REPLACING GASOLINE?

By Gustav Egloff

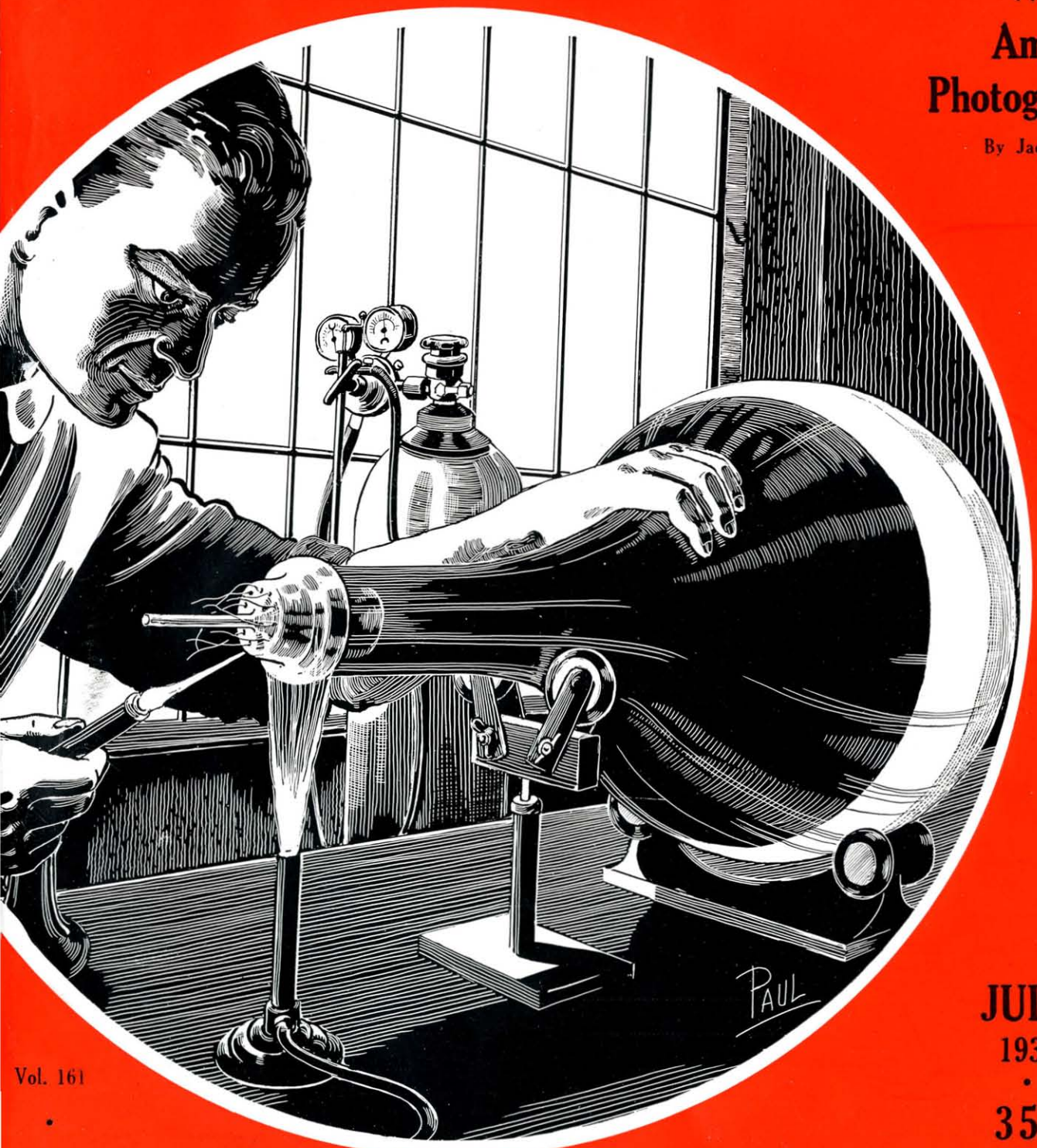
SCIENTIFIC AMERICAN

Including:
A DIGEST OF
SCIENCE & INDUSTRY

. . also . .

Amateur Photography

By Jacob Deschin



Vol. 161

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No. 1

JULY
1939

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The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

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NINETY-FIFTH YEAR • **ORSON D. MUNN, Editor**

CONTENTS • JULY • 1939

THE most intricate part of a television receiving set is the cathode-ray tube, described in some detail on page 28 of this issue and illustrated during one process of manufacture on our front cover. Here the operator, a skilled glass worker, is sealing into the narrow neck of the funnel-shaped tube the "plug" through which pass the wires that form the electrical connections to the internal elements of the tube.

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OUR POINT OF VIEW

"Self-Sufficiency"

UNDER the title "In Case of War," this journal published in the March, 1936, issue, a discussion of those strategic raw materials which this country must import because we have little or none at home and which are absolutely necessary to the proper functioning of our vast industrial empire. The list of these vital imports given in that article totalled more than two dozen at the time of publication. There is today no essential difference in the number and kinds of materials in such a list, yet there has been a momentous change in the picture. Chemistry has provided satisfactory substitutes for some of them, found ways of providing nearer-home supplies of others.

In this issue is an article which summarizes startlingly the ends to which Europe must go in order not only to prepare for the operation of motor vehicles during a possible future war but also to assist in the present economic war. A similar motor fuel problem will not have to be faced by the United States perhaps during the lifetime of present generations. Yet on this side of the Atlantic there are other, no less pressing problems to be faced and solved if we are to maintain our national economy with little disruption in time of an emergency.

A second article in this issue serves to emphasize one problem which we do have—that of supplying rubber, which we must import, to a large number of industries. More important, this article also gives a hint of what we are doing to face this situation. It shows that we, too, have ersatz materials; that is, substitutes for natural products. What people do not generally know is that this business of finding something of native compounding to take the place of scarce or imported necessities is important in its own right. It is this that has changed the picture alluded to above.

Synthetic resins are being used now where imported tin was hitherto indispensable; chromium and platinum are giving way to domestic alloying materials; organic substances are used for rubber, silk, quinine, Manila fiber, and opium; and improved processes are making available hitherto unworkable deposits of low-grade manganese ore.

So far, only a start has been made in this drive for a form of self-sufficiency. Yet an enormous effort is being made in this direction, and it can be stated positively that, in case of a future war, we will be in a much better position to supply the materials required by industry than most people imagine.—*F. D. M.*

Incomparable Promise or Awful Threat?

FOR years past, scientific writers have been pointing out the fact that if the energy known to be confined within the atom could be practically and commercially released and employed, there would be power in amounts today unknown. A handful of atoms would suffice to drive a liner to Europe and back, for example. The atomic energy of a piece of coal would exceed that of the same coal burned beneath a boiler by a ratio of a whole billion to one. Such writers have usually hastened to add that there was no prospect of man's ever unlocking these stores of power, and some have hinted that perhaps this was just as well.

Once more the foolhardiness of predicting impossibilities threatens to be demonstrated because, as this is written, physicists are at work on experiments that seem to contain the possibility if not the probability that the billion-to-one power source is at least within view. The uranium isotope 235, when bombarded with slow neutrons, releases inconceivable energy. Simultaneously it releases more neutrons and, if uranium 235 isotope be present in quantity, the result of this trigger effect is a chain reaction of far more than terrible power. Fortunately, uranium 235 is only one hundredth as common in the ores as ordinary uranium 238, else exceedingly dire results—explosions of magnitude heretofore unknown—would automatically follow unless proper control were provided.

Here, in this last clause is the question that is worrying the physicists. The minute a new force for man's benefit is found, individual examples of the genus homo begin plotting to use it as a destructive threat or in actual destruction for their own selfish, reckless ends. First impulse, then, among physicists is to abandon the experiments. Second thought shows that this would be merely to abandon them to these self-seekers, the war-makers and world conquerors. The physicist cannot stop. At first it might seem that, by an agreement, all the physicists could simply drop the matter and that this would end it. But the physicist is no more certain in advance whether his discoveries will be a curse or a boon than anyone else. He is a part of the stream of only slightly foreseeable human events. He cannot control his own discoveries, once they are given out, for he is far outnumbered. And if the human race won't leave its new playthings alone, and gets badly hurt, that's its own funeral. In a few years we may have the answer.—*A. G. I.*

Television Problems

COMMENTS, criticisms, suggestions, questions regarding television have been reaching this writer in increasing numbers since the beginning of regular scheduled television service in the metropolitan area. Two phases of the subject stand out above all others as being of great apparent interest to a large number of people. The first has to do with the service range of transmitters and the second with the possibility of constructing sets in the home workshop.

The service range of a television transmitter, under present conditions, is severely limited and that's all there is to it. With the extremely high frequencies that must be used to bring television signals into the home the range of the transmitter is practically limited to the optical horizon. Freak reception may be recorded occasionally beyond this area, but such freaks do not alter the situation as far as the average person is concerned. In other words, it must not be expected that the DX nights of early radio broadcasting will be revived in television reception. If you live within the service area of a television transmitter, you can enjoy television reception; if you do not, the only thing you can do is to wait until such service is made available in your locality. It would be useless, for example, for a resident of Texas to purchase a television receiver with the expectation of being able, even occasionally, to receive television broadcasts from New York City.

Television receivers are admittedly expensive. They must be so because of their extreme complexity. This same complexity militates against the construction of receivers in the home workshop, although kits of parts are available for those hardy souls who will try anything once. Just because a person once built a satisfactory radio sound receiver, however, is no indication that he will be able to achieve the same degree of success with a television set. The skill required is far greater than that called for in constructing even a very elaborate sound receiver. Then, too, there is the element of danger from high voltages (kept under "lock and key" in commercial television receivers) that might lead the constructor into serious trouble.

Does all this seem pessimistic? It is not intended to be so, but rather is intended to present the facts as they stand. Television is bound to become an important factor in our daily lives; don't spoil it for yourself by starting off on the wrong foot.—*A. P. P.*

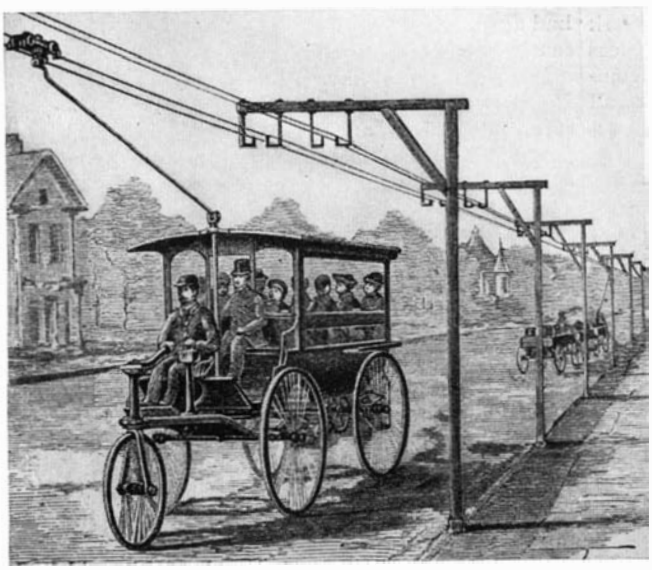
50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of July, 1889)

VALUE—" 'If I gave you a pound of metal and ordered you to make the most out of it, what kind of metal would you select?' asked a well known jeweler. 'Gold, of course,' was the prompt reply. 'I'd prefer a pound of steel,' said the jeweler, 'and I'd have it made into hair springs for watches. A pound of such springs would sell for an even $140,000.' "

ELECTRIC CARRIAGE—"The accompanying illustration represents the application of a system of electrical propulsion for common roads, by means of which traffic is designed to be carried on without employing a railroad track, the steering gear being so arranged



that the wagon will automatically run parallel with the line of the conductors. . . . The wagon body to which this improvement is applied is partly supported on a caster wheel, provided with a fork, journaled in the forward end of an extension of the frame of the body. Upon the rear axle, in this case carrying the drive wheels, is mounted a spur wheel engaged by a pinion on the armature shaft of a motor secured to the main frame of the body. Above the road bed are suspended electrical conductors, supported by poles and brackets, and each wagon is provided with a trolley which rides upon a pair of the conductors, whereby connection is made between the motor and conductors, through a vertical shaft, the electrical switch being close to the driver."

DEVELOPMENT—"Mr. Erastus Wiman, on the subject of telegraphs and telephones, in an address before the New York Electric Club, recently said, among other things, that it was a great blessing that the telegraph and telephone were early divorced, 'because I do not believe that the telephone would ever have been developed to one-quarter the extent to which it has been developed if it had been dependent on the telegraph.' "

POISON—"According to Mr. Stanley, the arrow poison used by the natives of the Lower Congo district is made from a species of red ants found in that locality. The ants are dried, crushed into powder and cooked in palm oil. The exceedingly irritating properties of the poison are supposed to be due to formic acid."

ELECTRIC LIGHT—"Electricity on ships of war is purely an American idea, and was first tried on the United States steamer *Trenton* in 1883. . . . Soon after the system had been tested the vessel sailed on a three years' cruise, and attracted much attention as the first vessel afloat to be lighted by electricity. The success of the *Trenton's* experiment practically settled the question in naval circles."

TELEPHONE—"Baltimore will be the first all-metallic circuit telephone exchange in the United States, and we predict that it will be without equal in the world."

JETTY—"The bar at the mouth of the Columbia River, Oregon, has been a source of dread to mariners frequenting that region. . . . Since the commencement of the development of the 'Inland Empire' to which this river affords communication . . . commerce has increased yearly until it has assumed such proportions as to demand radical measures in the way of improving the channels. . . . A project . . . which has been adopted by Congress, contemplates a single permanent channel across the bar, having the depth of 30 feet at mean low tide. . . . A rock jetty resting on brush mattresses is to be built from Point Adams . . . for a distance of 4½ miles, more or less, as circumstances may require, to a point about three miles south of Cape Disappointment."

HEART FAILURE—"The *American Analyst* thinks it would be an excellent idea if physicians of the present day would invent some other reason for all the deaths which occur nowadays than heart failure. It is difficult for any one conversant with the organs of the human body to understand how any human being can die without heart failure, while the causes of the failure of the heart at death may be very numerous."

STREET RAILWAYS—"The bill recently signed by the Governor of New York, allowing the street railroad companies to substitute mechanical motive power for horses, is an important one. We hope in time to see it lead to a general use of electric motors on the roads in this city."

ELASTICITY—"Professor John Trowbridge . . . calls attention to the importance, from an engineering point of view, of making careful photographs of steel and timber at the point of rupture under a breaking load, suggesting that in this way we may learn something important on the much vexed question of elasticity."

WORSTED-WOOLEN—"The question is asked, what is the difference between worsted cloth and woolen cloth? The answer is: Worsted goods are composed of wool that has been carded and combed, while woolen goods are made of wool that has been carded but not combed."

AND NOW FOR THE FUTURE

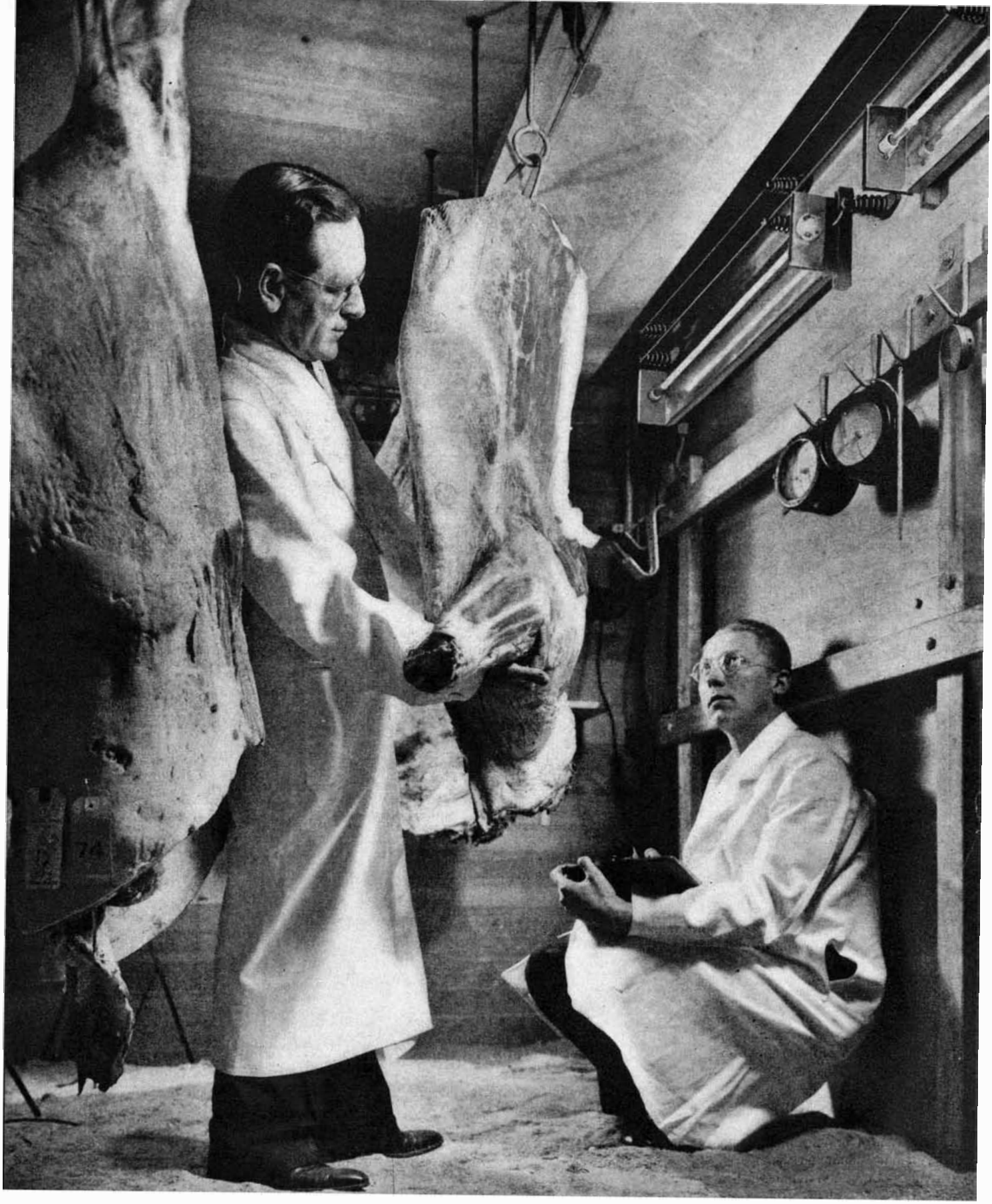
¶Noise Control—Science Takes the Noise Out of Our Daily Lives, by Philip H. Smith.

¶How the Boomerang, a Prehistoric Invention, Foreshadowed the Science of Aerodynamics, by A. E. Oxley, M.A., D.Sc.

¶American Shipping Enters a New Era in its Importance to the Nation, by H. Gerrish Smith.

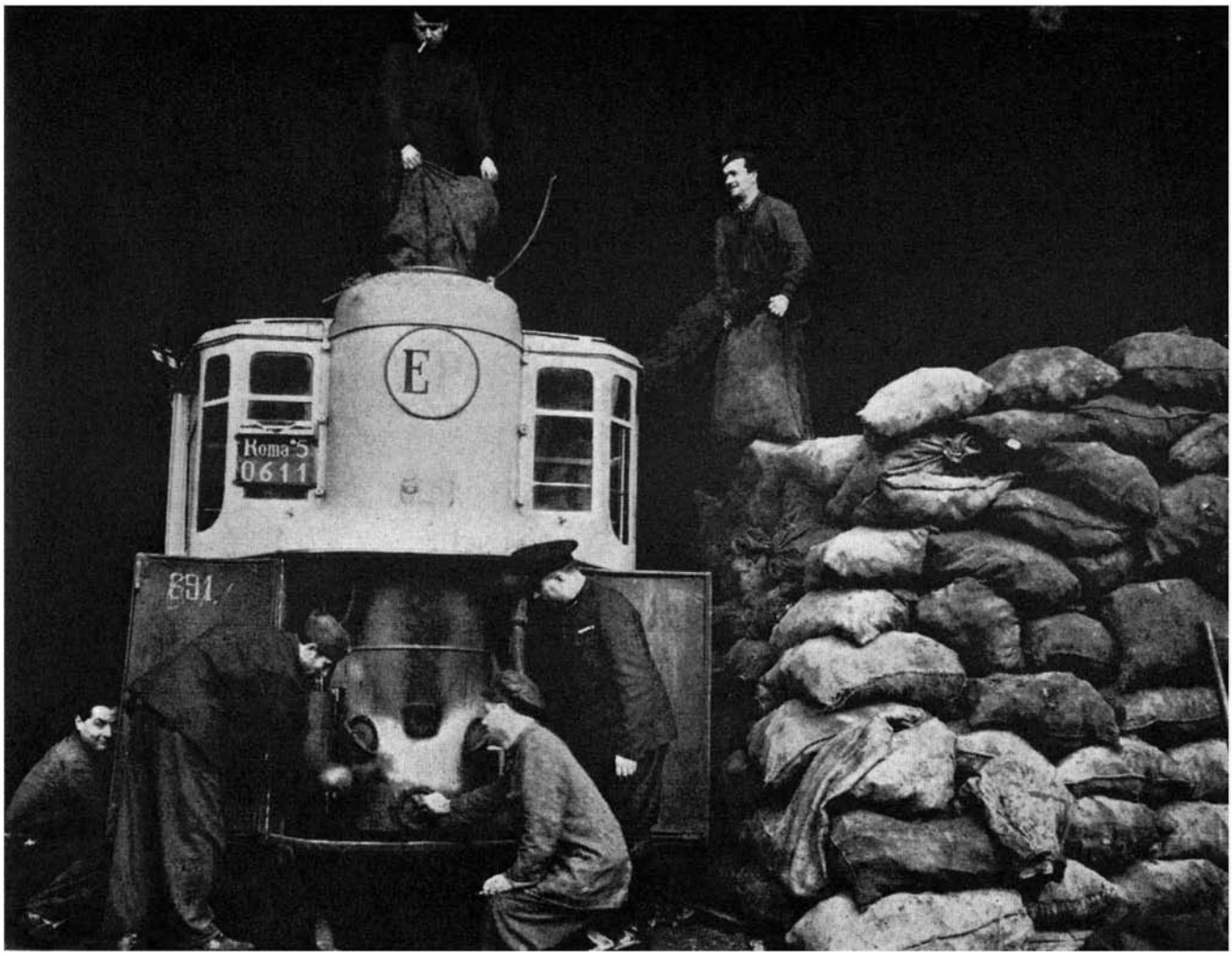
¶How Colors—Green, Red, Yellow—Become Clues to Life's Fascinating Mysteries, by Barclay Moon Newman.

¶Earthquakes Need Not Kill—If Man Will Learn the Lessons Taught by Engineering, by David O. Woodbury



AIR CONDITIONING AND LIGHTS TENDERIZE BEEF

AFTER a long study, initiated by the Kroger Food Foundation, scientists of Mellon Institute learned many things about the action of beef enzymes that "ripen," or tenderize, it. The final result was development of a process, which makes prime cuts of even the toughest beef, involving air conditioning and use of the Sterilamp, the ultra-violet ray destroyer of bacteria and fungi which was developed by Westinghouse. In the photograph, the tubular lamps are on the right wall.



A strange sight to an American: a "filling station" for Rome's 85 wood-burning buses. Small furnaces, concealed in the rear of the buses, and charged with blocks of wood cut in small sizes (or coal or charcoal), generate the gas which the motor uses

ERSATZ MOTOR FUELS

Europe's Desperate Nationalisms Force Use of Native Fuels . . . To Conserve Gasoline for Possible War . . . Result: Enormous Net Monetary Losses

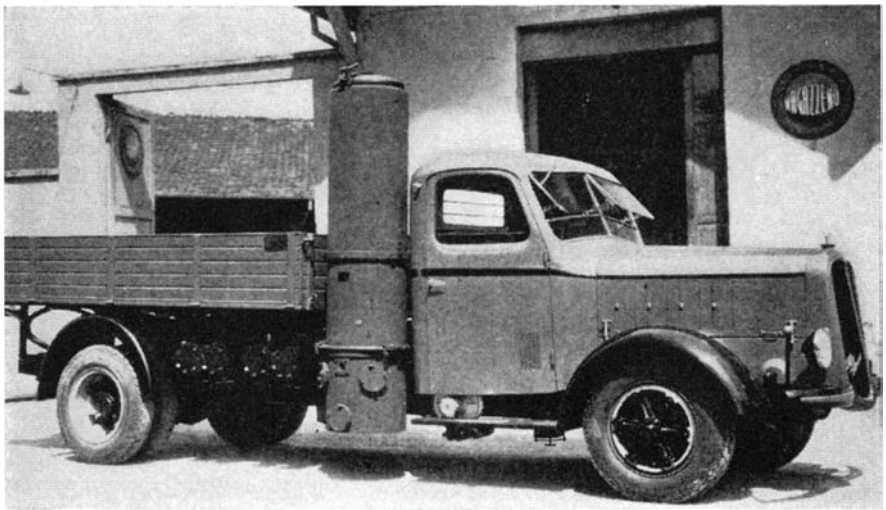
By GUSTAV EGLOFF
Director of Research, Universal Oil Products Company

THE dominant note in Europe today is self sufficiency; the dictates of nationalistic forces have made production of *all* wartime supplies of greatest importance. Under such a régime the economic side of the situation is subordinated to the necessity of maintaining within national borders the means of carrying on war measures in the face of an extensive blockade.

To the army and air forces of a fighting nation, motor fuel is almost as vital as man power, and since most of the nations concerned are deficient in oil supplies, the manufacture of substitute fuels has been forced to a new high since 1937. The willingness with which Europe accepts substitutes, which permit conservation and storage of gasoline against a possible war, points the way toward operation of all civilian motors on substitute fuel so that military machines may have the exclusive use of all gasoline. This would be the wartime ideal.

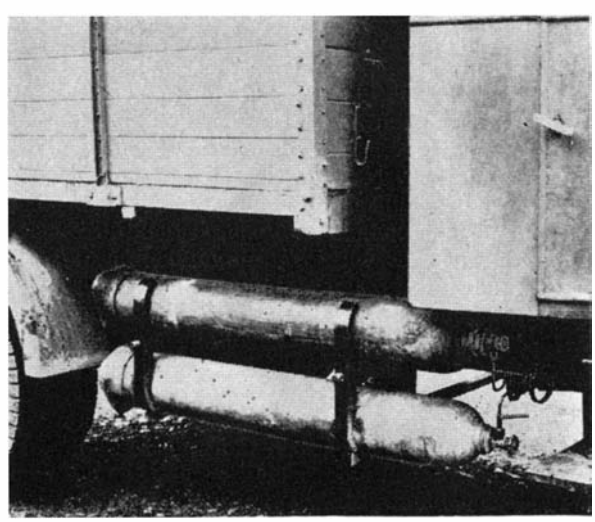
Eighteen percent of the motor fuel consumed in Europe during 1937 consisted of substitutes for gasoline. The substitutes used range all the way from solid substances such as wood and coal to compressed gases of several kinds. Offhand this might seem to indicate great saving since the cost of imported gasoline is extremely high in Europe as compared with gasoline cost to American motorists. By the use of substitutes, however, Europe lost approximately $235,000,000 during 1937. This was an all-time high. Yet 1938 showed an increase up to 25 percent of all motor fuel used and a loss of about $300,000.000 through subsidies and taxes.

Americans who have heard much of the plan, in this country, to use alcohol as a blending agent with gasoline, will be surprised to learn that use of power alcohol in Europe is steadily declining. The same war scare that is promoting use of motor fuel substitutes is diverting alcohol to the munitions industry where



it is a vital raw material. Furthermore, alcohol is essential in wartime for medicinal use, and motors adjusted to use it in peacetime would require costly readjustments to use other fuels when war breaks out. Already, there are insufficient supplies of alcohol in Europe, so that France and Italy were curtailing its use in 1937, while Germany not only twice reduced the mandatory percentage of alcohol in gasoline but also had to import supplies of it.

Even with declining use, with alcohol constituting only 4.3 percent of Europe's motor fuels in 1937, it cost Europe that year $104,040,000 more than an equivalent amount of imported, tax-paid gasoline. Other substitutes made up the remaining 13.4 percent and cost $130,826,000 more than imported gasoline. These losses are made up by the direct and indirect subsidies on native motor fuels, by special taxes on imported motor fuels, by partial elimination of taxes on native fuels and the vehicles using them, and, in some cases, by direct payments to operators of vehicles using native substitute fuels. As is the case in any country where any one group is aided by the government, it is the public—each and every individual—who pays, in taxes, the European motor fuel bill for the favored few.



Top of page: A producer-gas generator on a motor truck in Italy. Its fuel is wood. *Center:* One of the filling stations in Germany where methane gas may be pumped, under 5000 pounds pressure, into a car's fuel cylinders. *At right:* Mounting of compressed gas cylinders on a German gas-using truck which draws a trailer

WOOD, charcoal, coal, and lignite are used to make producer gas in generators on many European motor cars. Compressed natural and manufactured illuminating gases are carried in clumsy tanks on some cars. Experiments have been conducted in efforts to utilize acetylene, cracked ammonia, and hydrogen. Hydrogenated gasoline is, however, Europe's primary substitute motor fuel. While this fuel is actually gasoline, it is a manufactured product—from either coal or carbon monoxide—and is subject to the limitations of factory production.

Hydrogenated gasoline is the only one of the various substitutes which is of possible value to the United States. Small experimental plants are producing a small quantity of hydrogenated fuel in this country, looking toward the time when petroleum supplies will have become so nearly exhausted as to make necessary a supplemental supply of fuel. At present cost of production, hydrogenated gasoline is too expensive to use in America. In Europe, this fuel, whether produced by the hydrogenation of coal or of carbon monoxide, is believed to cost about 18 cents per United States gallon.

When units now under construction and designed are added to those now operating in Germany, that country's production of hydrogenated motor fuel will total about 17,000,000 barrels per year. In England, the production is about 1,300,000 barrels a year; while France is operating only a small unit producing 110,000 barrels a year. These figures may be compared with the world production of gasoline from petroleum by cracking and distillation totalling 775,000,000 barrels a year and it will be seen that only a tiny dent has been made in the problem of supplying manufactured gasoline to supplant that from petroleum.

Combustible gases of many kinds—including natural gas and gases recovered from both hydrogenation processes, from coal carbonization, and from the cracking process—are being used more and more widely in Europe. In Germany, lightweight alloy cylinders have been developed for attaching to motor cars to carry the combustible gas under pressure. These are picked up as replacements in filling stations that dot Germany, or are refilled at the stations with city gas, methane, or propane-butane. It is estimated that there are in Germany 25,000 vehicles using a total of about 250,000 such storage tank cylinders. Depending on the gas used, a given vehicle using two of the tanks will travel on one filling 25, 85, or 225 miles.

The use of compressed gas as a motor fuel requires conversion of vehicles, consisting of the installation of racks to carry the tanks, a regulating valve to control pressure, and a special gas-air mixer in place of the carbureter. To make this conversion, the cost may be from $150 to $300, depending upon the size and power of the vehicle. The number of tanks upon the vehicle varies from two to eight, depending upon the type of service; passenger buses may even pull trailers to carry the tanks. Each steel cylinder weighs 115 pounds empty and 215 pounds when filled with propane-butane at a pressure of 150 pounds per square inch. This net

100 pounds of gas is equivalent to 18 gallons of gasoline.

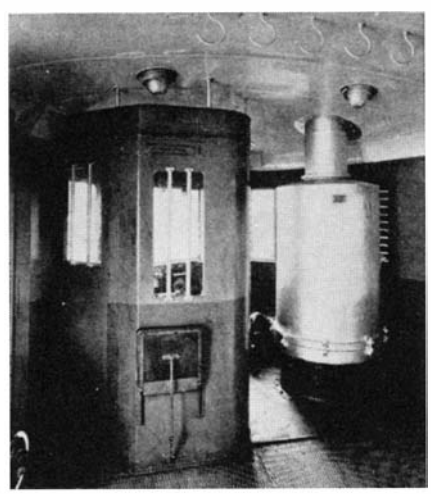
Perhaps the oddest motor fuel used in Europe, from the American point of view, is producer gas from wood and coal. Yet despite the fact that these two raw materials probably come nearest to being plentiful in some countries of Europe, relatively few vehicles burn gas made from them. Drastic laws have been passed to promote wider use of producer gas and government subsidies have been granted users, but there are even yet no more than about 9000 wood-burning vehicles. In France, Germany, and Italy they consume annually 450,000,000 pounds of wood. This amount is equivalent, in motor operation, to about 18,000,000 gallons of gasoline.

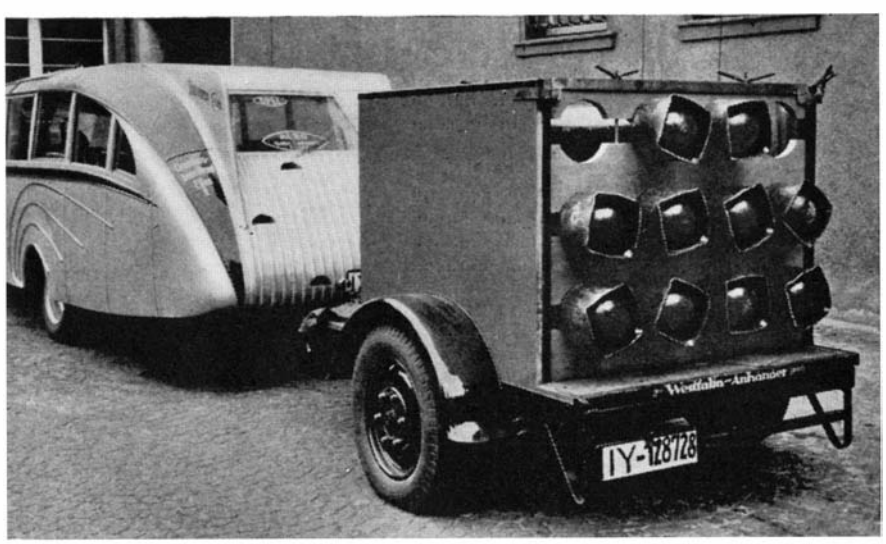
Some cars are built directly for using producer gas from wood, but more often gasoline types are converted by adding a stove to burn the wood; cooling pipes; filtering agent; tank to collect condensed water, tar, and acids; and sometimes a blower. The cost of this conversion may range from $300 to $500.

Gasogenes, as the units are called in Europe, operate by burning wood, wood charcoal, coal, lignite, or briquettes in a light steel cylinder which may be lined with a ceramic insulation. The fuel is loaded in through an opening at the top and lighted. Air is admitted through an opening at the bottom, and the gases resulting from combustion leave the tank through another opening at the bottom. The combustible gases are cleaned by passing through cooling pipes to collect water, tar, and acids. A dust catcher and a filtering chamber collect the colloidal particles of dust from the gas which is forced by a blower into the motor.

Despite its many disadvantages, the wood-burning motor has one point in its favor: the filling station can be any wood pile where good, air-dried wood is available. However, it takes about 25 pounds of wood to give the same distance performance as a gallon of gasoline. Many wood-filling stations are scattered over France, Germany, and Italy and from them 30- to 60-pound packages of wood may be purchased. The cost is low, but any comparison with the price of gasoline is fictitious because of the several subsidies and taxes that enter into the question. Furthermore, it can be confidently said that gasogene vehicles will never prove a satisfactory saver of petroleum products; if the entire annual wood production of France were used in this manner, it would still supply only 10 percent of the nation's requirements in motor fuel. The reduced efficiency, inconvenience, and delays in starting and for relatively frequent cleaning are other objections to the use of wood to make gas for motor fuel.

At right: A Parisian taxi driver attracts curious bystanders as he loads his wood-burning taxi with a charcoal-anthracite mixture. *Below:* Motorman's cab and wood-burning gas producer in a French passenger bus. *At bottom of page:* A German bus which carries compressed gas fuel in trailer tanks





Coal, in several grades, is more plentiful in Europe, and these raw materials, used singly or mixed in various ratios, could be used far more widely than at present in case of a national emergency.

Of the other substitute motor fuels used or tested in Europe, little need be said. In a number of countries, oil is being extracted from shale. This is a substitute, of course, only in the sense that it takes the place of *imported* motor fuel. In Italy, synthetic ammonia, after being cracked into nitrogen and hydrogen, has been used as a motor fuel, but its low efficiency and high cost are factors militating against its general adoption. Acetylene has been tried and found wanting in several respects. Hydrogen, compressed and carried in tanks as is city gas, does not seem to be a satisfactory fuel.

CLEARLY, gasoline would serve all motor needs in Europe more efficiently than these expensive substitutes and semi-substitutes, even under the prevailing strained economic conditions. Purely from a military standpoint, the huge loss of $300,000,000 brought about by their use might be used to better advantage in purchasing and storing petroleum for wartime needs. The reason civilian populations will tolerate this loss is probably due to the fact that the burden is relatively small because of the smaller number of cars in proportion to population. In all of Europe, with a population of over half a billion people, there are only 8,189,335 motor vehicles as compared with 30,000,000 automobiles for the United States; or one car for every 63 people as compared with our one car for every five people.

LIES—TRUTHS

A murder suspect being tested on the Polygraph lie detector by the author. A rubber tube encircling his chest and another on his arm transmit fluctuations in his breathing and pulse to the instrument, making record on a moving strip

WICHITA, Kansas, sometimes is called the proving ground for the Keeler Polygraph or so-called lie detector, for it is there that more persons are tested annually with Polygraph deception technique than anywhere else in the world.

The Wichita instrument is owned and operated by the Police Department. Each year more than 1300 persons submit to lie-detector tests, because of suspected criminal activities or because it is thought that they may be closely connected with certain criminal offenses. Each test is accurately and painstakingly recorded and statistical data are compiled to measure the instrument's value in police work and to determine its accuracy and inaccuracies.

Since scientific lie detection is comparatively new to police, and since it has only recently branched out into the commercial field, statistical data have been more or less limited and the technique of detecting deception has had to withstand the usual doubts and prejudices met by things new. The first question aroused in the minds of those in authority is: "How does it work?" Usually this question is followed closely by another: "What dependence can I place in such a procedure?"

The answer to the first question, of course, deals with the mechanics of the instrument, the theories or facts upon which its operation is based, and the procedure used in applying the technique. This question was comprehensively answered in my article, "Scientific Detection of Lies," which appeared in this magazine in June, 1937, and will be given only a short explanation here.

Polygraph deception technique is based on the fact that certain emotional disturbances take place within the body during attempted deception. These disturbances, when recorded, are discernible in the blood-pressure and respiration of the individual taking the test. The Polygraph instrument is so constructed that blood-pressure and respiration are recorded simultaneously on moving paper during the entire examination.

The second question can be answered only by application of the acid test—results. Heretofore, sufficient statistics have not been available, and therefore a comprehensive and factual answer could not be given. Now, however, with 4000 recorded examinations on file and a complete research of cases made during the years 1936, 1937, and 1938, it is reasonably safe to state that the lie detector is playing a most important part in weeding out the guilty from the large number of persons whom police find it necessary to investigate.

Segregating the 4000 examined subjects into units of "truthful" and "untruthful," it was found at Wichita that 3026 were able to produce "clear" records—those in which no deception was displayed. Of this number, 1690 were transients or vagrants picked up in the railroad yards or found loitering about the city streets. They were questioned about crime in general, and usually were released upon the completion of records which indicated that they had not committed any crimes and that they were not "wanted" by other authorities.

ON the other hand, 974 of the 4000 produced records which indicated that they were not telling the truth. From this number, police were able to secure 537 full confessions to the crime under investigation. Subtracting this number from the 974 in the supposed "untruthful" group, there still were 437 to be disposed of. Of this number, 287 were released because complainants refused to prosecute or because sufficient evidence to prove guilt was not obtainable. The remaining 150, police took through the courts. Of this number, 112 were convicted, 34 were acquitted, and four cases still are pending.

The foregoing figures, reduced to a percentage basis, show that 55.1 percent of those whose records indicated deception confessed their crime; that 74.7 percent of those whose records did indicate deception, but who did not confess, were successfully prosecuted in court; also that approximately 3026 persons, who were either suspected of crime or came under police observation, were spared the necessity of long incarcerations to permit the police to check up their many-angled stories.

During the accumulation of these records 31 persons, because of mental or physical abnormalities, produced records which were considered uninterpretable by the operator. Otherwise stated, 99.9 percent of all persons examined were able to produce records upon which a definite and immediate decision could be made.

Space will permit the discussion of only a few cases, hence random records have been selected. Take, for example, the graph produced by a young man. A salesman had parked his automobile in the down-town district, hidden a bag of money in the glove compartment, locked both the glove compartment and the car doors and gone about his business. Returning some two hours later, he found the car broken open and the money gone. Later in the day police picked up this suspect. The young man vigorously denied any knowledge of the theft and was requested to submit to

THE lie detector described in the accompanying article is one of four types discussed in *The Journal of the American Medical Association* (Chicago, Jan. 29, 1939, page 354). Where do lie detectors stand in general? This is largely a matter of opinion. One opinion, on the conservative side, is stated by the medical journal named above, which finds that many of these machines are being exploited by non-medical men although they involve the most complicated forensic clinical principles, and that sometimes instruction is too brief. The same journal recommends the following books on the subject: "Legal Psychology," by H. E. Burtt; "Lying and Its Detection," by John A. Larson in collaboration with Geo. W. Haney and Leonarde Keeler; "The Psychology of Feeling and Emotion," by Christian A. Reichsmid; "Trial Technique," by Irving Goldstein; "The Lie Detector Test," by William Marston; and "Scientific Methods of Crime Detection in the Judicial Process," by J. Edgar Hoover. —*The Editor.*

Now that the Lie Detector Has Been Used by the Wichita Police for Three Years, How Successful Has it Proved? . . . A Progress Report

By THOMAS HAYES JAYCOX
Polygraph ("Lie-Detector") Operator,
Police Department, Wichita, Kansas

Polygraph deception test technique. The graph below shows a "close-up" of the subject's record where he was asked questions concerning the stolen money. Notice the violent deviation from the "normal" in both the blood-pressure (lower part) and respiration (upper part). Immediately upon completion of the test, the graph was explained in detail to the lying young man. He confessed and led detectives to his home, where the stolen money bag had been cached.

The lower graph presents the reaction in a general investigation where police had charged no definite crime against the subject. These tests are given to hobos, vagrants, and to known criminals who are checked up from time to time. The operator simply goes "fishing" with his subject and often the results are more than worth the time and effort expended.

9. Have you stolen anything during the past year?
10. Have you answered all questions truthfully?

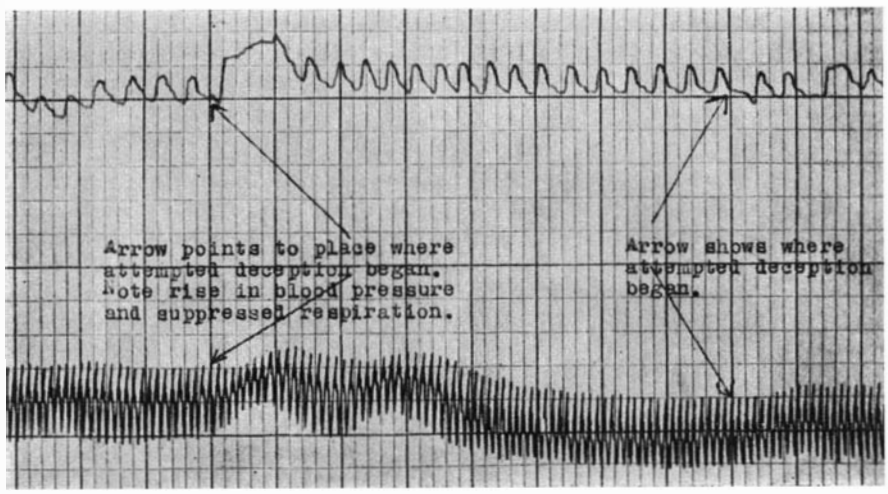
In a typical instance using these questions two young hobos were brought in for tests shortly after they had alighted from an incoming freight train. Both young men steadfastly insisted that they had never before been arrested and that they had committed no crimes. But their Polygraph records had an entirely different story to tell. Notice in the graph the responses in blood-pressure and respiration (shown by arrows) at point 4, where one of them was asked the fourth question, "Have you ever committed any crimes and not been caught?" Notice how similar reactions were displayed at points 5, 6, and 9, corresponding to the respective numbered questions. Obviously, the young man was lying when he answered negatively to these questions. Interpretation of his reactions indicated that he had committed a crime and that the crime was burglary of a house or store, as shown by his answer to question 5. He was wanted by the authorities, or thought he was (shown in question 6) and he had stolen something during the past year (question 9).

With these deductions the operator proceeded to question the young hobo, and soon the facts began coming out. When apprised of his reactions, as shown by the instrument, and when their meaning and reason were explained to him, the hobo confessed. His home, he admitted, was in an adjoining state. He and his companion had left there only the day before. Just prior to their leaving, they had broken into a dwelling house and stolen a pistol. The pistol was neatly hidden in a roll of clothing he had been carrying under his arm.

These two cases, extracted from the 537 confession cases previously mentioned, do not by any means tend to reflect that the lie detector is valuable only in minor thefts or lesser crimes. Among the 4000 cases now on file are 52 murder investigations, one of which is the well-known Wiant case. To the lie detector goes the credit for "cracking" this strange enigma and searching out the murderer from among nearly 50 suspects, as well as locating the murder weapon.

On the other hand, the lie detector is not a panacea for all criminal ills. It is simply one of the many tools used in scientific crime detection and, like the doctor or physician, the operator is not immune from an occasional misinterpretation of the symptoms.

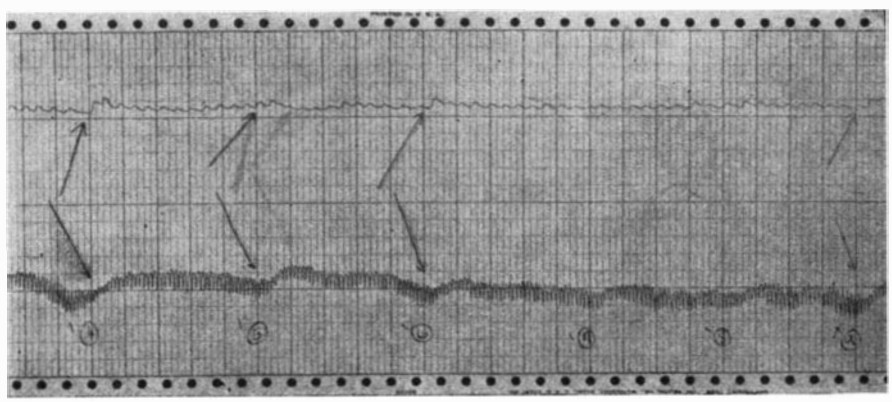
Yet with the 55.1 percent confession rate, and the successful prosecution of 74.7 percent of those who refuse to admit the truth, it is safe to assume that the lie detector, in police science, will average a high score in precision and accuracy. This assumption is true, however, only where a skilled and well-trained operator is conducting the tests. The instrument in the hands of a novice would be much like calling in a truck driver to diagnose some physical ailment—the recipient of his diagnosis would suffer.



The graph which incriminated the money bag thief, as told in the text

A questionnaire is used which includes nearly every type of crime listed in the statutes. For example:

1. Is your home in Wichita?
2. Do you live in Kansas?
3. Is this the month of _____?
4. Have you ever committed any crimes and not been caught?
5. Have you ever broken into a house or store for burglary?
6. Are you wanted by the authorities anywhere?
7. Have you ever held up and robbed anyone?
8. Have you ever stolen an automobile?



Breathing and blood-pressure fluctuations of a hobo under questioning

The Future of Navies

Second of Two Parts . . . Carriers, Cruisers, Destroyers, Submarines . . . Ships Building . . . Dimensions, Armor, Armament . . . Comparisons

By OSCAR PARKES
Associate of Institute of Naval Architects

NEXT in importance to the capital ship discussed last month comes the aircraft carrier, that extremely vulnerable floating aerodrome the existence of which in wartime is looked upon as hazardous, but which many naval officers regard as likely to become as important as the battleship.

Carriers: Since the World War, progress in carrier flying has been such that landing accidents are very rare, and all the elaborate arresting gear has been discarded. Very long and wide flight decks are still necessary—since in rough weather the pilot has to land amidships where the ship's motion is least and yet the plane may have a sufficient run—with ample beam so that an error in judgment, side-slip, or a rolling deck do not lead to a side crash. But "the bigger the ship the better the carrier" is no longer an accepted axiom, and both small and medium sized vessels are now being built instead of those of maximum dimensions so favored at the time of the Washington Treaty. A limit of 33,000 tons displacement, with guns no larger than 8-inch, was then agreed to, these limitations resulting in the U.S.S. *Saratoga* and *Lexington* and the Japanese *Kaga* and *Akagi*—immense vessels carrying cruiser armaments and a considerable weight in waterline protection. When the Treaty came into force, Britain had just completed the *Hermes* of 10,850 tons only, steaming at 25 knots and having an official complement of but 15 planes, while Japan had passed the 7470-ton *Hosyo* into service—a vessel of original design housing some 25 planes and capable of 25 knots.

In the *Hermes*, the deck was of sufficient width to allow for the funnel to be brought up through an island superstructure which an experimental canvas erection on the *Argus*—a clear-deck ship with side smoke ducts discharging at the stern—had shown to be a practical solution of the disadvantage of hangar heating, with restricted housing accommodation, experienced in both this ship and the *Furious*. But in the *Hosyo*, the deck was too narrow for this arrangement and recourse was had to small hinged side funnels which could be lowered to a horizontal position during flight work, as in the U.S.S. *Langley*, converted about two years after the Japanese ship was designed.

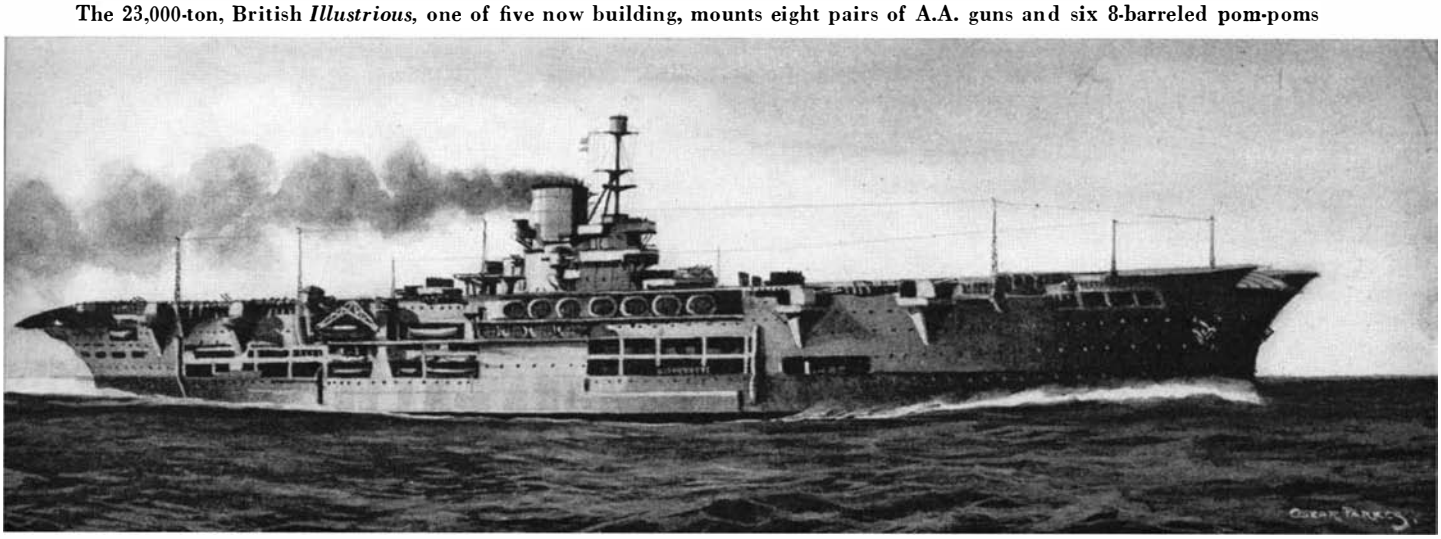
At the present time, both systems are in favor, while in the matter of size a considerable latitude is observed, depending upon the specific service for which the carrier is designed. Cost and vulnerability militate against maximum dimensions and the latest designs range from 10,000 to 23,000 tons with a wide variation in features dictated by national requirements.

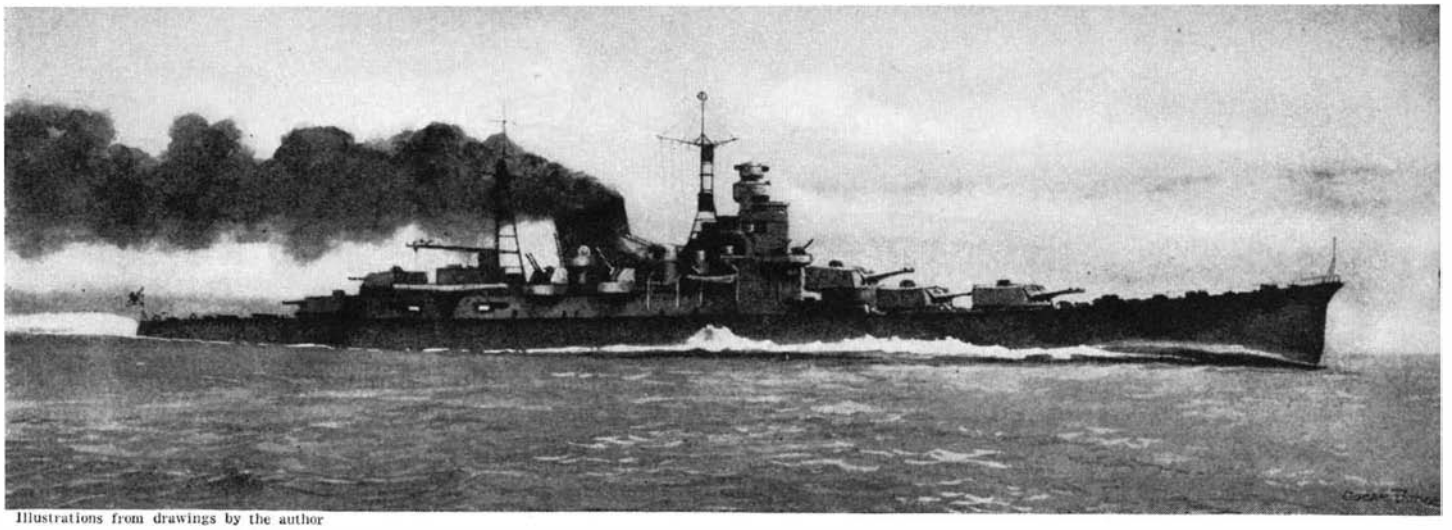
THE huge 27,000-ton *Kaga* and *Akagi*, of Japan, have recently been reconstructed, the alterations including a lengthening of the flight deck by some 150 feet so that it now extends to the bows; shifting of the forward 8-inch guns formerly carried in two turrets on the lower flight deck to casemates in line with the other six such guns on the main deck aft; addition of many machine guns along the topsides; and, in the case of the *Kaga*, an alteration in her funnels. Formerly she had great trunks from the furnace uptakes amidships, along the outsides of the hangar, discharging as bell-mouthed vents aft; these have now been replaced by a brace of curious side trunks amidships below deck level, one of which curves up and the other down—a system tried out and retained in the *Akagi*. During flying operations, the down trunk is used, the furnace exhausts being discharged away from the ship by an admixture of pressure steam.

In the *Ryuzyo*, built between 1929 and 1933, an attempt was made to produce a carrier of small displacement but able to house 25 planes. Thus upon a hull 548 feet long and drawing only 15½ feet, with a beam of 60½ feet, a huge hangar was erected with six pairs of 5-inch guns and numerous machine guns along the topsides. She also had a pair of side funnels amidships and made 25 knots on trials. But, in practice, she has not fulfilled expectations, having proved a bad sea-boat; hence, in three later carriers, *Soryu* (completed 1938), *Hiryu* (completing), and *Koryu* (building), some 3000 tons have been added to the displacement, yet the general characteristics of the *Ryuzyo* are retained. While in the *Ryuzyo*, the ratio of length to beam is 9 to 1 and beam to draft 4 to 1, in the *Soryu* it is 10 to 1 and rather more than 4 to 1, respectively, her dimensions being 688½ by 68½ by 16½ feet.

Most Japanese types appear to run to abnormal dimensions, and these ships seem to be asking for trouble. Compare

The 23,000-ton, British *Illustrious*, one of five now building, mounts eight pairs of A.A. guns and six 8-barreled pom-poms





Illustrations from drawings by the author

Japan's 8500-ton cruiser *Kumano* mounts five triple 6-inch turrets. Torpedo tubes are in curious ports by the main mast

them with the U.S.S. *Wasp*, of 14,700 tons, which is of the same length as the *Soryu* but has an 81-foot beam and draws 20 feet! Moreover, the *Wasp's* length is "water-line" whereas in the Japanese ships it is understood to be "between perpendiculars," so that the overhang of the stern from rudder pintle to counter must be added—probably another 30 feet. Such a long, narrow, and shallow hull, surmounted by a great wind-trap of hangar, does not appear to be a very happy conception, although the Japanese designers aim to increase stability by a marked flaring of the hull for three quarters of its length and the fitting of gyro-stabilizers.

These 10,000-ton Japanese carriers are reported to carry 30 to 40 planes, have a designed speed of 30 knots, and mount 12 5-inch guns. More seemly looking than the *Ryuzyo*, their sides have been spared that boskage of sponsons, platforms, pillar supports, and cluttered control positions which disfigure that ship; the funnels are small trunks on the starboard side only. Apart from a small patch of armor over the engine and boiler rooms, they are unprotected against surface attack although well armed for sky defense, and well represent a type of small carrier which has many advocates.

In the *Ranger* (completed 1934) the Construction Bureau of the U. S. Navy provided accommodation for 75 planes in a ship of 14,500 tons with a speed of 29 knots and armed with eight 5-inch guns. An island superstructure with bridges, control positions, and a light tripod mast was placed on the starboard 'midships, with three hinged funnels on each side toward the stern. The leeward set are used to keep the deck free from smoke and heat eddies. Following her came the *Enterprise* and *Yorktown* of 19,900 tons each, carrying over 100 planes at 34 knots. These are generally enlarged editions of the *Ranger* but with a much larger island built around a most imposing funnel as in the *Saratoga*. These ships have catapults on the flight and hangar deck forward so that aircraft can be shot off without having to raise them to the upper flight deck. Protection is limited to an armored deck and some plating amidships over the boiler and engine rooms, sufficient only to keep out small projectiles since their metier will be to avoid action and rely upon a protecting screen of ships.

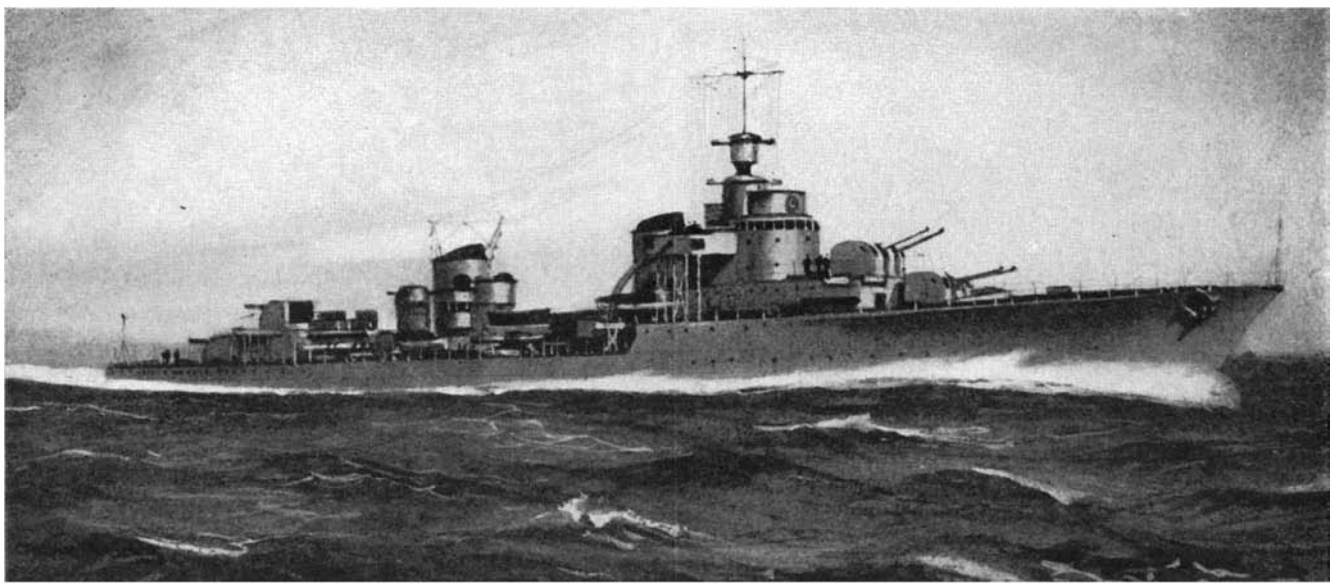
A return to smaller dimensions has been made in the *Wasp* and *Hornet*, now building, which are 14,700-ton vessels housing 75 planes. Presumably each will have an island superstructure and funnel to starboard, as this appears to be the best solution of the furnace uptake problem when practicable. There will be the same armament of eight 5-inch guns with 30-odd smaller machine guns; and they again are intended to be carriers pure and simple in distinction to the new German craft.

THE German *Graf Zeppelin*, recently launched, and "*B*," still on the stocks, were laid down in 1936 and are Germany's first attempt at carrier construction, which was forbidden to that country under the Versailles Treaty. Actually, so long as her naval operations were confined to the Baltic and North Sea, she had no need of such craft, as shore stations could provide the formations required in these waters. Neither was transport required to overseas stations, as she has none. Hence, when it was decided that a fleet air arm should be built up, the question as to what type of carrier was needed called for special considerations. Freed from coast defense duties, the new fleet was intended for the high seas, and *guerre de course* was to be the main function; hence carriers would have to be specifically designed to that end. They might act in company with the big ships, or on their own after being escorted through blockaded areas either by surface ships or submarines or both. Yet when attacking convoys, they would be compelled to face enemy escorts of certainly cruiser tonnage; to fight with any prospect of success, a cruiser armament, in addition to a heavy sky defense, would be a first consideration. To keep out the enemy's shell and to localize hits means armor and subdivision of the hull proper by heavy plating, which absorbs a lot of tonnage; high speed under economical power means a long ship, with adequate beam and draft for proper sea-going qualities in the Atlantic, and a high freeboard. There would be no call for a very large number of planes to be carried, while a small target would be a sensible advantage. Therefore hangar space was limited to 40 planes. Working upon these *desiderata* the Germans have produced a new conception which is bound to influence naval warfare very considerably.

Displacing 19,250 tons, the *Graf Zeppelin* is 820 feet long between perpendiculars—about 70 feet longer than the *Yorktown* (p.p.)—88½ feet in beam, and 18½ feet draft. The hull is simple and plain, four decks high, surmounted by a two-deck superstructure along which runs the flight deck. This falls short of the bows as in the *Ranger*, so that a hangar catapult is probable; apparently there are to be catapults on each side of the flight deck forward. Sixteen 6-inch guns will be mounted, two aside in deep embrasures up forward and again in sponsons towards the stern, with the rest—so it is reported—in twin turrets fore and aft of the island superstructure as in the *Saratoga*. These guns will all have high-angle elevation. Ten 4.1-inch and 22 smaller anti-aircraft guns make up a splendid all-purpose armament, fitting her for cruiser duties or for beating off air attack.

Forty planes will be carried by the *Graf Zeppelin* and "*B*" and the designed speed is 32 knots. No details as to protection are available but launch photos show an end-to-end armor belt and their hulls will probably be built on cruiser principles. From these details, it will be seen that, when operating on the trade routes, these two ships will introduce novel and difficult problems in the matter of counter measures.

Incidentally, it has been disclosed that Germany's planes can be equipped for mine-laying, the mines either being dropped from the air at low altitudes or released from seaplanes riding on the surface. The torpedo planes have 16-inch and 17.7-inch torpedoes loaded with 330 pounds of T.N.T. and 400 pounds of Novit, a new explosive. These are released at 20 to 50 feet above water, and both types have a range of 2200 yards at 45 knots with gyroscopic adjustment so that they run in straight, zigzag, or



Setting the destroyer pace, France's *Mogador*, a "cruiserette," mounts eight 5.5-inch guns and makes 39 knots

spiral courses. High explosive bombs vary from 110 to 1100 pounds, and there are armor-piercing bombs, gas and phosphorus bombs for use against personnel, and delayed-action 110-pound bombs for anti-submarine work.

Having had an experience of something like 20 years in the design and construction of carriers which has covered a wide variety in types, and every opportunity in the matter of trial and error over a wide field of experimentation in design and equipment, the British Admiralty has seen fit to revert to a type even larger than the *Courageous* which, a few years ago, was considered as an "out-size" not likely to be repeated. The 22,000-ton *Ark Royal* has recently been passed into service and five more about 50 feet longer and 1000 tons heavier are now on the stocks.

This latest type of carrier is 800 feet long over all, 94 feet beam, and 23 feet mean draft; that is, about 88 feet shorter and 11 feet narrower than the American *Saratoga* of 33,000 tons. Each carries 60 aircraft and an armament of 16 4.5-inch dual purpose guns, a sky defense of six multiple pom-poms, and eight multiple machine guns. According to present standards of arming, this is a very heavy equipment, but could only be used against destroyers and aircraft.

The effect of eight-barrelled pom-poms against destroyers has yet to be experienced, but in the opinion of torpedo officers they will have a devastating effect, being able to pierce plating and boilers, gun shields, and piping with such an overwhelming fusilade that no previous experience with rapid-fire guns can be compared with it. The writer has seen a multiple pom-pom battery open fire upon radio-controlled aircraft at such a height that they could be followed only with a powerful pair of glasses. There was a thunderous rolling—not the expected staccato of machine guns, but a continuous roar. In a few moments, a plane was twisting and tumbling down from direct hits, and was retrieved riddled!

The 4.5-inch is a new caliber, first mounted in the *Ark Royal*, which would appear to be rather an unnecessary substitute for the 4.7-inch. These guns are paired behind shields in side sponsons just below the level of the flight deck and have almost uninterrupted arcs of sky fire.

Sixty planes are carried in the *Ark Royal*, the hangars being arranged on two decks with three lifts transporting them to the flight deck. At the bow—which flares out to almost the extreme width of the deck—there are two catapults, with the deck between them ramped down to give a clear runway. The stern is quite an extraordinary structure with the end of the flight deck carried aft far beyond it as a fan-tail to facilitate landing. Apart from having a plated-in forecastle and stern section, the *Ark Royal* resembles the *Courageous* and, being actually a deck higher than the *Saratoga*, presents an immense target. Otherwise, she has no special points of interest in general design.

The French *Joffre* and *Painleve*, now building, are to be of 18,000 tons and are reported as designed for 32 knots. No details are as yet available and they will not be ready until 1941.

Italy has no need for carriers, as the Mediterranean can be covered from her shore stations.

Cruisers: In designing her cruisers, Japan has sought to compensate for an agreed inferiority in numbers, under the Naval Treaty, by installing superior armament in each ship. This has meant, in general, an increase in length to accommodate more turrets, with additional beam to give stability, and a necessary reduction in draft to keep displacement within Treaty limits. Her low free-board hulls, well sheered forward and tailed-down aft, flared at the bows and along the water-line, surmounted by weird tower masts, a serried line of turrets, and wildly raked and twisted funnels, present profiles which cannot be mistaken.

In the six ships of the 8500-ton *Mogami* class, commenced between 1931 and 1935, was mounted an armament of 15 6-inch and eight 5-inch anti-aircraft guns, with 12 torpedo tubes and two wing catapults, all of which, in conjunction with a long center-castle and considerable top-hamper in the matter of bridgework, made the first of the class unsatisfactory sea-boats. The two last, *Tone* and *Tikuma*, will carry only 12 6-inch guns, and have been considerably modified in other ways in order to regain the first consideration of all warships—sea-going abilities.

Five other cruisers are also reported as being under construction. These are 7000 tonners and by Japanese standards could carry 10 6-inch or a greater number of 5.5- or 5-inch guns. The 100-pound, 6-inch projectile has always presented a handling difficulty for lightweight Japanese seamen, and this caliber was retained only because of the adoption of power-loading. But, since power in place of human energy means a great increase in both cost and displacement, a reversion to a smaller, faster firing, man-handled gun, which is almost equally efficacious against present-day featherweight hulls, is probably being considered in Japan for the new 7000-ton ships as it is in Britain for the *Dido* class.

Such cruisers would make admirable commerce raiders or convoy guardians—and it must be remembered that, in wartime, Japan will be vastly concerned with the maintenance of communications between her ports and the mainland of China whence all supplies of necessary minerals will be drawn.

Four 8000-ton light cruisers were included in the 1937 United States program and these *Atlantas* are to carry 12 6-inch guns of only 47 caliber as against the 53-caliber, 6-inch guns in the *Omaha*, the shorter piece being a dual-purpose gun for use against sea and air targets. In general design it is believed that they will follow the *Brooklyn* lay-out with only two turrets forward and two aft, each housing three guns. Their commencement has been delayed until this year and they are not likely to be ready until 1942.

In England, at present, there are 21 light cruisers under construction, of which the *Edinburgh* and *Belfast* are enlarged editions of the 9100-ton *Southampton* class. They carry the same armament of 12 6-inch guns but the after turrets are a deck higher and the boilers are moved 50 feet aft to bring the catapult between the fore funnel and the hangar. Considerably more interesting are the nine *Fiji* class of 8000 tons, but also armed like the *Southampton* and steaming a knot faster—the first British cruisers carrying an adequate gun-power for their tonnage to be built since the War. In the four triple turrets are 12 6-inch guns, with eight 4-inch anti-aircraft guns amidships and multiple machine guns on top of the hangars each side of the forward funnel. There is a patch of armor amidships over the engine and machine rooms, with continuations fore and aft along the waterline 4 to 5 inches thick, with 2-inch armor on the turrets, so that these ships have a very fair measure of protection. Speed will be 33 knots with about 1700 tons of oil fuel.

The 10 ships of the *Dido* class, of 5450 tons each, represent a small, cheap, and well-armed type which can be built in quantity—a very necessary qualification for a cruiser design. They are slightly enlarged editions of the *Arethusa*—which carries six 6-inch guns and is not very favorably regarded. In the new ships, a larger armament has been achieved by the introduction of the 5.25-inch gun, ten of which are mounted in five twin turrets, three being forward on stepped levels and two aft so that six guns can fire ahead and four astern with wide arcs on each beam. Naturally, such ships can be only lightly protected, having 1-inch gunhouse armor and 2-inch plates amidships, plus the usual armor deck below water. With engines of about 70,000 horsepower, the designed speed is to be 33 knots, now a standard British figure for cruisers.

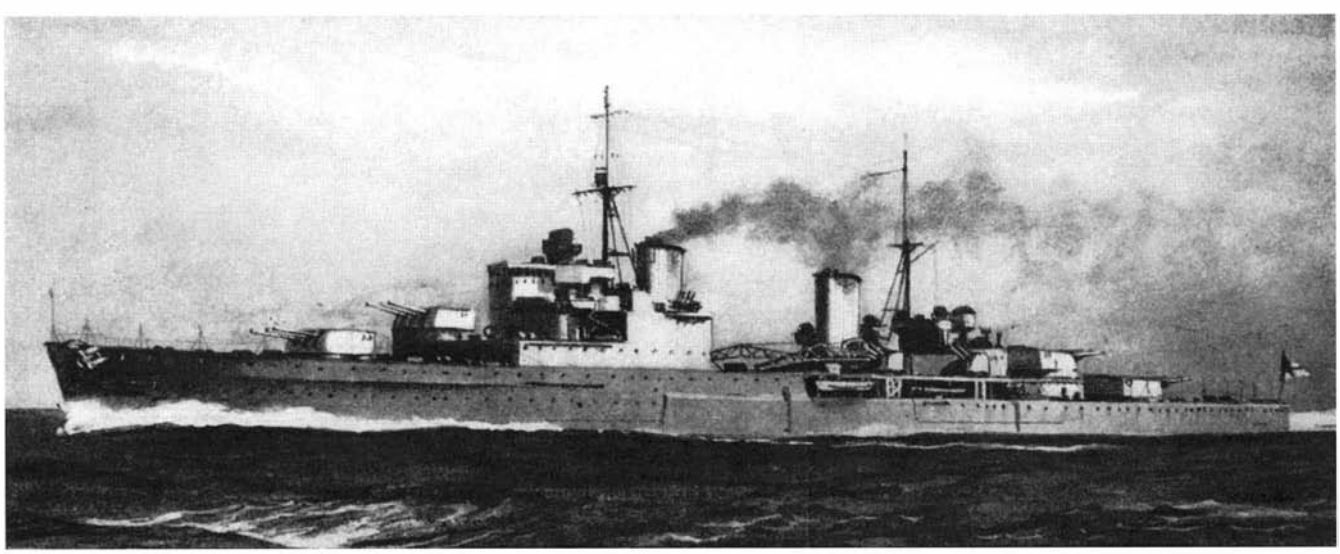
There are under construction three medium size French cruisers of the *De Grasse* class, which will be more or less replicas of the British *Fiji*—8000 tons, carrying 12 6-inch guns in four triple turrets, eight 3.5-inch anti-aircraft guns, and four planes. No details as to protection have been issued, but these ships should be almost as well armored as the *Gloire* class recently completed, with 3 to 4½-inch plate over the engines and boilers, 2½-inch decks, 5½-inch on turret faces, and 2-inch sides. Within recent years, France has been obtaining very good value for her displacement in all classes, and the *De Grasse* promises to be an excellent investment.

UP to now, the Treaty has limited German cruiser displacement to 6000 tons and 5.9-inch guns, but in the vessels now building, her constructors have gone to 10,000 tons and 8-inch guns for the *Blücher* and *Seydlitz* classes and 7000 tons for a group of medium size mounting 5.9-inch guns. The *Blücher* and *Admiral Hipper* are 640 by 70 by 15½ feet, compared with 588 by 61¾ by 19½ feet of the American *Astoria*, and will carry eight 8-inch guns in four turrets with 12 4.1-inch guns and 12 torpedo tubes. There will be one catapult and three planes, with hangars amidships. A high speed is not aimed at but with the new, very high pressure boilers, which require about two thirds of the normal hull space, a speed of 32 knots is expected. Launch photos show, from first to fourth turrets, a main-deck belt which is said to be 5 inches, with light bow and stern continuations—in which case they will be the best protected of the Washington cruisers afloat.

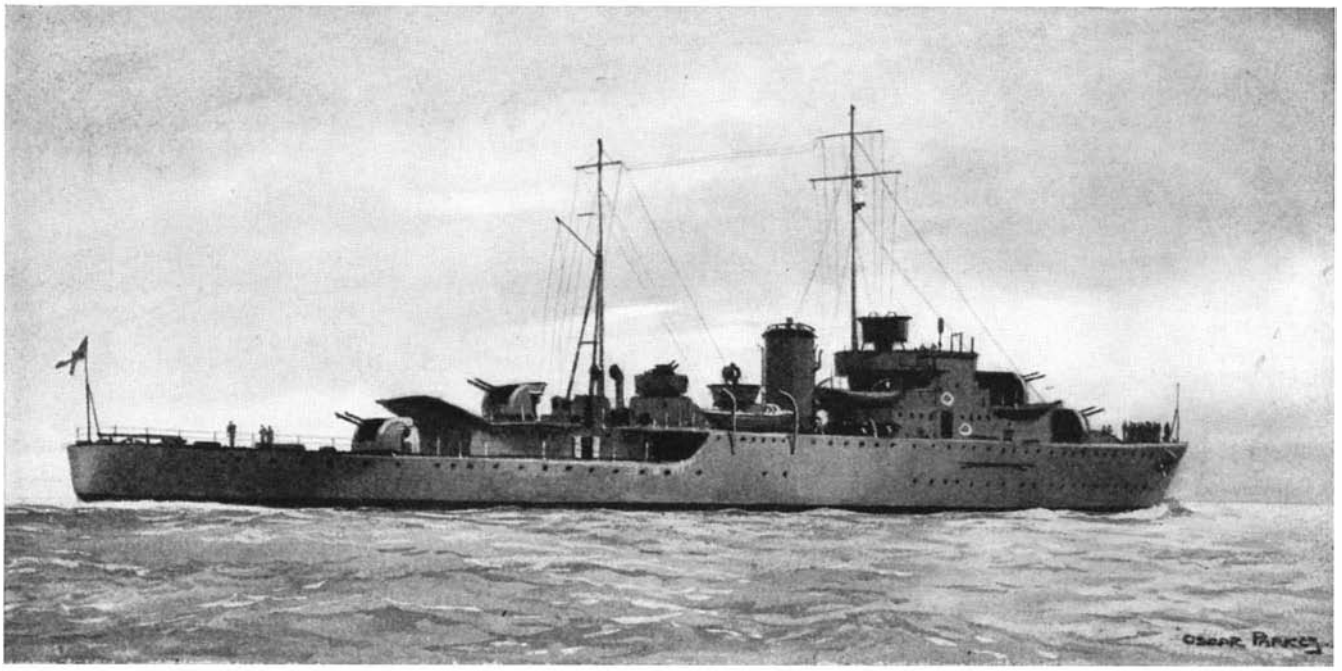
The second group, *Prinz Eugen*, *Seydlitz*, and "*L*," are 654½ by 71 by 15 feet, being longer, broader, and with slightly less draught for the 10,000 tons. A few months ago the writer was informed that the *Blücher* class were being changed to nine 8-inch guns, but as the name-ship is retaining her original armament, it is possible that the *Prinz Eugen* trio will carry the heavier armament in three triple turrets. It is worth noting that in these ships the Germans have increased beam and diminished draught beyond even the Japanese ratios, and their sides are markedly flared amidships as well as at the extremities, so that, as sea-boats, they would seem more suitable for the North Sea than the Atlantic.

Of the four 7000 tonners, nothing is known except that they will probably carry nine 5.9-inch guns. *Blücher* and *Hipper* are to be completed this year but "*M*" and "*N*" (7000 tons) were not laid down until 1937 and 1938, and "*O*" and "*P*" are to be begun this year, so that none of these may be expected to join the service until 1940 or 1941.

Since the completion of the two Italian *Garibaldis* in 1937, no cruisers of large or medium size have been laid down, but a new type of fighting ship has been evolved in answer to the French 2884-ton *Mogador* class which might be called "cruiserettes." These 12 vessels, of the *Regolo* class, are enlarged destroyers, or scouts, of 3362 tons armed with eight 5.2-inch and six anti-aircraft guns and eight 21-inch tubes, engined with 120,000 horsepower for 41 knots. They are the first warships to have a designed speed of over 40 knots. Their dimensions are: 444 by 44.7 by 13 feet so that they will be shorter, beamier, and shallower than



The British 8000-ton *Fiji* class of cruiser: 12 6-inch guns, good armor protection. Hangars beside forward funnel



Britain needs a host of small escort vessels, such as the *Black Swan*, for convoy purposes

the French ships, assuming that the length is between perpendiculars. They are essentially Mediterranean ships, able to make a very high-speed gun- and torpedo-attack with weapons of cruiser caliber, but without the sea-going qualities of a cruiser or her radius of action. At present, they mark a very interesting link between the cruiser proper and the destroyer—an up-to-date model of the "scout" which has appeared sporadically in most navies at one time or another.

Destroyers: As already noted, the line of demarkation between cruisers and destroyers has now almost disappeared. The French *Mogador* mounts eight 5.5-inch guns and 10 21-inch tubes and, with 90,000 horsepower, has exceeded her 38 knots. With guns able to exceed 25,000 yards with a maintained fire of 16 rounds a minute, she is a most formidable craft. The French now possess 32 ships of her general type. They are employed both in the Channel and Mediterranean and have led to the Germans enlarging their destroyers to 1811 tons, to carry an armament of five 5-inch guns in single mounts and eight 21-inch torpedo tubes, and to steam at 36 knots. Thirty ships of the German *Von Roeder* and *Maas* classes are now built or completing. These have been countered by the British *Tribal* class—1870 tons with eight 4.7-inch guns and only four 21-inch tubes —in which torpedo equipment has been sacrificed for gun power. As destroyers proper, the British have 14 of the *Javelin* class building and seven of the *Lightning* class recently laid down, the former being of 1690 tons and the latter of 1920 tons, with a common armament of six 4.7-inch and eight to ten 21-inch tubes. Just how the extra tonnage of the "*L*" class is to be utilized remains to be seen—probably in increased anti-aircraft guns.

For many years the Japanese have been in the forefront in destroyer design and since 1926 have, year by year, been adding to their flotillas heavy-weights carrying five and six 5-inch guns with six or eight tubes and able to steam at 34 knots. They were the first to give gun-house protection with high angle mounts, and to protect their torpedo gunners by shields. They also developed an exaggerated form of bridge, crowned by a heavy range-finder, and generally piled on topweight until the capsizing in 1934 of the *Tomoduru* (afterwards salved) led to a general criticism of this trend in design and a return to less extreme proportions in hull and curtailment of superstructure. In the eight units now building in the *Kurosio* class of 2000 tons the Japanese have followed the French and Italians in merging the destroyer with the light cruiser and producing a "cruiserette" carrying eight 5-inch guns and with 34 knots speed—which is well below what the United States and European Powers deem necessary for this type. But with an armament almost equivalent to that carried in Italian and French vessels of some 900 to 1400 tons greater displacement, they can afford to dispense with that extreme speed suitable for Mediterranean tactics and conditions; for Pacific purposes they should be compared with the U.S.S. *Somers*, of 1850 tons, mounting eight 5-inch guns and twelve tubes, steaming 37 knots, and carrying 500 tons of fuel.

Following the 12 *Maury* class destroyers of 1936 (U.S.), come the 12 *Sims* and 16 *Benson* classes now under construction—the latter being of 1620 tons and generally resembling the standard one funnel *Maury* class but with six 5-inch guns in pairs in place of four singles, and the extremely heavy torpedo armament of 16 tubes, of which eight fire on each beam. American designs favor the practice of stowing all torpedoes in their tubes on deck rather than carrying half the number of torpedoes on the center-line and keeping spare ones below deck.

Submarines and Auxiliaries: As regards submarine construction, no departures from the orthodox designs have been produced by any Power, although it is reported that a Russian boat of very large size—over 3000 tons by estimate—has been seen in the Black Sea.

The British, faced with the necessity of escorting a vast overseas traffic, have steadily added small escort craft to their Home and Dominion navies, of which the *Black Swan* is the latest sample. Of 1250 tons, she mounts four twin 4-inch dual-purpose guns and, with 3600 horsepower, will steam at 19¼ knots. She is designed to accompany a convoy through the submarine and aircraft zone. The earlier British escort vessels were very poorly armed, being first intended to be minesweepers, but are now down for re-armament with six or eight 4-inch guns.

Hosts of small craft—minelayers, mine-sweepers, motor torpedo boats, and so on—are being added to the European navies, but space precludes more than their mere mention. These brief descriptions of the capital ships, carriers, cruisers, and torpedo craft being built by the Powers give some indication of the tremendous activity being devoted to piling up offensive and defensive squadrons in preparation for the hostilities now threatened through territorial demands by Germany and Italy with Japan at the Far Eastern end of the "Axis."

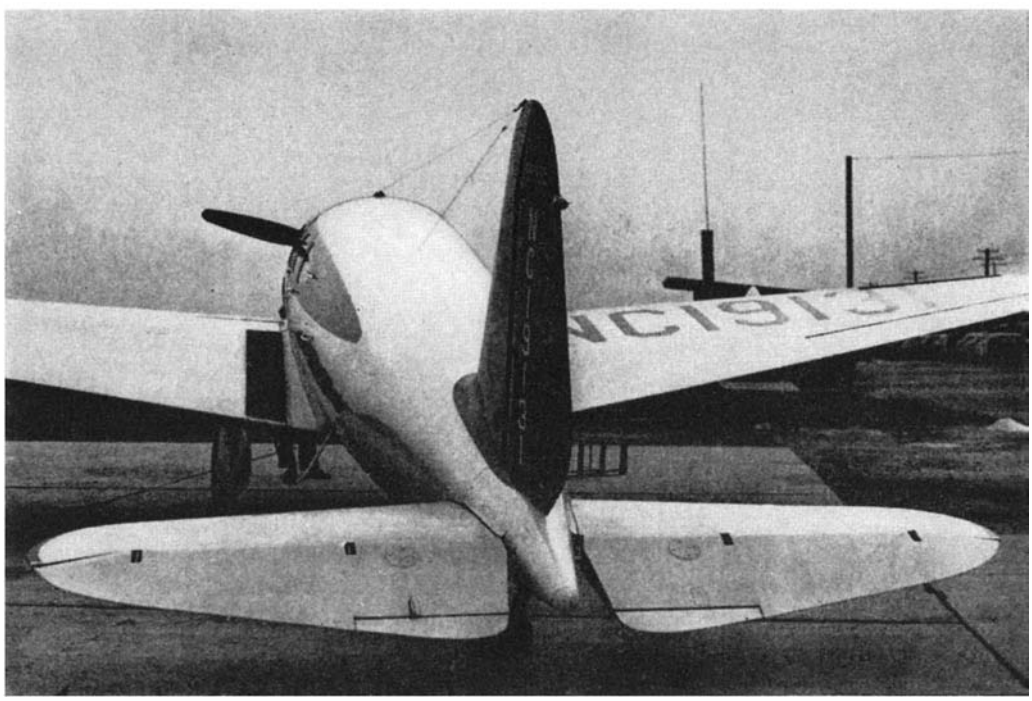
AIRPLANES, UNLIMITED!

Molded Fuselages and Wings Make Possible Mass Production . . . Plastics Employed . . . 36,000 Planes a Year . . . Tremendous Wartime Significance

By FORREST DAVIS

THE flying machine, in an age in which automobiles roll off the assembly line like shelled peas into a basket, is still hand made. In some stages of assembly, it takes two men four hours to rivet a single square foot of a metal plane's surface. In peace time, this deficiency of our most modern transport and military device is a machine-age paradox; in war, it might be a calamity. For years our air corps officers, aircraft designers and builders, and aviation experts, resenting this production lag, have been praying—more fervently than ever since Munich—for some method of producing planes as rapidly as automobiles.

Their prayers seem about to be answered. A new technique, developed primarily by Col. V. E. Clark, veteran designer and our Army's chief aviation engineer during the World War, and secondarily by Dr. Leo Hendrik Baekeland, the father of modern plastics, with the co-operation of the Haskelite Corporation, of Grand Rapids, makes possible (unless all signs fail) a practically unlimited supply of stout, cheap, fast airplanes.



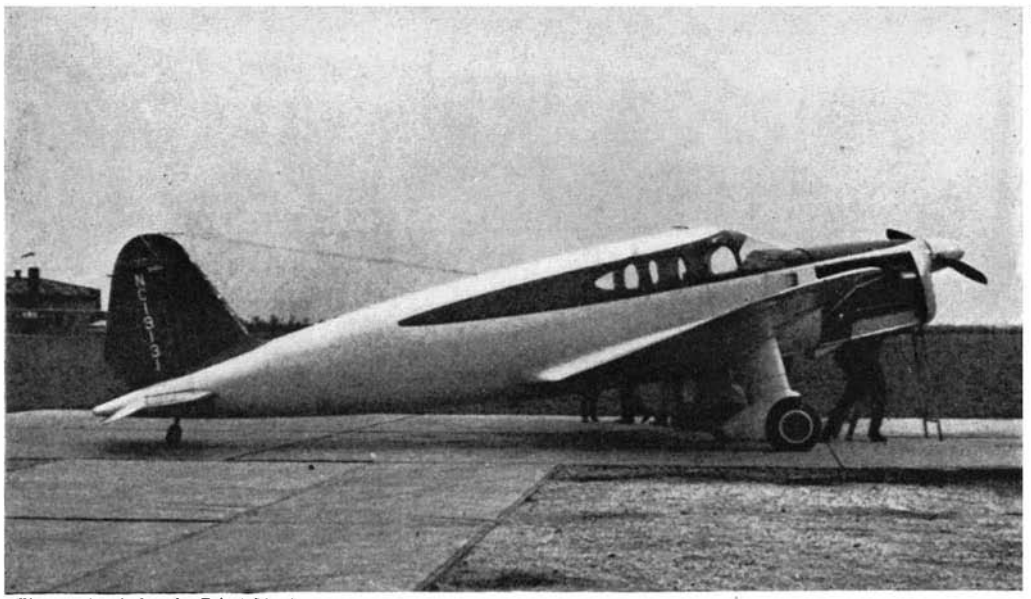
A hint of the future: The fuselage of this plane is molded from laminated plastics in two shells, can be manufactured economically in mass production, has been subjected to severe tests

For a year and a half a mystery ship, cream-colored with a vermilion stripe, had been haunting eastern airports from Florida to Quebec, undergoing all sorts of weather, as well as static, impact, and vibration tests. Then, in the course of a Congressional monopoly investigation last winter, Dr. Baekeland's son, George W. Baekeland, a World War aviator and aviation enthusiast, under fire of a quiz into patent relationships in that giant industrial stripling, plastics, digressed from his testimony long enough to reveal the existence of a laminated plastics plane fuselage which he said could be molded and made ready for the assembly line in two hours, half the time needed to buckle on a single square foot of the present airplane's skin. This was the cream and vermilion "Clark 46." Headlines flared briefly, but Colonel Clark, returning from Europe, squelched the sensation by wireless from his ship at sea. Only now, after months of gruelling tests, does he feel that his plane's performance justifies a public report on its nature and implications. This report I am authorized to make.

HOWEVER the January revelation struck the average newspaper reader, it was no news to rival designers, to builders, plastics researchers, or the National Advisory Committee for Aeronautics. Nor did it surprise the air ministries of certain European powers apart from the Rome-Berlin-Tokyo axis. Insiders here and abroad knew that Clark, a distinguished designer who, among many accomplishments, devised the airfoils, or wings, for Lindbergh's *Spirit of St. Louis*, had been working at Hagerstown, Maryland, on the mass-production problem. Some even recalled that during the World War he instigated experiments on a molded plane; an attempt which was abandoned after the Armistice because the technicians had been unable to form plywood in permanently smooth compound curvatures and because the adhesives then known failed to protect wood from deterioration.

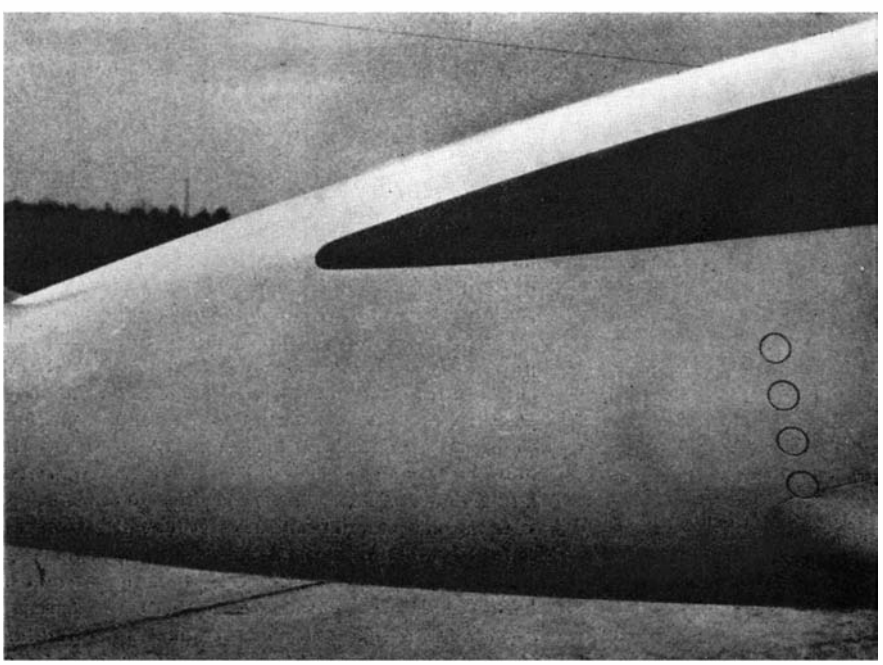
Few doubted Clark's eventual success. Here was no eccentric, long-haired inventor, but an able aeronautical engineer rated high in Wall Street as well as in his profession. His backers, since he tackled the big job in 1934, include some of the most noted industrialists and financiers in the country. Furthermore, a general feeling existed that the time was ripe for fundamental advances in the laggard art of airplane fabrication. If Clark didn't lift the curse of Adam from the industry, it was felt, some one else would—and pretty soon. New, synthetic resins brought out by the plastics laboratories had given aviation, as well as a host of other crafts, novel materials and tools.

Early planes were contraptions of doped silk, spruce strips, wire, and bamboo poles. The war brought plywood or veneers bound with animal or casein glue. Plywood was, and still is, unsatisfactory, since it is virtually impossible to protect



Photographs of plane by Robert Littell

Left: Side view of the "Clark 46," showing the sleek lines of the molded plastics fuselage. In this model, the wings are of plywood, to furnish comparisons between the two materials under operating conditions. *Below:* A close-up view of the molded fuselage, showing absence of rivets and other projections



wood against rot, fungi, moisture, warp, and check. In 1929 arrived the light, all-metal alloy plane, which made possible transatlantic clippers and the 350 mile-an-hour pursuit ship. But the inside of each wing, each fuselage of an all-metal plane is a forest of carefully calculated stiffening frames and stringers; the outside is peppered with thousands of rivets. It takes weeks, often months of the work of many skilled hands to complete such a plane. The great Douglas plant, under forced draught, needs 18 months to turn out 500 ships for the British.

NOW examine the "Clark 46," which in time may relegate metal planes to the shelves of history. Its fuselage is sleek, glass-smooth, and rivetless. There are a few discolorations and nicks on the belly, made by stones cast up from the wheels. (In the case of a metal fuselage, stones striking its underside leave noticeable dents.) Otherwise its perfect flanks give no indication of the 1600 hours it has spent in the air, deliberately exposed to every flying stress and strain, to every onslaught of rain, sleet, and snow. Rap on it, and wonder at the light, unsubstantial sound. Peer into the dark interior, climb into the cockpit, and notice the complete absence of structural supports. All the space is free. And there is only a faint seam to show where the two 20-foot half-shells that form the fuselage were joined together.

Colonel Clark has given the name "Duramold" to the new material from which this fuselage is made. Manufactured by a secret process employing phenolic resins discovered by Dr. Baekeland, Duramold, roughly speaking, is a laminated plastic similar to the glossy table tops and decorative panels often found in night clubs or cafeteria-bars.

Technically, Duramold stands somewhere between the plywood built into airplanes between 1917 and 1931, and a true plastic. The difference between a laminated and a true plastic is this: a laminated product uses organic fiber, such as wood or cotton, for its base, and employs resin as an adhesive, a forming, and a coating agent; whereas the true plastic has resin as its base and may or may not use fiber as a reinforcing filler. Practically, a true plastic requires high temperatures and enormous pressures for forming. Duramold is molded inexpensively in a die. Exactly how this is done can not be explained since the secret is well kept. I can only reason that thin strips or sheets of plywood, of long straight grain, are formed into the desired curvature, that they are then fixed into a mold, partially impregnated with a phenolic resin, and then pressed into a cohesive mass that is no longer wood nor synthetic resin but virtually a new synthesis.

Duramold does not chip or corrode; it resists water, oil, and acids; and is stronger than metal. Says Colonel Clark: "In the form of a simple thin-walled cylinder of given weight under compression, Duramold is, roughly, 10.4 times as strong as stainless steel, 3.4 times as strong as aluminum alloy, and 12.1 times as strong as reinforced solid phenol formaldehyde resin (a plastic)." Its basic ingredients are cheap and, in part, absurdly common. Set in molds, Duramold can be given any desired shape—and will keep that shape.

The shape of a plane is all important. Experts in aerodynamics know that tiny bumps or depressions measurably interfere with the flight of a plane. In metal planes such flaws are hard to avoid; in planes of Duramold, true to a few ten-thousandths of an inch, there need be none. Engineers have said that the "Clark 46" is, aerodynamically, the most nearly perfect plane they have ever flown.

And only the fuselage of the "Clark 46" is Duramold. The ailerons and rudder are of alloy; the wings are of im-

proved plywood—used partly because a plastic fuselage was sufficient for experimental purposes, and partly because Colonel Clark wanted to compare the behavior of the two materials. Even laymen who have examined the plane have remarked the fact that, while the Duramold has stood the tests of 20 months, the plywood has not. The wings, applied in sections—not molded in two longitudinal parts like the fuselage—show signs of repair. One joint has been damaged by the weather—or by rot.

Within a few months we shall see a plane in which wings as well as fuselage are made of Duramold, for the wings are no more difficult to fabricate. At the present stage of this new process, Duramold may be pressed in lengths no longer than 40 feet, giving a wing spread of 85 feet, ample for most military purposes. Duramold planes will be as strong as metal; more fatigue resisting, it is believed; as safe in the air; and probably less hazardous in a crash, since wood breaks more slowly than metal under impact. Under gunfire, Duramold fuselages and wings will fare better than metal ones because they will have no vital structural points to be shot away.

BECAUSE of its seamless, rivetless skin, a high-speed, all-Duramold plane will have a frictional drag no greater than glass, and will be theoretically 7 percent faster than its all-metal counterpart. At 300 miles per hour, this would be a gain of 21 miles.

But the revolutionary feature of this new process is, of course, the speed of manufacture. At the Haskelite plant in Grand Rapids, nine men molded a half section of the "Clark 46" in one hour—two hours for the whole member. Shipped to the Fairchild factory, only 5 hours and 20 minutes were required to assemble the entire fuselage and fit it, without filing or drilling, to the completed plane. And this, remember, was an experimental job. In factory production, when that comes, the time will be cut down even further. There is no reason why Duramold wings and fuselages may not eventually be turned out as rapidly as Fords.

Colonel Clark undertook his researches as a preparedness project. Having learned a lesson from our pitifully inadequate air building program during the last war, he foresaw a period of heartbreak for the air arm in the next war while production awaited the slow, manual job of fixing stringers in airplanes and fastening them with millions of rivets. The answer was the elimination of stiffeners and rivets. Sherman Fairchild, of the Fairchild Aviation Corporation at Hagerstown, shared his views; the chemists of the Bakelite Company advised: and the Haskelite Company, a laminated plastics firm at Grand Rapids, gave invaluable aid based on extensive experience which they have gained in the highly specialized field of plywood fabrication.

Personally, Colonel Clark is a well-girthed, patient-voiced gentleman of 53, with kind manners, an abstracted air, and blue eyes as cold as calculus. Born in Uniontown, Pennsylvania, and christened Virginius Evans, Clark went to Annapolis, transferred later to the Army's Coast Artillery, finally to the Aviation Section, Signal Corps. At 29, he was made chief

Col. V. E. Clark, veteran airplane designer, who is pioneering in the field of laminated plastics planes

engineer of Army aviation, a post he held throughout the war and until he retired from the Army in 1920 to become chief aeronautical engineer of General Motors at the Dayton-Wright plant. When General Motors withdrew from aviation in 1923, Colonel Clark helped organize and became chief engineer and vice president of Consolidated Aircraft at Buffalo, designing and building more than 800 training ships there for the Army and Navy.

From the standpoint of national policy, the use of Duramold, or other easily obtainable plastics materials, would free aircraft makers from their present dependence on aluminum alloys. But what is more important, the Clark method may realize the long-standing dream of airplanes as cheap and accessible as automobiles. It is not inconceivable that Clark might one day be the Ford of the skyways. The fact that production of plastics airplanes has no observable limits gives his enterprise exciting scope at this juncture in European affairs.

Nazi Germany terrified the world by turning out 10,000 metal planes in one year. The democracies—including ourselves—knew that it would take months, perhaps years, to overcome this preponderance. We can tumble airplane motors, instruments, propellers, fittings off the assembly line. But production bogs down in the bottleneck of the great structural parts, with their thousands of man-hours and millions of rivets. The German war plane program calls for 160,000 skilled workers in the airplane plants alone, plus 240,000 more to make parts and metal sheeting. Duramold planes will break the bottleneck. With ten sets of dies, two hundred men in a factory covering one city block could build enough Duramold fuselage, wing, and tail shells for 300 planes a month; with 100 dies, 2000 workmen, only semi-skilled at that, could, in one year, mold and assemble 36,000 Duramold planes.

THESE things are just around the bend of the future. Colonel Clark, long a pioneer, has rivals. Glenn Martin, who built hedgehoppers contemporaneously with the Wrights and Glenn Curtiss, has been conducting research in his Maryland plant for two years, and has established a fellowship at the Mellon Institute under Dr. William L. Rast, with the hope of evolving his own plastics type ship. Another group with a dozen chemists and engineers is at work at Hasbrouck Heights, N. J., under Eugene L. Vidal, former Director of Aeronautics in the Department of Commerce. They have already molded seaplane pontoons which are now being tested by the Navy. In Europe, the race for solution of the problem of mass production planes is furious, the contestants being England, France, Germany, Italy, Holland, and the U. S. S. R. The English De Havilland Company leads in research. Plastics propellers—lighter, stronger, and cheaper than metal—are being produced in England and in the United States. The German Heinkel Works is supposedly making three planes a day of plastics plywood panels—which is primitive compared with Colonel Clark's achievements. Another German firm is said by the British Aviation Journal, *The Aeroplane*, to be installing 12,000-ton plastics molding presses, possibly large enough to form structural airplane parts. The implications of all this are tremendous. When the new science of plastics has helped solve the problem of mass production of planes, the winged fear that made Munich possible need never be repeated. No one nation will be able to cow another from the air for long. Portugal and Peru, if they wish, may have air fleets as large as those that terrorized Europe last September. Preponderance in aviation may give way to equality; planes may become as commonplace and unimportant in the balance of war and peace as rifles are today. The only possible superiority in the air may depend on morale, flying skill, strategy, and a ready supply of petroleum. If peace lasts until plastics planes are as much a reality as Fords, their sheer quantity may help to keep the peace. And to peacetime aviation, their cheapness, durability, and steadiness may open up as yet undreamed of vistas.

What Keeps the Stars Shining?

According to Bethe's Theory, the Most Notable Achievement of Theoretical Astrophysics of the Last Fifteen Years, It is Atomic Transformations

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

READERS who have had the patience to follow our story of stellar energy into a third installment may be excused for asking what dramatic conclusion justifies so long a tale. So far, we have built up the situation, and shown that the climax of the play must be a transformation scene, in which atoms of some kinds combine and change into atoms of others, with liberation of the energy which keeps the stars shining. This atomic—or, rather, nuclear—interplay was first fully interpreted, very recently, by the brilliant work of Professor Bethe of Cornell. The plot is a bit complicated, and it will be well if we begin with a list of *dramatis personae*—that is, of the various sorts of atoms, and of those of their properties which concern the action:

The Lighter Atoms.

Name	*Symbol*	*Charge*	*Mass*
Electron	e	−1	0.00055
Neutron	n	0	1.00893
Hydrogen	H^1	1	1.00813
Deuterium	H^2	1	2.01473
Helium	He^3	2	3.01699
Helium	He^4	2	4.00386
Lithium	Li^6	3	6.01686
Lithium	Li^7	3	7.01818
Beryllium	Be^9	4	9.01504
Boron	B^{10}	5	10.01631
Boron	B^{11}	5	11.01292
Carbon	C^{12}	6	12.00398
Carbon	C^{13}	6	13.00761
Nitrogen	N^{14}	7	14.00750
Nitrogen	N^{15}	7	15.00489
Oxygen	O^{16}	8	16.00000

The masses given in the last column are the values for the whole atom—to get that of the nucleus, subtract the mass of the number of electrons given in the third column; for example, a hydrogen nucleus (proton) has the mass 1.00758, and a helium nucleus (alpha particle) 4.00276. The various isotopes of the elements are listed separately. The more abundant ones are named in italics. We have now to fix our attention on the small decimal parts of the numbers in this last column. In a reaction between nuclei—whether they combine or break up—the main part of the mass is not altered—only the small "mass excess" above a whole number.[1] We may, if we will, think of the whole numbers as representing in some way the "quantity of matter" (whatever that may mean) and the decimal parts the differences in the amounts of energy with which they are bound together into a unit. The tighter they are bound, the smaller, naturally, is the mass-excess.

It thus appears that the helium nucleus, and those of carbon and the following elements, represent configurations of low internal energy, while hydrogen is highest up on the scale (except for neutrons, which, as we pointed out last month, will be very short lived inside a star).

The transformation of hydrogen into heavier elements is therefore the main process to which we must look within the stars. Four neutral hydrogen atoms have a mass 4.03252, which exceeds that of a helium atom by 0.02866, or one part in 141. This looks small; but if the Sun was made of hydrogen, and turned into helium, the energy corresponding to the loss of mass would keep it shining at the present rate for 106 billion years. We have at last found an adequate source of stellar energy. Other transformations would give much less; for example, to turn four helium atoms into one of oxygen (if possible) would diminish the mass by one part in 1040, and be but a tenth as effective.

WE may now—following Bethe—consider what is known about the various reactions between these atoms.

In the first place, only hydrogen nuclei (protons or deuterons) produce effects of importance. An alpha-particle has twice the charge of the proton, and so is more strongly repelled, and, having four times the mass, it moves but half as fast at the same temperature. It is therefore enormously less likely to "penetrate" another nucleus.

Secondly, most of the nuclei in the table can be penetrated by a proton, if hit hard enough, and transformed; but there is one great exception. Helium is invulnerable. If a proton entered an alpha-particle and fused with it, the resulting nucleus would have mass 5 and charge 3—it would be Li^5. It might be, however, that as the proton entered, it knocked out a positive electron, reducing the charge by a unit: this would give He^5. Neither of these has been found, experimentally; and there is very strong reason to believe that such nuclei are inherently unstable—not capable of independent existence for even the minute fraction of a second for which some radioactive nuclei endure. If two alpha-particles should penetrate one another, they would form Be^8 (charge 4, mass 8). This is now known to be unstable; it breaks up again into the two alpha-particles. Hence helium, once formed, appears to be indestructible. Nothing more can happen to it. If hydrogen is the fuel of the stars, helium is the ashes.

Thirdly, the lighter nuclei, from deuterium to boron, react rather readily with protons. But, either at once or after two or three successive changes, the resulting products break up into helium. To take examples observed in the laboratory

$$Li^7+H^1=2He^4;\ B^{11}+H^1=3He^4$$

If hydrogen and light elements are originally present, these reactions will liberate a large amount of energy; but each light nucleus, once caught, is *used up*, so that the process has a limit. With carbon, however, a new situation appears. As worked out by Bethe, the first reaction is

$$C^{12}+H^1=N^{13}+\gamma$$

that is, a proton enters the carbon nucleus, producing a new nucleus of mass 13 and charge 7 (nitrogen). The energy corresponding to the loss in mass is liberated as a gamma-ray (γ). The nucleus N^{13} has been produced artificially, and is radio-active, emitting a positive electron, and dropping back to charge 6.

$$N^{13}=C^{13}+\varepsilon^+$$

Another proton builds this up into ordinary nitrogen

$$C^{13}+H^1=N^{14}+\gamma$$

and still another into an isotope of oxygen

$$N^{14}+H^1=O^{15}+\gamma$$

This, again, is a known artificial radioactive element.

$$O^{15}=N^{15}+\varepsilon^+$$

We might expect N^{15} to be built up into O^{16}—common oxygen—but Bethe gives good reasons for supposing that, except in perhaps one case in ten thousand, the product of the next collision will break up into two pieces, according to the

[1] For many heavier atoms, such as iron, there is a small "mass defect," but this does not concern us now.

equation

$$N^{15}+H^{1}=C^{12}+He^{4}.$$

One of these is a helium nucleus—and the other is the carbon with which we started. We have here a regenerative process. The carbon is not used up, but reappears at the end of the cycle, and the net result is that four protons have disappeared, and been replaced by one alpha-particle. The energy corresponding to the loss of mass is liberated in various ways—as gamma-rays, or as kinetic energy of motion of the ejected positive electron or alpha-particle; but these will quickly be converted into energy of heat-motion in the gas.

The positive electrons, by the way, will not last long. They will meet negative electrons, and, in this case (unlike whole atoms) the two may annihilate one another—liberating still more energy.

Finally, the rates at which all these reactions occur increase very rapidly with the temperature—but, at a given temperature, are always most rapid for the nuclei of smallest charge. Their actual amounts at a given temperature and density can be calculated in many cases from laboratory observations of the yield of the products under known conditions, and estimated in the others on the basis of a fairly extensive knowledge of the general properties of the nuclei.

Suppose now that we had a mass equal to the Sun's, containing (like the Sun) 35 percent of hydrogen, and all sorts of other elements. If it started with a very large diameter, its central temperature would be low, and none of the nuclear reactions would work. It would have to contract to keep shining, and so grow hotter inside.

WHEN the central temperature reached about 300,000 degrees (according to Bethe) hydrogen and deuterium would begin to interact, and by the time it had reached 400,000 degrees this reaction would supply enough heat to keep the star shining. The contraction would then almost cease until the deuterium was used up (not entirely, because, as it became exhausted, the temperature would have to rise a little to get enough heat out of the diminishing supply). When it was gone, contraction would ensue until, at about 2,000,000 degrees, lithium became available as "fuel" and called another halt. Beryllium would work at about 3,000,000 degrees, and the two isotopes of boron at five and nine. With all these possibilities, the star might keep going for a good while; but so far as we can determine from the study of the spectra of the Sun and the stars, all these light elements are rare; their total amount is but a very small fraction of the hydrogen.

When they were all gone, there would be more contraction till, at a temperature of 15,000,000 degrees, carbon began to be attacked. At first the carbon would be turned into nitrogen: but, at 18,000,000 degrees, this too would react. Bethe's cyclical process would then be in operation—the carbon would be regenerated, and act as a catalyst to turn more hydrogen into helium. This stage would continue so long as any hydrogen was left—that is, for very much longer than all the previous ones.

We should therefore expect to find the great majority of the stars in this situation—but how can we check this by observation? The test is very simple—the central temperature, calculated thus from

Hans Albrecht Bethe, professor of physics at Cornell University and originator of the notable theory

atomic theory, should agree with that derived from observations of the stars.

The rate of the carbon-chain reaction increases very rapidly with the temperature—about as its 18th power. Hence, in a star which radiated 100 times as much heat per unit of mass as the Sun does, the temperature would have to be only 14 percent higher (if the density were the same too). That is, most of the stars should have central temperatures of about 20 million degrees.

Now it has long been recognized that the stars of the main sequence—the most important of all groups—have all about the same internal temperature, and, when allowance is made for the hydrogen present, the temperature comes out close to 20,000,000 degrees. Even the differences between the bright white stars at the top of the sequence and the smaller and cooler ones like the Sun are represented by the theory. Bethe gives the following comparison (central temperatures in millions of degrees):

	Sun	Sirius	U Ophiuchi	Y Cygni
Theory	18.5	22	26	30
Observation	19	26	25	32

The theoretical values would be changed by a few percent by different assumptions as to the amounts of carbon and nitrogen present in the stars, and the observed values by different adopted "models" of internal density. But the conspicuous agreement could hardly be vitiated.

Here we reach the climax of the drama. Previously we could calculate, from the general properties of atoms, that a star of given mass and hydrogen content should be of a certain brightness. Now, from the properties of atomic nuclei, we can show that most stars of the given mass should also be of a certain diameter, and a corresponding surface temperature.

In other words, from the mere statement that there is a body having 330,000 times the Earth's mass, and containing 35 percent of hydrogen, we can predict that it will have the size, brightness and temperature of the Sun. We could do the same for Sirius, and for innumerable other stars. The Main Sequence is theoretically explained.

This is the most notable achievement of theoretical astrophysics since the establishment of the relation between mass and luminosity, and deserves all the credit that can be given it.

Certain consequences of Bethe's theory may be briefly discussed in closing.

Nuclear reactions involving heavier atoms—for example, building up oxygen into fluorine—are quite possible; but they would work at an appreciable rate only at higher temperatures than the carbon cycle, and so would not have a chance to happen in the stars. Bethe and Gamow have given a great deal of attention to the question whether side-reactions, which happen to only a small percentage of the nuclei in a star, may build up heavier atoms, but have found every road blocked. There is at present no explanation how such elements as sodium, calcium and iron can have been formed. We must assume that they are "older than the stars" and for the present let it go at that.

THE history of a star, after the carbon cycle is at work, appears to be fairly clear. As it gradually uses up its hydrogen, it must get brighter—and expand a little, to keep its central temperature from rising too rapidly. After a very long time (Bethe calculates 12 billion years for the Sun) the hydrogen will become exhausted, the star will once more contract and draw upon gravity. Stars of small mass will end up as white dwarfs; those of large mass will shrink still more.

Finally, the giant stars are not yet accounted for. Their central temperatures must be far too low to "turn on" the carbon cycle—unless they are built internally upon a very different model with very high central condensation. This may be true: or they may contain large quantities of light atoms, and be consuming these; or perhaps they draw upon some energy-liberating process which has not yet been duplicated in the laboratory. We must at the moment rest uncertain—and the students of the stars have still something to work out.—*Princeton University Observatory, April 5, 1939.*

RUBBER'S 'LITTLE BROTHER'

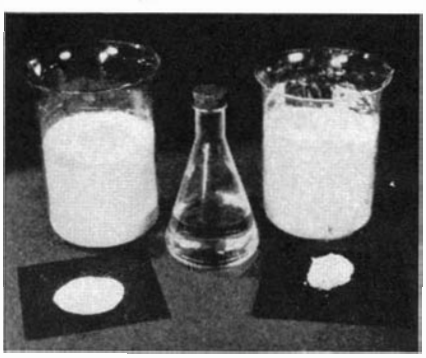
Rubber-Like Material . . . Koroseal . . . Made of Limestone, Coke, Salt . . . Superior to Rubber in Several Ways . . . Not Yet Adapted to Automobile Tires

By FLORIAN E. WOOD

AMERICANS have become so accustomed to newspaper headlines proclaiming another minor miracle in science that it requires an outstanding achievement nowadays to make them pause and take notice.

Such an achievement has come out of the laboratory of the oldest rubber company in the middle west where scientists have brought into the world a synthetic material so closely akin to rubber that it is being called rubber's "little brother." The new substance is Koroseal, and, significantly, its wonders can be introduced to the world on the one-hundredth anniversary of the discovery, by Charles Goodyear over his Massachusetts kitchen stove, of the process for vulcanizing rubber.

Koroseal is not a synthetic rubber, its scientific god-parents are careful to point out, for no true synthetic rubber exists



Purified basic ingredients of the new material. Limestone, coke and salt are so common that only factory conditions can limit production

in the world today, although there are other rubber substitutes. Scientists have been searching for decades for the secret of nature that would enable them to manufacture rubber cheaply in the test tube, but the quest has been catalogued with such "impossibles" as the philosopher's stone. Yet Koroseal, its discoverers confide, has many of the qualities a synthetic rubber should possess and is, in fact, better in some respects than natural rubber. It is made from such common substances as limestone, coke, and salt.

This new chemical compound opens up a vast new field of utility because it has proved its ability to operate in places where rubber never could perform. It is adaptable to varied uses, and in a variety of forms ranging from the fire-resisting coating on power transmission cables to lining in hot acid tanks and the fine-textured clothing in milady's wardrobe.

Since natural rubber is an indispensable product in daily life, and, therefore, a vital commodity in war-time, the discovery of Koroseal is highly significant as nations rush ahead with armaments. In the United States, a number of rubber-like synthetics have been developed since the World War, but the total annual commercial consumption of the artificial products has amounted to only about 1 percent of that of rubber. Nevertheless, such scientific strides have been made with these synthetics that the price of one artificial rubber product has been lowered from $1.05 to 65 cents a pound, while natural rubber hovers currently about the 15-cent mark.

Some American chemists have been bold enough to predict, in the light of rapid developments in the synthetic rubber field, that the rubber industry could make the United States independent of the need for natural rubber in one year with a sizable expenditure for equipment to manufacture Koroseal and other synthetic, rubber-like products. They point out that it required much larger sums and many years longer to bring natural rubber to a point of wide utility.

Significantly, scientists point out that it would require an acre of rubber trees 17,520,000 hours, or 2000 years, to produce the same amount of natural rubber which could be turned out synthetically in *one hour* by a laboratory only one acre in area. This fact alone dramatically illustrates the importance of any synthetic material which possesses qualities that would enable science and industry to substitute it in services where natural rubber long has functioned. For in commercial use today, rubber is the vital sinew of more than 32,000 varied products, most of which are indispensable to every-day life.

This elaborate gown, prize-winner at America's first Rubber Ball, was fashioned of Koroseal

MANY "first cousins" of rubber have bobbed up in the laboratory, but only in very recent years have products been discovered and developed which, in addition to having rubber-like physical properties, are so chemically constituted that in many special cases they will outserve rubber. For example, acids that chew the life out of every metal except the "noble metals," and devour stone or glass with equal ease, leave Koroseal unblemished. Oils that permeate the pores of many substances, including rubber, and cause them to swell, soften, and disintegrate, practice their wiles in vain on Koroseal. Oxygen, great leveller of flesh, wood, and iron, won't leave a smudge on its face; and in resistance to water, a duck's back is no better, by comparison.

Koroseal's sire is a corrosive gas and its dam a colorless flammable gas. The factor which gives Koroseal an edge over rubber is its immunity to ozone, rays of the sun, and oil—all deadly enemies of natural rubber. How-

OF the mis-called "synthetic rubbers" commercially available today, only one is dealt with specifically in the accompanying article. There are, in fact, three important synthetics in this class; the following paragraphs summarize their characteristics and detail the uses to which industry is putting them:

Koroseal products are resistant to moisture, oxygen, ozone, strong acids and alkalies, and most corrosive chemicals. Typical applications are wire and cable insulation and sheathing, textile roll covering, tank lining, pipe covering, coating for plating racks, chemically-resistant tubing, impregnated fabrics.

Neoprene is used primarily because of its resistance (1) to swelling in oil and gasoline, (2) to cracking in sunlight, (3) to deterioration under oxidizing conditions, and (4) to softening at fairly high temperatures. It finds application in curb pump gasoline hose, crude oil hose, distillate hose, automotive goods such as gaskets and vibration insulators, printing plates and rollers, oil resisting transmission and conveyor belts, oil resisting packing, and the like.

Thiokol products are noted for their resistance to solvents, lacquers, gasoline, and oils; their resistance to sunlight and ozone; and their low permeability to gases. Principal uses are lacquer hose, crude oil hose, curb pump gasoline hose, ignition cable coverings, oil-proof extension cord, impregnated paper gaskets, and printing plates.—*The Editor.*

ever, scientists still face several problems in connection with Koroseal. There is, for example, the problem of resiliency, where Koroseal lacks characteristics of rubber. Then, too, while Koroseal can adapt itself to temperature ranges from minus 40 degrees, Fahrenheit, to plus 150, Fahrenheit, research experts hope to increase this range and to change some of its present characteristics so that it will maintain a more stable consistency under temperature changes.

The peculiar difficulty of Koroseal to react favorably under wide variances of temperature makes it unadaptable, at present, to automobile tires. Likewise, it cannot function under conditions where abrasion is encountered at high temperatures, although at low temperatures Koroseal can withstand abrasion very well. With the objective of effecting these improvements, a staff of 20 technical experts is at work in the laboratory of The B. F. Goodrich Company, where the synthetic was discovered, to overcome its disadvantages.

The new material so nearly resembles rubber that it may be worked on rubber machinery

Koroseal made its first commercial appearance quite inauspiciously to rid electro-plating of one of its greatest handicaps since that industry's inception. Some metal racks on which were suspended objects to be plated in electrolytic baths were found to absorb more metal than the products plated. Koroseal's peculiar resistance to plating solutions made it highly satisfactory for insulating these racks. It has found its way into the steel industry as a lining for pickling vats, and it is the only material so far discovered that defies the hot acids which are used in the pickling of stainless steel. Recently, petroleum engineers in the west discovered that the great underground network of pipes which transports oil many miles from field to reservoir was being destroyed by salts of the earth acting upon the metal. Koroseal came to the rescue, supplying a protective coating similar to the pickling vat lining.

Transparent Koroseal is superior to any other flexible material in resisting the diffusion of certain toxic gases which might be used in wartime. The psychological effect of a transparent Koroseal gas mask is said by scientists to lift the soldier's morale 100 percent. Another possible war use for Koroseal is its application to soldiers' uniforms, by coating or impregnation, to prevent mustard gas wounds. During the World War, thousands of soldiers received life-time wounds from this vicious gas, one of the most difficult to combat on the battlefield. Koroseal is three times more effective than rubber in resisting mustard gas.

It is evident that this new synthetic has boundless possibilities in the fields of transportation, communication, and heavy industry, as well as in countless varieties of products, including wearing apparel. It can be poured, molded, or cut, coated, painted, impregnated, or laminated. It can be firmly attached to metal, fabric, or even to natural rubber.

BECAUSE Koroseal can be made jelly-soft or bone-hard, it has an extreme range of utility. The soft form, Korogel, was one of the first products sold commercially; it was found highly satisfactory for making flexible molds from which plaster reproductions of art objects could be turned out with great facility. Koroseal's indifference to oil has made it possible to create molded parts for hydraulic shock absorbers and for gaskets, cups, or plungers which must withstand oil or grease. The laboratory has practically completed the development of a form of Koroseal for use as a container material for liquids, such as acids and oils, which cannot otherwise be marketed without considerable packaging expense.

Since it is waterproof, sun-resisting, and heat-repelling, Koroseal is especially adaptable to the home for table coverings, wall paper, draperies, shower curtains, covering for outdoor furniture, and a horde of other uses. It can be utilized as a transparent coating or readily takes colors ranging from the brightest hues to the mistiest pastels. Brightly colored printed linens, silks, and other fabrics, impregnated with Koroseal, are being turned into attractive rainy day garments

Koroseal: after processing, as extruded tubing, and in film form

for sports, every-day wear, and for evening finery.

Indeed, this child of the test tube takes its place alongside such notable discoveries in the rubber industry as vulcanization, acceleration, reclamation, the pneumatic automobile tire, the airplane tire, the airplane de-icer, and other marvels of this age of chemical transformation. And although the search for nature's secret has not ended, scientists proclaim that this wonder baby is destined to extend widely the field of usefulness of artificial rubber-like materials.

RELATIVITY— 20 YEARS

An Evaluation of the Achievements of the Special and General Theories of Relativity During the 20 Years which Have Elapsed since the First Direct Observational Test of the General Theory

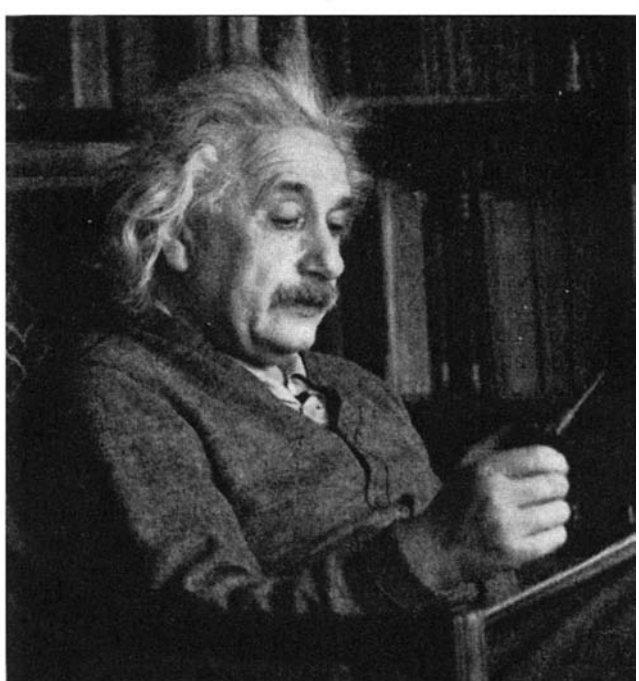
By H. P. ROBERTSON, Ph.D.
Professor of Mathematical Physics, Princeton University

(*Part Two*)

The General Theory

TURNING to the general theory of relativity, whose most distinguishing feature is its theory of gravitation, we find a very different situation from the one described last month with regard to the special theory. While generally acclaimed as one of the most important achievements of modern thought, its restricted field of application has severed it from contact with the most vital advances of present-day physics. Although both theories have been the target of hosts of irresponsible fanatics, the aloofness of the general theory has made possible attacks on it by a few presumably responsible scientists—even though it has, by and large, received general acceptance because of the few observational effects which it predicts, and general admiration as a monumental accomplishment of the human mind. In evaluating it we must be careful to seek the open way between the Scylla of blind *a priori* acceptance and the Charybdis of neglect engendered by the myopic view of the more extreme pragmatic cults.

In developing the general relativity theory of gravitation, Einstein took his cue from the empirical fact that the mass of a body, which is a measure of its ability to resist change of motion, is at the same time a measure of its ability to attract other bodies. This equivalence of "inertial" and "gravitational" mass is now attributed to the fact that in the general theory they are but two different aspects of one and the same thing—which we may, with suitable caution, take as a measure of the "curvature" of the physical space-time continuum. This geometrization supplants the Newtonian law of gravitation, to which it is equivalent in the first approximation, but its astronomical predictions differ from the classical ones in certain extremely minute details, the principal ones being the advance of the perihelion of Mercury, the bending of light passing the Sun, and the shift toward the red of light from massive bodies. In spite of the relative insignificance of these effects in the broader scheme of things, and in part because of the difficulties encountered in verifying them, there has been an unfortunate tendency to magnify their importance as crucial experiments, ignoring the more fundamental and most accurately verified cornerstone of the theory—the above-mentioned identity of gravitational and inertial mass.



Taken especially for Scientific American by Betty Menzies

Professor Einstein seated in his comfortable old reading chair in the study of his modest, old-fashioned home, smoking one of his pet pipes as he reads. Three walls of the study are lined from floor to ceiling with books and periodicals. The fourth is a large plate glass window

Even so, these three astronomical consequences have given a good account of themselves since their enunciation two decades ago, and in each case have lent weight to the theory, for even in those observations which fail to reveal decisively the predicted effects, the results are less discrepant with relativity than with classical theory. The question of the advance of Mercury's perihelion can now be answered in the affirmative more firmly than at the beginning of this period; its severest critics have never been able to establish their case against it, and the improved orbit announced by K. P. Williams of Indiana last year is completely consistent with the predicted advance. The bending of light from stars at the limb of the Sun, perhaps technically the most difficult of verification, seemed for a time reasonably established from the plates obtained during the 1919 and 1922 eclipses, which yield an average deviation but 2 percent greater than the value 1″.75 predicted by the theory for a star seen just past the limb of the Sun. But Freundlich and collaborators in Potsdam, on working up plates obtained during the 1929 eclipse, were led to a deviation of 2″.25 and, although an independent reduction made by Trumpler of California led to the predicted value, the original authors attributed this to arbitrariness in the reduction of the observations. In any case, the evidence is clearly in favor of the Einstein effect as opposed to the smaller value of 0″.87 expected on the Newtonian theory; future eclipse plates may be expected to yield a more definitive quantitative check on the theory.

The third test, the shift of spectral lines toward the red in light from massive bodies, is so small in the case of the Sun—a shift of the order of one one-hundredth of an Angstrom—that its existence is most difficult to establish. St. John of Mt. Wilson announced tentatively in 1923 that the residuals, after allowing for known effects such as the Doppler shift, were more consistent with the relativistic than with the classical theory; such is also the conclusion of the recent excellent work of the English astronomer Ever-

AFTER

shed on the problem. An unexpected test of this effect was furnished by Adams of Mt. Wilson in 1925, when he found that the companion of Sirius, a white dwarf, showed a residual red-shift 30 times as great as that expected from the Sun. Now the mass of the star is known, from the orbit, to be about 85 percent of that of the Sun, and the theory of these stars indicates that its radius should be between 2½ percent and 3 percent of the Sun's radius; the shift predicted by the theory for such a star is, to within the errors attendant upon such work, just that observed. This may be considered a most valuable indirect confirmation of the theory of relativity—or of the theory of dwarf stars, whichever is considered the more doubtful! It is often remarked that this effect is also a consequence of the photon theory of light, the shift being due to loss of energy by the light-quant in escaping from the gravitational field; this derivation is, however, dependent on the general theory of relativity, as it assumes the identity of inertial and gravitational mass for light.

WE turn now to the cosmological problem, and the speculative attempts to answer questions concerning the geometry and physics of the space-time universe as a whole. The general theory of relativity attributes local irregularities in the geometry—that is, local gravitational fields—to irregularities in the distribution of matter; thus the 4-dimensional geometry of the neighborhood of the Sun is such as to cause a planet to pursue what we, with our traditional ways of thinking, would express as a curved orbit described under the action of the Sun's gravitational field. This raises the question of what the geometry of the observable universe might be if we were to ignore these irregularities due to the agglomeration of matter into stars or systems of stars—that is, what the world-geometry would be if all matter were considered as more or less uniformly distributed in space. The first attempt to answer this question is that given by Einstein in 1918; on assuming that the mean density of all matter in the universe is a constant throughout space *and for all time*, he arrived at the view that space is closed—the 3-dimensional analogue of the 2-dimensional surface of a sphere—and that, accordingly, the total amount of matter in the universe is finite. The curvature of space, which is measured by the inverse square of its radius, would depend, and in a sense be due to, the total amount of the matter contained in the world. In order to obtain this solution, representing the world as on the whole static—the distance between any two nebulae remaining constant except for fluctuations which would iron out in the long run—it was necessary to introduce more or less arbitrarily a certain constant. The introduction of this "cosmological constant" λ is a freedom allowed by the form of the fundamental equations of the theory of gravitation, but one which is unfortunately subject to no direct observational check. Although on the hypothesis of the "Einstein universe" λ can be indirectly determined from the total amount of matter, this is an interpretation which is not valid in the more general solutions of the problem which are to be considered below.

Prof. R. C. Tolman, physical chemist, mathematical physicist and dean of the Graduate School at the California Institute of Technology, one of whose special interests in the world of science is relativistic cosmology

The great Dutch astronomer de Sitter seized upon the possibility opened by the introduction of λ to consider a universe in which the curvature is due *entirely* to the unknown constant, and in which the total amount of matter is so small as to have but a negligible effect on the curvature. But, in attempting to apply these hypothetical models to the explanation of large-scale phenomena in the actual world, both met with little success. In the first place, a most surprising effect was slowly coming to light through observations on the spiral nebulae, those great systems of stars, analogous to our own Milky Way system, distributed more or less at random throughout the observable universe. For they were found, almost without exception, to be receding from our galaxy—or, at least, their spectra exhibited a shift toward the red of exactly the same kind as that which would be caused by a motion of recession along the line of sight. And further, the more faint the nebula, and therefore presumably the more distant, the greater was the velocity of recession. This was a phenomenon utterly inexplicable in terms of the Einstein universe, and although it could be accounted for in terms of the de Sitter model, the amount of matter contained in the nebulae was found to be far too great to be considered as having a negligible effect on the geometrical structure of the universe.

Under these circumstances it seemed most natural to seek an intermediate solution, which could explain the existence and nature of this recession, but in which the effect of the matter was adequately taken into account. A family of possible solutions—actually, as it turned out later, the most general—was found by the late Russian mathematician A. Friedmann, in 1922, and has since been the subject of exhaustive investigations by Lemaître of Louvain, Tolman of Pasadena, the present author, and a host of others. Among the multitude of special cases contained in this most general solution were some in which λ was positive and space finite (at present the most favored), others in which λ could be set equal to zero and space taken either as finite or Euclidean, and still others (including all those for which λ is negative) in which the "radius" of the universe oscillates between a fixed maximum value and a very small minimum. The principal problem was then the determination of just which of these models would best fit the actual observations—that is, which choice of λ and the curvature would give a model which best reproduced the large-scale phenomena of the actual observable universe.

THE observations which were available for this selection, say in 1933, yielded two of the required empirical data—the red-shift constant and an estimate of the density of smoothed-out matter. The former was obtained from the work of Hubble and Humason of Mt. Wilson, according to which the red-shift of nebulae increases 550 kilometers per second with every million parsecs of distance, and the second was obtained from Hubble's estimates of the mass of an average nebula and the mean distance between them. But unfortunately these two important results were not enough, for they alone were too weak to single out a

unique solution—which accounts for the great variety of models consistent with these data with which we were bombarded at about this time. But all these solutions had one surprising feature in common; they all indicated that the present expansion could have gone on for at most a very few thousand million years, not much more than the age of the Earth as obtained by studies on the radio-activity

The Canon Georges Lemâitre, of the University of Louvain, one of the first to study the red shift

of the oldest geological strata! Although such a limited time would be difficult to reconcile with most of the theories of stellar evolution, there were nevertheless other observations which seemed also to indicate a comparable age for the solar system and the galaxy; many astronomers accordingly reconciled themselves tentatively to this "short time scale."

More recently another survey, again by Hubble, promised to supply the data needed to narrow down the selection of possible models. This consisted in counts of the number of nebulae in selected regions whose apparent magnitudes were less than certain limiting magnitudes; five such counts, ranging from magnitudes 18.5 to 21.0, were obtained. These may be thought of as giving the number of nebulae within a certain limiting distance of the observer. A little reflection on the nature of the surface of a sphere will make it clear that, in the three-dimensional analogue under consideration, the law of increase of these numbers should theoretically depend on the *curvature* of space; if their dependence is sufficiently marked, it should be practicable to obtain the curvature from these observations. Now the rate of increase of nebulae with distance, from these data, is different from that in a Euclidean space, the discrepancies being so large that if they are due to the proposed effect, the curvature must be surprisingly large. In fact, so large that the only model which fits both it and the red-shift data has a most uncomfortably small "radius" (470,000,000 light-years) and a still more limited time scale—less than a 1,000,000,000 years; no compelling way of reconciling this latter with the geological time scale has yet been suggested. But this is not the only trouble, for the mean density of matter in such a model exceeds that contained as luminous matter in the nebulae by a thousand-fold and, although it is conceivable that the universe contains this much dark matter, we have as yet no independent justification for assuming that it does.

TWO alternatives for escaping from these uncomfortable conclusions are at hand. First, the assumption of uniform density may not be a sufficiently valid approximation for the nebular counts, as relatively small fluctuations in the density of nebulae in the survey regions would be sufficient to account for the discrepancy without the introduction of such a marked curvative effect; this possibility has been suggested by Shapley of Harvard, who has recently published data in support of it from a survey of nebulae in the southern hemisphere. Decision on this question must presumably await further data—we may hope that it can be decided one way or the other with the aid of the 200-inch reflector now under construction at the California Institute of Technology. The other possible way out is to seek some effect hitherto unnoticed —perhaps to assume that the red-shift is due to a degradation of energy in light traveling great distances, and not to the effects of motion away from us. Although many such *ad hoc* explanations have been offered, it is contrary to respectable scientific methodology to accept any of them until they are supported by some independent verification.

The search for a unified field theory, which will geometrize electromagnetism in a way analogous to that in which the general theory treats gravitation, has not been successful. The most promising of these was that of Weyl, at that time in Zurich, but it too had to be surrendered; his fundamental principle of "gauge-invariance" has, however, been incorporated into modern quantum theory, where it promises to be an important tool for a future quantum electrodynamics. It has been found possible to give a *mathematically* unified treatment of electricity and gravitation by the use of a fifth dimension, as in the theories of Kaluza of Göttingen, Klein of Stockholm, and Veblen and Einstein of the Institute for Advanced Study, but this has not in itself materially furthered the physical problem. No attempt has been made to review here the status of Milne's weird cosmological theory, nor of Eddington's unholy union of quantum and relativity theories; these theories have been attacked as representing a return to the outmoded Aristotelian method in science—the attempt to derive natural law from *a priori* principles. It would therefore seem that, although at least the latter claims to have solved many of the really outstanding problems of physics, the acceptance of the methods by which the solutions have been obtained would represent a backward step.

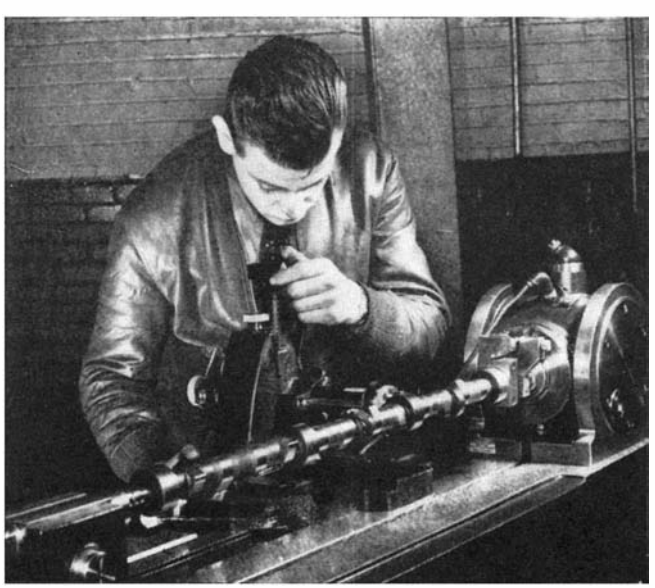
In conclusion, the past 20 years have seen the special theory of relativity more and more firmly established as one of the most important and useful fields of modern physics, without which much of the modern work on atomic and nuclear structure would have been materially curtailed, if not impossible. On the other hand, the general theory has had but little contact with the advancing front of physical science; its theory of gravitation has been successful in the limited range of astronomical phenomena in which it differs from the Newtonian, but its most important achievement has been the establishment of the identity of inertial and gravitational mass — an achievement which may be expected to grow in importance with the advent of some adequate theory of the ultimate constituents of matter, even though it may at the same time suffer radical modification. The rise or fall of its cosmological offshoot, the theory of the expanding universe, can be expected to have but little effect on the general theory; as long as the theory of gravitation is accepted, any attempt to approximate the real world in terms of a homogeneous background must utilize one of the models with which relativistic cosmology is concerned—even though it would constitute an awkward anticlimax if it turned out that the red-shift were due to some agency at present unknown rather than to the expansion, to which these models seem so admirably adapted!

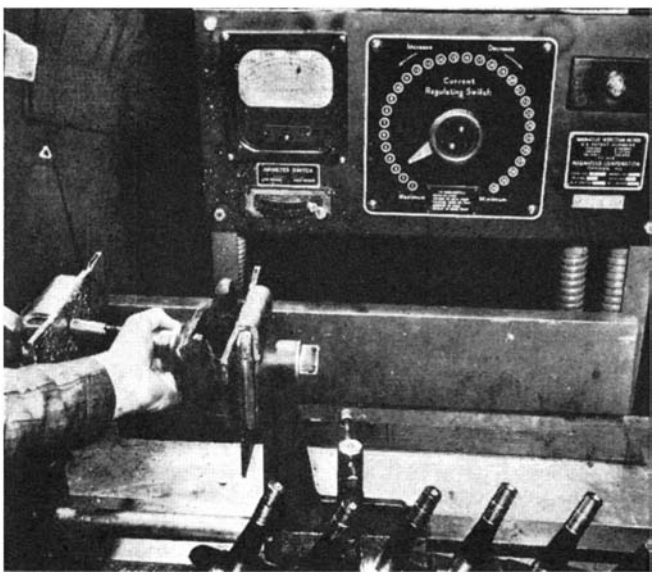
Dr. Edwin P. Hubble, Mount Wilson astronomer, who has contributed invaluable data on the red shift

Looking For Trouble

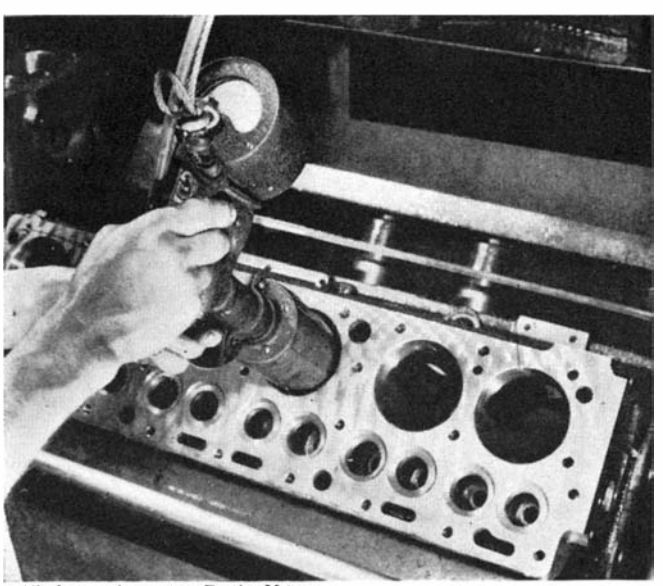
Chromium plated gadgets and super-streamlining will sell an automobile, but to keep it sold without complaints is the reason why manufacturers maintain elaborate inspection equipment. For example: at the right is shown one of the tests employed by one motor-car maker. Steering knuckles are being magnetized prior to inspection for forging flaws. Any minute flaw behaves like a magnet and is discovered when the knuckle is dipped into a suspension of iron filings in kerosene

The illustration at the right shows an electrical thickness gage which is being used to "caliper" the engine walls. It contains coils which create a magnetic field in the walls. The gage above measures the field strength; the scale has graduations that indicate cylinder wall thickness in 64ths of an inch





One of the most accurate and exacting jobs is that of fitting piston pins to pistons. This is a function of the inspection department. The illustration at the left shows a hydraulic fixture for inserting pins. The gage indicates the pressure required to force the pin into place. Tolerance limits are marked on the dial; piston is rejected if too much or too little pressure is used



All photographs courtesy Pontiac Motors

Not only is the inspection department responsible for the materials and parts which go into the automobile; it must check all master parts. At the left is shown one of the most precise inspection instruments; a cam checking fixture. Here it is being used to check the contour of all surfaces of one of the master cams that are used to control one manufacturer's camshaft production. Also, it is used in starting the production of a new model, for by means of this instrument it can be determined exactly what part of any surface is inaccurate. The micrometer scales are graduated to 0.00005 of an inch

THE GREAT AMERICAN RITE

What Many Doctors Think About the Too Casual and Routine Removal of Tonsils . . . The Public is Partly to Blame . . . Are Tonsils Useful?

By T. SWANN HARDING

WRITING in *Minnesota Medicine* for September, 1931, a doctor actually used this title: "The American Rite—Tonsillectomy." He was in a mood of penitence. He held that the operation was rarely performed on adults without full and sufficient reason, because they were big enough to fight back. But children were deprived of tonsils ruthlessly and often unnecessarily.

Broadly speaking, said this physician, tonsils should be removed if they are greatly enlarged and amount to throat obstruction; if they are the seat of prolonged inflammatory disease; also if they can be proved to secrete poisons—which brings up the theory of focal infection. Many children lose perfectly good tonsils which have swollen only temporarily while waging defensive warfare against infection, a congestion that can recur without permanent enlargement. The tonsils of infants should seldom or never be removed—that's what the Minnesota doctor said, take it or leave it.

The British journal, *The Medical Officer*, has also commented on the recent fashion of tonsil removal. In October, 1932, it remarked that a mere temporarily enlarged tonsil did not merit removal, and that it was impossible to divide tonsils into septic and nonseptic. Indeed, it said, we really have no way of settling whether they should or should not be taken out. In October, 1938, it was even more emphatic. A Dr. J. Alison Glover had just presented to the Royal Society of Medicine "strange facts" to speak for themselves. From 1929 to 1931 almost four percent of the children in Derbyshire had had their tonsils removed, but in 1933 the number had dropped to one tenth—yet there was no deterioration in child health. In two neighboring districts in London the respective removal rates were four percent and two tenths of one percent, without discernible differences in the health records of the children.

True, the idea that tonsils should go is an old one. Hindu physicians have removed them for ages—at least as early as 1000 B.C., but the theory of "focal infection," as it is known today, stemmed from articles by Dr. Frank Billings published between 1912 and 1914. In them, Billings ascribed arthritis, nephritis, and later a wide variety of ailments to infected teeth. In his Lane Memorial Lecture in 1915, Dr. Billings defined a focus of infection as a circumscribed area of tissue infected with pathogenic microorganisms that could spread not only to contiguous parts but to parts of the body not nearby at all. As such foci of infection, he cited particularly tonsil abscesses, chronic sinus infection, gallbladder and appendix infections, and bad teeth. E. C. Rosenow and others further developed his theory mainly by work on animals.

In 1938, Dr. David Riesman began to speculate as to whether painless, decayed teeth also might not cause ailments elsewhere in the body. Nor is there anything wrong with this theory, within strict scientific limitations. When it can be proved that a focus of infection definitely is causing disease elsewhere in the body, the focus—tonsil, teeth, gallbladder, appendix—should be removed. Often, however, the removal takes place in the absence of good evidence to indicate that the result will be good. And so many "preventive" removals do not act preventively. Too often the operation has not good, but bad, after-effects.

CONSIDER bad teeth. In *The Journal of the American Medical Association* as long ago as October, 1919, you will find an article by Dr. Walter C. Alvarez entitled "A Protest Against Reckless Extraction of Teeth" which is as true today as it was then. Too often removal of the teeth or of any other supposed focus of infection has no beneficial effect upon the patient's health. "In view of the fact that the most thorough removal of focal infections often fails to cure arthritis and other diseases, let us be more honest and conservative with our patients," wrote Dr. Alvarez.

In the same journal, in May, 1923, the same doctor wrote on "Lessons to Be Learned from the Results of Tonsillectomies in Adult Life." He demonstrated, after following up more than 300 cases, that the resultant improvement in health supposed to follow the tonsil amputation often did not occur. Those who had tonsillitis were almost always helped, but those who had no sore throat or tonsillitis were rarely pleased with the result of their operation. It paid best to remove tonsils for tonsillitis or sore throat. It paid less well to remove them for frequent colds. It did not pay at all to remove them on general principles, as a preventive measure in the hope of helping headaches, deafness, enlarged neck glands, rheumatism, halitosis, and so on. In many such cases health became definitely worse after that operation than before. In two thirds of the rheumatism cases there was no benefit.

In many cases, Dr. Alvarez continued, repeated operations had been undergone because certain physicians attributed symptoms to tonsil fragments left behind by others. Some had had three and four operations with no benefit. Many had had tonsils removed for most trivial reasons. Another man decided to have his tonsils out because of one mild attack of constipation. He nearly died of pneumonia following the operation. Two others succumbed to the temptation because they had physicians as personal friends who would operate gratis. Another had his removed because he blinked his eyes; he still blinked after his tonsils were subtracted. Another thought the operation would cure his insomnia. As a whole, nearly one in ten victims of tonsillectomy had bad results.

Some nearly bled to death in the operation or died of pneumonia afterward. Some had recurrent bronchitis, difficulty in swallowing, odd feelings in the throat, loss in weight, nervous breakdowns, increased frequency of colds, sinusitis, ear noises, or no relief from the original symptoms leading to the operation.

It should be emphasized that, according to an editorial in our leading medical journal in 1926, both tonsil operations and mass extractions of teeth ought to be classified as major operations. Broncho-pneumonia and lung abscesses can and often do follow tonsillectomies under ether. Very severe and sometimes fatal complications have also followed an occasional tooth extraction. Tonsillectomy under a local anesthetic is relatively safe. In other words, these are operations that should be undertaken only when the indications clearly justify such drastic procedure.

In short, the entire literature on tonsillectomy is convincingly consistent in showing that too many tonsils are sacri-

ficed and the expected beneficial results too rarely occur.

Go back to 1927. In *The Journal of the American Medical Association* for December 24, you will find Dr. Albert J. Welch giving a statistical report on 1000 pairs of tonsils excised. In nearly half the cases no benefit to health resulted. Bacterial studies were futile because any organism having access to the mouth—and that means myriads—can be shown to be present in the tonsils. Only four bad infective or malignant lesions were found in the lot. Only 70 showed ulceration.

In 1928, a Public Health Bulletin, No. 175, appeared and the work of Dr. Kaiser of Rochester was also being discussed. Kaiser found that tonsil removals did nothing to remedy rheumatism, chorea, or heart defects in children but did reduce sore throats and head colds. The Public Health Service bulletin indicated that tonsillectomy did not reduce the frequency of sore throat among children. But it added that the words "normal," "diseased," and "enlarged," as applied to tonsils, were meaningless because so differently interpreted by different people.

IN the December, 1928, *American Heart Journal* you will find a report on 413 tonsillectomies which had no effect on rheumatic infection. Neither were they beneficial in heart disease.

In the *Archives of Internal Medicine* for April, 1931, Dr. Ruby L. Cunningham discussed "Normal, Absent, and Pathologic Tonsils in Young Women," making a most careful study of the entire literature on this subject. She showed that all sorts of unproved hypotheses were held on the basis of poorly controlled and interpreted clinical observations. Careful statistical studies were made of 12,530 white female students, one third each with normal, absent, or diseased tonsils. The incidence of measles, mumps, chickenpox, whooping cough, scarlet fever, diphtheria, pneumonia, pleurisy, chronic colds, chorea, appendicitis operations, mastoiditis, and nasal operations was the same among the normals as among those with diseased tonsils. The group with absent tonsils actually had a higher incidence of all illnesses and operations than did either the normal or pathologic groups. Indications were that the removal of tonsils had had little helpful effect.

"A review of the literature relative to the effect of the condition of the tonsils on general health reveals a great lack of accurate information on the effect of tonsillectomy, when one considers the number of operations that have been performed," said Dr. Cunningham. Opinions were widely variant. But, even at that time, there was a sharply growing sentiment against taking the tonsils out for preventive or prophylactic reasons.

The trend of these investigations shows an unvarying consistency. We shall note but two more of them. Glover and Wilson reported in *The British Medical Journal* in September, 1932, on the end results of removing tonsils and adenoids from adolescents and, in general, found that they did not justify the great number of such operations. The incidence of sore throat might thus be slightly diminished, but colds were just as frequent, otitis, mastoid disease, bronchitis, and pneumonia also. No one could claim that

A doctor must be a hero to fight off some who shop for operations

the operation helped in acute rheumatic or heart ailments. The conclusions of Dr. Cunningham (above) were considered fully supported and "a large proportion of the tonsillectomies now done in children are unnecessary, entail some risk, and give little or no return."

Finally, in *The American Journal of the Diseases of Children*, for August 1932, will be found reports showing that the removal of the tonsils affects neither susceptibility to diphtheria nor the incidence of scarlet fever. Meanwhile there is always a possibility that the tonsils actually perform some useful function, as Dr. Ivor Griffiths of London suggested in *The Lancet* for September 25, 1937. In some cases, said Dr. Griffiths, treatment of the sinuses would give the relief expected from tonsil removal. Removal of tonsils does not improve cases of middle ear disease, nasal catarrh, or acute explosive snoring. He then propounded the theory that the function of the tonsils was to excrete into the pharynx certain organisms that pass into them from the sinuses *via* the lymphatic glands. Hence tonsils should never be removed for nasal catarrh. Various experiments on dogs were offered in evidence. Dyes did pass into the tonsils via the lymphatics. Moreover, Dr. Griffiths did not think the helpful results commonly attributed to tonsillectomy usually occurred as hopefully predicted. He found discharging ears and mastoid disease in many of 5000 tonsil-less children. He held that many objectionable living bacteria are routed to the tonsils to be excreted into the alimentary tract for destruction. Hence it appears probable that tonsils are of some use. They may not only perform regular lymphatic functions, but they have this special bacteria-destroying function also (such is this theory) because of their anatomical position. And, advertising to the contrary notwithstanding, it should be emphasized that germs swallowed are rapidly destroyed by the stomach acid and the intestinal juices. Infection via the oral route cannot so easily occur, nor is gargling a very effective preventive measure.

Despite all this mass of evidence, discarded teeth continue to rain into the dentist's garbage pail and discarded tonsils to make flames roar in the hospital incinerator.

What, then, may we conclude to be constructive with regard to tonsils?

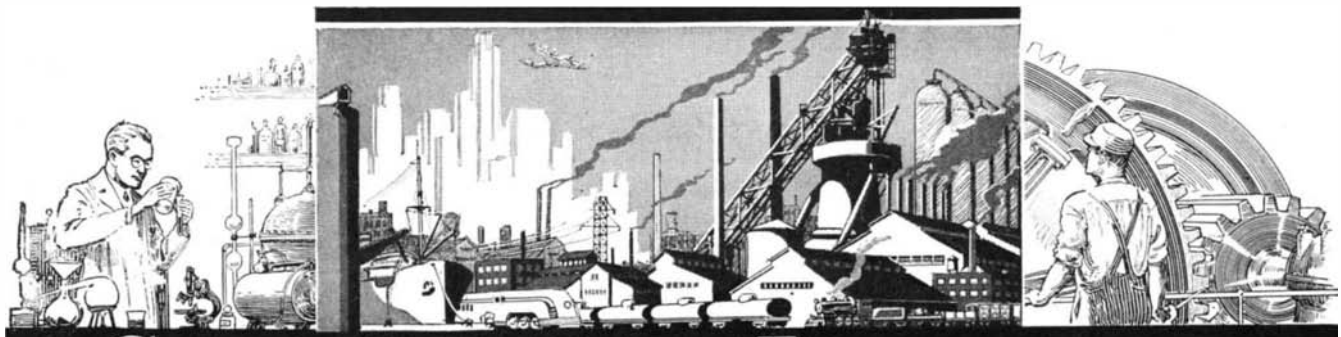
An editorial in the *Journal of Laboratory and Clinical Medicine* for May, 1933, said essentially that doctors should not regard the discovery of infected tonsils as sufficient cause to neglect the rest of a complete physical examination. Bad tonsils are potential factors in producing generalized diseases and infections far from their site, but people should not be led to expect miracles from tonsillectomies.

The removal of tonsils does tend to decrease the recurrence of sore throat, but you can have sore throat without tonsils, and many do. Respiratory infections and most other ailments are about as frequent after as before the operation. Anyway, it takes about ten years fully to demonstrate benefit from the operation in case of serious ailments.

THE removal of tonsils under ether should be regarded as a major operation, always undertaken in the light of its possible hazards and never in the lack of complete justification. Laymen should stop shopping around among doctors, as so many of them do now, trying to persuade them to do an unnecessary tonsillectomy.

Undoubtedly the operation, when its need is properly indicated, can be very beneficial. It is frequently advisable in children but is rather rarely of real value to older people. It is doubtful whether the removal of a focus of infection has a particle of influence on dozens of diseases for which it is done. Practical help occurs oftenest in arthritis, but in case of older people this is too often like locking the barn 50 or 60 years after the horse was stolen.

A person having a lot of tonsillitis and sore throat gets definite benefit from the operation; a person with none gets none. That, according to one of the best informed doctors the writer knows, is the most important thing to remember in connection with tonsillectomy.



SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
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D. H. KILLEFFER
Chemical Engineer

The Screen of Television

THE heart of the television set, the "screen" on which the image appears, is the cathode-ray tube. Within it is a mass of metals coated with suitable chemicals which, when heated, emit electrons. These electron particles are formed into a stream or beam by suitable elements within the tube and are projected to a fluorescent screen at the wide end of the cathode-ray tube.

Sealing-off a cathode-ray tube

Impinging of the electrons on the screen causes visible illumination of the screen at the point of impact. At any given instant there is only a single dot of light on the cathode-ray screen. The beam sweeps across the screen at more than two miles a second and serves to weave a television image. The cathode-ray tubes now being produced for home television entertainment have a face diameter of 12 to 14 inches for the large sets, and five inches for the smaller. These tubes are costly to produce and range in price from about $35 for the small tubes to more than $75 for the larger tubes.

Because of the high vacuum in cathode-ray tubes, there is a pressure over the entire glass surface which runs into many tons for the larger tubes. To withstand this crushing strain, the tubes have glass walls averaging about ¼ of an inch thick. Also, the tubes are examined for weakness, prior to being used, in a device known as a polariscope, which indicates the strength or weakness of any parts of the glass.

The elements of the cathode-ray tube comprise an intricate assembly of nickel cylinders, deflecting plates, and a cathode. The cylinders serve to accelerate the electrons and to form them into a sharp electron beam, to focus the beam on the fluorescent screen, and to increase or decrease the intensity of the beam.

The assembly of metal and glass parts is mounted in a funnel shaped glass envelope and sealed in place, as shown on our front cover. A glass tube permits pumping the air out of the glass envelope, this operation taking over two hours for the larger tubes. While the pumping operation is being conducted, the glass envelope is baked in an oven, which is part of the exhaust equipment, at a temperature of approximately 750 degrees, Fahrenheit. This baking drives off moisture which might otherwise remain inside the tube. Another precaution taken to eliminate undesirable gases in the evacuated tube is a bombardment of the metal parts, accomplished by slipping heavy coils, carrying high frequency current, about the neck of the cathode-ray tube, so that the metal parts are heated to incandescence through high frequency induction.

The construction and assembly of the cathode-ray tube calls for exceptional accuracy in positioning and spacing the parts, since such details affect the quality of finished tubes. Also, the metal parts must be imbedded in the glass, which calls for great skill on the part of workers familiar with glass working.

Make-Up in Defense

LURID-WHITE "cosmetics" are used by some oil-well and petroleum-pipe-line workers. The oil-workers' facial adornment, however, is put on for defense.

Petroleum geologists have discovered many oil fields beneath the waters of the Gulf of Mexico off the shores of Louisiana and Texas. Building a derrick foundation under these difficult conditions made it necessary to use creosoted, water-resistant timbers. Crews working on and around these timbers soon found that they caused painful facial inflammation and burns. Pipe-line workers, coating pipes with a black water-and-corrosion resistant, had the same trouble.

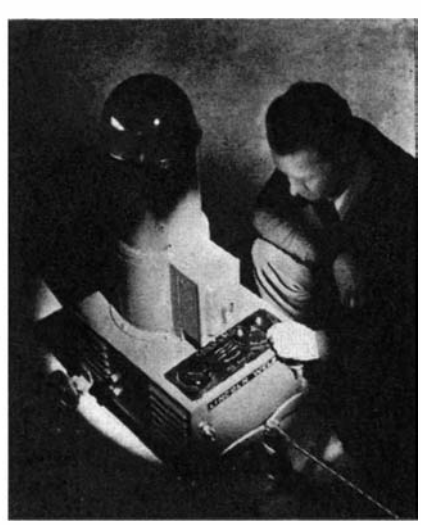
To protect themselves, they now daub their faces liberally with a zinc oxide preparation that gives them a bizarre appearance, but saves blisters and infections.

Small Arc Welder

A SMALL motor-generator type arc welder, said to provide greater convenience and accuracy in welding because of a new self-indicating dual continuous current control, has been announced by The Lincoln Electric Company.

Because of its advanced features and moderate price, this unit is expected to widen the application of welding in new fields such as garages, bus and truck fleet repair shops, sheet metal shops, maintenance departments of pulp and paper mills, paint mills, cement plants, textile plants, gas plants, and similar plants, as well as metal fabricating shops, piping work, and so on.

The welder, known as the "SA-150," has both job selector and current control calibrated and equipped with dials which indicate the type of work and number of amperes for each and every setting. It is



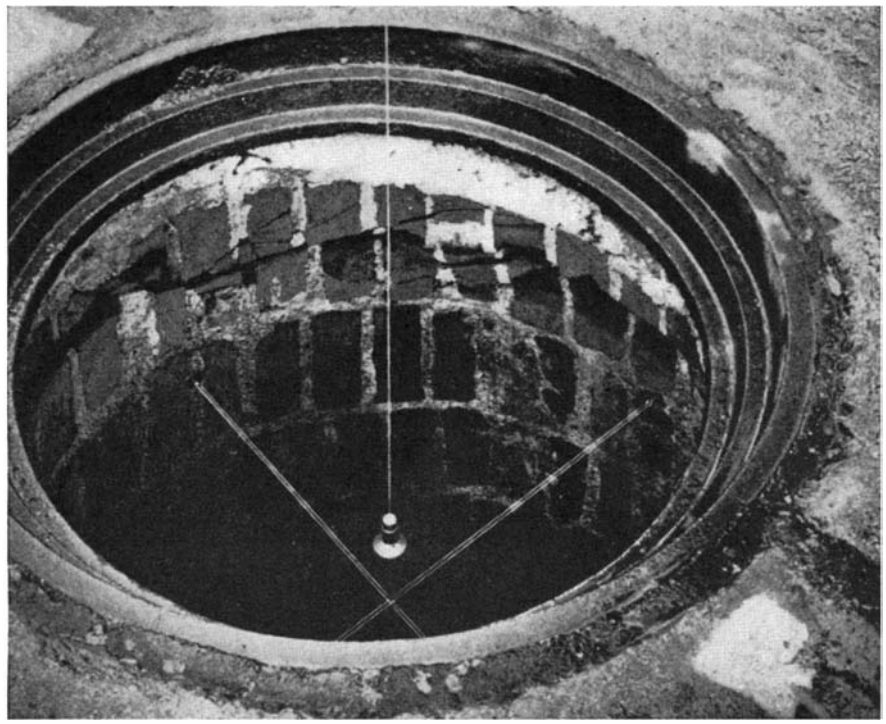
For accuracy in welding

claimed that this development enables the welding operator to secure highest quality welds and highest possible welding speeds because he can vary both the slope of the volt-ampere curve and the amount of welding current independently and positively to suit every job encountered.

The unit is powered with a "Linc-Weld," squirrel-cage, induction type motor for across-the-line starting. Connections are readily accessible for either 220 or 440 volts, 3 or 2-phase, 60 or 50 cycles as desired; the machine can be supplied for 550 volts or special voltages. Its current range is from 45 to 200 amperes.

SULFURIC

AIR and water, coming in contact with iron pyrites in coal mines, forms sulfuric acid amounting to about 2,802,000 tons per year, estimates the U. S. Public Health Service. Since this water flows outward and pollutes streams, abandoned mines are being sealed up as fast as possible.



Even though the pavement moves, reference points of this type remain effective

Engineering Costs Reduced

THE tremendous force exerted by the expansion of concrete with the heat of the sun does costly damage to curbs and pavements and presents a serious problem to the engineers responsible for the establishment and maintenance of the monuments marking the lines of our city streets.

An accompanying photograph is a view looking down into a manhole in the street and shows how the expanding pavement has moved toward the left, carrying with it the cast-iron rim that supports the manhole cover, and crushing the upper course of bricks.

It frequently happens that the place for the engineer's monument at the intersection of the center lines of the streets coincides with what is also the desirable place for a manhole and the likelihood of movement of points set on a manhole cover or in the pavement is well illustrated.

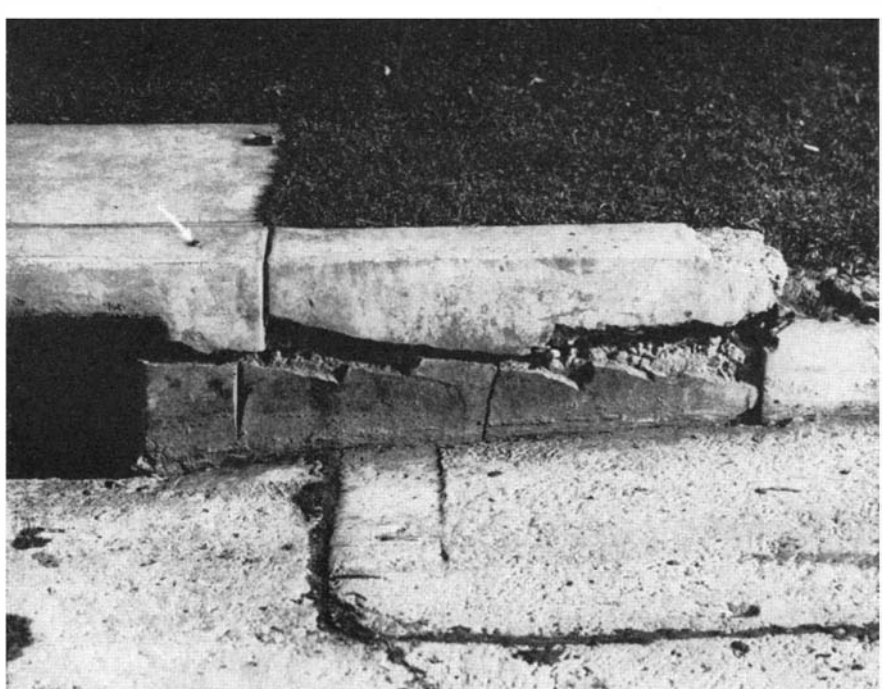
The instability of reference points in the curbs and walks at the side of the street is shown in a second photograph. The arrow indicates the head of a spike set in the curb at a catch basin to serve both as a reference point and bench mark. Under pressure of expansion the curb has shifted more than an inch to the right, shearing off the wall of the catch basin, and has raised up nearly half an inch, spoiling the value of the spike both as a reference point and as a bench mark.

By an original method of utilizing the brick structure of existing manholes, below the pavement, the engineers of the Los Angeles Bureau of Engineering have reduced the cost of maintenance and at the same time increased the stability of the system of points marking the street lines.

Four holes are drilled in the manhole wall and lead plugs driven into them. Brass hooks are then screwed into the lead plugs in such a position that strings stretched between opposite hooks as shown in the illustration will intersect at the intersection of the street lines.

In practice, the manhole cover is lifted and strings or long rubber bands placed on the hooks and the point of intersection used as if it were on the surface.

Painting the hooks with liquid asphalt protects them from corrosion by gases that may be present in the manhole.—*Edwin L. Stocking.*



A serious problem for engineers: Expansion has moved a curb reference point

Oxygen Preserves Milk

A NEW method of preserving liquid milk and milk products, reported from Germany, consists of holding the milk at low temperature under oxygen pressure.—*D. H. K.*

Acid-Resistant Bottle Closure

THEIR acid-resistant transparent closure has won for Merck & Company, Inc., honors in the Closure Group of the 1938 All-America Package Competition, sponsored by *Modern Packaging Magazine.* This same closure also was selected for second award in the Scientific Group of the Third Annual Modern Plastics Competition, conducted by *Modern Plastics Magazine.*

This prize-winner utilizes an amber transparent polygon-shaped plastic cap, with a liner of impregnated glass cloth. The polystyrene cap is unaffected by the acid contents, and is always easy to remove and safe from leakage or breakage. It is used on an amber "Pour-Clean" bottle, which is named from the special pouring lip which is an in-

tegral part of the bottle opening and is covered by the acid-resistant closure.

The prize-winning closure was molded by the Mack Molding Company from Bakelite Polystyrene material, supplied by the Bakelite Corporation. The glass cloth for the cap liner is supplied by Owens Corning Fiberglas Corporation; the amber bottle by Anchor-Hocking Glass Corporation.

EXPANSION

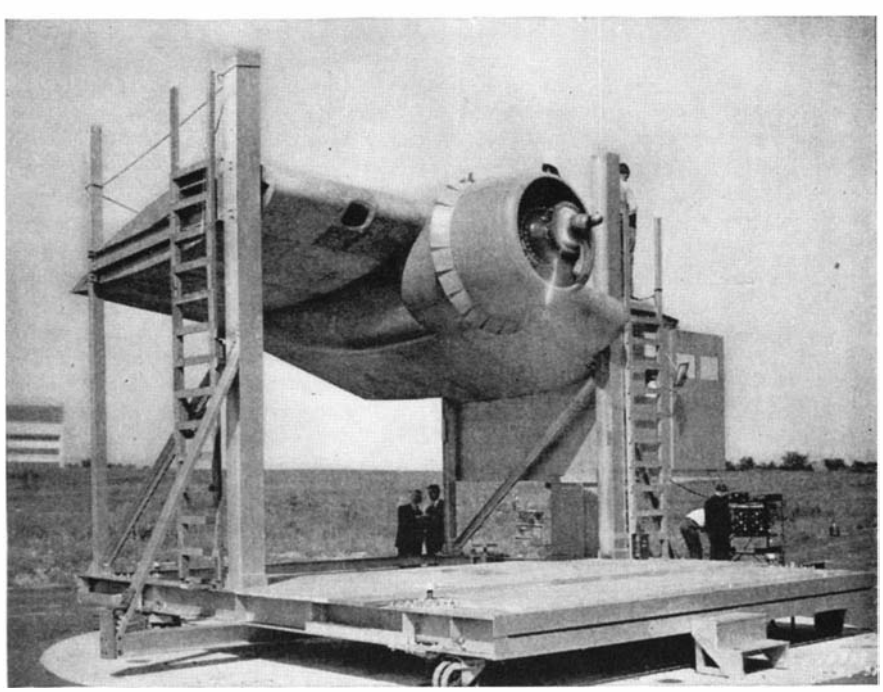
BY high pressure hydrogenation, one and one fifth gallons of gasoline is being obtained in the United States from one gallon of oil. This is the highest yield yet attained by any process of treating petroleum.

Pre-Testing the Airplane Power Plant

FLIGHT testing a huge flying boat or a large landplane is a tremendously expensive undertaking because of the powerful engines and the large crews required. Anything that can be done on the ground to shorten the flight tests is highly desirable, and the Glenn L. Martin Company has developed an engine test rig to achieve such an objective. By the use of this rig, illustrated in one of our photographs, it is possible to determine the operating characteristics of the power plant months in advance of the trial flights.

The rig consists of a turntable on which is mounted a "mock-up" of a portion of the airplane embracing a section of a wing and an engine in its nacelle. In the "observers' balcony" (to the right), located on a level with the engine, but shielded from it by a wall, are the instruments for recording temperature and pressure conditions throughout the fuel, oil, and cooling systems. Our photograph also shows an elaborate portable rig for vibration study, which is an important part of power-plant study. The propeller is, of course, included in the setup. The turntable makes testing possible with wind from various directions.

The use of the new rig speeds up delivery of a new model by as much as two months, reduces the hours needed for test flying by one third to one half, and fully justifies the somewhat heavy expense of building such a test installation.—*A. K.*



Airplane power plants are effectively pre-flight tested in this rig

Flashlight Photos 9000 Feet Under Water

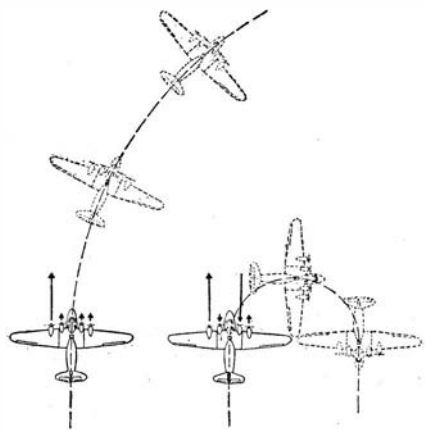
AN apparatus able to make flashlight pictures 9000 feet beneath the surface of the water is the invention of Dr. Hofmann, a leading engineer of Munich. It is a deep-sea camera with which he has already conducted successful experiments in the depths of Bodensee, or the Lake of Constance, as it is known to many American tourists. This invention is shortly to be subjected to further tests, this time 9000 feet below the level of the Tyrrhenian Sea between Sardinia and the Italian mainland.

In recent times divers have penetrated farther and farther into the depths of the ocean but after they reach a certain depth, the pressure of the water is so great that the stoutest diving suits are unable to offer resistance. Dr. Hofmann's deep-sea camera has the advantage that no human being needs to accompany it into the ocean depths. It consists of a chamber nearly 18 inches in diameter, weighing rather more than a hundred pounds. This bulb-like receptacle has three projecting bull's-eyes. A miniature camera is mounted behind the lower window; behind the two upper bull's-eyes is a flashlight apparatus operated by a clockwork.

Increasing Flying Boat Maneuverability on the Water

ONLY small seaplanes have water rudders. The large flying boats have none, and the air rudder has but little effect when the flying boat is moving slowly on the water. The maneuverability under such conditions is therefore very poor. To increase this maneuverability when using the present type of non-reversible pitch propellers, the pilot who wishes to turn to the right idles three engines of the four, and lets the left outboard engine pull him around. The turn is executed slowly and requires a great deal of room.

With the Curtiss electrically controlled propeller, it is now possible to reverse the pitch of the blades. When the pitch is reversed, so is the thrust. The turn can then



Turning radii of flying boat on water with conventional propellers (left) and with reversible propellers

be executed much more rapidly, as indicated in the diagram, in which the arrows indicate the direction and relative magnitude of the thrust. It is obvious that, with appropriate reversal of pitch, a powerful turning movement can be applied. The pitch reversibility may also be employed in shortening the length of the run after alighting.—*A. K.*

Safe Airplanes

TENTATIVE specifications for private airplanes, intended to secure greater safety, have been issued by the Civil Aeronautics Authority. If these specifications—which are only tentative—are met, the Authority will allow the present dual instruction and solo flying time to be reduced appreciably in obtaining a private pilot's certificate.

The sad history of the $700 "flivver" airplane has made the industry a trifle skeptical of the new specifications. Airplane builders say that their small craft are already reasonably safe, that safety is a matter of care in flying, and that radical changes in design or construction are apt to defeat the very purpose of increased safety. We shall not attempt to present the arguments pro and con, but we are convinced that the requirements as set forth have a very appealing character, and that the majority of them are already realized or could be realized without very much trouble, as exemplified by the following quotation from the specifications:

"*Landing and Taxying:* (1) The airplane shall be capable of being landed easily at any speed between the minimum and at least twice the minimum and shall tend to remain on the ground after contact. (2) Full application of brakes up to the point of skidding the tires throughout the entire landing run shall be possible with no danger of nosing over. (3) The landing gear shall be stable in taxying and entirely free from ground looping tendencies. The airplane shall be

easily steerable. (4) The airplane shall be capable of being landed over a 50-foot obstacle in a straight glide with no wind and brought to a stop within a horizontal distance of 500 feet. (5) The landing gear shall be capable of satisfactorily withstanding (a) landings having a vertical component of the velocity of 15 feet per second, and (b) straight glides to the ground in still air with the elevator control full back, without overstressing any part of the airplane. (6) The airplane shall be able to taxi in any direction and under complete control in winds up to 30 m.p.h."

We believe that these requirements can be readily met by the use of the front nose wheel or "tricycle" landing gear; by bold use of flaps or air brakes; and by designing the shock absorber with a large travel and powerful shock absorbing qualities.

Other requirements call for stability under varied conditions, impossibility of spinning under any conditions, and the provision of only two air controls, one governing the longitudinal attitude and the other for turning, both operated from the same control column.

Here we disagree with the specifications. An airplane should be difficult to spin, but it is inconceivable that it should never spin. And a machine which cannot be spun voluntarily may also be hard to get out of the spin. Again, we do not believe that it is so difficult to learn to fly with three controls as to justify sacrifice of the rudder. It is on these aerodynamic or flying requirements that controversy is likely to be concentrated.

But it would be a great boon if the following "Minimum Field of View" were really made available to the pilot:

"The airplane while standing or taxying on level ground shall permit the pilot an unobstructed level view straight ahead and through a lateral sweep of approximately 90 degrees to each side without moving from a natural comfortable position, and by reasonable movement the pilot shall be able to see the ground within 20 feet ahead of the airplane."

With an inverted engine of narrow proportions, or a pusher machine, or just good design and plenty of window area, we think that our designers can come very close to securing this degree of vision.—*A. K.*

Measuring Horsepower in Flight

IN airline operation, as much payload as possible must be carried on fast schedule, with the smallest fuel expenditure, and with the least wear on the engine. To check the two last items, the operator should have, at all times during a flight, an accurate record of the power developed by the engine. A number of ways exist for estimating the power, but none of them is completely accurate. Mr. W. G. Lundquist, of the Wright Aeronautical Company, in a paper presented before the Society of Automotive Engineers, advocates the use of a torque meter for this purpose. With such a meter, the power developed by the engine in flight can be determined with almost as much accuracy as in a test laboratory on the ground.

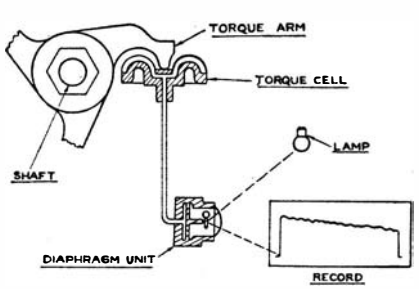
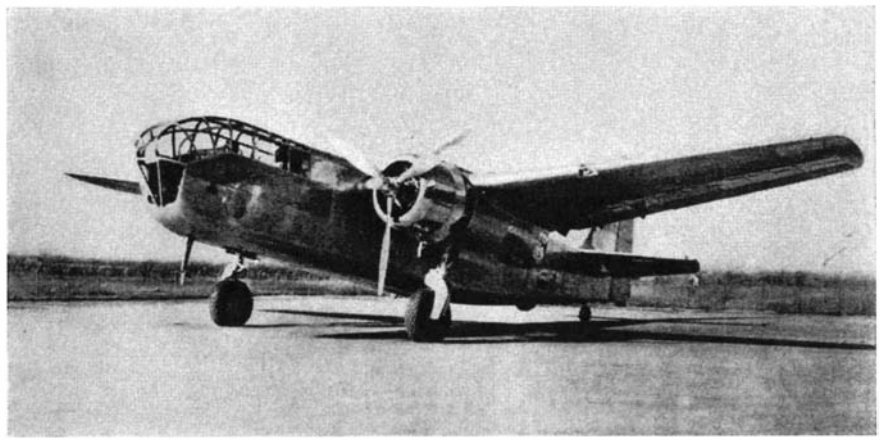


Diagram of a flying torque meter for measuring horsepower in flight

An example of the flying torque meter is shown in one of our diagrams. This device measures the torque transmitted from the engine to the propeller. Three "spider" arms are splined to the propeller shaft; three pressure-sensitive elements are attached to the propeller hub itself. These elements contain a sealed-in fluid, and the fluid pressure generated is transmitted to a measuring diaphragm. The diaphragm actuates a small pivoted mirror which reflects a beam of light upon a photographic film rotating on a drum. The wavy line traced out on the film serves, with proper calibration, to give the exact power of the engine.

The use of a torque meter is but one example of the means which transport companies employ to check their operations. —*A. K.*



Stearman attack bomber, representative of advanced military practice

Air Corps Expansion

OUR readers are no doubt familiar, in general, with the program of Army Air Corps. By July, 1941, the Air Corps is to have a fighting force of 5500 to 6000 airplanes. Even these figures are lower than those which have been quoted as available now in Germany or Russia. But there is always a question in our minds when the large numbers of European military airplanes are quoted, as to whether or not out-moded or otherwise inferior craft are included. On the other hand, when the Chief of our Army Air Corps states that he has a certain number of fighting planes at his command, we may be sure that he means ultra-modern machines, the very best of their kind.

In reading the various announcements, one is impressed first of all by the multiplicity of types available. Even towards the end of the World War, training, single-seater pursuit, day bomber, and heavy night bomber practically completed the classification. Now, further experience in various small wars, and careful tactical studies, have led to a multiplicity of types, each adapted to one, or at most two, specialized purposes—four-engined flying fortresses, heavy bombers, single-engined pursuits, twin-engined pursuits having speeds in the neighborhood of 400 miles an hour, troop carrying machines, interceptors to stop enemy bombers, multi-place fighters, and so on.

Both military designers and Corps tacticians are as a rule suspicious of airplanes which are to serve more than strictly limited purposes, because it has been found in the past that "all-purpose" machines serve all purposes badly. The construction of an "attack-bomber" seems legitimate, however, for combining the high speed and powerful machine gun fire of the attack plane with the bomb equipment of a light bomber is logical enough. One of our photographs shows an attack bomber, the Stearman X-100, recently submitted in a competition in which North American and Glenn L. Martin were also among the participants. The X-100 is undoubtedly representative of the very latest practice. It is powered with two 1400-horsepower Pratt & Whitney R-2180 engines, the gross weight is approximately nine tons, the wing span is 65 feet, and the length is 52 feet. There is a crew of four to take care of navigation and machine gun and bomb equipment. A feature of the new plane is the extreme vision afforded by the transparent panels which make up the entire forward portion. Since an absolutely smooth skin is imperative at high speeds, flush type rivets are used over the entire outside surface of wings and body. In the design of the machine, an attempt has also been made to combine the ultimate in streamlining with the demands of rapid, large-scale production.—*A. K.*

Straw for Fuel

RUSSIAN tests of straw as fuel in gas producers have yielded one kilowatt hour by burning three kilograms of straw. —*D. H. K.*

Machine Calculates Timber Volume in Five Seconds

A MACHINE which in five seconds gives the exact volume of a growing tree of any kind and any dimensions, and two other interesting instruments for timber assessments, have been built by a Swedish inventor.

The "trunk volume calculator," as the machine is called, has been constructed by a Swedish forestry technical expert, Capt. Alvar Drangel of Stockholm, and it has been

considered of such value that the Swedish government has helped finance manufacture and exploitation. It is a "nomo-mechanical" calculating machine, equipped with certain mechanical devices through which a number of scales can be set in relation to each other. The machine is, practically speaking, an endless table system, which in five seconds solves an equation after five of its variables have been given exact values. For assessment of the cubic content of growing trees, the machine is thus set for the values of the trunk curvature, the class of bark, the taper percentage, the length of the trunk and, finally, the diameter of the tree at breast height. The volume is then immediately obtained, exact to a ten thousandth of a cubic meter. The machine, which has about the shape of an ordinary calculating machine, but is operated by dials instead of keys, is able to deliver no less than 8,000,000 volume figures.

The two other instruments, constructed by the same inventor, are a "trunk diameter registrator," working on the same principles as the first-mentioned machine and of about the same type, and a precision height measuring instrument, by means of which the height from the cut to any desired point on the trunk can be rapidly and correctly fixed. The trunk diameter registrator is used for pre-calculation of the quantity of usable timber that can be obtained from a tree. By means of it can be exactly fixed the top diameter in eighths of an inch within bark at a certain length from the cut or, the reverse, the log length at a certain desired top diameter.—*Holger Lundbergh.*

World's Best Lighted Field for Night Baseball

WHEN Connie Mack's Athletics and the Cleveland Indians inaugurated night baseball for the American League at Shibe Park, Philadelphia, on May 16, they played on the best lighted sports field in the world.

Comprising 780 Westinghouse floodlights of 1500-watt capacity each, the new two-billion beam-candlepower lighting installation is of sufficient intensity to light a street 160

Two-billion candlepower makes this ball field the best lighted in the world. *Below:* One of the 1500-watt floodlights that are employed

miles long as brilliantly as Philadelphia's famous Broad Street; to provide light for more than 2000 homes; to make newspapers readable 175 miles from the light source, if the floodlights were all concentrated in a single unit.

"The Shibe Park infield is 20 times brighter than the average well-lighted office," according to John Kilpatrick, lighting engineer. "It is several hundred times brighter than New York's Times Square on New Year's Eve."

There is no glare and resulting eyestrain for either spectators or players, Mr. Kilpatrick reported. This is due to the design of the floodlights and the unusual height at which they are placed. Top rows of lights in eight steel towers surrounding the park are 155 feet above the ground.

Six towers support targets on which are mounted 110 of the big 20-inch floodlights in 10 horizontal rows of 11 lights each. Two others support 60 floodlights in five horizontal rows each containing 12 lights.

Club officials announce that seven night games will be played at Shibe Park this season by the Athletics, and seven by the Phillies. It is also expected that the park will be used for night football games this fall.

Measuring 2/100,000 of a Millimeter

A REMARKABLE measuring instrument, known as the "Microkator," which is capable of registering measurements down to 2/100,000 of a millimeter, has been invented by Hugo Abramson, Swedish engineer.

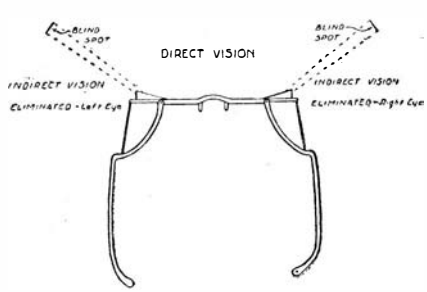
The principle applies a frictionless gearing to measuring instruments, and is remarkably simple. Its unit comprises, in the main, a thin strip of phosphor-bronze, twisted around its own longitudinal axis, half its length in one direction and half in the other. If the band is stretched between a stationary and a movable point, its center moves in the same way as a twisted yarn when pulled. A mirror placed at the center furnishes an extremely sensitive indicating device, and when the band is stretched 1/100 of a millimeter, its center turns 54 degrees; if a thousandth millimeter, 5.4 degrees. By using a lever system, still finer readings may be obtained.

The inventor of this instrument, which is manufactured by the Swedish manufacturers of the well-known Johansson gage blocks and precision measuring instruments, the C. E. Johansson Company, of Eskilstuna, also has a number of other inventions in the precision measuring line to his credit, as, for example, the heart-beat indicator constructed by himself and his brother. Mr. Abramson also has received the Gold Medal of the Swedish Academy for Engineering Research.—*Holger Lundbergh.*

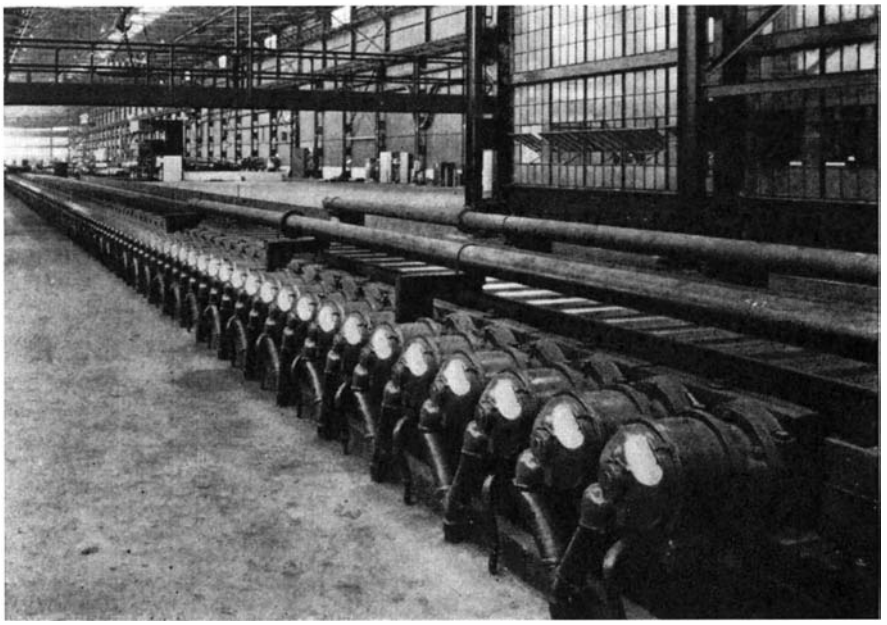
Vision Concentrators

IT is almost instinctive for a person on certain occasions to cup his hands about his eyes the better to concentrate his vision on some scene or work before him. There is a definite principle involved in this action. Eliminating indirect vision—or wide-angle vision—gives what is technically called "central fixation"—essentially, "tunnel vision." In specific seeing tasks, this is advantageous for, since objects in the periphery are shut out, the brain is relieved of the problem of viewing them simultaneously with those on which the attention is focused.

A simple device to attain this advantage has been developed by Frederick Saunders



and is being manufactured by the Columbia Protektosite Company. The invention came about as the result of Mr. Saunders' experimental use of two rolled-up programs at a moving picture show. Viewing the screen with them at his eyes started Mr. Saunders on a long study which resulted in the device called Concentrators. They literally concen-



A striking example of a multiple electric motor installation. Not just one large motor or several smaller ones, but scores of individual units drive the many rolls on this run-out table at the new Sparrows Point, Maryland, hot-strip mill of the Bethlehem Steel Company. Westinghouse made all the electrical equipment of this plant which turns out up to 2000 linear feet per minute of strip steel during long runs of tonnage

trate the sight and thus enable the user to concentrate more efficiently mentally.

Concentrators look somewhat like ordinary spectacles, but they differ in having no lenses—unless the user needs sight correcting lenses—and in their patented features. To the outer circumference of each eye-piece there is molded a small opaque rim flange which projects forward and cuts down the angle of vision from side to side. Projecting backward from the same rims, are shields which cut off all side light. The result is that all distracting side vision is completely eliminated. The effect is so marked that Dr. Martin Grabau, former Harvard University physics professor, after testing and approving Concentrators, remarked that it was amazing how much could be accomplished so simply.

Concentrators will be useful for students, stenographers, golfers and other sportsmen, theater-goers, and all those who must concentrate on work in hand.

Growing Tobacco without Nicotine

REPORTS from Italy state that tobacco leaves grafted on tomato plants grow with a total disappearance of nicotine. Leaves normally containing 2 to 2.5 percent nicotine were used in the experiments and lost all their nicotine content without having it appear in the leaves of the plant to which the graft was made.—*D. H. K.*

"Pullman" for Giant Salmon

TRUCKS are built these days to perform most any transportation job you care to name, but few are designed for a purpose as unusual as a fleet of eight recently ordered by the U. S. Bureau of Reclamation.

These are to carry thousands of giant salmon, 30, 40, or 50 at a time, alive and undamaged, to destinations they never would reach unaided. The fish will travel in 1000 gallons of Columbia River water, constantly aerated to supply the occupants with adequate oxygen, protected by insulation against outside temperatures ranging from 108 degrees down to 30. In transit, the salmon compartment will be cooled gradually to prepare the occupants for the chill waters of Wenatchee River and Icicle Creek. Cracked ice, weighing 1800 pounds, is carried in a special compartment for this purpose.

Extraordinary precautions are being taken to keep the motoring fish comfortable and unhurt. Every inside contour of the tanks is to be smoothed, and they are designed so as to fill to the brim, since the salmon must not be banged against the sides by sloshing water. Specifications demand a 50-mile top speed with a gross load of 25,000 pounds.

The job is an important one, affecting the future of a great industry.

Up the Columbia River each year moves the greatest salmon run in the world, some three million fish, Chinook and Steelhead, bound for the headwaters to spawn and start the life of a new generation. The parent fish die but tiny youngsters go down to the ocean to grow. Five years later, averaging 22 to 30 pounds apiece, these splendid salmon retrace their way upstream to their native waters.

A $15,000,000 a year industry depends upon the continuance of this vast migration, but its way now is disputed by power dams built to harness the vast energy of the turbulent hurrying river. Millions have been spent to build fish ladders to get them past Bonneville Dam, but at Grand Coulee, 450 miles from the sea, the way is blocked.

The task given the eight fish "limousines" is to collect the salmon whose instinct heads them to the streams above Grand Coulee, and carry them to other, unblocked tributaries.

It will not be an easy job. From July to the end of September, the run will be at its peak, and fish trucks will have to be on the go all the time, emptying the fish traps, hustling a load to new streams or to holding ponds where the spawning will take place, and back to the traps for more salmon.

Courtesy Bureau of Reclamation

Special truck designed to carry giant salmon, alive

ENZYMES

SOME of the enzymes present in beef, are: peptase, arginase, tryptase, urease, ereptase, hippuricase, deamidase, salicase, helicase, nuclease, aldehydase, peroxidase, nitrase, lipase, lecithase, amylase, maltase, glycogenase, sucrase, glycolase, arbutase, phosphotase, catalase, salolase.

Some?

Alcohol Antiseptic for War-Wounded

HOW war-torn Spain became the proving ground for a new type of alcohol antiseptic is revealed for the first time in *Military Surgeon*, official publication of the U. S. Association of Military Surgeons. Adding weight to the report is the fact that its author, Major S. Perez-Vasquez, M.D., was physician in charge of the famous Hospital de Carabineros in Madrid.

The new alcohol antiseptic which Dr. Perez-Vasquez found to be the "most satisfactory of any preparation in general use" may have even wider application in peace. He writes that, on war wounds of all types,

it not only controlled infection with less discomfort to the patient, but also speeded healing and shortened the period of hospitalization.

"Even when . . . used several hours after injury, a quick drop in fever is observed, and within four days after beginning treatment, healthy granulation tissue appears. Much less operative surgery was required."

The new antiseptic—a mixture of ethyl alcohol, glycerine, thymol, phenol, and camphor—was evolved by Dr. Perez-Vasquez and his associates in an effort to find a solution which could be used with simple irrigation in place of the cumbersome technique and specialized apparatus of the Carrell-Dakin method.

It was perfected, Dr. Perez-Vasquez states, after a careful trial of other approved and generally used antiseptics including iodine and several proprietary products.

The article in the *Military Surgeon* gives the formula and directions for compounding the solution.

A Professor's Scientific Pipe

WHEN science invades the sanctity of man's popular pastime of pipe smoking, the result is a highly-engineered job which offers convenience and satisfaction to the smoker. Latest evidence of this fact is

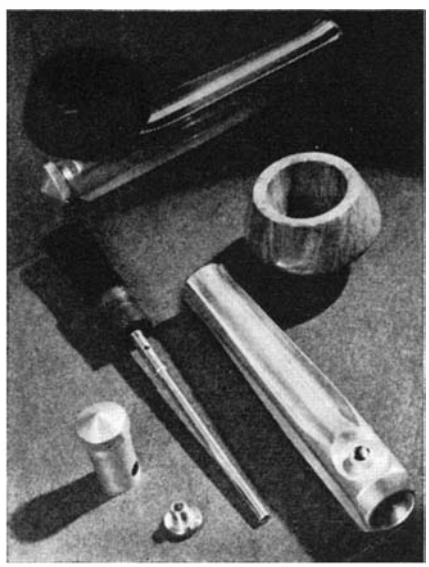
the scientifically-designed pipe invented and perfected by F. K. Kirsten, professor in the school of Aeronautical Engineering at the University of Washington.

An enthusiastic pipe smoker himself, Prof. Kirsten set about to apply engineering principles in developing a pipe that would eliminate the objectional features ordinarily associated with pipe smoking.

The Kirsten pipe is based upon effective cooling of the smoke so that undesirable oils and tars, which are in volatile form, are removed by condensation before reaching the smoker's mouth. To obtain efficient cooling, a unique stem, or barrel, is used. It is made of aluminum alloy and has a characteristic high heat conductivity supplemented by an efficient fluted design which increases the rate of heat dissipation.

In order to allow ample time for the smoke to cool completely, the volume of the radiator has been precisely determined so that it holds the equivalent of the average smoker's puff, or from six to twelve cubic centimeters. Because of the radiator's volume, the gases can remain in it for the duration of and the interval between puffs. Experiment has shown that this period is long enough for the complete cooling of the smoke and to permit the undesirable contents to condense.

The condensed tars and water vapor collect in a small radiator cap, also of aluminum alloy, at the lower end of the barrel—the lowest point of the pipe when in the smoking position. Their flow back into the bowl is prevented by a valve mechanism which is incorporated in the radiator cap. By giving the cap a right angle turn, the valve closes the bowl outlet, and the pipe can be turned upside down to discharge ashes. The condensate is securely trapped in the radiator



Left: **The scientifically designed pipe has an aluminum stem.** ***Above:*** **Each part of the pipe is designed to accurate engineering specifications. Parts are interchangeable.** ***Right:*** **The same principles have been applied to a cigarette holder**

and none of its odors can escape. The radiator cap can readily be removed to empty the condensates.

The bowl of the Kirsten pipe is detachable, being held in place by a double-slotted aluminum alloy screw which forms the bottom of the bowl. This feature permits the smoker to interchange the bowl with any one of a variety of stock shapes and sizes available. The inner walls of the bowl are sloped to give the most efficient combustion of the tobacco. It was found that the most uniform burning was effected by shaping the sides of the bowl so that they formed an angle of 13 degrees with the vertical.

An aluminum ramrod is attached to the intake tube fitted in the mouthpiece and serves as an aid in cleaning the pipe by running a piece of tissue paper through the radiator, an action not unlike cleaning the barrel of a gun.

The pipe is 10 to 50 percent lighter than the conventional design pipes.

The scientific principles of the Kirsten pipe have been carried a step further in the Kirsten cigarette holder which also cools (and cleans) the smoke through radiation from a finned aluminum alloy stem.

Diphenyl Saves Palestine's Citrus Industry

LONG distance shipping of Palestine's citrus fruit crop is made possible by wrapping it in impregnated paper. Losses by spoilage are reduced by this method to approximately 10 percent of their former value. Diphenyl is used to impregnate the wrapping paper and this in no way affects the odor, taste, or appearance of the fruit. This method may save the citrus fruit industry of Palestine by permitting the economical export of its product to remote markets in north Europe.—*D. H. K.*

Self-Adhesive Labels

SELF-ADHESIVE labels, manufactured by Avery Adhesives, coated on one side with a non-drying gum, will adhere to any smooth, hard surface without leaving any stain or gummy residue no matter how long they are in place. These Kum Klean labels can be used for marking glassware, silver, office supplies, pottery, china, toys, furniture, and other merchandise.

Insects *versus* Weeds

A TINY Argentine moth has saved a large part of a continent from being turned into desert by a predacious plant which was devouring more than 1,000,000 acres a year, literally driving farmers out of their houses, and resisting attacks with liquid fire. The plant is the prickly pear, a species of cactus common over the United States, Mexico, and South America, and which is often grown as an ornamental in gardens.

Nearly a half century ago a few plants were introduced into Australia from North America, intended for flower gardens. The prickly pears found themselves in an earthly paradise where they could run wild with nothing to stop them. By 1925, they had

covered more than 60,000,000 acres in Queensland and New South Wales. Most of this had been good grazing and farming land. About half of it was in the grip of a dense jungle of cactus from three to five feet high and so thick that it was impenetrable. The other half was covered by less dense growth, but was rendered nearly useless for agriculture.

Just when the problem seemed unsolvable, salvation came in the form of the little Argentine moth. Australian entomologists had hunted all over the Americas for insects which might help get rid of the cactus. Many type specimens were studied in the collections of the Smithsonian Institution. The majority of them, it was found, did no real good. Their larvae ate the cactus, but the

plant was too tough to be killed by them. The Argentine moth, however, displayed life habits which admirably fitted it to rescue a continent.

The Australian entomologists tell of one stretch in Southwest Queensland where the prickly pear extended in a dense, almost continuous belt for 100 miles. A moth colony was planted in this neighborhood. A year later the entomologists were in despair. The insects seemed to have done no good whatsoever. But another 12 months and the whole jungle had simply collapsed. At least 90 percent of the plants were destroyed and the land was made available for farming again. Altogether the insect has reclaimed more than 15,000,000 acres to date.

Sulfanilamide For Smallpox?

THE new drug sulfanilamide appears to have value in treating smallpox. Four cases in which it largely prevented the eruption from the disease are reported in the *Journal of the American Medical Association* by Dr. Walter O. McCammon of Springfield, Kentucky.

Seven cases of smallpox recently came under the observation of Dr. McCammon. He used sulfanilamide in treating four, and there was only a slight eruption which soon disappeared. The patients were back at work a week sooner than were the other three cases which were treated symptomatically and in which the typical eruption of smallpox developed.

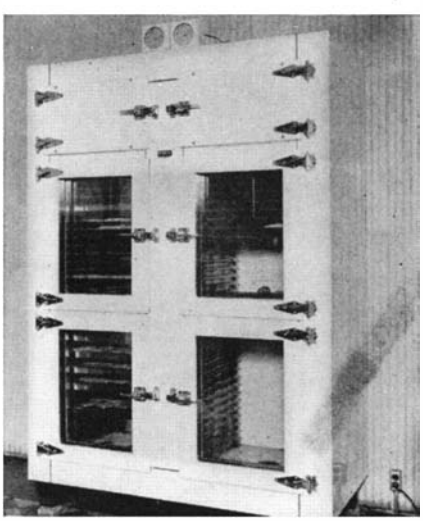
In an editorial, the medical journal points out that no conclusions as to the value of sulfanilamide in preventing deaths from smallpox can be drawn from such a small number of cases.

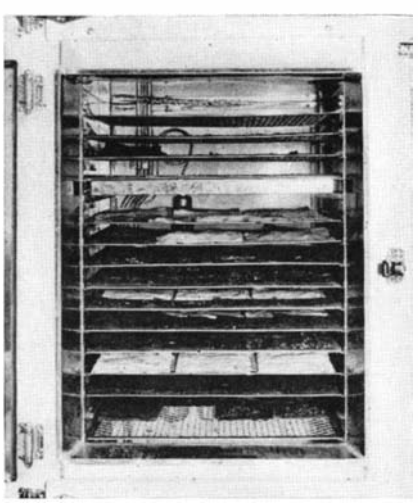
Although smallpox is increasing (there were 14,355 cases reported last year) the disease is now mild.—*Science Service*

Seed Germination with Air Conditioning

NATURE'S way with seeds has always been hard to figure out—a hit-and-miss proposition largely based on guesswork. But the Peppard and the Rudy-Patrick Seed Companies of Kansas City, Missouri, have eliminated the guesswork and reduced the whole process to a science. They employ the use of seed germination boxes to test the growing ability of all varieties of field grasses and garden seed. In this way, Mother Nature's future whims are accurately prognosticated.

Below: **The air-conditioned unit for seed germination and,** *right,* **shelves on which seeds are placed**

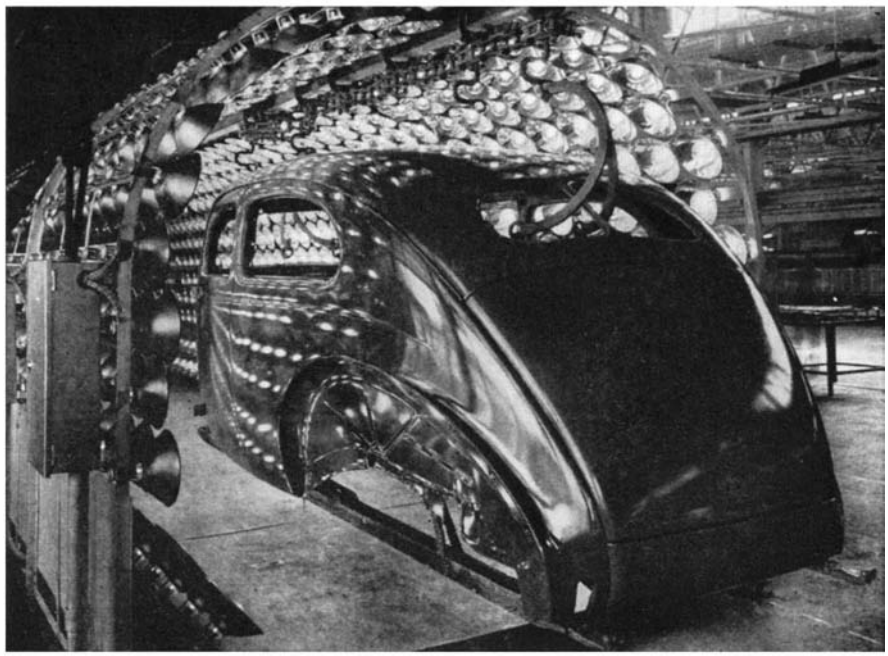




A given number of seeds from any one lot is placed on moist blotting paper and inserted in the germinating box. Within the box, it is imperative to hold the relative humidity at 90 percent and to maintain temperatures which correspond as nearly as possible to the temperatures to which the seeds would be exposed in the fields during their planting or sprouting period. This temperature, of course, varies during the 24-hour daily cycle. Therefore, in the germinator, varying temperatures are maintained—namely 68 degrees for 16 hours simulating the night, and 85 degrees during the eight hours corresponding to the sunlight cycle.

Of course, there are seeds which must be planted the first thing in the spring, such as radishes, lettuce, alfalfa, and clovers. These do not require as much heat to sprout and, therefore, are placed in one compartment of the germinator which maintains a constant temperature of 68 degrees. It is for this reason that each germinator is constructed with two compartments—one equipped only with refrigeration and the other with both refrigeration and an electric strip heater.

The Creamery Package Manufacturing Company of Chicago, through its Kansas City office, furnished these Trane germinating units.



Gold in an automobile factory may seem incongruous, yet in the Rouge plant of the Ford Motor Car Company it does a "laborer's" job of expediting the drying of enamels with which motor-car parts are coated. (See also Scientific American, May, 1939, page 325.) This striking photograph shows one of the tunnels through which bodies are drawn, after painting, to be dried rapidly by the infra-red rays from a battery of lamps. These lamps are backed by reflectors, the surfaces of which are gold plated, since it has been found that such a surface most efficiently concentrates the desired rays on the automobile bodies

Industrial Use of Papain

FROM 1932 to 1938 the United States imports of crude papain increased approximately four-fold to 223,000 pounds. This enzyme is the dried milky juice obtained from the skin of the unripe papaya, which grows in tropic and subtropic regions throughout the world. Aside from its value in medicine as a digestive, papain is used to make tough meat tender and has a similar effect on other foodstuffs. Although papayas grow in Florida, Texas and California, the chief American supply of papain comes from Ceylon.—*D. H. K.*

Non-Shock Treatment for Mental Disease

MENTALLY sick patients are now being rescued from the world of the insane by the simple and comparatively safe measure of breathing nitrogen, it was announced at a recent meeting of the Federation of American Societies for Experimental Biology.

"Encouraging results" of this new, non-

shock treatment for insanity in a small series of cases were reported by Drs. H. E. Himwich, F. A. D. Alexander, Basile Lipetz, and J. F. Fazekas, of Albany, New York, Medical College and Union University.

The new treatment achieves its effect by the same mechanism as the drastic insulin and metrazol shock treatments. This is by decreasing the metabolic activity of the brain. The nitrogen inhalation treatment, however, is easier to give than insulin shock and does not produce the fearful convulsions of metrazol treatments which are dreaded by both patients and physicians.

With the new treatment, patients breathe nitrogen long enough to deprive the brain of its oxygen supply for about five minutes. These treatments are given three times a week for a period of about three months.

Cutting down the oxygen supply to the brain reduces its metabolic activity. Metrazol does the same thing by temporarily arresting breathing movements. Insulin shock does it by depleting the sugar supply to the brain, without which the brain cannot use oxygen.

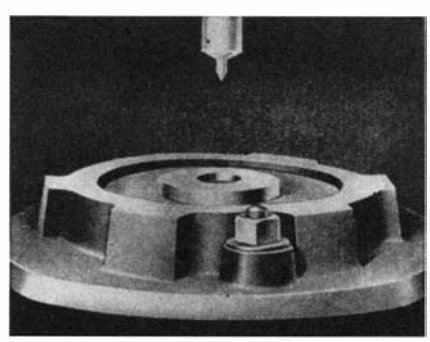
The fact that metrazol and insulin-shock treatments both produced this effect of decreased metabolic activity was discovered a year ago by a University of Toronto research team under the leadership of Sir Frederick Banting and Dr. G. Edward Hall. At that time Dr. Hall predicted that neither insulin nor metrazol would be the last word in treatment of schizophrenia and that a better and less severe remedy would be found to replace them. The nitrogen inhalation treatment seems now to be that remedy.—*Science Service.*

ALUMINUM IS SQUIRTED

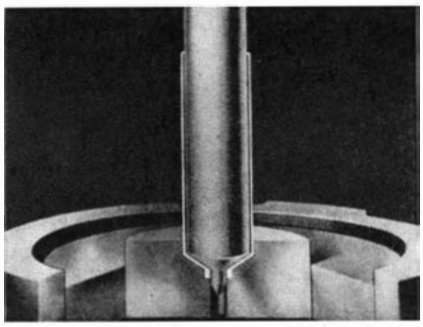
AMONG the manufacturing operations performed on aluminum alloys, none is more interesting and spectacular than the impact extrusion process. By this method, a small biscuit-shaped slug of aluminum is transformed in the twinkling of an eye into a tooth paste tube, a flashlight case, or any one of several hundred commonplace containers and shapes.

The moving head of an impact extrusion press is fitted with a punch or hammer which is slightly smaller in cross-sectional dimensions than the stationary die. The slug of aluminum is placed on the die, the hammer strikes the slug, and the high pressure forces the aluminum slug to "flow" up past the clearance between die and hammer, thus forming a collapsible tube or any other shape determined by the die. The metal is literally "squirted" into the desired shape.

Pieces and containers of various sizes, shapes, and intricacy of design can be formed at high speed and low cost by the impact



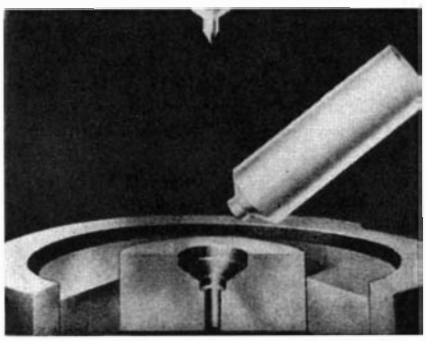
A slug of aluminum is in the die



The aluminum is squirted . . .

extrusion process. Many parts ordinarily made by drawing, spinning, stamping or turning can be produced to advantage by this method. The chief advantages to be obtained by adopting this process are close dimensional tolerances, a high degree of uniformity in parts, and surprisingly low production costs.

By the nature of the impact extrusion process, the metal is strain-hardened, developing its strength and stiffness. Thermal treatment may be used to anneal the finished product for the softness necessary in collapsible tubes or the parts may be given even higher strength by controlled heat treatment. Thus, various properties are at the option of the designer.



. . . and a formed tube results

There are almost no limitations on the shapes of impact extrusions. Symmetrical and basically cylindrical forms are the best suited to this process, but square, oval, rectangular, and asymmetrical parts can be made rapidly and at low unit cost. The wall thickness of parts can be varied from thick wall at points of stress and strain to thin wall where strength is not needed. To the natural light weight of aluminum is added the advantage of less metal where not needed.

Beware! Ticks Carry Spotted Fever

CONSIDER all ticks dangerous, advises the U. S. Public Health Service, even though only one in 300 of the eight-legged pests is capable of transmitting spotted fever, in the most heavily infected areas.

Although the exceedingly dangerous tick-borne disease was first found in the west, whence its name of Rocky Mountain spotted fever, it is now known to exist eastward to the Atlantic, as far north as Massachusetts, and as far south as Georgia.

If you live where ticks abound, or if your dog brings them to the house after cruising in the brush, better examine yourself all over at least once a day. If you find a tick has taken hold, remove him with a pair of

tweezers or a small piece of cotton or paper, being careful not to crush it. Tick "juice" can be very dangerous.

Drop the tick in kerosene or gasoline, to kill it. Swab the bitten spot with iodine, and dip your fingers and the forceps in alcohol or wash them thoroughly, the Public Health Service advises. It is highly advisable also to "de-tick" your dog at frequent intervals, with the same precautions.—*Science Service.*

Inkless Recording Instruments

CONTINUOUS accurate operation for 30 days without attention, at temperatures as low as —10 degrees, Fahrenheit, and as high as 120 degrees, Fahrenheit, is made possible by the new Type CF-1 line of inkless recording single- and double-range A.C. ammeters and voltmeters just announced by

the General Electric Company. The units are in the low-price range and are particularly well suited for voltage surveys, complaint investigations, and checking circuit load conditions. The inkless mechanism, which uses a typewriter ribbon to make the record by a series of dots, results in greater simplicity, small size, and light weight. There is no inkwell to clean, no pen to start, and nothing to freeze in cold weather. A cast aluminum alloy case protects the mechanism and further suits the new instruments for service while exposed to the weather. Although they are portable, the new instruments may be wall- or pole-mounted.

Flameproof Fabrics

THE opening of San Francisco's Golden Gate Exposition emphasizes the usefulness of flameproofed fabrics. More than 200,000 yards of decorative materials have been treated with fire retardant chemicals to reduce the hazard of fire. The chemical used, ammonium sulfamate, does not affect the decorative beauty of the treated fabrics. Although the San Francisco Exposition was the first World's Fair to open using flameproof fabrics throughout, the New York World's Fair imposed similar regulations. —*D. H. K.*

Factory Precision

DON'T believe it if someone tells you that E. E. Burger, shown in an accompanying illustration, is sighting his bow and arrow for a bull's-eye shot at a target. The bull's-eye at which he is "aiming" is the measurement of any difference between the

Determining expansion coefficients

expansion coefficients of metal and glass. In the manufacture of vacuum tubes, insulators, and other electrical products, metal and glass must be sealed together to withstand varying temperatures; and it is through this telescopic "sight" that Mr. Burger determines expansions as small as ten millionths of an inch in the Research Laboratory of the General Electric Company.

Welded Hack Saw Blades

HIGH efficiency is the claim of the Armstrong-Blum Manufacturing Company for its Marvel high-speed-edge hack saw blades. They are manufactured by uniting a high-speed steel tooth edge with a supporting body of chromium vanadium steel. The two parts are integrally welded by a patented electric welding process.

It is claimed that the high-speed steel edge provides all the fast-cutting and long-wearing qualities of good cutting tools, while the body of chromium vanadium steel contributes exceptional strength.

Electroplating with a Brush

SMALL repair shops and home workshops can now have their own electroplating equipment. An inexpensive kit recently put on the market by the Rapid Plating Process, Inc., enables the shop or home user without previous experience to electroplate individual articles or worn spots on various objects.

The plating is done with a specially designed brush through which an electric current passes. Only one or two dry cells are required. The plating compound is of a jelly-like consistency and contains, in a highly concentrated form, the metal to be deposited. This compound adheres to the surface being plated without spilling or running. Objects even in overhead positions may be plated without dismantling or loss of time from service.

It is claimed that the quality and permanency of the platings are equal to commercial platings, thickness for thickness. Nickel coatings of 1½ to 2 ten-thousandths can be successfully deposited with a com-

paratively few brush strokes. Cadmium 2 to 4 ten-thousandths and silver 1 to 10 ten-thousandths can be deposited, depending upon the time expended in the operation. Other metals which can be plated by this method are gold, copper, tin, and zinc.

The process is not designed to replace the commercial method of electroplating but rather to supplement it. The brush method is particularly useful for miscellaneous small jobs and for touching up small areas which are not subject to heavy wear.

ICE

APPROXIMATELY 15 million tons of ice—enough to make 240 billion average-size cubes—are required annually by the American railroads to keep freight and passengers cool. The great bulk of ice purchased or manufactured by the railroads and refrigerator car companies—nearly 13 million tons of it—goes in what have become known as "America's rolling refrigerators."

Squeaking Rubber

THE problem of the squeaking rubber-mounted spring shackle is an annoying one for motorists. Oil should not be used as a lubricant because of possible softening of the rubber, and brake fluid affords, at best, only a temporary remedy. A satisfactory lubricant is made of colloidal graphite in glycerin and water, reports B. H. Porter, of Acheson Colloid Corporation. Glycerin has desirable characteristics as a rubber lubricant and it increases the retention of the graphite by the lubricated parts. The water acts as a carrier and soon evaporates.

Corn Cob Lignin Softens City Water

IN their search for some practical use for lignin, one of the principal waste products of the country, chemists have discovered that recovered lignin is more effective in treating hard water containing iron than commercial compounds now in use.

At the Agricultural By-Products Laboratory, Ames, Iowa, chemists of the U. S. Department of Agriculture treated hard city water, hard well water, and water containing added iron with lignin prepared from corn cobs and found this material to be effective as an iron-removal agent.

Supplies of lignin are inexpensive because they are almost limitless. Roughly, one fourth of all wood plants, including trees, is lignin. As a waste product of wood pulp mills, where its disposal pollutes streams, it amounts to about 1,500,000 dry-weight-tons each year. At least six million tons a year is available from corn stalks and an equal quantity from wheat straw. Other extensive supplies are cottonseed hulls and sugar cane bagasse—the fiber remaining after the juice has been squeezed from it.

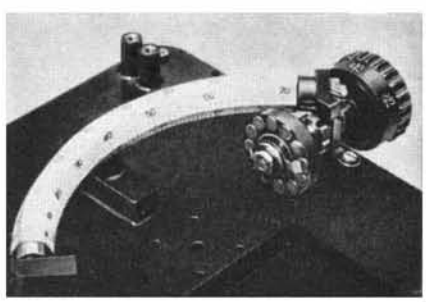
In treating water that contained about 36 parts per million of iron with 500 parts per million of lignin, the iron content was reduced to an average of about two tenths of one part per million. The lignin was recovered and used again up to 10 times with no appreciable lessening of efficiency. The same

amount of an inorganic compound commonly in use reduced an identical iron content to only one and one half parts per million for the first six times it was used and thereafter rapidly lost its ability to remove the iron. The cheaper lignin powder not only removes more iron, but can be recovered and used more times.

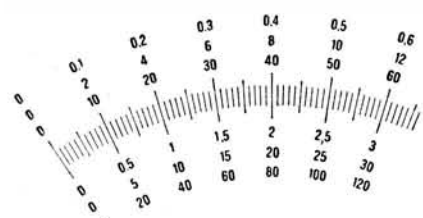
Many cities may find it possible to use the lignin treatment with existing water filtration plants by adding the recovered lignin to the water in the mixing and sedimentation tanks, or applying it as the water enters the filters where carbons are used for odor removal.

Revolving Multiple-Scales for Meters

ON the measuring instruments of the present day with several measuring ranges, it is necessary to multiply the results by a given factor which has a different magnitude for each measuring range. These calculations not only entail waste of time, but they are a source of possible errors, and this, of course, means that they may constitute an



Above: Flexible multiple scale for meters. *Below:* Several rows of numbers on a conventional meter scale



element of danger for apparatus through which current flows. The difficulties are peculiarly serious in the case of several scales with varying characteristics.

The elimination of all calculating work, when using electric measuring instruments, can be made possible by introducing suitably divided and numbered divisions into the scale-field for each measuring range; on the other hand, it must not be necessary that a measuring range represent a given multiple of another range. This problem has been solved by the Toroid Multiple Scale. A rope pull, or toothed-wheel, coupling between measuring-range selector and multiple scale effects a positive change-over of the scale, along with the change-over of the measuring range, with the result that all risk of confusion is eliminated.

One of our illustrations shows the construction of the new revolving multiple-scale. A flexible roller, preferably a seamless fold-tube in spring-bronze, is arranged to revolve on an axle which is curved to correspond with the form of the scale as it must appear behind the window of the case. It is coupled

with the measuring range selector which is constructed in the form of a rotary switch. Surrounding the flexible roller, an elastic sheathing in either cylindrical or prismatic form is firmly connected with the fold-tube, and on this the numerals or divisions are marked. Thanks to its unique construction, the fold-tube has been found quite torsion-proof. It can be driven from one side, without twisting and there will, consequently, be no distortion of the divisions. The cylindrical revolving body is used when several rows of numerals must be interchangeable, while the prismatic form will be selected when not only numerals but also complete divisions must be changed.

Inventors Keep After Auto Improvements

ONE in five of the 43,000 patents granted by the United States during 1938 had an automotive application.

A total of 8268 of the patents granted related to the motor vehicle in some fashion. Not all affected the mechanical or exterior design of the car itself, many dealing with manufacture and repair, with parts, accessories, lubricants, fuels, as well as special machines and processes usable in car production.

Of these, only 349 were issued to automobile manufacturing companies. The automotive patents represented an increase of 1004 over the number granted in 1937, while the total volume of all patents granted was only 271 above the 1937 total.

Rubber Paint

A PAINT containing a rubber hydrocarbon is said to be especially suitable for chemical laboratories because it is not only decorative but also resistant to acids, alkalies, fumes, and moisture, according to the Fisher Scientific Company. Other claims are that the paint will not crack or peel at temperatures up to 350 degrees, Fahrenheit, and that it can be applied to wood, metal, plaster, concrete, or brick. Plicote, as the paint is known, is available in ten colors and white.

Compounded Wood Is New Milling Advance

THE old practice of veneering furniture, which turned out a mahogany table for five dollars, is back in a new and much more fundamentally important form.

Compounding wood, as the process of veneering is known to the trade, is now turning to the new field of making wooden beams which have all the uniformity of characteristics of steel and other metals. Do you wish a wood with a given density, a given elastic strength and other properties? Compounded wood is the answer and each time you place an order with the mills it comes through the same, time after time.

Wood unsuited for many construction purposes becomes the core of the plank and laminated layers supply the exterior. The proportions of each are varied so that the same characteristics can be repeated at will.

In part, the use of phenolic resins as the gluing agent in the finished board is the difference between older veneer panels and the new beams of technologic mill working. The various layers of wood are arranged in

"books," dried, coated with the resin, heated electrically, and finally pressed at proper temperatures into finished lumber.

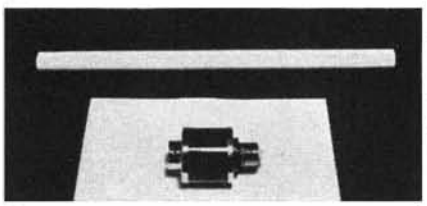
"These boards," states the *Industrial Bulletin* of Arthur D. Little, Inc., "meet predetermined specifications, with widths previously unavailable, and with a uniform adherence to specification comparable to that of the steel construction industry."

The resin used in the process impregnates the board with vapors which are obnoxious to fungi and thus the long-sought fungus-proof board is at hand.—*Science Service.*

"SCREW-SOCKET" FLUORESCENT

THE accompanying photograph shows a new type of fluorescent lamp, which may be screwed into the conventional electrical socket without special installation or wiring, as completed by the Duro-Test Corporation.

The new lamp will be marketed for commercial lighting as well as for certain types



The new fluorescent lamp, at top, and its bayonet-joint screw socket

of domestic illumination. It is estimated that all fluorescent lamps reduce current costs about 80 percent to give light equal that provided by the incandescent type of lamp. The tube itself, when it burns out, can be detached from the starting device which forms the part which screws into the socket. In addition, Duro-Test's new fluorescent starting device uses only 2½ watts.

BIRDS OF PREY MAY CARRY BUBONIC PLAGUE

BUBONIC plague, like other forms of death in these days, has apparently taken to air travel. Not on the man-made wings of airplanes, but on the wings of hawks, owls, crows, and other predatory and scavenger birds, says the U. S. Public Health Service.

The suggestion comes from William L. Jellison, assistant parasitologist at the Rocky Mountain Laboratory of the Service. Thirty years ago, Dr. W. C. Rucker made a similar suggestion, but limited it to one species of burrowing owl that shares habitations with ground squirrels and other rodents that carry fleas which are in turn the ultimate carriers of the plague germs. Mr. Jellison, however, greatly extends the list of suspected birds, to include two species of hawks, two of falcon, three of owl, and one species each of eagle, magpie, and crow.

All these birds prey abundantly on the plague-carrying rodents. The scavengers, like crows, devour their catches on the spot, but predators, like hawks and owls, carry the carcasses to their nests, with the possibility of distributing the fleas either on the way or after they arrive. In several cases, these flesh-eating birds were observed in attacks on rodents dead or dying of the plague.—*Science Service.*

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

Simplify Your Table-Topping

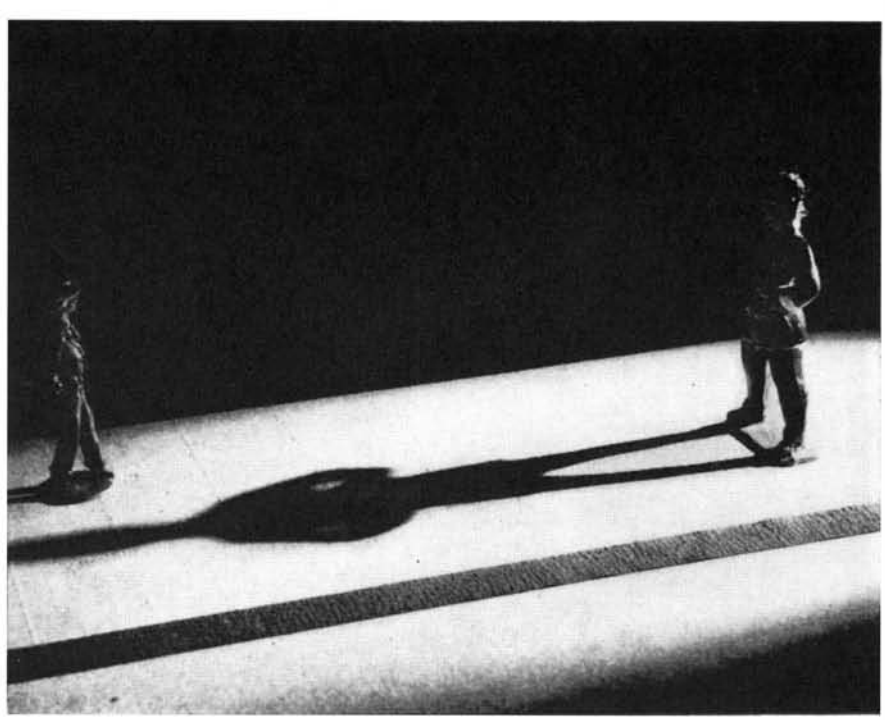
THE art of table-top photography is continually stressed by photographic writers as being one of the simplest of camera endeavors. Frequently, however, these same writers deliberately contradict themselves by introducing methods and illustrations not easily within the reach of the average amateur. Nevertheless, table-topping is a simple exercise when discussed from the point of view of the amateur worker. The truth is that there is table-topping and table-topping. In its most elaborate form it calls for trained, professional craftsmanship, as, for example, the miniature settings designed and executed for use in motion picture studios.

But, for you and me, table-topping means something else again. It means, actually, a clear space on a table upon which are arranged a number of simple odds and ends either found around the house, purchased in the five-and-ten-cent stores, or, if you are at all handy, made by yourself.

Your principal difficulty will be in providing suitable figures. If you can make them yourself, so much the better, but most of us cannot. However, the little iron and other toy figures in the stores will usually do the trick admirably.

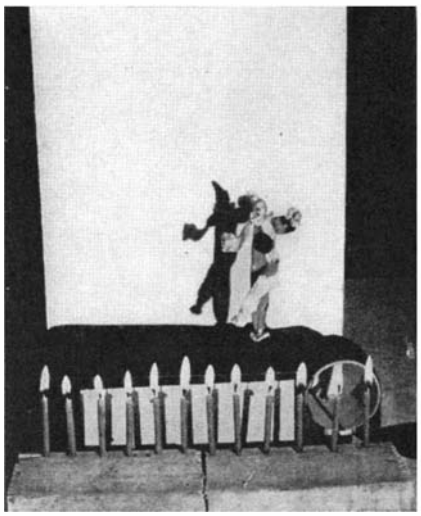
Another feature of table-top set-ups is the question of furniture. Occasionally it is possible to pick up miniature reproductions of furniture pieces, but the best procedure is to make the furniture yourself. This is not as difficult as it may sound. Ordinary cardboard will often serve the purpose and a column may easily be simulated with a small cardboard mailing tube or even a sheet of paper twisted round and held together with a strip of adhesive. An excellent medium for miniature furniture-making is balsa wood, now obtainable in home craftsman packages, comprising an assortment of

Above: **Making the set-up for "The Shadow of the Law," as described in the text and, *below,* the result**



balsa wood in several thicknesses and lengths.

"The Shadow of the Law" illustrates what can be done with a couple of iron figures bought in the five-and-ten-cent store. These consisted of a policeman and a strolling pedestrian. The objective was to arrange in a simple manner a street scene showing a policeman, whose body cast a long shadow down the sidewalk, while a civilian approached him from the opposite direction.



Set-up for "Performance"

A piece of cardboard was scored with a pen knife at one inch intervals over a space about four inches wide, and a strip of black Scotch tape separated this portion from the rest of the cardboard. Thus, when the light beam was directed at the low angle necessary for the projection of the long shadow, these depressions caught the light in characteristic texture fashion and provided the effect of separating grooves between the "stone slabs" of the sidewalk.

In order to complete the impression desired, no effort was made to continue any further in the matter of a set-up other than to provide a black void beyond the sidewalk edge. This was done by placing the cardboard on a black cloth and so arranging the light that very little of it reached this cloth. The spotlight used to illuminate the subject

Illuminated by one large candle to lower left of figure. No other illumination was employed for this

"Performance"

was, therefore, cut down in beam size through the use of a piece of cardboard in the center of which a hole was cut of approximately the diameter required to bring about the desired limitation of the illuminated area. In order to throw some light into the face of the policeman a reflecting screen covered with silver foil was placed as shown. This caught some of the light, and, by suitable angling of the screen, brought a little light onto the front of the policeman's figure that otherwise would have been dark. With the lens stopped down considerably, the exposure was about 20 seconds.

Given an interesting figure, several variations are possible with different lighting arrangements. This is illustrated in the figure of the costumed dancer, which is another 10-cent purchase.

Simulation of a stage performance by the dancing figure was accomplished by employing twelve tiny birthday candles set up on two wooden blocks before a "stage" consisting of a box covered with black cloth. For the background a sheet of light-toned cardboard was used. The twelve candles were lighted quickly one after the other just before the exposure was made because these tiny candles burn away rather quickly. To avoid including the lights in the field of view, as well as to prevent unwanted light reaching the lens and causing possible glare, the lighted candles were shielded from the lens with a cardboard blind. The presence of so many light sources caused a multiplicity of shadows to appear in the background but because one shadow was partially merged with the succeeding one and because of the large number of light sources, no one shadow was definitely apparent. If it is desired to show such a projected shadow, the best method is to use only one candle, a large one, placed to one side of the figure and at about the level of the small candles or even a bit higher, provided the flame is not included in the camera view.

Find Out For Yourself

THE value of experimentation was recently demonstrated by Ivan Dmitri, the famous color photographer and one of the judges in the Scientific American annual photographic competitions. Mr. Dmitri, in a

public lecture in New York City in which he described his experiences in shooting color pictures with his Leica camera, declared that he learned the proper exposure time to give under various lighting circumstances by making a series of experimental shots over a period of time. From the results he was able to arrive at what he describes as his basic exposure, namely, *f*/6.3 at 1/60 of a second. Where a higher shutter speed is required he simply runs down the scale and opens the lens wider in proportion to the speed required to stop the action involved, using the stop *f*/1.5 and a shutter speed of 1/500 or 1/1000 of a second when necessary. Similarly, in the case of subjects that are a bit too dark for the basic exposure set-up he opens his lens wider for the basic shutter speed.

There is much to be said in favor of Mr. Dmitri's method and it would repay every worker to set up some similar basic exposure method whether he shoots in color or black and white. Mr. Dmitri says that he hardly ever uses an exposure meter because his exposures have become standardized by his personal method of working. However, it must be remembered that Mr. Dmitri shoots entirely in color, using 35mm Kodachrome exclusively. Having used this over a long period of time, he has become thoroughly familiar with the results he can expect under various circumstances. For general photography an exposure meter would seem to be one of the musts in the photographer's equipment; however, the worker must train himself not to rely absolutely on this guide to correct exposure, but to think for himself as well, and to interpret the readings rather than to follow them without question.

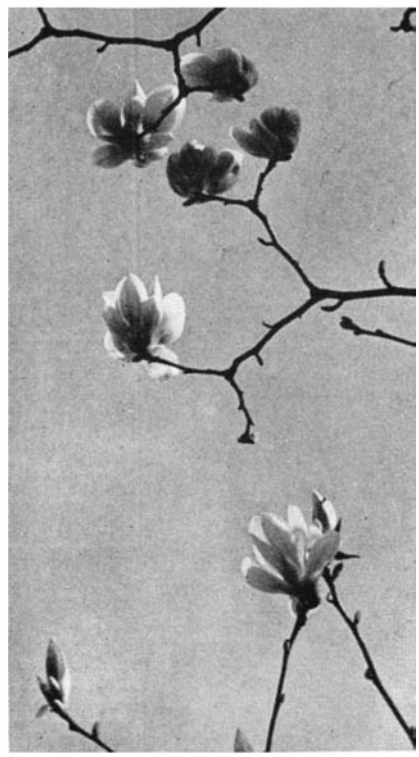
One of the surest ways of acquiring the ability to make such interpretations is to shoot a number of different exposures of the same subject under the same lighting conditions and then compare the results. Pick out the negative that seems to you to provide the type you want. If this was less or more than the actual meter reading, adjust your meter calculations accordingly. For example, if the meter said f/8 at 1/100 and your shot at *f*/11 seemed to give the better negative, all you will have to do thereafter will be to take one stop smaller than the meter dictates, adjust the shutter to twice the speed indicated, or use a different Weston rating for your film.

Color Department

RECOGNIZING the wide interest in color photography as something that is here to stay and to bring greater demands for supplies and information as time goes on, Willoughby's camera store in New York City has inaugurated a special department in its store manned by two color experts ready to answer questions and sell color materials and equipment. The management expects that this department will fill a real need and become one of the store's most active services.

Flowers in the Parks

ONE of the chief reasons for the failures experienced by amateurs in shooting pictures of blossoms and flowers is due to the fact that too much of the subject is included in the view. Of course, we know it is very difficult to isolate a subject in such a manner that it is made to stand away from the rest of the branch and still be appropriately lighted and have the sky for background. There is always some way out of the difficulty, even if it becomes necessary for someone to hold a branch in a certain position for the duration of the exposure or to hold obstructing branches out of the way



"Japanese Magnolias"

of a particular subject. Lighting is very important, for a promising subject will be missed completely if the lighting is unsuitable. One of the most effective methods is that of back lighting, illustrated in the accompanying picture of magnolias. Notice, too, that an effort was made to bring about a good balance in the composition by including the bud in the lower left-hand corner.

X-33 Fine-Grain Formula

UNTIL recently a closely guarded laboratory secret, the formula from which the developer X-33 is made up has now been disclosed by the makers. The formula follows:

Water (85° to 90°)	26 ozs.
Diotol F-R	120 grs.
Monotol F-R	82 grs.
Sodium Sulfite, Anhydrous	2¾ ozs.
Glycin	22 grs.
Sodium Phosphate Tribasic	45 grs.
Potassium Bromide, U.S.P.	3½ grs.
Add cold water to	32 ozs.

The chemicals are mixed in the order given, each thoroughly dissolved before adding the next. The solution may be used immediately after cooling.

Focusing Kink

WHEN working at fairly close range on a subject having considerable depth and which must appear sharp from front to back, difficulty will be encountered unless a certain well tried rule of focusing under such circumstances is employed. Suppose

the front of the subject is 20 inches from the lens and the back of the subject 30 inches from the lens, namely, a depth of 10 inches in all. In order to determine the point at which the camera lens must be focused, it is necessary first to multiply the two distances, namely, 20 by 30 and the result by 2, which comes to 1200. Next, add the two numbers, 20 plus 30 equals 50, and divide this into the first result, 1200. The answer is 24. Therefore, it is necessary to focus on a point 24 inches from the lens diaphragm or 6 inches from the back of the object. Focusing on this point is done with the lens wide open and the closing down of the lens brings both front and back of object into sharp focus.

Time Exposures at the Zoo

MANY persons are discouraged from picture-making in zoo interiors because of the poor lighting available. However, if one watches his chances he will frequently be rewarded with opportunities such as that encountered by this department in the alligator subject here illustrated. The alligators were as still as though carved in stone and a full, unobstructed view was afforded by the large window behind which they were enjoying their afternoon siesta. Because there was such a large shadow area, a relatively long exposure was required, especially in view of the stop *f*/8 that was required to bring the several subjects into sharp focus. An exposure of 20 seconds was made possible without the use of a tripod by resting the miniature reflex on a ledge and slightly tilting the camera by tucking the front of the eveready case under the camera.

"Alligator Siesta"

Kalart Contest

TWENTY-FIVE awards of $10 each are offered in a photographic contest sponsored by the Kalart Company, who will pay the total of $250 for the best pictures taken with a Kalart Micromatic Speed Flash. Closing date is December 1, 1939, and there are no restrictions as to type of flash pictures, time when taken, and so on. Print sizes should range from 2¼ by 3¼ inches to not larger than 11 by 14 inches. Enlargements and contact prints are both acceptable. Nega-

tives should not be sent until requested. The following data should appear on the back of each print submitted: Make of camera; lens; shutter used; shutter speed; lens opening; filter used, if any; film used; size and number of flash bulbs used and distance from subject; if taken in daylight, include position of sun and time of day. Entry blanks may be secured from dealers.

Shadow on Pattern

AN intriguing pattern such as that of the floor in the illustration would normally be lacking in picture interest, but add to it the lively shadow of the walking boy silhouetted against the bright sky and you have

"Patterns"

a subject worth shooting. The stop *f*/16 was used in order to get satisfactory sharpness from foreground to boy subject; the time being late afternoon, 1/25 of a second was the fastest shutter speed we could attempt. This was not sufficient completely to stop the movement of the boy's raised leg, but this does not appear to have seriously hampered the general effect.

Oval Table Elections

TWO recent additions to the Oval Table Society, Inc., of New York City, sponsor of several of the most important photographic shows in recent years, have been the election of Associate Members Nickolas Muray, the country's leading color photographer, and C. W. Gibbs, A.R.P.S., a man of the laboratories who has become widely known as a writer on photographic subjects. The Society's roster of some of the best known photographic workers in this country is thus increased by two names with enviable reputations.

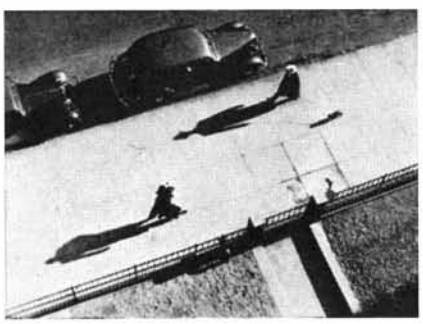
Argus Radio Program

A SERIES of transcribed radio programs featuring Karl A. Barleben, F.R.P.S., is being sponsored by the International Research Corporation under the title, "Today's Candid Story." The series is being used by photographic dealers in several cities throughout the country over their local radio

stations. The series is one of the first camera programs to be sponsored by a photographic manufacturer and presents the fast-action, true-life type of camera drama.

"Strolling Shadows"

OPPOSING shadows in a diagonal frame constitute the chief attraction of this picture shot from the seventh floor of our apartment house, and the little dog helps to fill in an otherwise barren space. The height being so great, we were obliged, by the focal



"Strolling Shadows"

length of our lens, to choose patterns that would compose satisfactorily in a large space. To this end, we watched the "strolling shadows" as they passed in and out of the area until the idea of opposing figures brought the answer to the problem and provided a picture in which the figures, though small, adequately filled in the space by the length of their shadows.

Spots on Sepia Prints

TO remove the stains and spots which occasionally appear on sepia prints, practical workers have found hydrogen peroxide to be fully effective. This is simply poured over the spots or stains or applied with a wad of cotton. A rinsing completes the job.

Cameras as Police Equipment

THE Beverly Hills (California) Police Department is now equipped to go after law violators both with gun and camera. Recently Police Chief Charles C. Blair, of that department, bought a number of Univex Mercury cameras for use by all officers of his department. Which prompts F. G. Klock, of the Universal Camera Corporation, to remark that he wonders "if the day isn't rapidly approaching when every city policeman and town constable will tramp his beat with a candid camera slung over his shoulder."

WHAT'S NEW

In Photographic Equipment

If you are interested in any of the items described below, and cannot find them in our advertising columns or at your photographic dealer, we shall be glad to tell you where you can get them. Please accompany your request by a stamped envelope.

Besbee Reel Clip (75c for box of 8mm, $1 for twelve 16mm): Designed for fastening movie film ends on any 8mm or 16mm projection reel, large or small. Clip is small, handy metal device, with spring fingers, which may be pushed easily between flanges

of any movie reel and holds film securely in place. Clip provided with matte outer surface, upon which film title, number or other distinguishing mark may be written in ink, crayon, or pencil.

19 POINT WILLOETTE ENLARGER ($39.50 without lens): Enlarges all size negatives from 35mm to 2¼ by 3¼ inches; uses standard 75-watt opal bulb; employs two 4½-inch condensers which can be removed for cleaning by loosening two screws; lamp house and throat of enlarger well ventilated; one-hand raising and lowering mechanism, with automatic brake to prevent slipping when desired height is reached, and screw knob for locking; swings in horizontal and vertical planes for correction or caricature; automatically returns to true vertical position by locking knob; distance from center of lens to column can be changed from 9¼ to 12½ inches; enlarger housing is separate unit which can be removed for storing away when not in use; design of enlarger throat gives ½-inch space to insert negative carriers from front; automatic centering of negative carriers; choice of metal negative carriers with guide pins for films in rolls; accommodates larger films, permitting enlargement of portion of larger negative; long extension leather bellows; rack and pinion focusing; detachable lens board for lenses of different focal length; swinging red filter; baseboard, combined with paper drawer measuring 14¼ by 15¼ inches, measures 17 by 21 inches; flush type toggle switch in side of cabinet; 30-inch steel chromium-plated column permits enlarging on base to 12 diameters with 2-inch lens, larger by projection over edge of cabinet or by tilting enlarger.

BEE BEE MONOTONE VIEWING FILTER ($1): Designed to give one-color rendition of scene to be photographed on panchromatic film. Filter made of dyed-in-the-mass glass; has no gelatin or plastic composition. About two inches in diameter.

SYNCHROSCOPE: Device for testing synchronization of camera shutter with peak intensity of Photoflash bulbs. Electrically operated from battery of any Kalart Speed Flash and does not require use of flash bulbs, film, or darkroom. Clear visual indication given of shutter timing efficiency. Device is fastened in front of lens and shutter by sliding adjustable crossed bars in camera track. Viewing window adjustable in height to center with lens. Gazing directly into front window while releasing synchronizer, two slits are seen as they quickly flash by in opposite directions. Synchronizer is properly adjusted if the two slits are seen end to end as one line. Electric lamp or daylight through open back of camera will show up the slits.

WILLO NEGATIVE CARRIERS ($1, 35mm; $2, 2¼ by 2¼ inches): Smooth, scratchproof "book" type negative holder device

made of durable, rustless Alleghany stainless steel, and available in two sizes to fit all standard miniature enlargers: 24 by 36mm (1 by 1½ inches) and 6 by 6cm (2¼ by 2¼ inches). Accurate design assures perfect masking to the practical dimensions of the negative. Removal and insertion of negatives made convenient by provision of a "lip" at the two free corners of the carrier.

ROCKER RINSER ($2): Device for washing prints and flat negatives in 15 minutes. Comprises 11 by 14 inch tray with open channels at four corners, divided by barrier into two sections, one of which is large enough to take prints or negatives up to 8 by 10 inches, and other taking sizes 4 by 5 inches and smaller. Under side of device fitted with off-center beam, on which unit rocks. In use, device is placed under faucet in flat sink or tub; stream strikes deflecting baffle on barrier between two print compartments. As one section fills with water, it tilts and second section starts filling. Water meanwhile runs out of first section through two vents at corners, agitating and flushing prints or negatives at same time. Rubber bumpers prevent noise.

SOLAR SPECIAL 4 by 5 Enlarger ($49.50): Designed to take negatives up to 4 by 5 inches. Diffused light source is principal feature. Lamp house counterbalanced to permit one hand operation in raising and lowering. Enlarger furnished complete with roomy baseboard.

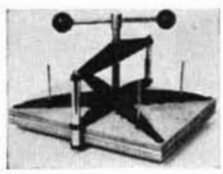
LEITZ FILM TANK: For loading bulk 35mm film in full daylight into camera magazines. Accommodates bulk load of 300 feet of 35mm film. Loading done simply by turning conveniently located crank. Film safeguarded against scratching or fogging. Constructed to take Leica camera magazines, but also useful in loading Contax magazines.

CURTIS COLOR SCOUT (with Goerz Dogmar *f*/4.5, 7½ inch lens, three registered holders, lens shade, carrying case, and three dozen loads of sensitive material, $325; same outfit with Bausch and Lomb IIb Tessar *f*/6.3 in Compur shutter, $280): New, two-mirror, three-color camera, that provides 2¼ by 3¼ negatives. Weighs 5 pounds; with lens and one dozen loads of film, total weight 7 pounds. Size of camera comparable with 2¼ by 3¼ reflex camera. Constructed entirely of aluminum alloys, embodies features making for precision of register, color balance, freedom from internal reflections and flare, maintenance of even illumination of the three emulsion apertures, convenience

and speed of operation as well as compactness and light-weight. Fitted with Curtis Diafon mirrors, which, manufacturers claim, eliminate refraction or double image and have highest reflection-to-transmission ratio of any beam-splitting device. Register accomplished by micrometer adjustment of mirrors in novel optical arrangement. Camera successfully employs, according to manufacturers, film-pack without registration difficulties.

FEDCO TONE CONTROL FILTER ($1): Made of cobalt blue glass, optically ground and polished. Can be used indoors and outdoors for checking tone contrasts. Reduces degree of illumination to point where delicate shadow gradations are clearly visible. Complete in carrying case with silk neck cord.

WILLO PRINT PRESS ($10): Takes print sizes ranging up to 11 by 14 inches. Notable chiefly for pressure equalizing arrangement, consisting of center spiral type post which propels pressure board up or down by simply twirling balancing ball at end of horizontal control bar. Ball is touched lightly with tip of finger and thus moved steadily around; final grip on cross bar tightens device and firmly "sandwiches" prints between pressure board and bed. Four metal guide posts set into four holes equidistant from center post and varying in position according to size of prints —4 by 6 inch, 5 by 7 inch, and 8 by 10 inch. Prints 11 by 14 do not require guide posts. Bed and pressure board made of seasoned laminated five-ply wood ¾ of an inch thick, proof against warping. Overall measurement of bed and pressure board 12 by 15 inches.



FEDERAL #245 PHOTO ENLARGER ($39.50): Sold complete with *f*/4.5 anastigmat lens mounted with iris diaphragm. Model #230, same as #245, but with *f*/6.3 lens, $34.50. Features: combination condenser and opal illuminating system interchangeable; micro-lever focusing; new negative carrier for use with either dust-proof metal frame or glass; adjustable metal mask eliminates need of separate masks and takes negatives from miniatures up to 2¼ by 3¼ inches and intermediate sizes; linear enlargement from two to eight times on baseboard, larger on floor; polished steel 36-inch rigid round post; machined parts accurately alined; large double ventilated lamphousing. Operates on AC or DC. Accessories include filter attachment, one 25-watt projector lamp, control switch, cord and plug.

LAFAYETTE HI-LO PHOTOFLOOD SWITCH ($3.89): Designed to prolong life of Photoflood lamps, reduce heating, and minimize glare for subject. Takes up to four Photofloods. With switch on "high," illumination normal; on "low," lamps automat-

ically placed in series across line, each lamp receiving part of total line voltage. At this reduced voltage, lamp life increased to several hundred hours instead of usual two to six hours. Reduced illumination is ample for focusing. "High" value needed only for determining best placement of lights and when actually shooting pictures. Entire unit enclosed in steel box four inches square, two inches high. All current carrying parts rated to handle 1200 watts.

CROSLEY CAMERA PRESS JR. MODEL (Complete with reflector and steadying handle, $7.95): New camera design and construction. Back of camera curved to bring 35mm film to good plane of focus. High-lights: universal focus, no adjustments required, with usable depth of field three feet to infinity. Built-in flash bulb synchronizer and battery supply. When button is pressed to make exposure, flash bulb is automatically flashed. Automatic film transport. Automatic locking device prevents over-winding. Camera loaded in 10 to 20 seconds. Automatic counting mechanism. Makes eight 35mm exposures to the roll. Available in black and aluminum finish. Measures 4 inches long, 3¾ inches wide and 2⅜ inches deep.

THALHAMMER THRIFTY-10 ($10; Head or tripod alone, $5.50 each): Tripod and pan head combination. Tilt-pan head has natural satin finish, incorporating Thalhammer "Instant-On" Plug. Tripod made of selected, seasoned wood, finished in clear lacquered metal parts, polished, or coated with black enamel. Head or tripod may be purchased separately.

MINI ELECTRIC EXPOSURE METER ($12.50, with neck cord and a copy of "exposure meter manual" with film speed insert): Measures 1⅞ by 2½ by ¾ inches, weighs 3½ ounces. All moving parts fully enclosed. Small hinged flap protects sensitive cell when meter not in use. Mini is pre-set for any given film and shutter speed (or cine frames per second), no further adjustment being necessary until change is desired in one of these factors. Meter indicates proper stop to employ. Cell is placed at acute angle, thus excluding top light influence. Protecting flap folds down when meter is in use, eliminating reflections from foreground, when using meter on snow, water scene or similar subject. Black finish with silver figures. Necessary figures large and clear.

JACK POWELL ETCHING SCREEN (11 by 14, $3.50; 8 by 10, $2.50; 5 by 7, $1.50): Designed to add texture to photographic prints. Styles include Renaissance for transforming ordinary portrait or landscape into "Old Master"; Jack Frost matrix for crystal pattern; tapestry for distinctive textured quality; bromoil for imitating bromoil process; paper negative to cause picture to assume air brushed or charcoal appearance; Steeline to impart effect of fine steel engraving, and Freeline etching screen that gives the snap of a hand-etched print.

CAMERA ANGLES ROUND TABLE

JACOB DESCHIN, *conductor of our "Camera Angles" department, will answer in these columns questions of general interest to amateur photographers. If an answer is desired by mail, enclose a stamped, addressed envelope. Queries should be specific, but Mr. Deschin cannot undertake to draw comparisons between manufactured products nor to advise on the purchase of equipment or materials.*—The Editor.

Q. **I am in the market for a 35mm. camera and would like your unbiased opinion on the following: I have narrowed the field down to include three cameras, two with Compur shutters to 1/500 of a second and the third with focal plane shutter speeds to 1/1250. The first two are equipped, respectively, with an *f*/2 and an *f*/2.9 lens, and the last with *f*/2.8 lens. All have coupled range finders. I would like to take pictures under adverse conditions, including indoor and night shots. I would appreciate your comparison of the three cameras, including the following: Shots possible with *f*/2.9 lens and its limitations, quality of lenses, advantages or disadvantages of the two kinds of shutters, whether 1/1250 of a second can be used with an *f*/2.8 opening. I would also appreciate the names of better quality cameras in the same price class and also the names of enlargers.—S. J. S.**

A. It would need a Solomon greater than he of the Bible to tell a man what camera he should buy, so many are the variables and so much depending on the individual's requirements and his personal taste. It seems to us that probably the best adviser on this score is the local photographic dealer. Usually he has no axe to grind; he sells all kinds of cameras and he would just as soon sell you the one as the other. Let him give you the benefit of his experience, based on his contact with the many persons to whom he has sold cameras in the past. The three cameras you mention all have their good points and all will make good pictures once you learn how to use them.

Pictures under adverse lighting conditions may be taken with any lens provided you allow enough exposure. Even moderate snapshots can be made in poor light if this light is sufficiently close to the subject and your film is of the "super" type. Under certain "adverse" lighting conditions, even a lens of *f*/1.5 speed will be inadequate.

On the question of lens choice, see our reply to J.G.B., June issue; the *f*/2 you refer to may possibly have a little "edge" on the others. If very high shutter speeds are what you want, you will find the focal plane shutter preferable on this account. Many prefer the Compur because it has a tradition of reliability. Nevertheless, some of the highest priced and most efficient instruments on the market today have focal plane shutters and are none the worse for being so equipped. The use of very high shutter speeds is entirely a matter of the amount of light available for photography and the sensitivity of the film emulsion in your camera. Therefore, a 1/1250 exposure at *f*/2.8 or even smaller stop is entirely possible; generally, the necessary light volume will be available only when shooting outdoors on a bright day.

As to your last request, you may find the answer by making a tour of the photographic shops or by writing to the manufacturers and dealers whose advertisements appear in these columns.

Q. **1.—I have read statements of certain professionals who mentioned that they had bought a Contax and had it thoroughly checked by Carl Zeiss before they went to work with it. Does this mean that some lenses of the Sonnar *f*/2, 5cm specifications, for instance, are capable of better results because of the greater accuracy in manufacture? If so, will Carl Zeiss check any purchaser's camera, so that he may feel confident that, from the equipment standpoint, Toni Frissell has no better chance of getting a sharper negative than himself? 2.—Is there any possible way of obtaining a sharper projected image for enlarging than using my Sonnar *f*/2, 5cm lens in the Magniphot enlarger? Is there meant to be any adjustment on the light source in this enlarger, or is it fixed? Have you ever seen a direct enlargement made from any 35mm negative to the tremendous size of Toni Frissell's exhibit prints? Even considering intermediate negatives, how is it possible to preserve such hair-line detail? And where did the grain go? 4.—Who makes the enlargements for the Zeiss and Leica exhibits?—H. W. E.**

A. 1.—Carl Zeiss or any other company will gladly check the accuracy of a camera lens for the mere asking. The reason a purchaser desires a check-up is due to the natural feeling that a camera handled on a store

counter, perhaps dozens of times before the actual purchaser came along, may have been slightly mishandled by inexperienced hands. A professional photographer must be sure of results from the start, particularly if he is about to undertake an important assignment. Even if he wishes merely to try it out for a while before actually getting to work with it, he wants to be certain that he is starting off on the right foot and that if there is something wrong with the results, it is probably due to his unfamiliarity with the workings of his camera. Provided you operate the camera properly, your negatives will be just as sharp as those made by Toni Frissell or any other experienced professional worker. The lens that you get with your camera is not a whit better or worse than a similar one furnished to Toni Frissell.

2.—The sharpness of the projected image is governed by the precision with which you focus the image on the easel and your Sonnar will give you this sharp image if you focus carefully and accurately. The light source is adjustable as to distance from the negative holder.

3.—We have seen prints of this size and even much greater made from a single 35mm negative. The preservation of detail and the lack of visible grain are due entirely to good processing throughout, from the development of the negative to the final printing. We have it on the word of the Zeiss people that the Frissell enlargements were made directly from the 35mm negative and that intermediate negatives were not used. In fact, they add, direct enlargement is one of the chief contributing factors to that preservation of detail and tone gradation which you admired.

4.—The enlargements for both the Leitz and the Zeiss exhibitions are made by the individual photographers themselves. The possible exception is in the case of duplicate prints for traveling exhibitions or when the company has acquired a negative as the result of a competition or otherwise. The large murals are naturally made by an outside finisher because the average photographic worker does not have the facilities for turning out prints of this size.

***Q.* I have a Rolleicord *f*/3.5 and would appreciate advice as to what lens opening and distance to set for fixed focus exposures.—W. L. P.**

A. If you will set the distance at 10 meters and close down the lens diaphragm to *f*/11, everything will be in focus from five meters —that is a little over 16 feet—to infinity. The stop *f*/16 will give you a still deeper field of focus, namely, a little under 12 feet as the closest distance when the meter scale is set at about seven meters.

***Q.* I recently constructed a small print dryer similar to commercial dryers, topped with a curved chromium plate and covered with a removable piece of canvas. Heat is supplied by two 100-watt electric lights in the interior. The dryer works well when ferrotyping glossy prints, but causes matte prints to wrinkle all around the edges. Is there any way that this wrinkling can be remedied? The first batch of prints, by the way, usually does not wrinkle, but the following batches do.—W. H. B.**

A. Application of too much heat is probably the reason for the wrinkling of the edges of the matte prints. Since the first batch of prints does not wrinkle, it is suggested that you attempt to determine the approximate temperature at which the first batch was dried and try to maintain this heat, as nearly as possible, for the succeeding batches.

***Q.* Is there any difference in performance, other factors being equal, between filters of the stained optical-glass type and the gelatin-cemented-in-glass type? Cemented gelatin light filters are frequently described as being available in A glass or in B glass. Just what is the difference between A glass and B glass? What, in a practical sense, is the importance of this difference in general photography?—J. A. R.**

A. So far as performance is concerned, there is practically no difference between the stained optical-glass type and gelatin-between-glass types of filters. The principal difference lies in the fact that inasmuch as in the one case we have a solid, colored disk of glass, and in the other we have a piece of soft gelatin between two protecting cover glasses, the latter is obviously susceptible to certain hazards from which the other is free. Among these hazards one must include the facts that the latter may not be exposed to the sun for too long a period, must not suffer too great pressure, and must generally be given greater care than the solid glass type. The A glass consists of so-called "optical flats," of the highest quality but too costly for general photographic use. The B glass filters are the most generally used and are satisfactory for regular photographic purposes.

***Q.* Will you please give me what information you have on the subject of enlarger adapters for conventional cameras? I am informed that such an adapter, when properly adjusted upon the ordinary camera, with back removed, yields quite satisfactory enlargements. The camera lens, of course, serves to expand the image and, for this reason, the cost of the device is relatively low in comparison to the prevailing prices of regular enlargers.—G. W., Jr.**

A. There are available such enlarging attachments, permitting the owner of a camera equipped with a removable back, to convert his camera into an enlarging outfit by attaching the enlarger housing unit and negative holder. The projection of the image is usually horizontal instead of the popular vertical arrangement employed with regular enlargers. The cost of such a unit is considerably lower than that of a regular enlarging outfit, but it is significant that these units are not especially popular, workers generally preferring the complete outfit rather than an adapter.

***Q.* I would like to learn how to develop my own pictures. Could you give me a list of what I would need and directions?—J. N.**

A. A number of developing kits are available containing the necessary equipment and supplies for developing negatives and making prints from them. These kits also include a short explanation of the photographic process and directions for developing and printing. In addition, it is suggested that you obtain a copy of an inexpensive elementary handbook, which your dealer can supply for 25 or 50 cents.

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TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

FEW refracting telescopes are made by amateurs—perhaps because of the time and accessories needed, but largely, it is suspected, because in earlier years when amateurs regarded optical work with awe and mystery a tradition that objective lens-making was very advanced work became established and has not yet been scotched. Yet, whenever someone who has made one

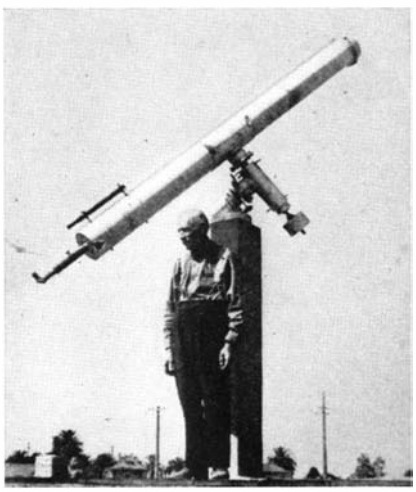


Figure 1: Garrison and refractor

writes to this magazine, he never mentions any especial history of trials, tribulations, and headaches. The job, with its four surfaces to work, is a bit tedious, and probably should not form the beginner's maiden optical work, but for all its tedium it is not more *difficult* than reflector making. The working tolerance, in fact, is not so close. It is suspected also that in earlier years many who dared not tackle a refractor convinced themselves, because of this fear, that the reflector was superior. But most persons who are honest with themselves and who know both instruments do not say this. Each type has its superiorities, one superiority for the refractor being much steadier images.

In Figure 1 is an 8″ refractor made by H. P. Garrison, R.F.D. 1, Oceanside, Calif., working from the very detailed instructions by Haviland in "ATMA", the companion volume to "Amateur Telescope Making".

"The objective lens," Garrison writes, "was made from a pair of Chance Brothers hard crown and dense flint, ground to a focal length of 134″, or *f*/16.75. I spent much time regrinding and polishing five times, but I did not mind that because I was learning all the time. Now I have a lens that will stand 75 diameters' magnification to the aperture inch when the seeing is good, and I feel I am very well repaid for the extra work.

"The mounting is made from Chevrolet truck parts, steel pipe, and boiler plate, and the axes are mounted on ball bearings. The tube is of 20-gage galvanized iron 8½″ in diameter.

"The mounting works very smoothly but, in the wind, as shown in the illustration, taken before a 14′ by 14′ roofless observatory with 6′ walls was erected, it was very shaky.

"The cell, Figure 2, is made of aluminum cast in one piece, and is held in place by means of brass clips. This permits removal of the lens without disturbing the adjustment."

FRAMED attractively in the twigs of a neighboring tree, as shown in Figure 3, stands the huge, 137′ dome for the 200″ telescope, atop Mt. Palomar, California, with the great mounting inside practically ready to receive the big mirror next year. This artistic photograph was taken by Ted Watterson, official photographer at Mt. Palomar.

Figure 4 is a 1/340-scale replica of the same great dome, cast in brass and aluminum by Fred Ferson, 404 Reynoir St., Biloxi, Miss., author of the chapter on molding and casting in "ATMA". The patterns were made by Russell W. Porter and presented to Ferson, a friend. Ferson then poured the castings, machined them, and finished them to a degree of neatness that makes of this replica a most attractive desk, or other, ornament—suitable also for adaptation as a cigaret humidor, ash receiver, or other utility. Ferson hopes to install in some of these replicas a model of the 200″ telescope itself, if there is enough demand.

The base is 8½″ in diameter, is made of brass, weighs about six pounds and is lettered "Two-hundred Inch Telescope Observatory A.D. 1940." This brass base includes an integral standing collar part reaching upward as far as the bead seen above the entrance doorway. The upper portion is cast

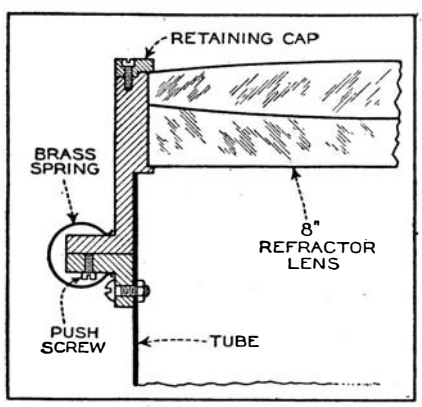


Figure 2: The clip-attached cell

in aluminum, contrasting attractively in hue with the brass base, and consists of a hollow spherical dome 5⅝″ in diameter, to which an accurate replica of the shutters is attached fixedly. This upper portion may be rotated, as on the original, also lifted off to get at the interior, which is machine-finished.

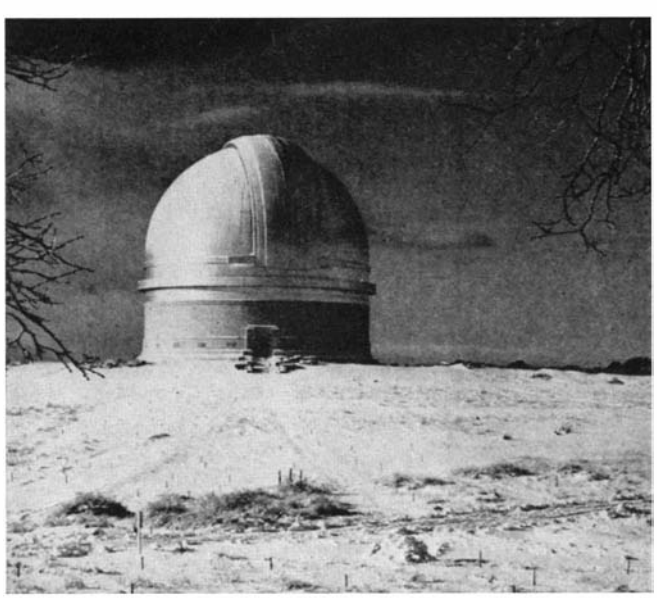


Figure 3: Big dome at Mt. Palomar

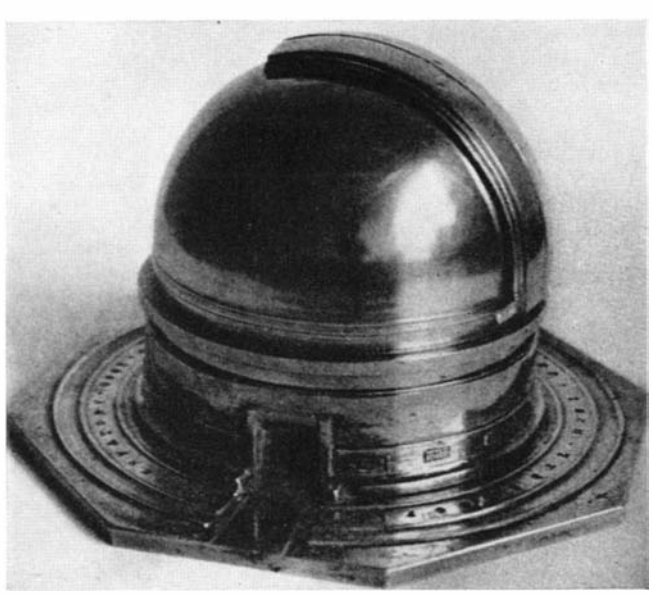


Figure 4: Ferson's big-dome replica

Sharp-eyed comparisons will reveal that the entrance door in Figure 2 differs from that in Figure 1, the original. These, however, are different doors and on different sides, the door in the replica being the huge one for the introduction of the big mirror and the other merely for the introduction of the astronomers.

In Figure 5 are two lesser items cast by casting-enthusiast Ferson. The larger is a

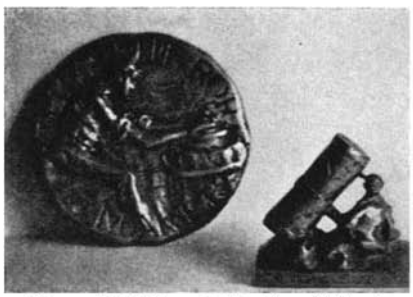


Figure 5: "Mirror Maker" and "Nut"

34-ounce brass plaque, 5″ by ⅜″, made from a pattern by Porter who, when visiting at Ferson's home, poured plaster of Paris into a metal ring and with his jack-knife quickly whittled in bas relief in the soft plaster the cartoon of the "Mirror Maker" sweating and straining at his work of preliminary polishing. The smaller piece (32 ounces) is a brass "Telescope Nut" peering into an eyepiece from an awkward seated position, and was cast by Ferson from a pine pattern whittled out by Porter. The two photographs on page 337 of "ATMA" show Ferson with Porter smiling at the camera.

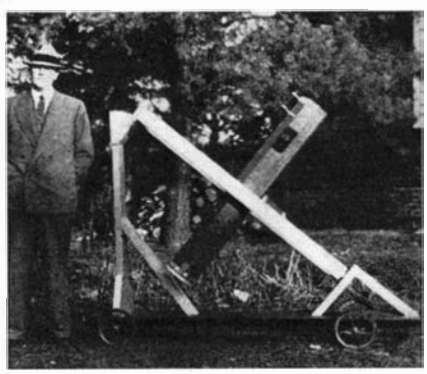
STELLAFANE'S annual convention or informal get-together of amateur telescope makers and astronomers will be held atop Mt. Porter, near Springfield, southeastern Vermont, on Saturday, July 22. All having interest in astronomy or telescopes may come freely and bring families, friends. They will find about 200 others similarly afflicted (that is, telescopitis, families) sitting on grass or hard outcrops of Vermont Jurassic schists ready to swap chin-music about telescoptics from noon to six. Then comes supper en masse in a big circus tent (about a dollar). At dusk, reports and speeches by amateurs from hither and yon begin and wear on till all are unconscious; following which those who revive may stay all night, using Stellafane's telescopes and those brought by visitors—bring yours. Good parking. Places to camp. Bubbling spring. Scenery. Air. Not a mosquito.

IN February 1938, in these pages Clyde Tombaugh of Lowell Observatory, described his sun telescope: a 12″ mirror, unsilvered, a right-angled prism with diagonal face turned directly toward the mirror, thus diverting some 93 percent of the light away through the other faces, and a pair of smoked glasses worn by the observer—the overall reduction in these three cutting the solar light to 1/7500 strength and thus permitting comfortable study of the solar surface. In April of the same year D. Everett Taylor told how to make a Herschel wedge of the general kind described by Bell, in "The Telescope," for use on Sun, Moon, and Venus, this being an attachment between telescope and eyepiece designed to divert or throw away 95 percent of the light by means of a thin, wedge-shaped elliptical

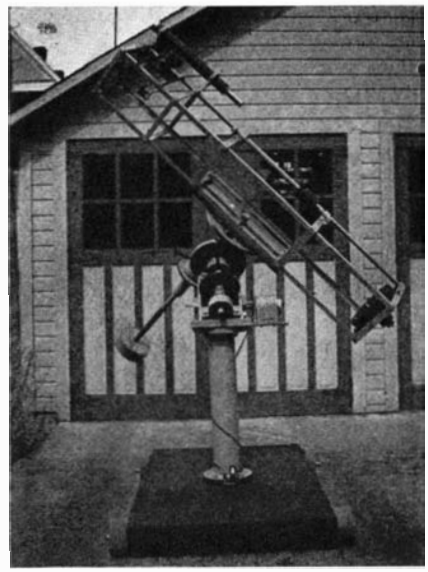
THE BEGINNER'S CORNER

PORTABILITY around a yard but no farther is often desired in a telescope and the two shown here were designed for that purpose; they are mounted permanently on wheels. The one at the left is a 6" reflecting instrument built by Robert M. Peterson, 455 Seminole St., Oradell, N. J., apparently with cart or perambulator wheels as its base. The mounting is the regular double yoke type, which is very easy to build and very solid. The tube shown is octagonal, made of wood, an excellent substance for a telescope tube—better, many think, than metal because a slow transmitter of the heat effects which deteriorate optical images.

The 9" reflector at the right is far heavier —700 pounds. Here the only desire was to wheel the telescope no farther than out of a garage and a few feet distant on solid paths. Irving H. Friend, 40 Cooper St., Torrington, Conn., is the maker of this instrument. The tube is square and built of angles and welded bands—very rigid. Where a mirror is in the open, as this one is, a pair of cloth sleeves may be slipped temporarily over the ends—say, if your neighbor turns on a bright light nearby, for stray light makes trouble. This particular telescope has a Telechron motor drive in right ascension but the beginner may safely forget this refinement. However, he may well study the cleanness of this piece of workmanship.



Peterson and his portable mounting



Friend's semi-portable mounting

TELESCOPTICS

(*Continued from preceding page*)

8 or 10 degree, plate glass prism.

Alan Gee, "ATMA" p. 320, a cadet at the United States Military Academy, West Point, N. Y., in rummaging round the previously unused but recently rehabilitated observatory there, ran across the item shown in Figure 6, an old polarizing diagonal of considerable value, and at our invitation he describes it as follows:

"A diagonal employing the principle of polarization by reflection to cut the Sun's light and heat down to a minimum without cutting the aperture (see Bell, "The Telescope", pp. 167-8) gives beautiful colorless views of the Sun. The following is a description of such a diagonal (probably made by Alvan Clark about 1880) as used on a 12" refractor of 180" focal length at full aperture.

Figure 6: **The polarizing diagonal**

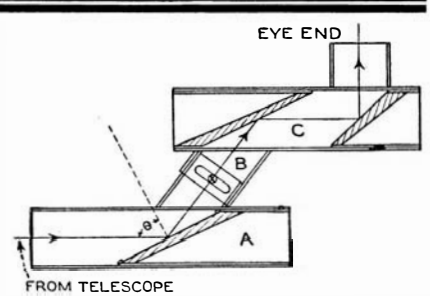


Figure 7: **A longitudinal section**

"The construction of this diagonal is very simple. It consists essentially of three wedge (Herschel) prisms, two of which are so mounted that the incident and reflected rays to each make angles of about 57 degrees with the normal to the reflecting surfaces and thus are plane-polarized. The third wedge is intended to increase the available light range and to get a favorable observing position, and is mounted just in front of the eyepiece like an ordinary diagonal. Figure 7 shows the arrangement schematically, and Figure 8 as it appears in use. The tubes of the diagonal are of brass, soldered at the necessary angle. The two separate parts of the diagonal—the lower part *A*, (Figure 7) carrying one prism and attaching to the 'scope, and the upper part *C* carrying two prisms and the eyepiece—rotate with respect to each other about the short connecting tube *B*. This rotates the planes of polarization and thus controls the amount of light

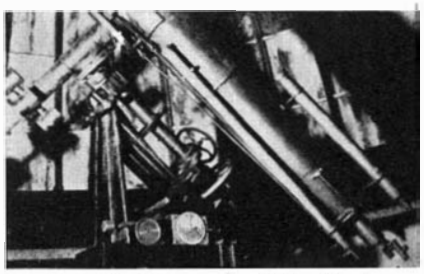


Figure 8: Diagonal on 12″ refractor

passed on to the eyepiece and eye.

"For minimum light," Gee continues, "tube *C* would be perpendicular to tube *A*, as shown in Figure 6; for maximum light they would be parallel, as shown in Figure 7.

"The wedge prisms in this particular diagonal are mounted against soldered shoulders in separate pieces of tubing that slide into the soldered tubes forming the angle. This simplifies construction and allows removal for cleaning.

"The angle the wedges must make with the incident ray is a function of the index of refraction of the glass used. The equation, *tangent* $\theta=\mu$, where θ=the angle between incident ray and normal, and $\mu=$

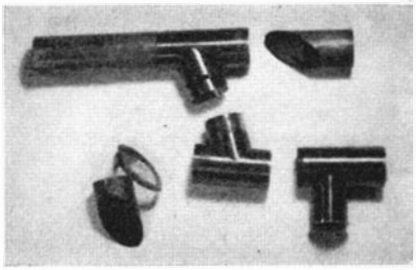


Figure 9: The diagonal dissected

index of refraction, gives the exact value of the angle. For ordinary glass ($\mu=1.55$, approx.) the angle is 57°. As all the incident rays are not parallel, anyway, this is close enough for most conditions. However, if a particularly light or dense glass is used, the exact angle should be calculated.

"Silvered surfaces or the like will not polarize by reflection, although colored glass will. Black glass can be used in place of wedge prisms if available, but should be used with the third wedge of clear glass to discard extra heat. The new polarizing materials now on the market, usually consisting of thin sheets that polarize by transmission, are not suitable for a diagonal. They pass the violet and deep red (and most of the heat) even when set for extinction, and thus are but little superior to any colored filter. Nicol prisms will work if available but are far too expensive.

"The biggest advantage of this type of diagonal lies in the fact that it cuts down the light (and heat) without cutting the aperture and without coloring the image. No colored glasses are needed. The Sun appears perfectly white and can be rigidly controlled in brilliance simply by rotating one tube with respect to the other. The difficulties of construction should not be great, the optical surfaces representing most of the work. If used on a reflector one of the wedges mounted at the required angle could well replace the main diagonal, the other being mounted before the eyepiece. The beautiful views that such a set-up gives of the 'rice grains', spots, and faculae on the Sun surely make it worth considering."

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LEGAL HIGH-LIGHTS

Patent, Trade Mark, and Related Legal Proceedings That May Have a Direct Effect on Your Business

By ORSON D. MUNN, Litt.B., LL.B., Sc.D.
New York Bar
Editor, Scientific American

RETURN MATCH

THE maxim "If at first you don't succeed, try, try again" does not apply to patent litigation. If, in a suit filed by a patentee against the manufacturer of an article, it is decided that the patent is invalid or not infringed by the article in question, the patentee cannot relitigate the same question in a suit against a customer of the manufacturer charging that the same article infringes the patent.

This principle was recognized by the United States Supreme Court many years ago in a suit in which an injunction was granted against a patentee restraining him from suing the customer of a manufacturer after it had already been determined in a prior suit that the manufacturer did not infringe the patent in question.

More recently the principle was reiterated by the Circuit Court of Appeals for the Fourth Circuit in a suit in which the Court held that a patentee was estopped from charging that the customers of a manufacturer were infringing the patent in suit when it had been determined in a prior suit against the manufacturer that the articles produced and sold by the manufacturer did not infringe the patent. In this connection the Court stated:

"In such case we think that the patentee is estopped by the judgment in favor of the manufacturer from recovering damages on account of infringement from persons who have purchased from the manufacturer the articles which are alleged to infringe but which in the judgment have been held not to infringe."

FOREIGN INVENTION

WHERE a patent is obtained in the United States by a non-resident who developed the invention abroad, the question frequently arises as to the date of invention to which the non-resident inventor is entitled. In other words, under our patent law, is the non-resident inventor entitled to the date on which he conceived, developed and reduced the invention to practice abroad, or is he limited to the date on which he first introduced the invention into the United States? Arbitrary and illogical as it may seem, it nevertheless is a fact that, if the question arises in a proceeding between the non-resident inventor and an infringer owning a patent or a patent application covering the same invention, the non-resident is only entitled to prove the date on which he first introduced the invention into the United States, whereas, on the other hand, if the question should arise in a suit brought by the non-resident against a person who does not own a United States patent or patent application, the non-resident is entitled to prove his date of conception and reduction to practice abroad.

This is illustrated by a decision of the United States Supreme Court in a suit for patent infringement brought by a resident and citizen of Japan against an American company. One of the patents in suit was applied for in the United States in January, 1922. It was proved by the American company that it had used the invention covered by the patent in commercial operations since June, 1921, almost a year prior to the filing of the patent application. However, the American company did not obtain a patent on the invention. It was held that under those circumstances the Japanese was permitted to prove that he had conceived and reduced the invention to practice in Japan in 1919 which was prior to the commercial use by the American company.

The Court pointed out that if the American company had obtained a patent in the United States the Japanese would have been precluded, under the American patent law, from proving his dates of conception and reduction to practice in Japan and would have been limited to the filing date in the United States as his date of invention. Under those circumstances, the patent would have been invalid because of knowledge and use in the United States prior to the proved date of invention by the Japanese. This rather arbitrary distinction as to the rights of a non-resident inventor against an American patentee on the one hand and against an American who does not own a patent on the other hand places a penalty on an American who does not obtain a patent on an invention. The Supreme Court recognized the arbitrary character of this distinction but said that it could only be corrected by legislative action since the courts were bound by the patent law as enacted by Congress.

In this connection the Court stated:

"We have no way of knowing whether the discrimination results from inadvertence or from some undisclosed legislative policy, but, in order to redress the disadvantage under which one in the petitioner's situation suffers, we should have to read into the law words which plainly are missing. We cannot thus rewrite the statute."

VINYL RESIN

WHEN does the substitution of one material for another constitute invention? Ordinarily the substitution of one material having known characteristics for another material having similar characteristics does not amount to invention even though improved results might be obtained. However, where the substitution of one material for another produces a new and unexpected result or where it solves a problem of long standing in the art it is held that the substitution constitutes invention.

The principles of law set forth above are relatively simple but the application of the principles to any particular set of facts is quite difficult. The difficulty presented in such cases is illustrated by a recent suit brought against the Commissioner of Patents to compel him to issue a patent for an improved package or container. The package consisted of a metal container having a coating or lining formed of vinyl resin for the purpose of protecting food products packed therein. Other coatings or lining materials had been used on metal containers and it was argued by the Commissioner of Patents that the substitution of the vinyl resin coating for other types of coatings constituted a mere substitution of materials and did not amount to invention.

The Court found, however, that for many years it had been recognized that it was desirable to coat metal containers for food products with some type of material that would protect the food product from the action of the metal. However, no satisfactory coating material had been developed for metal foil used in packing cheese or for metal containers for beverages. The Court found further that the use of a vinyl resin coating material for these purposes solved the problems of the prior art and provided a satisfactory package that could be used with all types of food products. The fact that the substitution of one material for another resulted in solving a problem of long standing in the art was considered by the Court to be proof of the fact that the development of the package constituted invention and warranted the granting of a patent.

PERSONAL PERFORMANCE

A MUSICIAN or other interpretive artist may control the use to which electrical transcriptions of his renditions may be applied. This is illustrated by a suit brought by an orchestra leader against the proprietor of a radio station to restrain the unauthorized broadcasting of electrical transcriptions of renditions by the leader's orchestra.

The orchestra had made certain electrical recordings to be used on a specific radio program and the records contained a notice that they were to be used for that purpose only. The proprietor of the radio station used the recordings in connection with an unauthorized program and the leader of the orchestra filed suit to restrain such unauthorized use.

The Court granted an injunction, holding that the renditions and interpretations of musicians were property and that the musicians had the right to restrict the use thereof. In its opinion, the Court stated:

"The great singers and actors of this day give something to the composition that is particularly theirs, and to say that they could not limit its use is to deny them the right to distribute their art, as they may see fit, when they see fit. Surely, their labors and talents are entitled to the privilege of distribution, especially where, as here, the privilege is subject to definite terms and bounds."

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For MEN

who want to become independent in the NEXT TEN YEARS

IN the Spring of 1949 two business men will be sitting in a mid-town restaurant. "I wonder what's going to happen next year," one of them will say. "My business is fine now—but the next few years are going to be hard ones, and we may as well face the facts."

The man across the table will laugh.

"That's just what they said back in 1939," he will answer. "Remember? People were looking ahead apprehensively—and see what happened! Since then there has been the greatest growth in our history—more business done, more fortunes made, than ever before. They've certainly been good years for *me*."

He will lean back in his chair with the easy confidence and poise that are the hallmark of real prosperity.

The older man will sit quiet a moment and then in a tone of infinite pathos:

"I wish I had those ten years back," he will say.

● Today the interview quoted above is purely imaginary. But be assured of this—it will come true. Right now, at this very hour, the business men of America are dividing themselves into two groups, represented by the two individuals whose words are quoted. A few years from now there will be ten thousand such luncheons and one of the men will say:

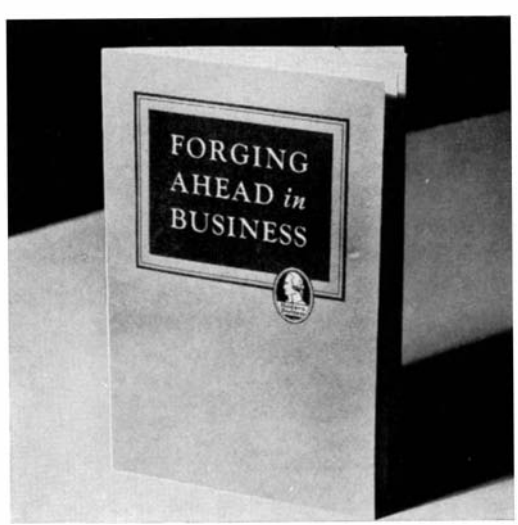
"I've got what I wanted."

And the other will answer:

"I wish I had those years back."

In which class are you putting yourself? The real difference between the two classes is this—one class of men hope vaguely to be independent *sometime;* the other class have convinced themselves that they can do it within the next few years. Do you believe this? Do you care enough about independence to give us a chance to prove it? Will you invest one single evening in reading a booklet that has put 400,000 men on the road to more rapid progress?

This booklet costs you nothing—and for a good reason. It is worth only what you make it worth. It explains how for more than thirty years it has been the privilege of the Alexander Hamilton Institute to help men shorten the path to success; to increase their earning power; to make them masters of the larger opportunities in business.



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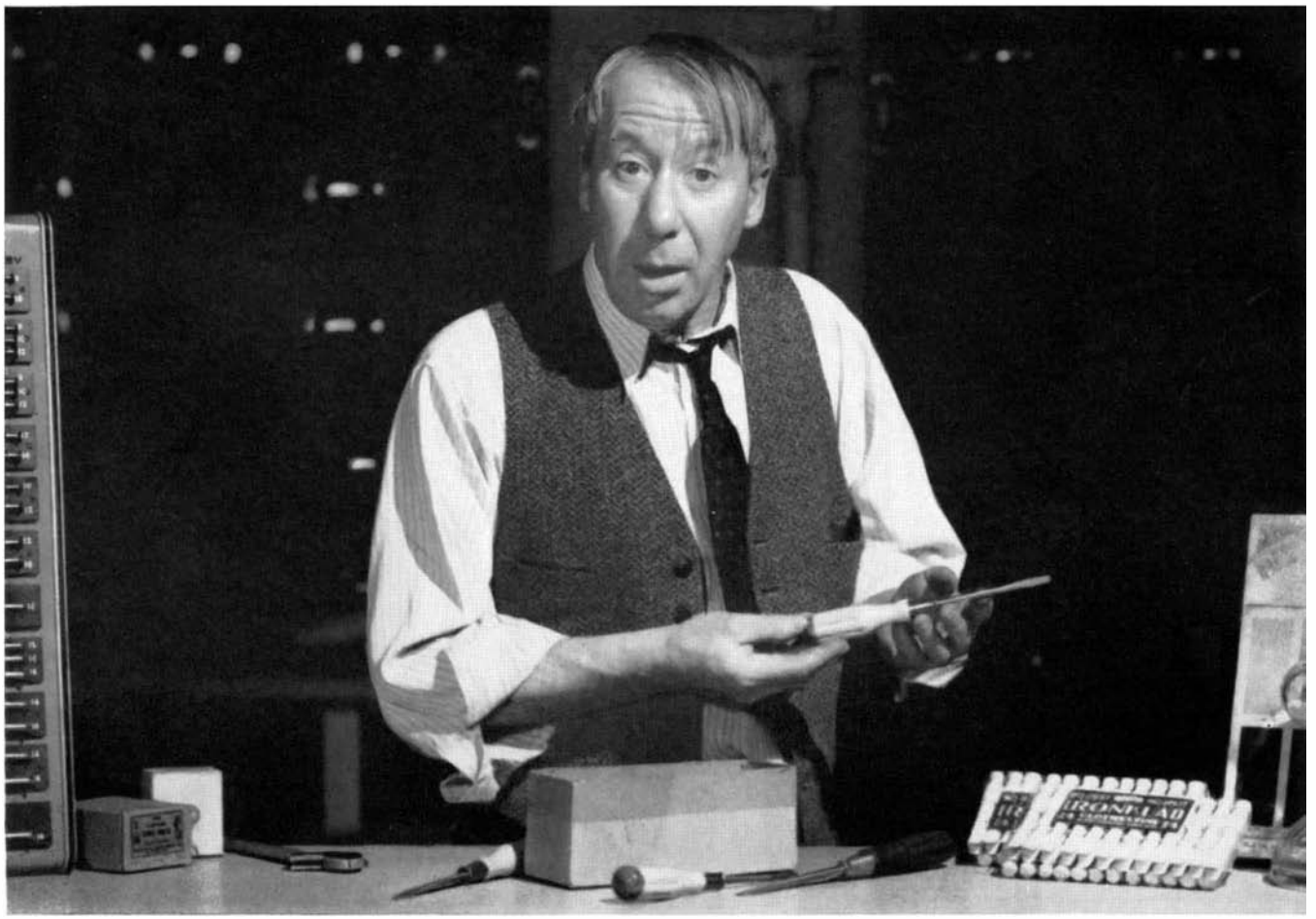

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