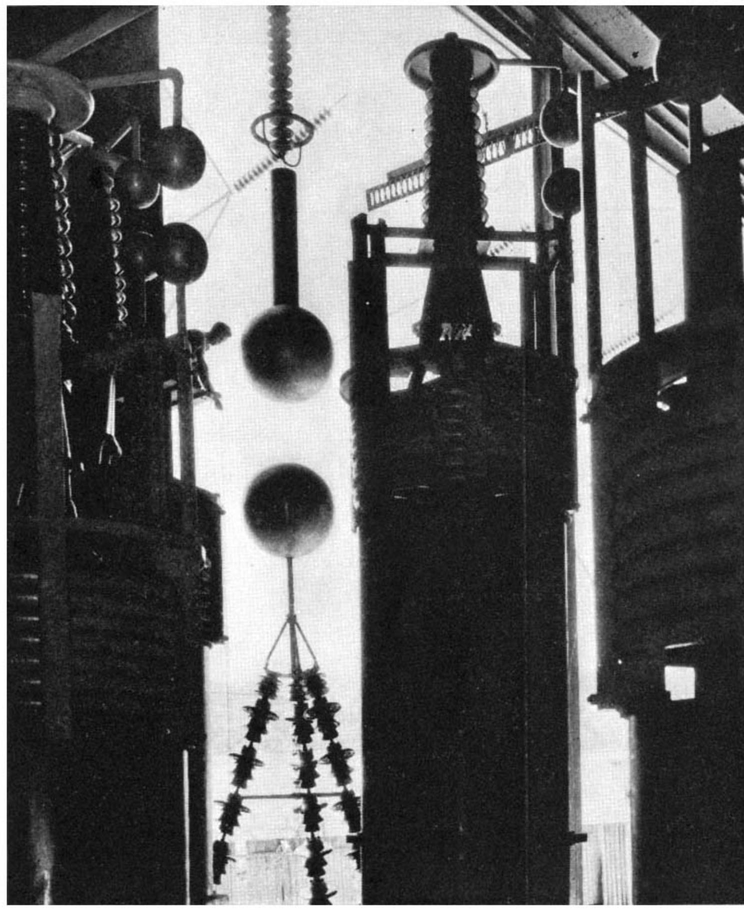
40,000 volts leaping the ing of insulators (left)

little loss in transit provided the cable is large enough to carry the load. Low voltage may be likened to low pressure. The volume may be started through one end of the cable but without pressure it peters out toward the end of the line into a mere trickle. Recently, in the Ryan Laboratory, Dr. Carroll has conducted experiments looking not only to protection of high voltage lines against lightning, but also to determine what size conductors are necessary to carry as much as 287,000 volts over a distance of 275 miles. How large in diameter the cables should be, how much copper or aluminum they should contain, whether they should be hollow or solid, what kind of surface they should have, were questions unanswered by precedent.

IN seeking answers, the laboratory staff strung up ⅕-mile lengths of different diameters of cables, suspending them from towers extending across the fields nearby. Motor-dynamos in the power room and transformers in the laboratory shot into the cables a voltage of 600,000—twice that demanded for practical service. Losses were measured by carefully adjusted wattmeters. From these data the world's largest conductors were designed.

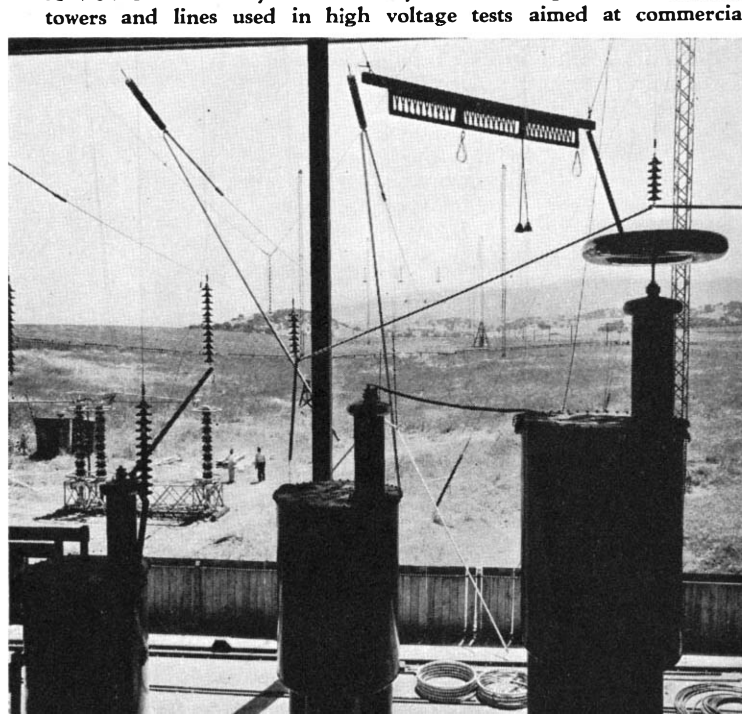
For certain phases of the work in the laboratory Dr. Carroll brought the mountains and deserts into the laboratory by constructing an ingenious "weather tube," a steel tank 30 feet high and five feet in diameter. Within this cylinder he produces climates at will, making them dry and hot for the desert, damp and cold for the mountains, and lowering the pressure for high altitudes. Thus, within a small space, "cord-wood cables" were tested under weather conditions approximating those on a line running through mountains and desert. These tests revealed that hollow conductors give the least loss on the world's highest power line.

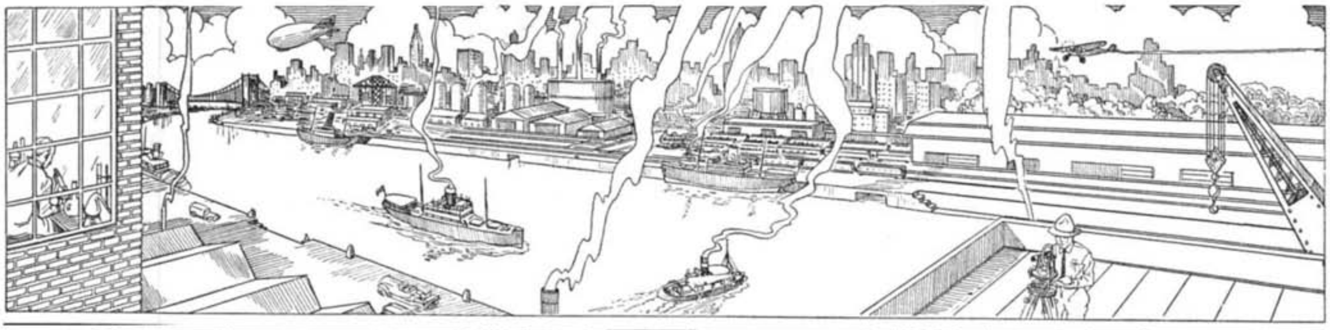
While he toys with artificial lightning, one bolt of which if misdirected could snuff out the lives of all nearby, Dr. Carroll hopes some day to catch a bolt of real lightning and direct the bolt into a photographic recording device to measure its strength. Somewhat more practically, he already is anticipating the day when engineers will demand means for handling a half-million volts over transmission lines. Since power is transmitted most economically at 1000 volts for every mile of line, he foresees the time when wired lightning will flash across the countryside in 500-mile steps, kicked along by 500,000 volts.



Lining up (see man at left center) one of the huge sphere gaps used as part of the wattmeter equipment for measuring high powers

A view from the Ryan Laboratory over the experimental transmis towers and lines used in high voltage tests aimed at commercial





THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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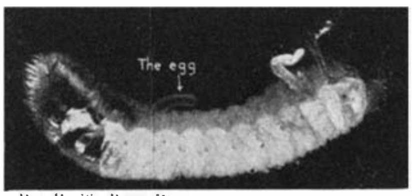
Bug Eat Bug

SAVING of thousands of tons of America's cane sugar supply from Hawaii, which has been destroyed in past years by an insect pest, is expected through the activity of another insect which has just been found to be established in the fields where



Pan-Pacific Press Bureau

How bugs battle bugs

the pest has been most destructive. *Elis pulchrina,* a small wasp from Guatemala, is the latest immigrant brought to this part of the United States to attack the worst surviving enemy of sugar cane in the territory. The Guatemala wasp is one of many parasites which have been introduced by the entomologists of the Hawaiian Sugar Planters' Association Experiment Station to bring various pests under control, and the latest of three to attack the anomala beetle.

The anomala does its harm while in the grub stage. The grub lives in the ground around the cane and eats the roots and the part of the stalk below the surface of the earth, depriving the cane of nourishment and weakening it severely. It has been considered a serious menace to America's sugar industry.

The adult wasp lays a tiny egg on a certain segment of the grub when the grub is in the ground around the roots of the cane. The egg hatches and a larva appears—what the layman would call, in common parlance, a "worm." The wasp larva gnaws into the grub, which is helpless to defend itself, and in about eight days there is very little of the grub left.

By that time the larva is ready to go into its next stage. It spins a cocoon—a shell of silky fiber shaped like a short, fat dirigible balloon—and remains in it while developing to adult form. In about three weeks a mature wasp gnaws its way out of the cocoon, finds a mate and carries on the breeding cycle.

The anomala beetle stowed away somewhere in the Orient—probably in Japan—and entered Hawaii by accident about 1908. Entomologists went to the Orient to seek its natural enemies. The parasites found in Japan did not become established in Hawaii, but two species from the Philippines did.

WIRE MILEAGE

TELEPHONE wire in use in the United States totals 87,000,000 miles. This is 56.92 percent of the world's total, Germany being second with 10.14 percent.

Moving A Highway With Hose

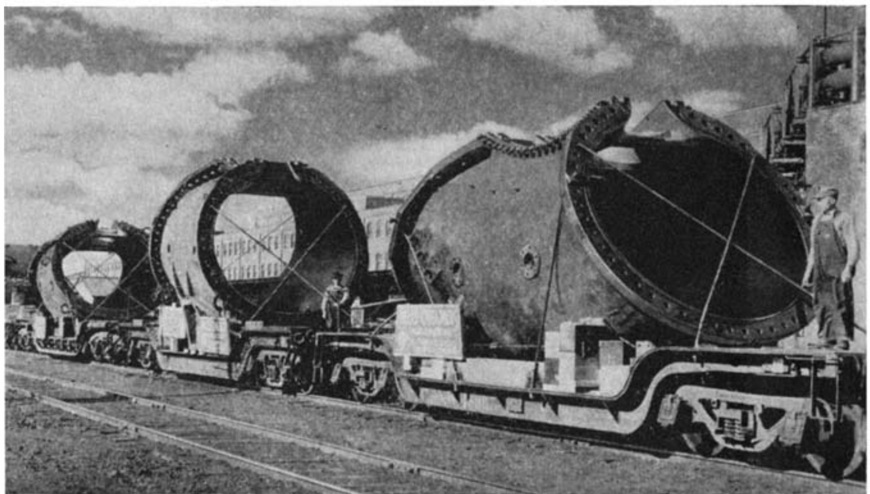
A USE for hose believed to be without precedent has just been made by the New Jersey State Highway Department. Along New Jersey Route No. 26, between New Brunswick and Trenton, the first eight miles of a 40-mile stretch of concrete roadway has been moved 12 feet to one side to provide a safety island in the center of the present four-lane highway. This island was constructed in an effort to reduce the number of accidents; during 1934 there were nearly 90 motor car deaths on this highway. New Jersey highway officials are hoping that the addition of the safety island will eliminate many of these accidents.

Ready to insert the three-inch hose in the unusual highway-moving system described in these columns

The present highway is made up of three concrete slabs, the center and west ones being 14½ feet wide and the east slab 10 feet wide. The 14½-foot slab on the west edge of the highway was the one moved. A new slab 10 feet wide will be built outside of the one moved, so that when finished the completed project will present a highway 25 feet wide on each side of a center 12-foot safety isle.

The highway strips are moved three inches at a time. Blocks are then inserted for the next sidewise "push"

Since it was decided to move the road rather than build over or break it up, it became a problem of moving the slabs without damage. Mr. Sigvald Johannesson, New Jersey State Highway Engineer, conceived the idea of accomplishing this with hose. The road was moved in approximately 500-foot lengths, which consist of fourteen slabs, each slab being 35 feet long. After



Courtesy Allis-Chalmers Manufacturing Company

A shipment of the spiral casing for one of the hydraulic turbines at Boulder Dam. Six cars were necessary to carry the complete casing; 26 cars were required to transport the entire 115,000 horsepower, 1,250,000-pound turbine

the road shoulder had been graded down to the proper level, the asphaltic joint filler in the longitudinal joint running lengthwise of the section was removed by means of a steel blade drawn by a steam roller.

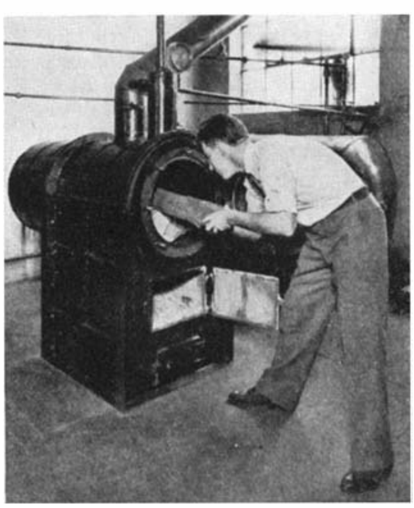
The removal of this joint filler left a crack about half an inch wide. Into this crack was inserted a flattened length of three-inch United States Worthy Linen Hose, previously soaked in water and treated with graphite. Five 100-foot sections of this hose were coupled together and air under pressure was forced into the hose. As the hose expanded, it forced the entire 500-foot length of roadway to move approximately two inches.

The separation between the slabs was then wide enough to accommodate an especially constructed, double jacket cotton rubber-lined six-inch hose. The process of expanding the hose with compressed air was then repeated, the slabs moving three inches with each inflation. After each inflation and deflation, proper blocking was placed behind the hose and the process repeated. Each cycle consumed somewhat less than five minutes. The moving proceeded at a rate of approximately 800 feet of slabbing per day. Mud jack crews followed the moving gang and formed a new permanent base for the transplanted highway by pumping a fluid mixture of top soil and cement through small holes previously drilled through the concrete.

When one realizes that every cycle of this operation consumed somewhat less than five minutes and that in that time a strip of concrete $14\frac{1}{2}$ feet wide, 500 feet long and weighing approximately 840,000 pounds was moved three inches, the ingeniousness of this engineering feat is truly amazing.

Home Gas Generator

A NEW gas generator, which will produce gas on farms or for rural homes, and will burn almost any kind of fuel that may be available, has just been placed on the market. The gases it produces include carbon monoxide, methane, and hydrogen in a mixture which is satisfactory for cooking, lighting, refrigeration, or other domestic uses. The fuel used may be any combustible vegetable or fatty matter such as wood, sawdust, leaves, corncobs, cornstalks, straw, and even old shoes, rags and other waste material. The makers, the Economy Gas Generator Company, say that after they are installed these generators are operated practically without further cost and will last a lifetime.



Gas generator for the home

A "run" is said to take about $3\frac{1}{2}$ hours, no skill being required for the operation, for the process is one of controlled, high-pressure destructive distillation. In this process the gases are distilled from the material used and, as far as possible, all crackable products distilled from the material are also cracked into gas. The manufacturer claims that the gas produced by the generator has a heating value of approximately 500 British thermal units.

Besides the combustible gases it produces, there is also a quantity of creosote and creosote water produced in the run. Needless to say, these products are also useful on the farm.

Non-Skid Tire

FOR years various kinds of tires have been advertised as non-skid, yet we have known that most of these were far from perfection in non-skid qualities. Now, however, there is one which seems to approach very much closer to that long desired point. This is the new General Dual-10.

Narrow fins reduce skidding

This new tire departs rather radically from the old practice of building complex patterns on the tread. Its virtue lies in the thin peripheral fins which are but $\frac{1}{8}$ of an inch wide and stand $\frac{1}{4}$ of an inch high on the tire, with less than $\frac{1}{16}$ of an inch space between. On first examination one would say that these fins are too soft and flexible, but that appears to give them their non-skid characteristic. As shown in tests, these fins, under the weight of a car, bend into a snaky pattern with the applied torque of the engine or in braking, so that they give a squeegee effect. With this snaky twisting of a number of the fins, there will always be many edges which are opposed to the line of motion of the car, thus squeegeeing the roadway and giving better traction for driving or braking.

Moving pictures of cars using these tires under test show that they will stop a car dead-straight on a wet pavement at speeds at which cars with ordinary tires will skid badly. The manufacturer claims that they will stop a car quicker and more safely on a wet pavement than will ordinary tires on a dry pavement.

MAN'S COSMETICS

OF all things: Men with eyes darkened to make them large and interesting and hair curled with curlers, and with perfumes and powders commonly used, as mere man says, for women's vanity! Egyptian "he-men" of 1500 B.C. wore such make up—and probably their wives called them vain. These facts were learned from examination of the family tomb of the private secretary to Queen Hatshepsut.

New Synthetic Rubber Shows 500 Percent Elongation

AN oil-proof synthetic rubber with a tensile strength up to 1700 pounds per square inch, has been put on the market by the Thiokol Corporation. While it will stand even lower temperatures, it is claimed to be very flexible at −45 degrees, Fahrenheit. Among the many features claimed for it are: Elongation around 500 percent; abrasion resistance of the order of rubber; tear-resistance equal to or better than rubber; mild, not objectionable, odor; and, in addition to being oil-proof, good resistance to Duco thinners, lacquers, printing inks, benzo-gasoline blends, and most ordinary solvents. It is sold in crude sheet form corresponding to natural crude rubber.—*A. E. B.*

TEMPERATURES

WHILE the outside surface of the sun is only 6000 degrees, Centigrade, Dr. T. E. Sterne, astrophysicist of Harvard College Observatory, recently guessed that the internal temperatures of some stars must be as much as 1,000,000,000 degrees, Centigrade. We say "guessed" because there is no known way of making an actual determination.

A New Armor Piercing Shell

DURING the past 30 years, the development of long range naval gunnery has been a never-ending problem to the gun-mounting manufacturer, the ship constructor, the maker of optical instruments, and the steel master. When the armament manufacturer has designed a high-elevation mounting capable of standing up to the enormous recoil stress of a big gun firing at, say, 30 degrees, the naval constructor has to allow for the increased strain and must strengthen his hull to stand the shock. Then the makers of gunnery control devices—the range-finders, director gear, and the dozen and one complex pieces of equipment which go to make up mechanized gunnery—provide of their best to insure hitting at maximum range, leaving it to the steel master to furnish the armor-piercing shell. The ability of the shell to pierce the target and burst would seem to be something we should take for granted as the final factor in the delivery of a crippling salvo.

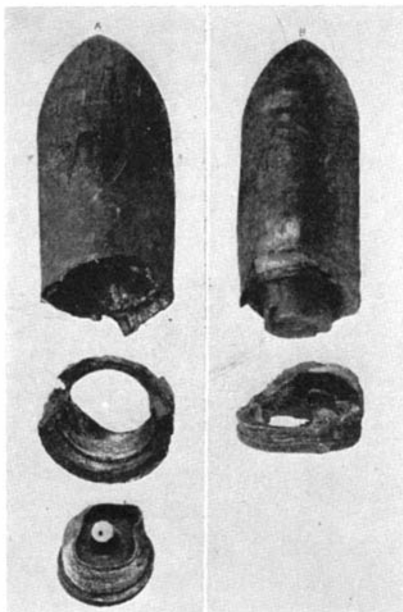
It so happens, however, that the projectile provides a difficult problem. Time and time again, when perfect co-ordination has resulted in high percentage hitting at long ranges, it has been found that shells fail to burst when they have pierced thick armor. Examination of them has shown that not only has the fuse been rendered unable to perform its function by becoming mutilated and detached from the body of the shell with the breaking away of the base of the shell, but the explosive charge itself is made practically harmless by being provided with a large vent.

It is not a question of shells being badly made; the most stringent system of selection would seem to be no safeguard against this happening, as it is simply a matter of the luck of the hit! With shells of ordinary construction, fracture of the base-end may occur at any velocity and does so in a percentage of rounds when striking the armor at high angles of incidence. With increasing range and diminished striking velocity this percentage becomes greater until a point is reached when such failures become inevitable.

Formerly, the manufacturer was concerned in producing a cap which would enable the projectile to pierce the armor; now that the cap difficulty has been greatly reduced, it is frequently the base which fails to protect the fuse. The reason for the fracture is that when a shell hits obliquely it tends to turn to the normal in its passage through the plate owing to the inequality of resistance offered to the two sides of the ogival head. This turn to the normal in so short a space of time causes a rapid and violent swing of the shell so that under certain conditions of velocity and thickness of plate its base-end will strike the edge of the hole with such force as to tear the base off—or at least distort it to such an extent as to damage and prevent the action of the fuse.

These unfavorable conditions are most likely to occur when the projectile strikes thick hard-faced armor at long ranges with an increased obliquity of impact due to the greater angle of descent. Although the ordinary type of projectile may perforate under these conditions, the shell will too often be blind for the reasons already mentioned.

It was to overcome this difficulty that the British firm of Messrs. Hadfields, Sheffield,



Courtesy Hadfields Ltd.

The effect of perforating an armor plate, at high angle of impact, with (left) an ordinary shell, and (right) with the relief base type

turned their attention to, and succeeded in producing, a shell which would be proof against this type of failure and would isolate the vital functions of the shell and fuse from the effects of the base-end blow.

In these new and patented shells, the result of the violent swing to which they are subjected during perforation of the armor is merely to remove the non-essential portion of the base and leave a fully effective projectile; that is, one in which the bursting charge remains completely enclosed and in contact with the fuse which is retained intact as shown in the accompanying illustrations. These are reproduced by permission of Messrs. Hadfields who hold world patents (including those for the U.S.A.) for this and several other important improvements also patented, so necessary for the manufacture of a successful armor-piercing projectile.

It may also be added that from a tactical point of view the benefit in question is of far-reaching importance because any attempt to increase the effective fighting range of an existing shell means an increase in the angle of impact; or, if to avoid this, its ballistic flight is improved by increasing its sectional density, an increase in its length is necessitated. Unfortunately, an increase in either the angle of descent or the length of the shell raises immediately the risk of base-end failure which has thus become the limiting factor against an increase in effective fighting range. The removal of this limiting factor and of the risk of failures from other causes, by means of the shell manufactured under the Hadfields' patents, would seem to open up new tactical possibilities in which a fleet so equipped can choose its fighting range where it can inflict heavy damage on its opponent while remaining beyond the reach of any effective reply.

At this time when a revival of naval activity is imminent it is a matter which calls for serious consideration.—*Dr. Oscar Parkes.*

TRANSPLANTED HEADS

IN Vienna, "nymphs" of grasshoppers fed and shed their skins in regular fashion after exchanging heads with other "nymphs." Dr. Atma Malabotti, who performed the transplanting operations, says that the female grasshoppers grew up, eventually laid eggs, and hatched quite normal little grasshoppers.

Skin Graft Triumph

A NOTABLE triumph in skin grafting has been scored by an Australian surgeon. New eyebrows and lids have been grafted over the staring, though still functioning, eyes of a youth who was badly burned by acid. Piece by piece, skin from other parts of the body is being grafted to the face and other damaged parts.

Eight operations have been performed at Sydney and there are still three more to be done. Medical men from all over Australia have been watching the progress of the case and photographs of the successive stages have been forwarded to the British Medical Association.—*Australian Press Bureau.*

A Lost Gold Art Revived

GOLD beads so tiny that a row an inch long would contain a hundred of them figure prominently in the intricate jewelry art of the ancient Etruscans, who throve in Italy before the rise of Rome. But the making of them became a lost art.

Now an English goldsmith named Blackband is able to make them again, by a process which he believes is identical with that used by the long-dead early masters.

Mr. Blackband's rediscovery was more or less accidental. He spilled a small quantity of molten gold, which splashed as it fell. When he gathered up the scattered precious metal, he found that the smallest drops had hardened into perfect little spheres. Now he purposely splashes molten gold-copper alloy onto a sloping shelf in a little box, and turns out "Etruscan" beadlets in quantity.

The next problem was to find out how to form them into the complicated patterns of double lines, hexagons, and triangles such as figure on Etruscan jewelry. This proved to be not particularly difficult. Drawing a wet line with a finely pointed camel's-hair pencil, Mr. Blackband saw his beads range themselves in rows along it, held by the surface tension of the water.

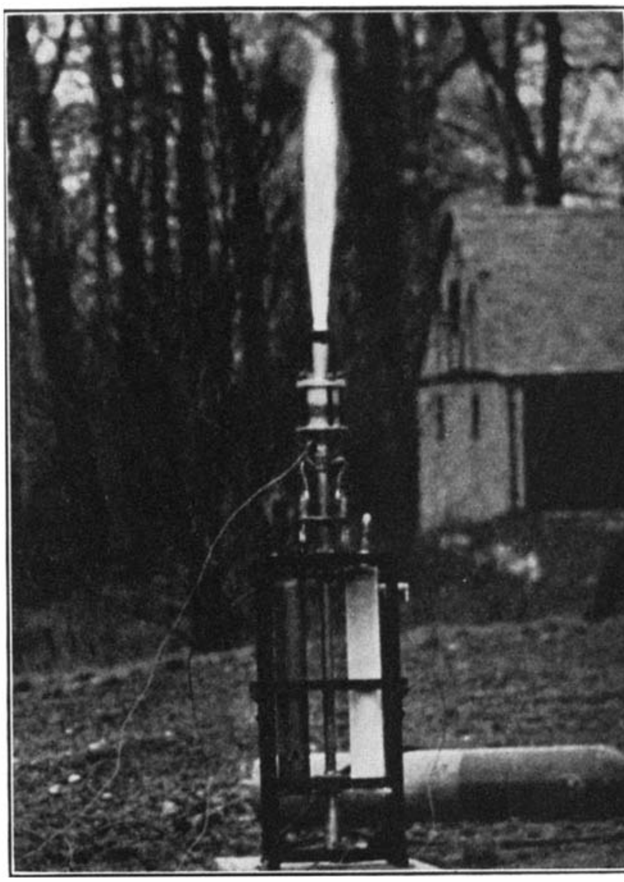
Then he used a wet, hair-fine wire. The beads adhered to the wire. He bent it into the desired pattern, the beads still sticking in place, and then heated it until the wire and beads fused together. Now he can duplicate any pattern the Etruscans had.—*Science Service.*

DAYLIGHT

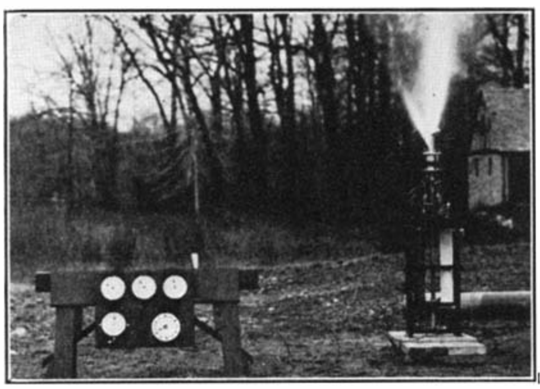
TED LARSEN, United Air Lines meteorologist, points out that during early morning and late afternoon hours the sun is visible from planes in flight while the earth below is in darkness. From an altitude of 10,000 feet, the sunrise may be seen ten minutes earlier than from the ground.

Home Airplane Design

WALTER H. KORFF'S "Lightplane Design" is a workmanlike book with some 110 illustrations which, without any difficult mathematics, takes up the aerodynamics, balance, and general design of a small airplane. The construction drawings are good though not highly detailed. For an amateur airplane constructor no better introduction has been published or given anywhere. Also, we know quite definitely that a number of amateur constructors have produced satisfactory small airplanes in various parts of the country. Whether such home-made aircraft are to be encouraged or not is another question. Even with the machines produced by the best manufacturers in the country, with fine engineering staffs, equipment is still a cause for accident. Homemade machines will provide an intensely interesting hobby, but they certainly will not increase safety.—*A. K.*



A close-up of the experimental rocket nozzle in operation, showing how reaction readings are obtained. The containers for alcohol and liquid oxygen are held in the framework. Fuel lines connect them to the combustion chamber and the nozzle at the top



The test stand and the instrument board, where the pressures in the alcohol and oxygen cylinders are recorded during rocket experiments

Pioneer Work with Rockets

THE American Rocket Society is composed of well informed men, many of them engineers and chemists, who, after an initial burst of uncontrolled enthusiasm, have settled down to a thoroughly practical yet scientific series of tests. The Society is still too young to employ whole time professional investigators, but the members devote all their spare time, Saturday afternoons, and Sundays, and steadily increase their knowledge and mastery of the problems involved.

We were privileged visitors on a recent Sunday to watch the Society's new proving stand in operation. It is obviously both expensive and unsatisfactory to build a rocket, fire it, and perhaps lose it forever. At this stage of the game it is better to learn on a proving stand exactly what may be expected of a rocket motor under varying conditions.

Briefly described, the proving stand comprises an alcohol container, a container for liquid oxygen, piping and valves for bringing the two fuels together into a combustion chamber, and at the top of the combustion chamber a variety of nozzles which can be screwed in. The fuel inlets are two pairs of opposing orifices in the combustion chamber; the small pair for fuel, the larger for oxygen. The liquid oxygen, of course, is under pressure already. The alcohol is brought up to pressure by compressed nitrogen. A series of pressure indicators are mounted on a board and show the pressure in the explosion chamber, in the alcohol cylinder, the oxygen cylinder, and so on. A powder fuse is used to ignite the mixture. The charge consists, as a rule, of one pint of alcohol and two pints of oxygen. A careful technique in loading, mixing, and firing has been developed. The reaction of the upgoing nozzle is measured on a hydraulic pressure gage mounted at the bottom of the firing stand. The intrepid scientists get rid of the crowd of observers by blowing a whistle and seek shelter at a distance behind a strong wooden partition and via steel helmets.

Once or twice the combustion chamber itself has burst. At other times the firing is incomplete. Still more frequent is the burning out of the nozzle. The nozzle material has to withstand temperatures of 3000 degress, Fahrenheit or more, and the erosive properties of gas shooting out at several thousand feet per second. Nozzle after nozzle has been tried and the material which will be entirely satisfactory is still to be found. Tungsten carbide has been suggested and other materials are also under consideration.

A typical short run with a pressure of 300 pounds in the firing chamber lasting nine seconds developed a maximum thrust of 59 pounds and an impulse of 430 pounds a second.

The most difficult problem remains in the development of a strong combustion chamber, adequately cooled, with a nozzle which can stand up indefinitely. We hope to make further visits to the scene of these attempts and to report more fully on progress achieved.—*A. K.*

Cold Weather Air Operation

JUST about the time of writing this note, the difficulties of cold weather operation force themselves on the attention of both the automobile and the airplane operator. The specialized experience of Canadian aviation, with its immense wild areas and intense cold, is of considerable interest to such operators and they would do well to study a paper read by Alan Ferrier (of the Royal Canadian Air Force) before the Society of Automotive Engineers.

When winter flying operations started seriously in Canada shortly after the World War, the technique at the beginning and termination of a flight was terribly laborious. Describing the starting of a four-engined, water cooled, Handley Page bomber the author writes ". . . Hordes of assistants 'chain-ganging' buckets of boiling water into the radiators until the outlets on the far end of the water manifolds ran hot; of pouring hot oil into the tanks; of warming at least 48 spark-plugs on a shovel over the fire and then putting them in; and of the fourth engine sulking and the other three having to be shut down for fear of overheating on the ground; and then of starting the whole process over again."

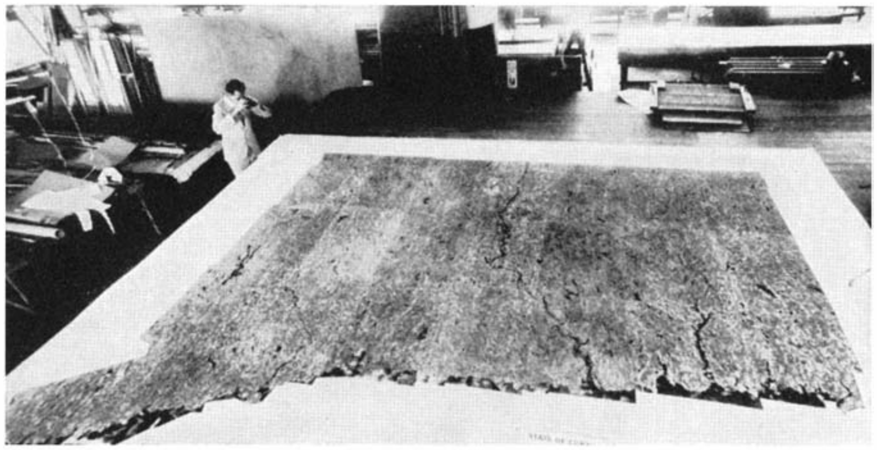
Of course the introduction of the air-cooled engine reduced these difficulties appreciably. But many difficulties still remain, as borne out by the following remarks: "To ensure a start it has been and still is the practice to warm the motor by encasing it in a heavy canvas cover or a nose tent supported on the vertical propeller and applying heat under the cover by means of a blow lamp, gasoline stove, or even a wood-burning stove. This process takes from half an hour to an hour and the cover has to be removed before an attempt is made to start. The oil was poured in at the last possible moment. If for any reason the engine refused to start, the whole process of draining and re-heating the oil, replacing the engine cover and warming the cylinders had to be repeated."

For several years these arduous conditions were accepted as the inevitable accompaniment of winter. They were not only arduous but dangerous, with an obvious fire hazard. Now an attack has been made from a new angle: the modification of lubrication so that a "cold" start is possible.

Correct lubrication depends upon the "viscosity" of the oil. If the viscosity is too high the flow under the pump pressure will be too small, and though the oil film in the bearings may be strong enough to take bearing pressures there will not be enough oil spilled to lubricate the cylinders and pistons. Cold increases viscosity, and hence cold means difficulties in lubrication.

These difficulties have been met by the following simple measures: The technologists were asked to produce an oil which would pour easily and have little viscosity in the coldest weather. They responded by producing an "arctic" type oil which flows readily at −20 degrees, Fahrenheit. Oil tanks and feeder lines were protected as much as possible from the cold atmosphere. To insure starting, some highly volatile ether was injected at the start of a run into the engine manifolds.

Without any of the laborious technique described previously, cold starts are now easily achieved. With further progress in arctic oils, Mr. Ferrier thinks that a cold start will finally be possible just above the freezing point of gasoline; namely, −70 degrees, Fahrenheit. There is no object in going below this point, since it probably is the limit of human endurance.—*A. K.*



The composite map of Connecticut made from aerial photographs

GLASS RAZOR BLADES

AFTER long experiment, Czechoslovakia is reported to be turning out razor blades made of glass. The importance of this development lies in the low cost of the blades, mainly, although the fact that they cannot be resharpened will mean more sales for the manufacturer.

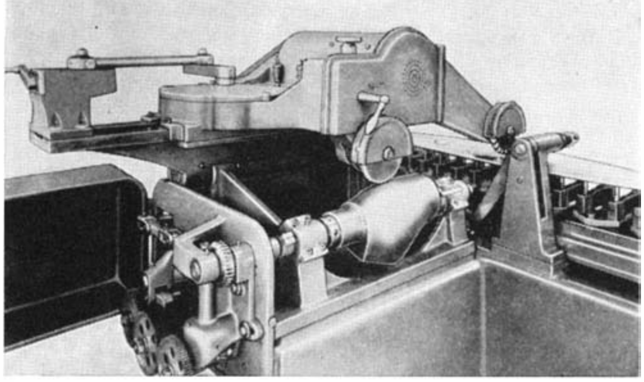
Aerial Photograph of a Whole State

THE entire state of Connecticut can be seen in a single aerial map which was exhibited at the Tercentenary Industrial Exposition held in Hartford. This map has dimensions of 18 feet by 13 feet and an area of 234 square feet. The map was made by flying at an altitude of 11,400 feet by Fairchild Aerial Surveys, and includes 34 composites which were derived from 10,479 exposures. When the huge picture was hung on the wall of the State Armory at Hartford, spectators using field glasses to magnify detail were able to pick out small landmarks such as hedges, chicken houses, trails, or small streams.—*A. K.*

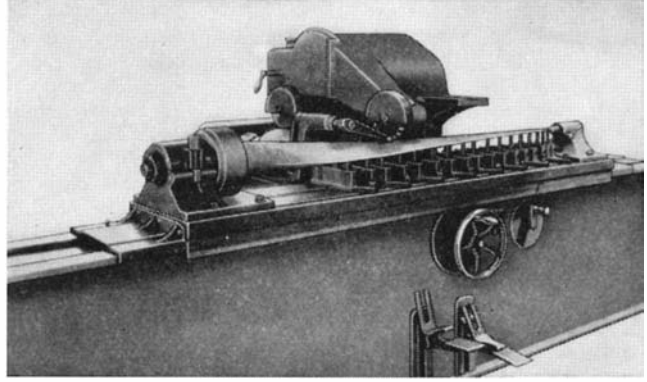
Machining Propeller Blades

THE metal airplane propeller is better in almost every way than the wooden propeller, and is rapidly displacing the latter on airplanes of every type. Its one disadvantage is in higher cost. Therefore, it is highly desirable to have "profiling" machines for low-cost production of metal blades, such as the one developed by the Engineering and Research Corporation. The development work extended over four or five years, and the machine includes a variety of mechanical devices, a complete description of which would involve many drawings and a lengthy pamphlet. But if our readers study the two photographs carefully, they will have a very fair general idea of the functioning of this device, which has proved highly successful and is being widely accepted by the aircraft industry.

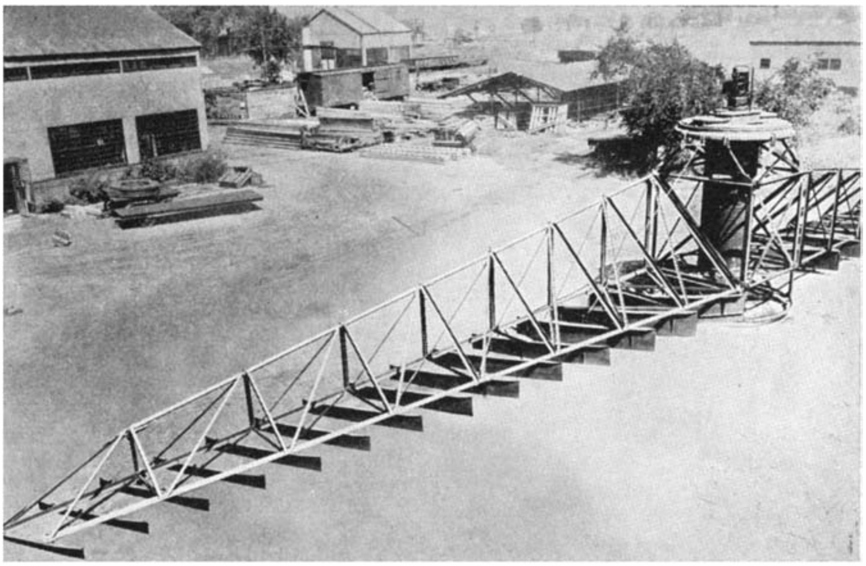
A single master cam or form of solid cast iron is employed. This master cam, with a peculiar form, has a length of two inches more than the maximum width of the blade being produced. The cam rotates and is directly geared and synchronized with the table holding the blade forging which is fed horizontally past the cutter. Owing to this synchronization, each line radially on



The roller is guided by the master cam and, in turn, guides the cutter that does the work on the propeller blade



The propeller forging, with its bed, travels horizontally, while the cam-guided cutter gradually shapes the blades



One of the Dorr Clarifiers for the All-American Canal desilting plant

the master cam or form represents a corresponding element of the propeller blade. Of course, a separate master cam is needed for each side of the blade.

With the aid of a roller, traveling on the cam, and an appropriate linkage, the cutter travels back and forth with simple harmonic motion, and oscillates freely about a trunnion which permits the necessary vertical travel.

The blade is fed horizontally past the cutter from tip to hub. At about 18 inches from the hub, the cutter lifts off the forging and the machine is automatically shut off. The table is then cranked back to the starting position by means of a hand wheel, a new forging is inserted, and the machine is restarted by means of a conveniently located push button switch. The propeller is supported on the table by a hand and tail stock. The cutter is of special design and has a peripheral speed of approximately five thousand feet a minute. Lengths of strokes, position relative to the center line of the table, and number of strokes per minute can all be varied. The cutter can remove three eighths of an inch of metal with one powerful cut.

To produce the master cam or form, the cutter and roller are reversed on the machine. A master blade is placed in position on the table, and guides the roller. The cutter (which is now located where the roller was previously) now fashions a wooden block which is on the master camshaft. The iron casting is fashioned from the carefully cut wooden pattern.

The blade of a ten-foot propeller can be machined in one hour, and generally but a single cut is necessary, though it takes one hundred and fifty hours to produce the master cam. We saw this machine in action, and were positively fascinated by its ingenuity and accuracy.—*A. K.*

70,000 Tons of Silt Daily

As much as 70,000 tons of silt a day will be removed from something like eight billion gallons of Colorado River water pouring into the new All-American Canal from the Imperial Dam. This desilting process will be performed by what will be the world's largest water treatment plant, to be constructed 15 miles northeast of Yuma, Arizona, at the above-mentioned dam which is about 250 miles below Boulder Dam. The solid matter removed by this plant will at times amount to 70,000 tons daily while the average will be about 50,000 tons.

The desilting plant shown in the accompanying illustrations will have mechanically-operated Dorr Clarifiers which have been worked out by the Dorr Company, Inc., in collaboration with government engineers.

The desilting plant will consist of six huge settling basins, each approximately 769 feet long, 269 feet wide, with an average depth of 14 feet, arranged in pairs. Each pair of settling basins will be fed by an influent channel, located between adjacent basins, and these influent channels will, in turn, receive their water from the headworks at the west end of the Imperial Diversion Dam where the rate of flow is to be controlled by four roller gates, each 75 feet long and 23 feet high. The inflowing raw water will be uniformly distributed and will flow across the basins to the effluent side, depositing en route upon the bottoms of the basins the greater part of the suspended solids.

The removal of deposited silt is going to be accomplished by the largest battery of Dorr Clarifiers ever installed. Seventy-two of these mechanically-operated clarifiers —measuring 125 feet in diameter each— will continuously plow the accumulating solids to outlets in the bottoms of the basins whence they will be continuously discharged into sluicing channels and returned to the Colorado River below the diversion dam.

GASOLINE MOONSHINERS

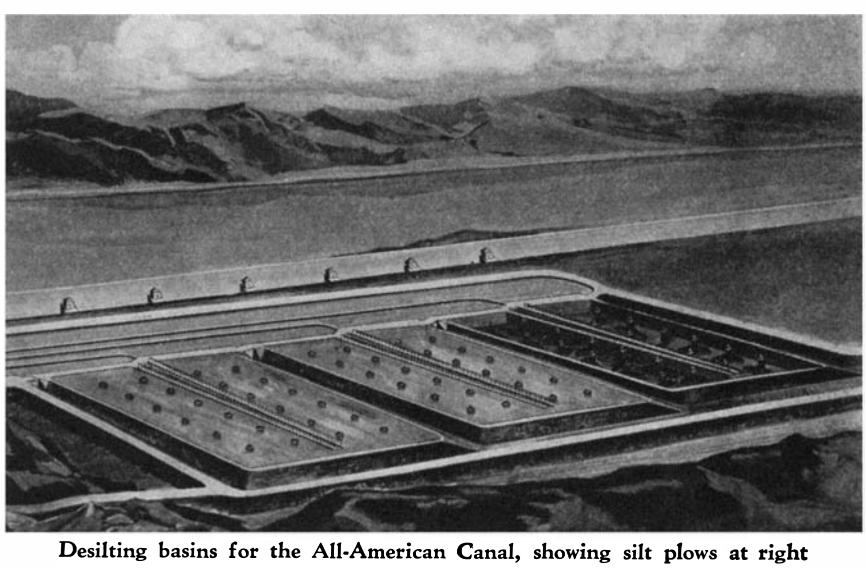
Officers, finding and destroying a moonshine still in the hills of eastern Washington county, Ohio, were puzzled by the absence of mash barrels when they first sighted the still. Investigation showed that the plant was producing gasoline, thus evading the Federal tax of one cent per gallon on gasoline at the refinery.

Conquering Two Plagues

A MAJOR triumph in disease fighting in Sweden, reported at the meeting of the American Public Health Association, has fired the enthusiasm of American health officers engaged in what seems like a hopeless fight against the same diseases. The triumph, reported by Dr. Einar Rietz, health commissioner of Stockholm, is the practical eradication in Sweden of the two venereal diseases, syphilis and gonorrhea.

American health officers trying to accomplish the same results here must fight not only the disease but *an antagonistic public opinion which largely forbids even the mention of the diseases by name.* Yet these unmentionable plagues are the cause of more suffering and disability than any other communicable disease. The point is that syphilis and gonorrhea are diseases as are typhoid fever, tuberculosis, and yellow fever. They may be brought under control and practically wiped out by much the same methods that have eradicated yellow fever from this country and have brought so many other former plagues under control.

Using the familiar and trusty weapons of all disease fighting, the number of new cases of syphilis in Sweden has been reduced from 6000 a year to 431, Dr. Rietz reported. The population of Sweden is about the same as that of the state of New York, outside of New York City. Best estimates of the number of new cases in



Desilting basins for the All-American Canal, showing silt plows at right

New York state every year reach 11,000.

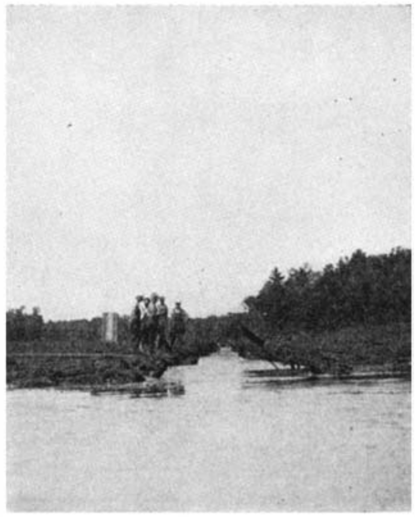
One feature of the Swedish method of handling the disease is provision of free medical and hospital care and medicine to any patient who has syphilis in the infectious stage. All patients must take treatment. Those who do not are subject to various penalties. Yet Dr. Rietz assured his American colleagues that personal liberty is safeguarded as carefully in Sweden as in the United States. Cases are reported to the health department without the patient's name. Sources of infection must be reported just as in the case of typhoid fever or any other communicable disease. Cases of syphilis are now so rare in Sweden that professors have difficulty in finding material to use in teaching medical students.

Encouraged by the Swedish experience, American health workers are hoping they will be given the opportunity to repeat the triumph over these two plagues in this country.—*Science Service.*

Reclaiming "Deadheads" with Dynamite

Legion are the tales of the mighty log drives down the Menominee River, which takes its source in the upper peninsula of Michigan, where the Brule and Michigan Rivers meet. Millions of the great white pine trees, once standing in grand forests away in the sands of Michigan and Wisconsin, were fed into the maw of this scenic river, and floated to the one-time flourishing sawmill towns that are now the prosperous cities of Menominee, Michigan, and Marinette, Wisconsin, located where the river empties its cold spring water into Green Bay.

Paul Bunyan, the mightiest of all loggers, a legend tells, was always the first to deliver his drive to the Menominee and Marinette sawmills. When his season's sawing, skidding and "decking" on the river's banks were done, he did not wait for the ice to thaw. He commanded his seven mighty ax-men to chop large blocks of ice forty rods long and of the river's width, in advance of his drive. With mighty tongs of his own design, harness made of 37-pronged deer hides and porcupine quills, and his great Blue Ox, he hauled the blocks of ice ashore, out and in again, as his logs floated down stream. Paul Bunyan never lost a log on any of his drives on the Menominee River. There is yet to be found a single white pine "deadhead" in the river bearing his brand mark. Paul Bunyan was circumspect; his sour dough cooks never fed a flapjack to a lumberjack who would not respect a white pine log from the moment his seven mighty ax-men felled the tree until the log was delivered to the mill.



In reclaiming logs embedded in the silt and gravel of a river bed, explosives were used to cut a new channel through the mass of silt, thus permitting the river water to flow through, scour the remaining silt, and uncover the "deadheads"

Photographs courtesy *Ag-Ex News*

Barricade used by shot firer reclaiming "deadheads" by dynamite

Less sagacious were those who followed Paul Bunyan, says Alfred Mathewson, writing in the *Ag-Ex News.* Their deficiency is evidenced by the presence of countless "deadheads" embedded in silt and gravel in the bottom of the Menominee River.

Recently the reclamation of these "deadheads" has been accompanied with the assistance of dynamite. To make the required channel, cartridges of Ditching Dynamite were placed at intervals of 18 inches and at a uniform depth of eight inches along the site of the new channel. The cartridge in the end hole contained an electric blasting cap. Leading wires were attached to the wires of an electric blasting cap, and the other ends of the leading wire fastened to the terminals upon the blasting machine placed at a safe distance from the dynamite location. The presence of sufficient moisture in the ground permits the "shock-wave" to propagate throughout the entire length of the required ditch.

The quantity of explosives was not large, nor was much time required to load the necessary charges, but the employment of explosives to expose a valuable "deposit" of timber is one more example of what can be done with dynamite when ingenious and intelligent methods are employed.

Chemistry in the Movies

Hollywood studio technicians have been trying to find some substance that will act and look like lava in the volcanic scenes of "The Last Days of Pompeii." They finally found that powdered aluminum mixed with water gives a perfect photographic effect. As it runs quite rapidly, however, the eruption scenes had to be filmed in slow motion.

The filming of "Dante's Inferno" called for some kind of fire that would allow actors to walk through flame, and not be burned, or even heated. The Arthur M. Maas Laboratories, of Los Angeles, finally perfected "cold fire" which could be delivered in cans, and is a nicely balanced compound of an inflammable solvent and one that is not inflammable. The burning ingredient furnishes the flames—and beautiful flames they are—while the non-inflammable ingredient actually cools the flames, and keeps the actors safe and comfortable. —*A. E. B.*

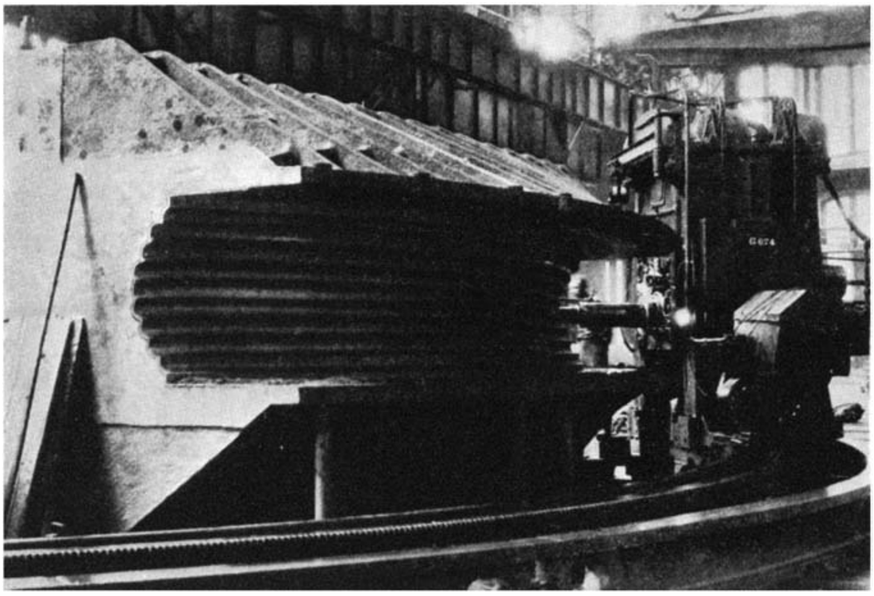
Wider Use for Sponge Rubber

While many uses have been found for the well known sponge rubber, heretofore there has been no practical way to slice it into thin sheets. Manufacturers realized that many additional uses could be found for this resilient, cushion material if they could but cut it in thicknesses less than ¼ inch, which was formerly the lower limit of slicing operations. It has, of course, been manufactured as thin as ⅛ inch but when so made it must have a rubber skin on both sides which naturally detracts from its peculiar qualities.

Now, by a new process worked out by Minneapolis Linen Company, Inc., sponge rubber may be sliced to 1/32 of an inch, with a high degree of uniformity. If the porosity will allow, an even thinner sheet may be attained. In this process a solidifying agent is first introduced into the pores of the rubber by immersing it and squeezing it between rollers. These rollers expel the air and as the rubber again expands the solidifying agent is drawn into the pores. In a short time the piece becomes fairly hard so that the rubber is in the form of a solid block. From this point on it is a simple matter to run the block through a slicing machine which cuts with a sharp wheel such as those used by butchers. As with the butchers' machine, adjustment can easily be made to regulate thickness of slice.

One of the "deadhead" blasts

After slicing, the solidifying agent is removed from the slices by placing them in water for a few moments. When dried once



The milling machine "walks" around the bridge saddle casting

more, the rubber is the same as in the beginning, none of its properties having been changed.

A suggested use for these thin slices is necktie linings to prevent wrinkling. (A patent is being taken out on this application.) Another suggestion is as a lining for winter clothing, for the dead air cells are comparable with the air cells in wool. Also it might form a very satisfactory non-slip bottom covering for household objects such as ash trays, flower pots, and the like.

Steel Castings Support Golden Gate Bridge Cables

A VIVID indication of the magnitude of the Golden Gate bridge is provided by the size of the steel castings which are employed to support the cables on the tops of its towers.

Each cable support or saddle consists of three segments bolted together, weighing approximately 150 tons. The maximum metal thickness is seven inches. Their inner grooved surfaces are designed to provide smooth curved supports for the cables.

Mounted on the tops of the towers, the saddles rest on nests of rollers, and in their original position are set shoreward, three to five feet from their final position. As the construction of the suspended portion of bridge structure proceeds, the cables tend to decrease in sag and elongate slightly, with the result that the saddles gradually move bayward as the weight increases, until they are in final position centered on the towers when the structure is completed. In this position the rolls will be "killed" and the saddles fixed or anchored permanently to the tower tops.

These huge castings originated in the steel foundry at the Bethlehem, Pennsylvania plant of the Bethlehem Steel Company, where the casting and rough machining operations were performed. They were finish machined by The Midvale Company.

Two open hearth furnaces were required to provide sufficient steel for these huge castings. The plain carbon steel was teemed from them simultaneously into large ladles, from which it was poured into pit molds that had been arranged for bottom pouring, with nine risers per segment. Following the removal of the risers, the segments were annealed to remove internal stresses, and rough machined at Bethlehem before being shipped to Midvale for finish machining operations.

Toe Out—Toe In—Toe Out

A GENERATION or two ago we were told to toe out, and then a few years later we were told to toe straight ahead "like the Indians." Evidently many took this later advice too literally, for now comes Dr. Dudley Morton, Associate Professor of Anatomy at Columbia University School of Medicine and an authority on the evolution of the feet of man and the apes, and tells us not to take the "Indian foot" walking doctrine quite so seriously as health faddists formerly asserted. In a new book, "The Human Foot," Dr. Morton says that examinations of American youth and African natives concur in demonstrating that a mild degree of out-toeing in walking is predominant in normal and healthy individuals. "The angle tends to vary with each step, according to the circumstances of speed and to the need for lateral stability of the body. From a physiological analysis, a mild degree of out-toeing is to be regarded as the position of greatest efficiency.

"The use of a conspicuous degree of out-toeing—90 degrees—in Continental armies for many generations seems sufficient evidence that even that position is not injurious to a normally designed and balanced foot, in spite of opinions to the contrary.

"In weak and unbalanced feet, however, the wide angle of gait is definitely harmful, being an added source of faulty strain. It is conducive to greater disturbance in the distribution of body weight through the foot, and therefore, to further unbalance and deformity."

Dry-Ice Well Leased by Government

THE Secretary of the Interior has signed the first lease in American history for the operation of a dry-ice well. The well, producing almost pure carbon dioxide, is located in Carbon County, Utah.

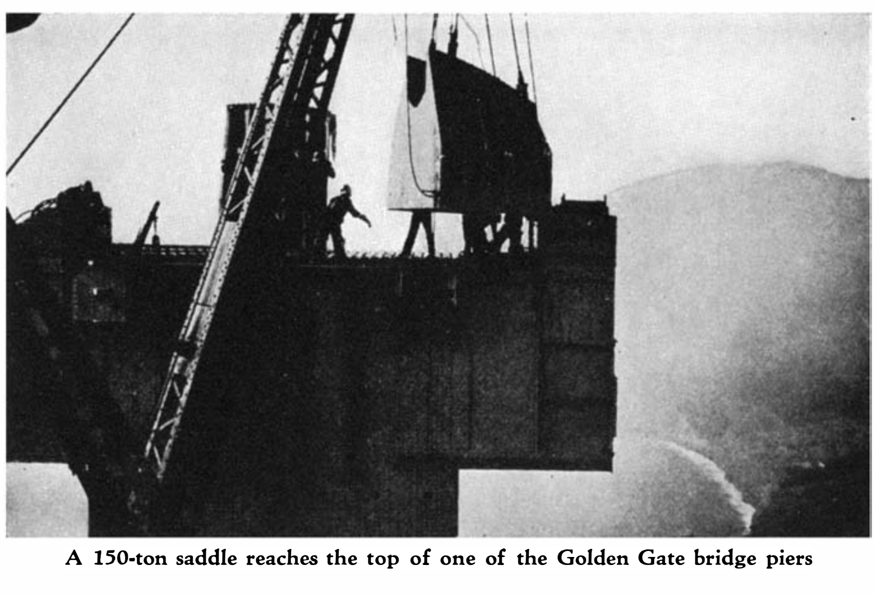
It was first drilled in January, 1924, showing a gas content under terrific pressure of more than 98 percent pure carbon dioxide. At that time there was no known means of utilizing the gas, except locally, so the well was plugged and temporarily abandoned. The lessee, the Farnham Dome Petroleum Company, and the operating company, the Carbon Dioxice and Chemical Company, believe they can work out a means of shipping the carbon dioxide without great loss, either in liquid or solid form.

The computed open flow of the well is 1,600,000 cubic feet per day, but geologists estimate that only 1,000,000 cubic feet per day can be withdrawn, because the release of pressure at the foot of the well will cause about 600,000 cubic feet daily to be frozen in the sands.—*A. E. B.*

No Sahara in Dust-Storm Area

DESPITE the Sahara-like atmosphere they create, the spectacular dust storms of 1934 and 1935 are not a sign that part of the United States is turning into a vast permanent desert, according to Dr. J. W. Humphreys, of the Weather Bureau.

The appearance on this continent of an



A 150-ton saddle reaches the top of one of the Golden Gate bridge piers

expanse of unproductive, drifting sand like that on the eastern hemisphere, Dr. Humphreys says, would call for a complete change in climate on the order of the one that, centuries ago, gave northern Africa its great desert. That change occurred through countless ages as the Europe of today slowly emerged from the ice cap which, for other countless ages, had covered it. With the melting of the ice beneath their northern range, the air currents that govern the earth's weather were shunted into new paths as they flowed south, thus altering Africa's climate.

No such climatic change is imminent in North America so long as the frozen north remains frozen, Dr. Humphreys says. Probably, he adds, the ice there will melt some day, but not for 5000, possibly 10,000, years.

Dust storms in the United States are nothing new. The west has always had them. Until the last two years, however, they have been purely local disturbances. But several years of drought, on top of the reckless denuding of thousands of acres of land where rainfall is normally relatively light, provided, in great abundance, the first ingredient of dust storms. The high winds that blow over the plains in spring and summer brought the second ingredient.

Unfavorable conditions brought about over a long period of years cannot be relieved in a single season. As the program recently adopted by the United States Department of Agriculture to prevent wind erosion of the soil goes into effect, however, dust storms may reasonably be expected to subside. Among other things, this program calls for putting back into grass those lands that never should have been plowed or overgrazed.

New Test for Oils

ONE of the hardest questions to answer has been why two oils almost identical in density, viscosity, and other common physical properties, may differ widely in their lubricating qualities. One cannot tell by any simple physical test, in advance of actual use of the oils, which one will be the better lubricant.

Chemists have discovered that the molecule of a good lubricant consists of a long chain of atoms, so that the molecule has the form of a long, slender filament. These molecules stand on end on a metallic surface, one end adhering firmly to the surface. In this way they pack very closely together, and pressure between two surfaces cannot squeeze them out.

A second layer of oil molecules stands on top of the first layer, another on that, and so on. Two metallic surfaces thus ride on velvety cushions and slide easily on each other.

The longer the filaments, and the more regularly and closely packed they are, the better is the lubricant.

These facts have been disclosed by the use of X rays.

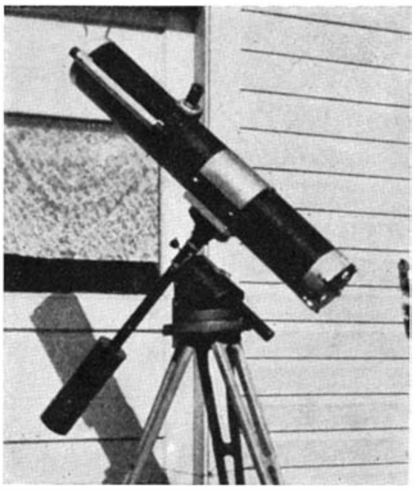
A new mode of testing has been applied by Dr. C. A. Murison and is reported in the *London Philosophical Magazine.* Dr. Murison directs a stream of electrons at a glancing angle at a film of oil and studies the diffraction pattern produced by the reflected electrons. From this he can tell at once the lubricating qualities of the oil. He

(*Please turn to page* 105)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

IN the new edition of "Amateur Telescope Making" Porter points out what he calls the "bottleneck"—that point on the declination axis of a telescope where it joins the tube, and which so many amateur telescope builders make too thin to avoid tube vibration. The neat little telescope shown below—a 4″—made by George Sunal of



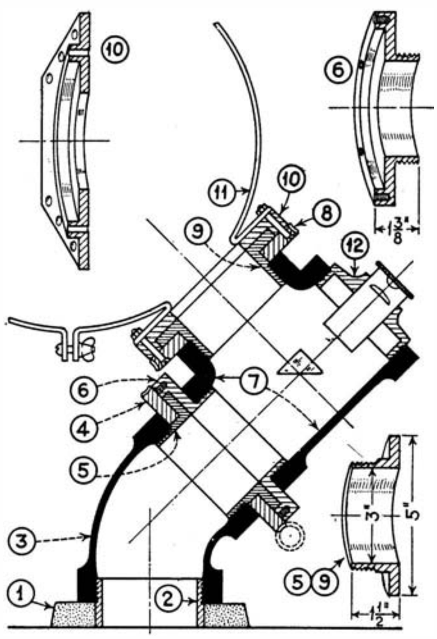
No "bottleneck" here

5046 Eugene Ave., Dearborn, Mich., shows better than usual design at the bottleneck.

The mounting in the center, made by R. S. Danielson, 1711 Ave. N., Galveston, Tex., has a real bull neck in the same place, and is designed all over on the same principle. "Here is a mounting that should be steady in one of our Gulf hurricanes down here on the Texas coast," Danielson writes. Your scribe spent the summer of '16 in that region and lived through two of these Texas hurricanes. Any mounting which will stand up in one of them is sufficiently rigid for astronomical work. This is one of the best adaptations of the Springfield that we have seen. On the drawing, 1 is a concrete pillar, 2 a pillar pipe, 3 a 45° el, 4 the worm driven ring gear, 5 the ring key, 6 the coupling ring, 7 a 3″ standard pipe T, 8 the worm driving ring gear, 9 the ring key (identical with 5), 10 the saddle coupling ring, 11 the tube clamps, and 12 a cap (machined to suit). Danielson explains that ring gear 8 can be driven by the worm, or can drive the worm, so that the tube may be moved quickly by hand, but that in the polar axis the worm drives the ring alone. Bearings 4 and 5 are friction. Ring 10 is rectangular, in order that greater spread can be had between the ends of clamps 11. All in all, this is a rugged, close-coupled, commendable mounting.

THE 8″ telescope at the bottom of this page was made by Dr. M. N. Duxbury, a Green Bay, Wisc., dentist. There is a phonograph motor drive on the pedestal. Note the declination slow motion control, the handscrew on the tube. One fine feature is the fact that the observer can rotate the tube in order to bring the eye to a desired position, with less exertion than is required in wrestling with a polar bear. "Look closely," Duxbury writes, "and you will see that there is a clearance of ¾″ between the basket circles and the tube for the roller bearings. The tube rolls very quietly and smoothly within the basket without loosening the thumbscrews."

IN "A. T. M.," pages 376-379, Hindle's method of plotting the readings in the knife-edge test is shown. The mirror is divided into zones of definite and known widths, and readings of zonal aberration made at those radii are plotted graphically. The purpose is to ascertain the total zonal aberration and whether the curve is paraboloidal. Nicholas M. Smith, Jr., Box 4, Pulaski Heights Station, Little Rock, Ark., uses a similar method, which is helpful in interpreting irregular mirrors whose shadows otherwise puzzle the tyro. But, instead of measuring the zonal aberration at known



The Texas Hurricane mounting

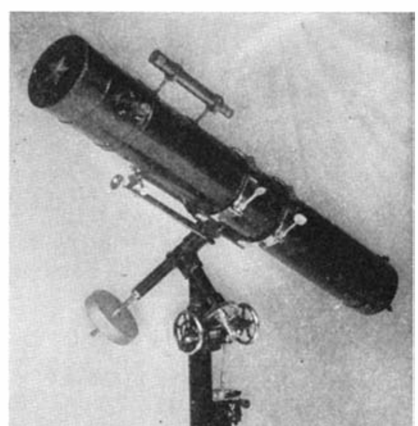
radii, he sets his knife-edge either at random distances from the mirror or at such distances that irregularities on it will be best revealed, and then measures the position of the "crest of the doughnut" at those particular knife-edge settings. Then he lets the mirror plot its own curve on cross-section paper.

"It often happens," he writes, "that the study of the shadow and the measurement of the difference between the radii of curvature of the inside and outside zones are insufficient to give the true nature of the curve—especially to one not too experienced with the various shadows. The only method left, then, is that of making a zonal test, measuring the aberration of the focal point between each zone and the center. This is usually accomplished by placing stops in front of the mirror, that are cut away in the zone to be tested. The knife-edge is adjusted until the two portions are lighted with equal intensity, and this position of the knife-edge is marked as the center of curvature of that zone, and so on, zone by zone—involving a long and laborious process.

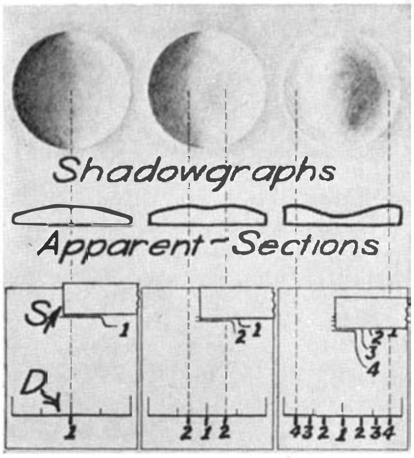
"It once occurred to me, while using the Hindle method of testing, to try a correlative procedure in determining the centers of curvature of various zones of the mirror. This was tried with great success. It was possible to make a full zonal test on an 8-inch, *f*/6 mirror in less than one minute, and all cumbersome stops were dispensed with.

"The method of procedure is this: The knife-edge carrier is provided with the usual straight-edge *S*, in the figure, and a paper is thumb-tacked to the table under it. A line *D*, representing the diameter of the mirror, is drawn on the paper, and divided into quarters. The knife-edge is first placed inside the center of curvature of the inside zone (or zone having the shortest radius of curvature) and brought back toward the eye until it stands just at the center of curvature of that zone, as indicated by the uniformity of the shadow at that area (illustrated in the first shadowgraph). A line is then drawn along the straight-edge and numbered '1'. Along the representative diameter at the bottom of the paper, the place on the diameter having this radius of curvature, by eye estimate, is indicated and numbered '1'.

"The knife-edge is then moved slightly back, a line is drawn along the straight-edge and numbered '2'. The position of the crest of the apparent bulge of the mirror is judged, and the corresponding positions are marked on the line representing the diameter, as shown in the second and third shadow-graphs. [A stick of wood bearing



Dr. Duxbury's ritzy job

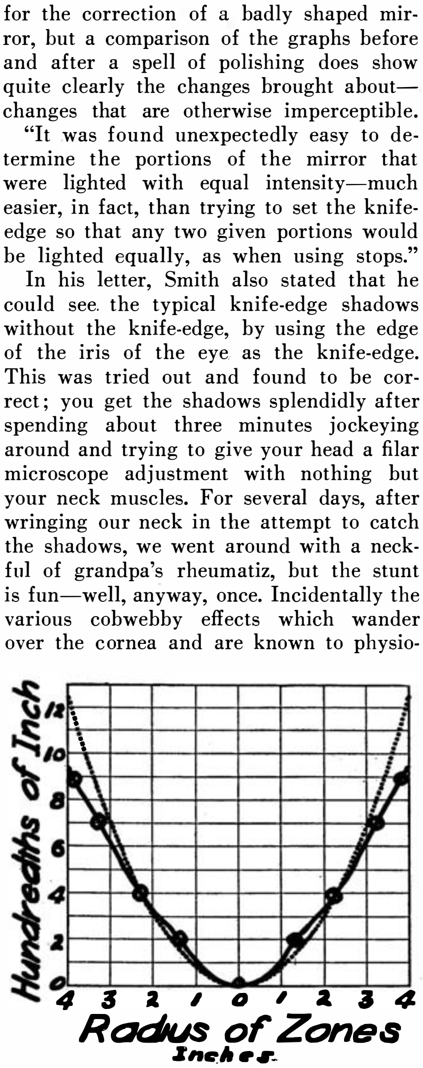


Nicholas M. Smith's test

pins at measured intervals (Everest's method) or a strip of metal having teeth filed at the same intervals (Mason's method) may be supported in front of the mirror, and will help in estimating the different radii.—*Ed.*] The process is continued in as many steps as desired, and from these data—the aberration of the light and the corresponding positions on the mirror—a graph can be drawn and compared with the ideal curve, as calculated from the r^2/R values. This graph is of little use in ascertaining the proper procedure for the correction of a badly shaped mirror, but a comparison of the graphs before and after a spell of polishing does show quite clearly the changes brought about—changes that are otherwise imperceptible.

"It was found unexpectedly easy to determine the portions of the mirror that were lighted with equal intensity—much easier, in fact, than trying to set the knife-edge so that any two given portions would be lighted equally, as when using stops."

In his letter, Smith also stated that he could see the typical knife-edge shadows without the knife-edge, by using the edge of the iris of the eye as the knife-edge. This was tried out and found to be correct; you get the shadows splendidly after spending about three minutes jockeying around and trying to give your head a filar microscope adjustment with nothing but your neck muscles. For several days, after wringing our neck in the attempt to catch the shadows, we went around with a neckful of grandpa's rheumatiz, but the stunt is fun—well, anyway, once. Incidentally the various cobwebby effects which wander over the cornea and are known to physio-



The graph worked out in the test as used by Nicholas M. Smith, who also furnished the drawing at top logical opticians by long Latin names do not show and the mirror looks better.

AT the right are several drawings done by our artist, J. F. Odenbach, after rough sketches by Ellsworth L. Martinelli, Box 402, Colfax, Calif., whose technic for HCF work they describe. In this technic the mirror is polished on HCF on glass. Then a tissue disk is laid on it, this is wetted, painstakingly adjusted and smoothed, and a plaster tool is cast (Fig. 1). The moist tissue is next rubbed off with the palm, taking pains that the plaster is entirely undamaged.

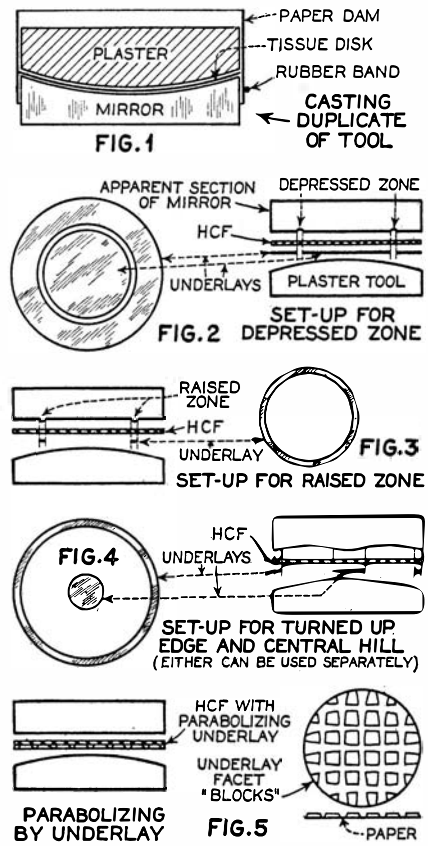
Figs. 2 and 3 show how underlays of light, unglazed card of about the weight of U. S. postal cards are inserted between tool and HCF, wherever a zone needs treatment. Cut the paper with a sharp knife, to avoid an edge burr.

Parabolizing is done as shown in Fig. 5. The layout is made on paper, transferred to cardboard heavier than that mentioned above, by means of carbon paper, the blocks are cut out and fastened to the original layout pattern with shellac and dried under weight. This makes another underlay for an HCF disk. Cold press and parabolize on it.

The above is an abstract, necessarily sketchy, of a 2300-word paper by Mr. Martinelli, but the figures show most of the data. The original paper will be lent to those who request it. In this paper the author frequently commented on the difficulty of using the HCF strip-and-patch technic, stating, as others have stated, that it leaves irregularities and depressed places at the edges of the strips. This is often true, at least the first time it is tried. But the user soon learns to avoid this by frequently shifting the strips, changing the stroke, mixing in some side motion or else toeing the strips in, to distribute the abrasion; and, in general, finessing. One can pick up the mirror with strips adherent to it, slide them over a hair or two, lay it down and go on working, much faster than one can potter with more precise substitutes. After mussing up about two initial attempts, the technic of removing a raised zone, and then removing every visible trace of its leavings, is soon learned. The matter of using measuring rods, dividers and so on, for spotting zonal locations, may be forgotten if the estimate powers of the eye are used. In short, the method soon becomes one of feeling and intuition and, after that, it is so direct and free from complication that it beats a more exact, more rational, but more complex method.

THE most expert workers seem to get scratches, while some of us who wish we were as expert can't seem to get them, even when we try hard. How they come is one of those impenetrable puzzles—the scratcheés say they take every known step to avoid them. This note from Hindle may explain some of them—though it is improbable that any one cause may be assigned to all cases or even a majority of cases. "Scratches during polishing are almost invariably due to filthy polishers. The rouge is allowed to dry on, and hardens; the polisher changes shape slightly and when next applied is resting on some of those hard points which cut into the polished surface, showing which way the polisher moved. When polishing is suspended, the polisher should be scrubbed down with a strong scrubbing brush, and plenty of water. Pay special attention to the grooves, and continue so long as any color comes off. Pour warm water, 100°-120° F., over the surface of the polisher before putting it on again to the rouged surface of mirror."

HERE is James L. Russell, lawyer, 318 Chester-Twelfth Bldg., Cleveland, Ohio, reporting what he calls a coo-coo idea: "If you can not get the mirror and the prism and the eyepiece in line try this. Set her up in full moonlight and point the tube toward the moon. Then blow a good puff of cigaret smoke down the tube. You will then see the cone of light coming off the mirror, and it will look so real that you can nearly cut it with a knife. The cone hits the prism and bounces right up into the eyepiece. Move the scope a little off and the cone will then miss the prism and it will project out of the end of the tube. It will go from the mirror to a point and then from the point it will again get large. It is a most beautiful sight." This idea isn't coo-coo, but should be added to the data in "A.T.M.," pages 381-382. As Russell writes, the idea in general is old—see top of page 390, for example. But it is a good one.

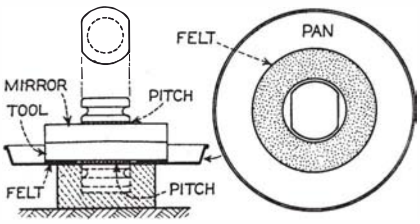


Martinelli's figuring method

LIEUT.-COL. Kendrick, U. S. Army, Retired, Jacksonville, Fla., writes R. W. Porter, with regard to testing pitch by biting it, that when he first took up the TN hobby a friend of his, Dr. S., did the biting, as follows: "Took some hot pitch—a piece as big as a thumb—dropped it in a glass of water, removed it and bit squarely into it. His teeth stuck solid. I grabbed a bottle of turps, pried open his lips and went to work. It blistered his mouth, and I finally had to get some gasoline before

I could get him unstuck." Pitch should be bitten in a gingerly, ladylike manner, not like Navy Cut Plug. Just try to imagine this colonel and the doctor—the one wildly running around, the other wildly gesticulating—in the described predicament! Maybe the joke was about 50-50, all in all.

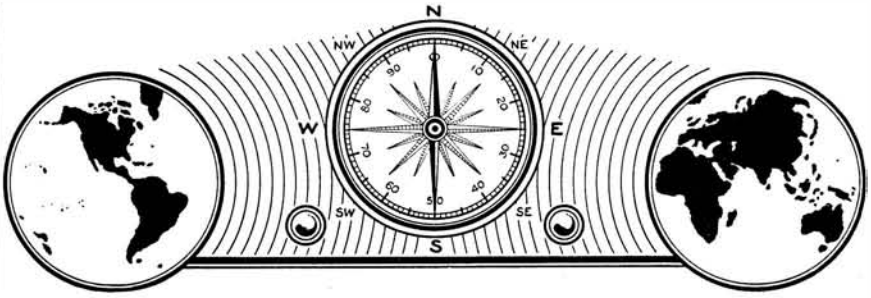
G. MERRILL, U. S. N. Hospital, Annapolis, Md., writes via John Pierce that he made his mirror in a morgue, which he claims is a record, and who will want to tie it! The traditional marble slab served as the test table and was steady as a dead man, while temperature conditions were fine. "Working till 1 A.M. was not bad," he comments, "once you got used to the environment." Can anyone beat that place as an odd workshop? Well, perhaps we can. We have learned that a certain telescope maker in Minneapolis (name will *not* be furnished on request) found himself inadvertently serving a term in jail, became bored and asked a confrère—confrère, that is, in telescope making—to bring his mirror making outfit to the jail, and turned out an A No. 1 mirror there. File this idea for possible future use.



The lazy mirror maker's delight

THE above drawing represents a sitting-down grinding and polishing rig, and was drawn by Odenbach, from a life-sized model sent us by the designer, E. B. McCartney of 76 Roslyn Road, Mineola, N. Y. He calls it his "Invertible, Sit-downable, Synchromesh Grinding and Polishing Ding-bat," and our brief preliminary test of it speaks loudly in its praise. The shaded part represents a plank which is to be clamped to a table or bench. Turning the rim of the pan turns the tool, the hole in the pan being shaped to the plan of the wooden knobs, in order to key the two together. McCartney belongs to the Long Island Amateur Telescope Makers' Club, a group which, like the Telescope Makers of Springfield, requires *completion* of a telescope before considering grant of membership. This club, inadvertently omitted from the new list of clubs in "A.T.M.," fourth edition, should be added to that list. Your scribe, who is getting fat and lazy, will use McCartney's patent dingbat on his next job, and remain seated. Somebody please think up one that can be used from a hammock.

Mathematics hounds may find interest in the following books which have been published: "The Calculation of the Orbits of Asteroids and Comets," 1934, by Kenneth P. Williams. Also "Planetary Theory," 1933, by Brown and Shook. Both are about the methods for the calculation of the general orbit of a planet, and for most mere mortals they will seem deep, deep, deep. A fine new German astronomy textbook, entitled "Astronomie," by Oswald Thomas, has recently appeared. It covers general astronomy—has fine cuts.



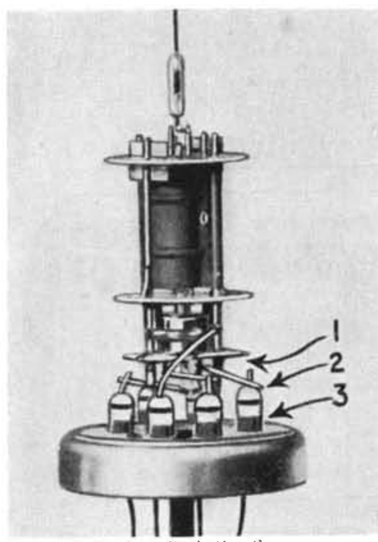
WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN*

Metal Tubes Here to Stay

THE all-metal tube has marched right up to the front line. Since its introduction some months ago, it has been improved in a number of ways. Most manufacturers of metal tubes have eliminated possible leakage by brazing the junctions between the Furnico eyelets, through which the connecting leads pass, and the metal support base.

Some difficulty was experienced in the early stages of metal-tube manufacture due



Courtesy Raytheon Production Corp.

Noise and leakage in metal tubes are eliminated by spraying the insulating beads (2) and the mica spacer (1) with a liquid ceramic. Tube leakage is prevented by brazing the Furnico junctions at (3)

to small particles of the "getter" material landing on the glass beads which insulate the element leads from the eyelets. Though metal shields were and are still used to prevent the vaporized "getter" from reaching the glass beads and the mica insulating spacer located near the base of the tube, some vapor still manages to condense on these points of insulation. Leakage paths are thus introduced, which cause the tube to become noisy.

This problem has been solved by spraying both the glass insulating beads and the mica spacer support with a liquid ceramic. The result is a rough insulating surface which, if magnified, would appear like groups of mountain ranges, with deep valleys. Because of this highly uneven surface, such particles of "getter" as may condense on the glass beads and the mica element support can do so only on the "mountain peaks." There is, in consequence, no continuous conduction path for electrical currents, as the conductive "getter" particles are unable to bridge the peaks.

Control-grid losses, due to leakage and high input capacity, have been reduced considerably through the use of a new type of phenolic insulation material. Small disks of this material are used in such tubes as have the control-grid connection at the top. The disk insulates the grid cap from the top of the metal shell, and reduces losses where it is most important to have them reduced—at the input, where the signal voltages are very small to begin with.

The result of these and other improvements is that all-metal tubes, designed to have electrical characteristics practically identical to those of the glass-type tube, are showing superior qualities in receiver circuits. Moreover, now that receiver design engineers have a better acquaintance with the metal tube, it is being used more effectively in all-wave receiver circuits. Slight alterations in the values of resistors and other changes have brought forth far superior results. For instance, bucking bias voltages, caused by gas current, have been eliminated in the receiver circuit with a resultant increase in over-all sensitivity.

Mysterious Interference

AT the time of this writing, there is a peculiar form of interference in the short-wave bands. It is an unkeyed (continuous) carrier, presumably modulated by 60-cycle alternating current. It appears at three different frequencies simultaneously and shifts about 100 kilocycles every three minutes. It may be heard most any time between the hours of 9 A.M. and 9 P.M.

This interfering carrier has been reported between the frequencies of 8 and 25 megacycles by the United States Army and Navy, RCA Communications, the A.T. and T., and by the airway radio stations. It is heard with equal strength in England and the United States, although the carrier is weak on the West Coast.

The writer has heard the same signal at frequencies as high as 30 megacycles, and it may extend further.

There is no question but that there is intelligence guiding the carrier, but for what purpose? And who may it be? It brings forth memories of the German radio

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

barrage transmissions during the World War. The theory has also been advanced that the interference may emanate from a new type of diathermy machine now in use.

"Queen Mary's" Radio Equipment

THE *Queen Mary*, new Cunard White Star superliner, will make use of a total of 32 different wavelengths; 11 for short wave, 9 for radio telephony, 7 for long wave and 5 for medium wave.

The use of different wavebands will make it possible to send and receive several messages simultaneously and also allow two ship-to-shore conversations at the same time, one to Europe and one to the United States.

For the operation of these wavelengths there will be at least nine separate aerial systems.

I-F Interference

INTERFERENCE from a code station which may be heard over the complete dial range does not indicate inadequate receiver selectivity. This form of interference is due to a code signal riding through the intermediate-frequency amplifier. This is possible when the wavelength or frequency of the code station is the same as, or close to, the wavelength or frequency to which the i-f amplifier is tuned.

This form of interference may be eliminated by inserting a wave-trap in series with the aerial lead-in wire. The trap should be tuned to the same frequency as the interfering signal.

Tube-for-Tube Comparisons

IT is interesting to observe that it is not possible to compare "metal" and "glass" receivers tube-for-tube. This is well worth remembering when you make a purchase.

In *all* metal-tube receivers manufactured up to the present, the diodes used for detection and automatic volume control are in a separate tube (the 6H6), whereas in receivers using glass tubes, the diodes are combined with a triode or pentode audio-frequency amplifier in a single envelope. In other words, in the metal-tube receiver, detection and automatic volume control are provided by one tube and audio amplification by another tube, while in the glass-tube receiver these three functions are handled by a single tube.

Thus a receiver employing *six* glass tubes is the equivalent of a receiver using *seven* metal tubes. Consequently, don't let a radio dealer tell you that a set with six glass tubes is superior to a set with six metal tubes—the comparison is not a fair one.

All-Wave Selectivity

THE 31- and 49-meter short-wave international broadcast bands, as well as the 20-, 75-, and 160-meter amateur 'phone bands, are so overcrowded that interference between stations is the rule rather than the exception.

The average all-wave receiver cannot cope with the situation. The only possibility of separating the stations in these bands is by the use of a crystal filter in the intermediate-frequency amplifier, or by the use of regeneration in the radio-frequency and/or intermediate-frequency stage. Even then, complete separation of all stations cannot be expected.

However, the use of regeneration or a crystal filter for increasing receiver selectivity to the maximum point will work wonders, but not without a sacrifice of quality. If the maximum selectivity of a crystal filter is used, voices are quite often unintelligible and music is deprived of its higher tones.

Neither regeneration or a crystal filter are to be recommended if quality reception is desired, but for the hunter of distant stations who cares not if voice and music are damaged by ultra-selectivity, either system will prove to advantage.

Practically all of the latest amateur receivers employ crystal filters; a few use regeneration instead.

New Metal Tubes

FIVE new all-metal tubes have been introduced recently. Four of these have glass counterparts, but the fifth is a distinctly new type. The 6Q7 is of particular interest, as it is the first tube in the metal line having diode plates combined with another tube section. To be specific, it is a

Two of the newest metal tubes

duo-diode triode, similar to the types 55 and 75 in the glass line.

The 0Z4, which has no filament whatsoever, is a rectifier of the gaseous conduction type. It is designed for use as a high-voltage rectifier in the power-supply unit of an auto-radio receiver. Since no filament current is required for this tube, there is less drain on the car battery.

A full-wave rectifier of the heater type has also been announced. It is the type 6X5, and is somewhat similar to the type 84 high-voltage rectifier in the glass line. The 6X5 is adaptable to the smaller a-c operated home receivers and to auto-radio sets—for use, of course, in the power supply.

The last two tubes recently announced are designed for use in small receivers of the a-c d-c combination type. The first is a power amplifier pentode, type 25A6, which has a 25-volt heater that may be connected in series with the other heaters in the set. The second is the 25Z6, which also has a 25-volt heater. This tube is a double half-wave rectifier, similar to the 25Z5 in the glass line. It may be used as a double half-wave rectifier or as a rectifier-voltage doubler.

CAMERA ANGLES

Conducted by JACOB DESCHIN

Photographic Caricature

THERE is distortion and distortion. Offhand its connotation is bad, but there are times when it is to be embraced as a definite aid in serious (or otherwise) photographic maneuvers.

Take photographic caricature, for example, but take it with a smile, or all your efforts will be in vain. A caricature, of course, may be made in the original ex-

Above: **An enlargement made as usual, and,** ***at right,*** **in caricature**

posure. That is, exaggerated foreshortening of a foot, whose owner's head, seemingly a mile off, is the size of a pea, or a "shot" from above a standing figure, showing the legs tapering down to the apparent size of toothpicks. But the caricature by distortion of which we shall speak here is that which is obtained from an ordinary negative projected from an enlarger.

Quite a variety of "trick-mirror" effects of family members and friends may be obtained in this manner. Whether or not they remain friends after seeing your handiwork depends, of course, on their sense of humor, but we must not forget also how much will rest on the manner in which you execute the job.

Distortion is had by tilting the enlarging easel, resting the easel on some firm support during the exposure. Tilting may be slight or it may be so extreme as to place the easel almost parallel with the beam of light coming through the enlarger lens. The support in the first case will be a simple enough matter, but in extreme cases more elaborate arrangements will be necessary. The darkroom worker accustomed to devising makeshifts for temporary matters will know what to do.

The first step, of course, is to insert the negative and project it, tilting the easel at various degrees of elevation, both horizontally and vertically. It will be found that at extreme elevations there will be a noticeable narrowing down of the image at that end of the easel that is nearest the lens. This obstacle in "framing" the picture is overcome by raising the enlarger housing in order to enlarge the picture area. High elevations of the easel will mean that the part of the easel nearer the lens will be better lighted than the lower part. This calls for a difference in exposure time for the two areas in order to get uniformity of tone over the entire picture. Test strips are made at the top and bottom, the latter

being given more exposure by means of "dodging." Another precaution to take is to make sure that the paper is placed on the easel (thumb tacks will do for this purpose) without moving the easel on which the image has been previously focused. To make sure on this point, use the red or orange filter on the enlarger, although the regular medium yellow filter will serve on lenses which are used in both the taking and the projecting cameras. Also, the lens will have to be stopped down considerably in order to get over-all sharpness.

A few trials will convince the experienced worker of the enormous possibilities of this phase of photographic endeavor. He will find that this medium will permit not only of fun-provoking exaggerations but may also be used by means of slight tilting to give a personal interpretation of the subject which is not possible with a straight "shot."

Incidentally, pictures involving straight lines which did not come out straight because the building or what-not was high and the camera had to be tilted upward may, within reason, be corrected under the enlarger by a tilt of the easel in the opposite direction. Obviously, this will not work in extreme cases but when feasible should be a very valuable "dodge" indeed.

Photo-Electric Exposure Meter

THE public demand for reliable exposure meters has brought several new products on the market, the latest of which is the photo-electric Photoscop, hitherto round in shape with a circular lens "eye" in its center, and now brought forth in rectangular form somewhat resembling a package of cigarettes, although slightly longer. But most important of all is the new Photoscop's original mechanical design. At one end of the meter, the body of which is of Bakelite, is a flat, narrow lens extending, for half the case's depth, from edge to edge of the meter's width and placed at an angle. The other half of the lens arrangement, also extending the full width of the meter, is a mirror. The general construction of the lens-mirror feature is that of a long triangular trough, the apex of which cuts into the end of the meter. Acting as a sort of "sunshade" as well as serving the equally practical purpose of limiting the field of the lens' vision to the usual 45 or 50 degrees, is an open-end box-like arrangement extending from the end of the meter and slightly beyond the limits of the lens and mirror.

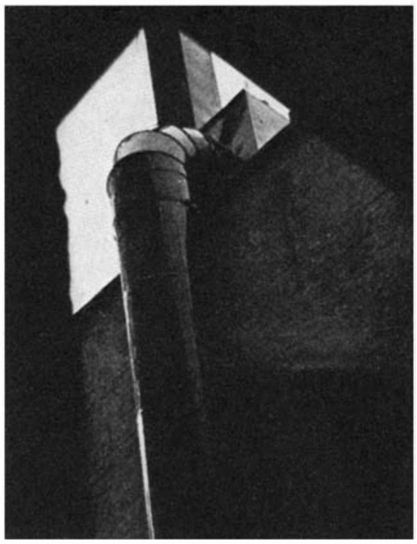
As explained to the conductor of this department in an exclusive interview in advance of placing the instrument on the market and before minor details had been definitely decided upon, the mirror feature is included principally for pictures in which the sky is to be included. The lighting from the sky strikes the mirror and is reflected to the lens, thus affording a more correct general reading than might otherwise be possible, since the sky light as reflected from the mirror will not be as strong as it would be if the meter were pointed directly at the sky. The resultant reading is thus more nearly accurate for the entire scene generally.

Another useful feature of the new meter is an arrangement whereby readings are made direct instead of first observing the reading and then making the calculations on a disk. An arrow is set on the exposure speed desired and another on the speed of the emulsion being used. When the meter is "aimed" the usual needle indicates the "F" stop to be used. The meter has scales for both still and motion picture cameras.

Many advanced amateurs, having tried them all and found one film emulsion best suited to their purposes, may never have to change the emulsion speed, unless they follow the desirable practice of using a slower, and therefore better contrast, film outdoors, and a faster one indoors when taking "candid" and other indoor type of pictures under relatively poor lighting conditions. Setting the exposure speed has also been found advantageous by some seasoned workers. Extreme cases are those of the man who never makes a picture except at a full second, varying his lens openings to suit the light conditions, and another man, who likes wire sharpness over the entire field and stops his lens way down when outdoors even if it means shooting at 1/20th of a second in broad sunlight.

Surfaces

MANY photographers find a delight in subjects merely because of their striking surface appearance. Subjects which they would not consider worth a second glance are raised to the level of artistic possibilities by the mere fact that at a certain time of day or night, or because of the magic effect



Rain on a tin pipe gives a surface character worthy of photography

of rain or sleet, commonplace objects are made to look extraordinarily attractive. The illustration shows what rain will do.

In late afternoon, a little while before the sun starts to retire, watch people's faces, the sides of buildings and other objects as they catch the slanting rays of the sun. The warmth and beauty of the texture of objects thus revealed is a lovely sight. At night, in some lonely street, you may find the gleam of trolley tracks and cobbles glowing under the street lamps or a shingled rooftop illuminated by a full moon one of the rare experiences of your photographic career.

Your camera, whatever it may be, accompanied by a good exposure meter, and—in late afternoon, early morning, and at night—a sturdy tripod, together with the indispensable "seeing eye" are all the equipment you need.

Others' Mistakes

WHILE it may be little solace to a man to know that someone else has made mistakes as bad as or worse than his, there is an undoubted value in hearing stories about the mistakes of others, however ludicrous those mistakes may have been. It teaches a man humility and an appreciation of the fact that no matter how far advanced he may be in the photographic game he must never lose sight of the necessity for careful adherence to the mechanical details.

There is the story of a professional photographer who was sent on a distant assignment to do a series of photographs for a client, the latter standing the expense of the trip. The photographer exposed three filmpacks during the course of the day and felt he had done a good job. The awakening came when he returned to his darkroom and found all three dozen films developed out without a dot on any of them, all because he had forgotten to pull the slide. Needless to say, he had to return another day, this time at his own expense, and retake the whole business.

Another professional, getting acquainted with a new flashing gadget on his camera, recently took a bunch of photoflash pictures at a horse show and pulled a blank every time (as the darkroom aftermath indicated) simply because he forgot to set his shutter before each exposure. Result: An evening wasted, cost of photoflash bulbs and film irretrievably gone, and a cluster of picture-taking opportunities snatched away forever.

A prize boner is one pulled by a news-photographer who left his lens behind when rushing off to an assignment, his paper's policy being to keep lenses locked up in a safe overnight. Another involves an advanced amateur who took so long composing a waterfront picture silhouetting a boat against the lowering sky that the boat started moving away just as he was about to start his time exposure.

Low-Priced Miniature

"MINIATURE" photography for the many appears to have arrived with the entry into this field of the Argus Miniature, based on higher-priced models and capable, according to the manufacturers, "of night, theater, indoor, candid and color photography," but costing, more or less, an office boy's week's earnings. While the lens, in this age of superspeed objectives, is considered "slow," being *f*/4.5, with shutter speeds ranging from 1/25th of a second to 1/200th, it is a triple anastigmat. The camera takes the regular daylight-loading 36-exposure 35-mm film rolls, has a visible automatic exposure counter, an arrangement for automatic focusing, eye level view finder of optical glass, and is offered in a variety of Bakelite cases, in black with chromium trim and, in the de luxe models, in gray and gun metal, in ivory and gold, and in brown and gold. A vertical enlarging outfit utilizes the camera—lens, body and all—the enlarger proper consisting of housing, standard, and easel. Enlargements may be made up to 8 by 10 inches. Placed horizontally, this enlarger may also be used as a projector for black and white or color projection on a viewing screen placed over the easel.

Stirring Rods

IT may be an immediate economy to have but a single stirring rod for both developer and hypo mixing, but in the long run one may pay very dearly for such parsimony. We all know how little hypo it takes to spoil the developing solution, so why take chances? Lightweight stirring rods are now distributed under the name "Safetee" in three colors, white, red and black, the first for the rinsing bath, the second for hypo, and the third for the developer. These rods are described as "acid-proof, water-proof, chemical-proof, tough and durable." The set of three sells for approximately the price of admission to a good movie.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 95)

found for one thing that oils of high molecular weight are superior.

Electron diffraction, it may be remembered, was discovered by Drs. C. J. Davisson and L. H. Germer of the Bell Telephone Laboratories in 1927, and demonstrated the wave properties of electrons predicted by Duc Louis De Broglie and Prof. E. Schrödinger.

An answer is thus given to those who want to know what is the use of all these recondite researches into atoms and electrons, for here is an application of great practical value. Doubtless many important applications will be found, as time goes on, for the scientific knowledge now piling up so rapidly.—*Science Service.*

AIRPLANES OF PLASTIC MATERIALS?

IN the last few years there has been a rapid trend to the complete metallization of the airplane. Wood and plywood are easy and cheap to work and have a good strength/weight ratio. But they are affected by continuous exposure to weather; they are inflammable, absorb water readily, and are liable to shrinkage and decay. The use of metal introduces the problem of corrosion, the expense of a multiplicity of rivets, the difficulty of local weakness in very thin metal covering, and the aerodynamic drag of exposed rivet heads.

Is it possible that quite different materials, plastics, will have their day in airplane construction? "Plastics" is the modern name given to synthetic materials consisting of artificial resins, with or without a suitable filler, and now well known under such trade names as Bakelite, Xylonite, Micarta, and so on. These materials have an enormous number of applications in every industry. In aircraft, Micarta propellers have been used very successfully, and both Bakelite and Micarta are used for aircraft instrument panels, pulleys, ball-bearing housings, and other parts.

The best plastic consists preferably of resin impregnated paper, rather than fabric. The paper is thoroughly impregnated with the solution of phenol-formaldehyde resin, dried and cut to size. The sheets are stacked up to the thickness required, then baked in steam-heated hydraulic presses. Then the sheets are made up into tubes by rolling the impregnated paper on a hot steel mandrel between hot rolls until the required thickness of wall is built up. The product is then pressed in steel moulds or dies.

Rods and bars can be similarly made up by using a thin wire instead of a mandrel. In fact there is no limit to the size and variety of forms which can be obtained in this manner. Ribs, spars, longerons, skin, or covering—all the component elements of an airplane have been produced in England in experimental form. While metal rivets and bolts have been used for connecting up parts, cold gluing has also proved effective for fastening elements together.

Comparisons of strength/weight ratios with wood or metal are not so favorable as yet, but progress is very rapid. In fatigue, plastics are as yet not as satisfactory as wood.

With a little imagination we can see vast possibilities in these materials for the production of a cheap and durable airplane. Could not a whole fuselage, for example, be produced of a single, very cheap plastic moulding? According to Marcus Langley, writing in *The Aeroplane*, considerable research is being undertaken in the use of plastics for aircraft. These materials are derived from coal. For Great Britain, with its vast and troublesome coal industry, the prospect of building airplanes as a derivative of the "black diamond" is particularly enticing.—*A. K.*

HIGH-OUTPUT PHOTRONIC CELL

A PHOTO-ELECTRIC cell of the "dry-plate" type which provides an increased current output has just been put on the market by the Weston Electrical Instrument Corporation. It is intended primarily for use at levels of illumination so low that

Compact, high-output photo cell

the regular photronic cell will not provide sufficient output for the purposes intended.

Current output of the new cell is approximately three times that of the regular photronic cell for the same illumination. Its spectral sensitivity is slightly greater in the blue end of the spectrum than that of the regular cell. In common with all known super-sensitized photo-electric cells, the new cell is not quite so stable as the regular type, but it will be found suitable where high output is more essential than strict permanence, especially for use in relatively low illumination.

MONKEY MALARIA FIGHTS PARESIS

MONKEY malaria has been successfully used for treating general paresis, the distressing mental illness which is an end-result of syphilis. For certain cases, at least, this latest method of relieving an age-old scourge may prove to be better than infecting the patients with strains of human malaria, as has been done so widely and usefully since the chance discovery of this treatment in 1920 by Prof. Wagner von Jauregg in Vienna.

The new method has been developed by Dr. C. E. van Rooyen, Halley Stewart Research Fellow at the University of Edinburgh, and Dr. G. R. Pile, senior assistant medical officer to the Midlothian and Peebles Asylum. They report the results of their research work to the *British Medical Journal.*

One of the chief advantages is that the monkey infection can be made more easily available than the human, since by suitable treatment a monkey can be kept in an infective condition for at least six months and in a laboratory close to centers of population which may be far distant from sufferers from human malaria. Other advantages are the comparatively short period of incubation with the monkey infection, the gentle onset of fever with this disease, and the particular ease with which the fever can be terminated with quinine.—*Science Service.*

Waterproof Lime

RECENT new chemical developments in the building trade include waterproof lime, a processed lime with which may be made a water repellent mortar that protects masonry against leaking. This process of the Rockland-Rockport Lime Company is described by George B. Wood in *Industrial and Engineering Chemistry.*—*A. E. B.*

RADIUM

THE Joachimsthal region of Czechoslovakia is celebrating the extraction of radium there just 40 years ago. This calls to mind the fact that in that time just 100 grams have been produced, the average yield at present being just three grams per year. The yield, however, can be increased upon demand to eight grams yearly.

Movie History

IT is commonly granted that the motion picture is important not only for its pervasive social effect but because it is one of the two most lively contemporary arts and the only new art-form of modern times. Unfortunately, films themselves are singularly evanescent. Of course, certain celebrated pictures enjoy a life long in comparison to the brief existence of the average screen production. Short versions of *The Cabinet of Dr. Caligari* and of *Potemkin*, for example, have been visible occasionally during the past year and *It Happened One Night* has not yet vanished totally. Generally speaking, however, a film two years old is a film which will not be seen again, and the situation is comparable with that which would be created in the world of literature if only those books published within the past 12 months were available. Amateurs of the films and the film-makers alike are consequently confined for purposes of study to what is strictly current. There is almost no opportunity to refer back, to compare, to trace progress or retrogression. It is possible to read about the work of pioneers like the Frenchman George Melies, about the startling innovations of D. W. Griffith and of the post-war German producers: but not to see their work.

In order to remedy this situation, The Museum of Modern Art Film Library has been established for the purpose of collecting and preserving outstanding motion pictures of all types and of making them available to colleges and museums, thus to render possible for the first time a considered study of the film as art. Already two preliminary programs are available for circulation, the first of these covering motion pictures in America from 1895 to 1932; and the second from 1896 to 1934.

All of the series of films assembled by the Film Library will be arranged primarily to afford the student for the first time an accurate perspective of the history and esthetic development of the motion picture since 1894. For example, in the first series the primitive American film is succeeded by the great creative work of Griffith, Ince, and Sennett: but the former includes work of the pioneer Frenchman, George Melies, since it exercised considerable influence on the native product.

Chemistry Speeds up Printing

A CHEMICAL "slip-sheet" which promises to be a boon to the printing trade, enabling increased press speeds up to 40 percent, is announced by *Solvent News.* The ordinary "slip-sheet" is a piece of paper that the printing press operator inserts, by hand, between printed sheets as they come off the press, in order that the wet ink will not smudge the back of the next sheet. Now a chemical spray has been developed which covers each printed sheet with a microscopic film that accomplishes the same result, eliminating the hand feeding and speeding up the printing operation.

One gallon of solution, known as "No-Offset," has a covering capacity of from 60,000 to 200,000 square feet, depending on the type of ink and stock used. One automatic airgun will cover paper widths from one to 42 inches, and two airguns (the most ever required) will cover up to 84 inches.

The solution, as it comes out of the airgun, is broken into a fine mist which covers the sheet with countless tiny particles and serves to separate the sheets so that the wet ink cannot touch the next sheet as it enters the delivery pile. This coating is so fine it can be detected only with the aid of a magnifying glass, and does not interfere with the drying of the ink nor affect the color in any way. It appears further to counteract the effect of the static electricity in the paper, which tends to draw the sheets together.

The solution is misted on the printed side only and has no effect on subsequent impressions as it is said that the particles dissolve when touched with inks or varnish. —*A. E. B.*

CURRENT BULLETIN BRIEFS

Cadet Days of Will Rogers is a beautifully presented little book which touches upon certain phases of the early school days of Will Rogers which have not been generally brought to light by his biographers. *Kemper Military School, Boonville, Missouri.—10 cents.*

Descriptive List of Eastman Classroom Films lists more than 200 reels of film which have been prepared especially for instructional purposes in the classrooms of schools and colleges. Prices are also given. *Write for Bulletin 236A to Scientific American, 24 West 40th Street, New York City. —3-cent stamp.*

Good Elevator Service for Office Buildings considers the requirements of good elevator service, adequate traffic handling facilities, regulation during peak traffic hours, and how planning should be directed toward the best possible elevator service for a given location. *Write for Bulletin 236B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

New Studies of Ship Motion by P. R. Bassett, Visitor, and F. P. Hodgkinson, Member, is a reprint of a paper read before the Society of Naval Architects and Marine Engineers. It is an engineering treatise on the subject and also deals briefly with mechanical stabilization. *Write for Bulletin 236D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

The Municipal Smoke Problem, by H. B. Meller and L. B. Sisson, is a brief treatise on the products of combustion of fuel and their effects. The booklet is comprehensive in scope and contains information and advice regarding combustion equipment, the selection of fuel, and the best method of burning it to secure efficiency and practical smokelessness. *Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pennsylvania.—Gratis.*

Evidence of Early Man in North America, by Edgar B. Howard. A 170-page illustrated monograph on the Folsom and Yuma cultures and, in general, the chief finds of recent years, tending to show that man has been in America 10,000 years. *The University Museum, University of Pennsylvania, Philadelphia, Pennsylvania.—$1.50.*

Folsom and Yuma Artifacts, by J. D. Figgins, is a pamphlet (Vol. 14, No. 2 of the Proceedings of the Colorado Museum of Natural History) on Indian artifacts of flint which seem to indicate high skill among the Americans thousands of years B.C. *Colorado Museum of Natural History, Denver, Colorado.—Gratis.*

Bulletin of the Texas Archeological and Paleontological Society, Volume 7, 1935. A paper-covered book containing 152 pages (of which 17 unnumbered pages are pictures) of articles on early Indian archeology in Texas, published annually by a widely known association of amateur archeologists. *Otto O. Watts, Secretary-Treasurer, Texas Archeological and Paleontological Society, 1925 Simmons Ave., Abilene, Texas.—$3.00.*

Maps. A set of maps on a scale of four miles to the inch, showing all details of the existing transportation systems in Iowa, has been prepared by the Bureau of Public Roads of the Department of Agriculture in co-operation with the United States Geological Survey. The set consists of eight sheets approximately 26 by 36 inches. *Superintendent of Documents, Washington, D. C.—$1.75 per set.*

PHOTOGRAPHIC ALMANAC contains a comprehensive listing of photographic equipment and gives much valuable data for the amateur. *Write for Bulletin 236C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

BAKELITE LAMINATED has been prepared to give information on this one particular plastic, its manufacture, properties, uses, and directions for working it. *Write for Bulletin 236E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

SERPENTS OF THE NORTHEASTERN STATES, by Raymond L. Ditmars. A new, revised, and enlarged edition of an illustrated booklet for identifying the venomous and non-venomous serpents east of central New York and Pennsylvania. *H. R. Mitchell, Manager, New York Zoological Park, 185th Street and Southern Boulevard, New York City.—50 cents.*

BUSINESS, INDUSTRY AND TAXATION is a reprint of an address by Lewis H. Brown, President, Johns-Manville Corporation, and reflects the attitude of a business man in high position toward the present status of industry and economics in the United States. *Write for Bulletin 236F to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

ELIMINATING BATS FROM BUILDINGS, by James Silver, gives directions for batproofing buildings and also for the application of bat repellents. Write for leaflet number 109, United States Department of Agriculture, to *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

PATENTS AND INDUSTRY

(Continued from page 79)

fy a legal mind, so the argument goes, to pass upon an abstruse technical fact which may have taken a highly trained technical man years of intense study to learn.

Against this plan is the argument that it would set a bad precedent for employing technical advisors in all special branches of law. This would materially increase the cost of a suit to the litigants, if it is to be passed on to them, or to the taxpayers, if they are to carry the burden. Another point is that it would tend to set up a body of theoretical experts disassociated from practical industry so that their opinions might be impractical.

While Number 4 was not given by the Committee the status of a major recommendation, it is, nevertheless, of first significance. It is predicated upon the theory that there are now in existence many unexpired patents "which are now known to be worthless by those who hold them." The intent is to "remove from consideration all such patents which are regarded by their owners to be not worth payment of a tax," for patents upon which the tax remains unpaid would lapse. A hidden reason for this would seem to be a desire to penalize those holders of patents (notably corporations, as rumor has it) who wilfully withhold a newly patented product out of practice in order to prevent competition of the newer product with one already being produced that is perhaps inferior yet cheaper to make.

Several good results might come from adoption of Recommendation No. 4 for an annual tax on patents. Such taxes would reduce the annual cost to the inventor of securing a patent, for this annual tax would make possible a reduction in the present inordinately high filing and final fees. They would remove from the path of future industrial development the worthless and impractical inventions, which are both an obstruction and a nuisance, for the taxes on such patents would probably not be paid and they would accordingly lapse. The total revenue to the Government from patents could probably be increased through such annual taxes, while permitting the initial cost to the inventor to be reduced, for an inventor could easily afford to pay a reasonable patent tax starting at about the fifth year after issuance, if he were realizing an income from the patent.

On the other hand, who can determine worth? This argument and the one that "if the invention is truly important it soon attracts funds for its development" can both be demolished by one example. The Zipper type of fastener, around which has grown a large industry, was patented in the 90's but did not come into practice on an appreciable scale until five or six years ago! The lone inventor who has, in our history, contributed vastly to our progress, has often been impecunious and more often has encountered great difficulty in financing worthwhile patents only to see the fruits of his labors enjoyed by others after his patent expired. He would suffer under this tax. He might lose his patent entirely. The tax would thus appear to be discriminatory, for wealthy corporations would simply pay their patent taxes and refuse to be forced by them to place their patented products in production. Furthermore, any tax once instituted is seldom reduced but is usually increased from time to time. Considerable additional Federal revenue will have to be found in the future and Congress will naturally turn to the most easily tapped sources, such as annual taxes for patents. Should this happen, there is the danger that the taxes on patents will be raised so high that the entire patent system will be destroyed.

The Personnel of this Committee is as follows: V. Bush, Chairman, Vice President, and Dean of Engineering, Massachusetts Institute of Technology; W. H. Carrier, Chairman of the Board, Carrier Engineering Corporation; D. M. Compton, Industrial Consultant; Frank B. Jewett, Vice President, American Telephone and Telegraph Company, President, Bell Telephone Laboratories; H. A. Poillon, President, Research Corporation; Maurice Holland, Director, Division of Engineering and Industrial Research, National Research Council, Executive Secretary of the Committee.

Books SELECTED BY THE EDITORS

CONSIDER THE HEAVENS

By Forest Ray Moulton, Ph.D., Sc.D.

PROFESSOR Moulton is widely known as one of the two originators of the famous Chamberlin-Moulton planetesimal hypothesis, also as the author of standard textbooks on astronomy, celestial mechanics, and ballistics, and as an astronomer. Just as his widely used textbook of astronomy was written in unusually attractive language for a textbook, so is the present book still more readable. It is essentially a popular astronomy—neither a textbook with textbook earmarks on the one hand, nor a light-weight "easy" book on the other. It has solid substance all through. It starts with the earth and builds up, chapter by chapter, to exterior galaxies, in a grand crescendo. The author devotes some space to adverse criticism of the mystics among scientists, and is favorable to the rational interpretation of the universe. Heretofore we have usually recommended the same author's "Astronomy" (the textbook) to serious readers who wished to take up the science of astronomy anew, whenever they have inquired for the "best book to begin on." Now we shall recommend the newer work as still more suitable for the intelligent home student's first book. —$3.70 postpaid.—*A. G. I.*

WORLDS WITHOUT END

By H. Spencer Jones, M. A., Sc. D., F. R. S.

THE author of this popular account of astronomy is the Astronomer Royal at the Greenwich Observatory. He proceeds in a direct, straightforward way to tell the lay reader the content of modern astronomy, avoiding the use of technical terms but not "writing down." This, like Professor Moulton's book, would be suitable for the intelligent adult readers' introduction to astronomy. —$3.15 postpaid.—*A. G. I.*

INSIDE THE MEDIUM'S CABINET

By Joseph Dunninger

IT seems that no matter how many times the trickery of fraudulent mediums is exposed, a certain proportion of otherwise intelligent people will continue to patronize these fly-by-night exploiters of human frailties and to encourage them to continue their nefarious work. In this book an exacting investigator reveals in complete and comprehensive form just exactly what he has found out by personal experience with well known and lesser known mediums. He discusses at some length the Houdini messages and reveals them once more as being fraudulent. If you have any interest at all in psychic investigation, you will want to read this book. If you have a friend who is being imposed upon by a so-called medium, give him a copy of the book.—$2.65 postpaid.—*A. P. P.*

IF YOU'RE GOING TO DRIVE FAST

By Ray W. Sherman

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

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By Julie Closson Kenley

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HANDBOOK FOR THE AMATEUR LAPIDARY

By J. Harry Howard

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