TWINS: What They Show About Heredity and Environment

SCIENTIFIC AMERICAN

August · 1937

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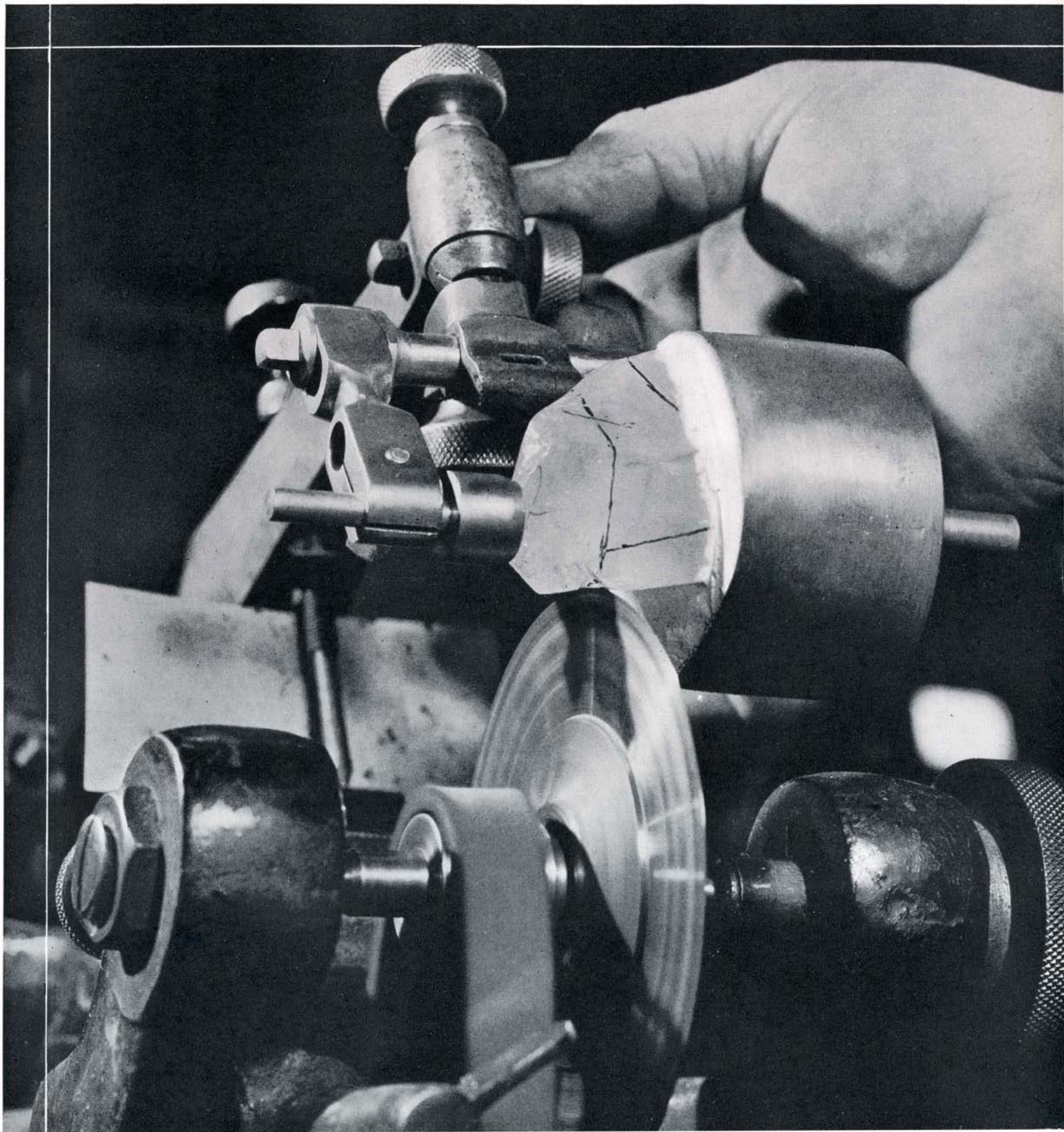

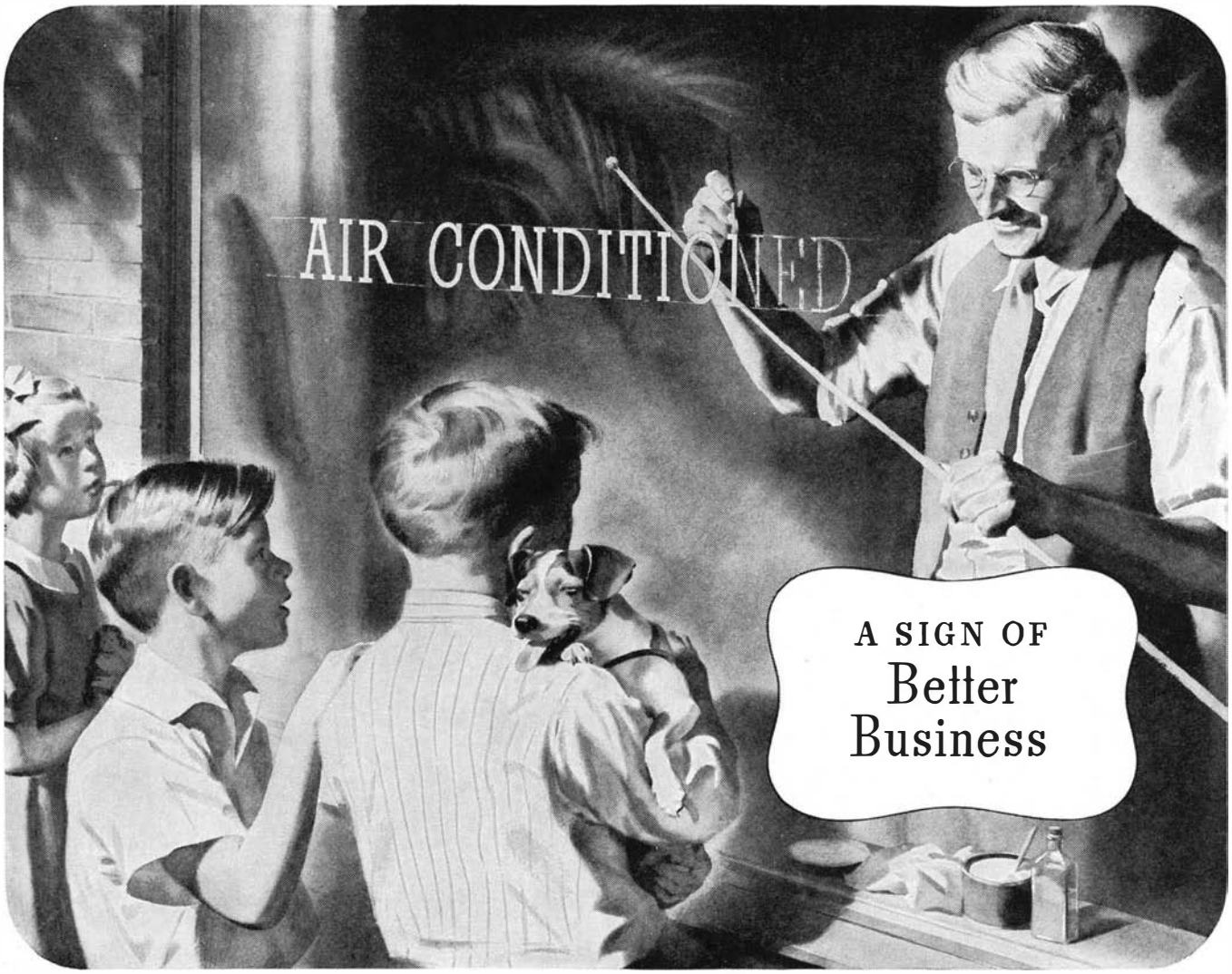

As signs like this go up, "For Rent" signs come down

THE asphalt may be melting in the streets outside, but there's May Day weather inside this place. Soon smart people by the hundreds will seek it out, and its proprietors will smile happily at mounting receipts. When winter comes and old-fashioned dry heat is making other places stuffy and close, its clean, fresh air will continue to beckon the crowds. "Tailor-made weather" is good for business, in any season.

Thousands of shops, theaters and dining places have already discovered this. Moreover, year-round comfort for homes and offices is being brought within reach of more and more people each year. We Americans usually get what we want, and when something new and desirable comes along, thousands get jobs making and selling it.

Like so many other new business-building developments, air conditioning has been helped in its growth by the electrical industry. Westinghouse engineers have made many substantial contributions, and the Westinghouse name on air conditioning equipment is another sign worth looking for.

Westinghouse

The name that means everything in electricity

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

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

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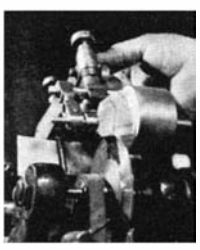

AFTER the now famous Jonker diamond, described on page 94 of this issue, had been cleaved following months of study of the cleavage planes, it was set up as shown in the photograph reproduced on our front cover. Then followed additional months of sawing, using a phosphor-bronze disk operating at 5000 revolutions per minute. The disk was supplied with olive oil and diamond dust. Sometimes the whirling disk made no progress into the stone for days at a time, but nothing else could be done. Only time, patience, and constant effort could achieve the desired results.—*Photograph courtesy Copper and Brass Research Association*

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50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of August, 1887)

PANAMA CANAL—"Recent advices from Panama show that serious injury to important portions of the excavations has been occasioned by the sliding down of the embankments, due to heavy rains. In some places the great ditch has been measurably refilled, and at some points it will have to be dug out a second time at great cost."

ECHIDNA—"Our engraving shows the rare and extraordinary echidna that has quite recently been discovered in Northern New Guinea (*Proechidna bruijni*). This curious animal in outward appearance resembles the hedgehogs in its spine-covered body and the ant eaters in its long and tapering snout. The latter is incapable of being opened, and the mouth consists of a small hole at the apex, through which the long and vermiform tongue is protruded. The spines are short and stout, but of needle-like sharpness, and spring from a thick coat of dark brown fur. The forefoot is furnished with three broad and nail-shaped claws, while those of the hinder limb are long, sickle-like, and very sharp. Worked by the powerful muscles with which the creature is provided, these are admirably adapted for digging. The tail is rudimentary."

VINEYARD PROTECTION—"An exchange says that artificial clouds were recently created for the protection of vines from frost at Pagny, on the Franco-German frontier. Liquid tar was ignited in tin boxes and pieces of solid tar on the ground near the vines. Large clouds of smoke arose and protected the vines for two hours. Although vines in the neighborhood were injured by the frost, all that remained under the clouds were left uninjured."

MINICAM—"The process of instantaneous photographing is rapidly becoming an evil. We hear talk already about specialists in photography for instantaneous pictures since the 'Detective Camera,' as it is called, was put upon the market. The box is so small that it can be carried anywhere without the slightest inconvenience. . . . No operator is required to fit the camera and lens correctly in position for the party to be photographed. All that is requisite is to pull a string and the photograph is at once taken."

NAVAL STRENGTH—"It appears from the 'Universal Register' for 1887 . . . that Great Britain has 6 guns capable of penetrating 36 inches of unbacked iron, and 16 others which can penetrate 28 inches of the same material. Italy has 20 guns which can penetrate 33 inches of iron. France 14 guns which can pierce 27 inches, and 14 others able to penetrate 25 inches of unbacked iron. Russia has 20 guns and Spain 2 equal to the penetration of 24 inches of iron."

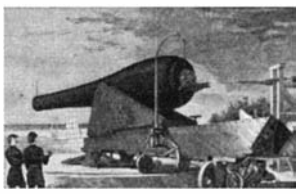
AMYL VARNISH — "This compound ether has recently come into use for manufacturing purposes without attracting any scientific attention. Its value depends on the excellent solvent power for pyroxylin which it possesses. Good soluble gun cotton will dissolve in it. . . . On this account it has become valuable to the manufacturer of celluloid and to the manufacturer of certain kinds of lacquer for coating brass and copper."

OIL-BURNER—"The Russian Minister of Marine has ordered liquid fuel furnaces to be fitted to the ironclad *Tchesme*, now under course of completion at Sebastopol. The decision is one of a very important character, since although liquid fuel has been applied to vessels of fairly large dimensions, this is the first time the use of it has been attempted on ironclads."

LIGHTING—"Perhaps most remarkable is that the coming of electrical lighting has not seriously hurt the business of the gas companies. Indeed, in many, very many, cases it has helped the gas companies, because, since its arrival the public have got used to having more light, and those using gas have turned on more burners to make up for the unwonted illumination about them."

FREIGHT HORSES—"English railroads do the major portion of their own carting, collecting and delivering freight at the freighters' doors. One of the largest companies, the Midland, have in constant employment no fewer than 3,200 horses; and of these 1,000 are located in London."

PNEUMATIC GUN CARRIAGE—"The pneumatic gun carriage at Sandy Hook, which we illustrate, is constructed after the famous Powlett design. It is worked by compressed air, which comes from a pipe connected with the breast of the carriage. By means of simple levers, this air, besides being used to check the force of the gun in recoiling after firing, can be made to train the gun, elevate and depress it, and move it quickly from side to side. The old style carronade and broadside gun, pygmies in comparison, could not be handled by their numerous crews more readily than the great modern gun weighing many tons can be worked by means of this really simple apparatus."



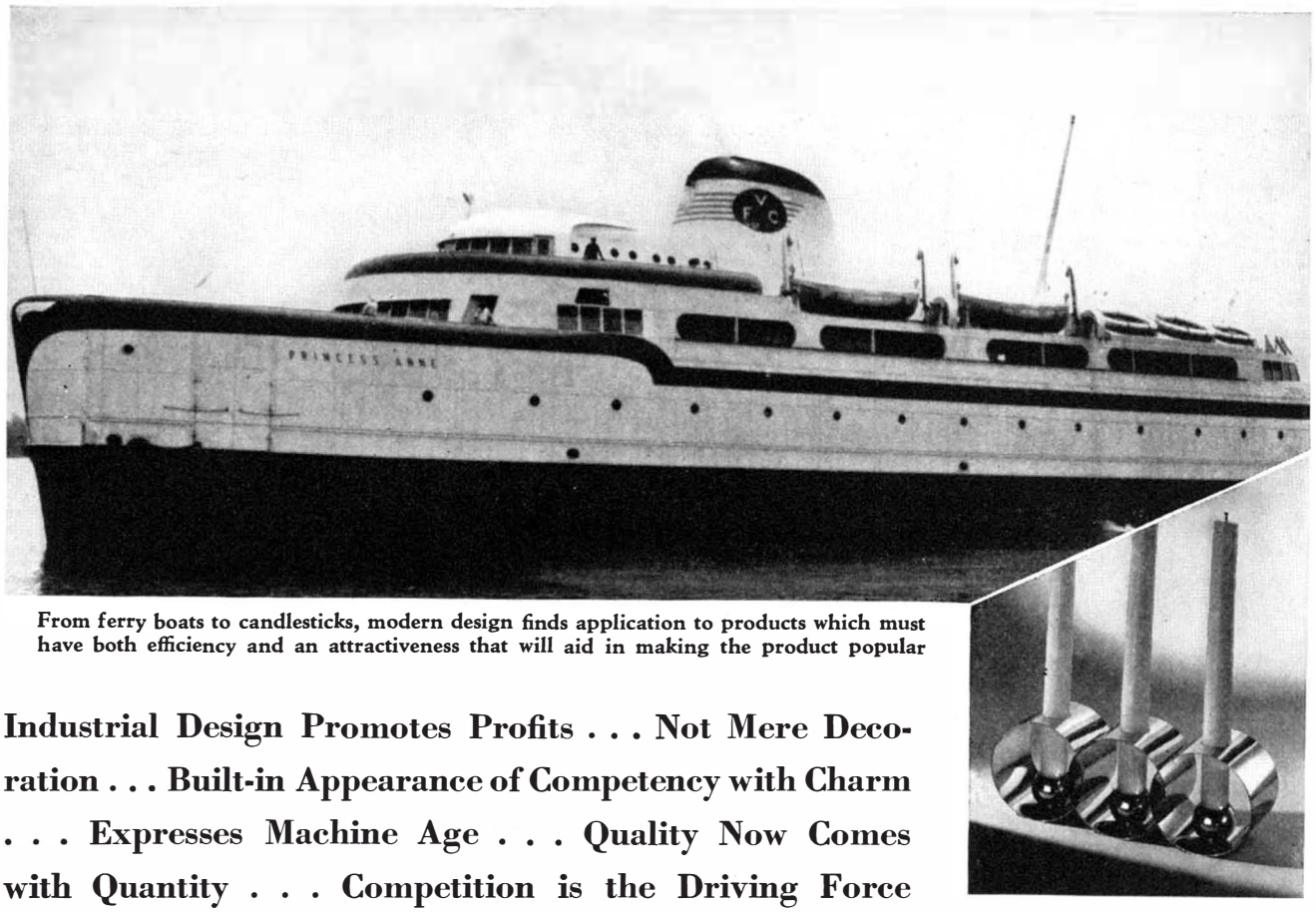
ALTITUDE—"The aeronauts Mallet and Jovis made an ascent, August 13, in the balloon *Horla*, starting from the Lavillette gas works, Paris. Their object was to penetrate to the greatest height at which it is possible to live. After a few hours' voyage in the air the balloon descended, landing in the village of Marche, Belgium. They reached an altitude of a little over four miles."

ELECTRICAL HEAT—"The Société des Usines Électriques of Berlin have announced that, in future, in addition to light, they will be prepared to furnish a supply of electricity for heating purposes. . . . For boiling water they have contrived a vessel having two cases, between which is placed a resistance coil. It is stated that with this appliance about 1½ pints of water can be raised to boiling point with 4 amperes 100 volts. In certain theaters electric stoves are employed for heating the curling tongs, the use of gas jets and spirit lamps being rigorously forbidden."

Photo Jean de Strzelecki

THE BIG TELESCOPE DISK— PRELIMINARY HAND WORK

IN building the 200-inch reflecting telescope which is to be erected about 1940 in southern California, the mirror disk of Pyrex glass was made first and shipped by rail from Corning, New York, to Pasadena, California. The mounting is being made at Philadelphia by Westinghouse and shipped by water, while the observatory building is under construction at the site, Mount Palomar, 93 miles southeast of Pasadena. The first job was to grind the back of the disk flat on a machine, but before this could be done the edges of the ribs on the back were chamfered off by hand, as shown. Other data on page 77.



From ferry boats to candlesticks, modern design finds application to products which must have both efficiency and an attractiveness that will aid in making the product popular

Industrial Design Promotes Profits . . . Not Mere Decoration . . . Built-in Appearance of Competency with Charm . . . Expresses Machine Age . . . Quality Now Comes with Quantity . . . Competition is the Driving Force

DESIGN FOR SALES

By PHILIP H. SMITH

WHEN sales of a manufactured product increase anywhere from 25 to 400 percent within a year, one of the factors most likely to have played a major rôle in the achievement is design. It doesn't matter whether the article is a sewing machine, a refrigerator, or a skillet, an expertly designed product attracts customers, swells sales volume, and garners profits.

Striking examples of industrial design success are to be seen everywhere: a mechanical refrigerator moved from fifteenth to third place in national sales volume in two years, largely because of design appeal.

A line of kitchen utensils proved so successful, even though launched during the lull of a summer, that the output planned for six months was completely sold out on the initial offering.

A check-writing machine jumped 66 percent in sales in one year, following a thorough-going re-designing.

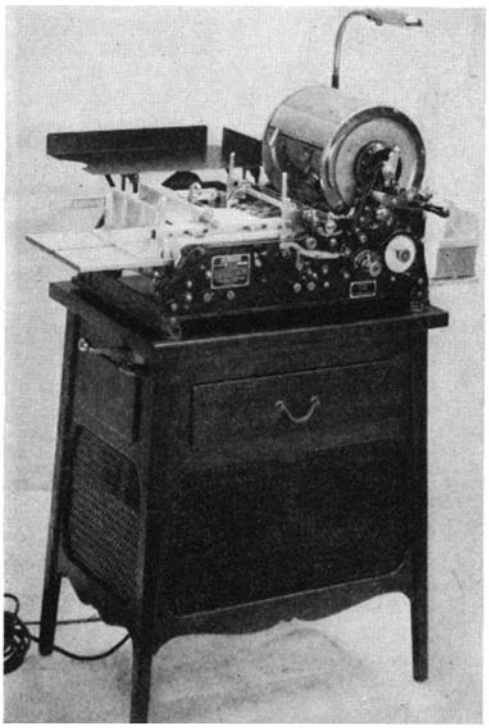
Even so prosaic a thing as a ferry has been made highly profitable by re-designing. The boat in question has proved so popular with tourists that they frequently adjust their driving schedules to avoid the old style boats and get the luxury ride on the new one.

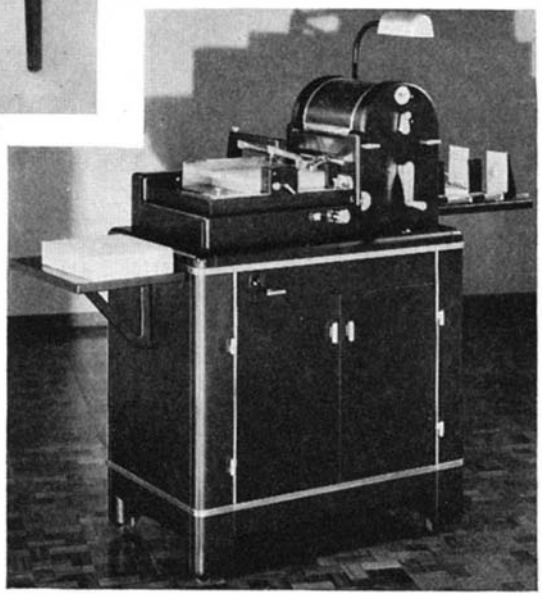
It is this commercial success of modern designed products, repeated again and again, which has furthered the profession of industrial designing and given it a secure place in the manufacturing world. There are very few people who question any longer that modern design has a commercial value, but there are still some who wonder whether it is transitory.

NO such query could arise if industrial designing were fully understood, if its roots were seen and its dynamism felt. There is a perfectly sound reason why it should come to full expression right now. It was a logical growth, as we shall attempt to show, and this in turn will provide a hint as to its destination.

Modern design is distinctly characteristic of this age. It is a reflection of our way of living and our attitude towards life. What distinguishes it from the design of other and earlier periods is its application to mass-produced items. We have always had modern design, though it was not so called. Today's modern design gives full consideration to the machine as the agent of production as contrasted to handicraft. It is frankly and unashamedly exploiting the potentialities of the machine which has given us things in abundance.

The development of modern design has traced scarcely 10 years. Perhaps the first step is expressed as well as any way by that advertising slogan which said: "We couldn't improve the product, so we improved the box." The verity of the slogan may be questioned, but in such a statement lies the idea that when technical problems have been pretty well solved, attention should be given to appearance. Modern design of mass-production items is in reality a complement to production achievements, because products became so uniformly good in their operation that a new element was needed for competition. Appearance provided it. You no longer look under the hood of an automobile before deciding to purchase; you ex-





Mimeograph machine before and after re-designing, an example of built-in design involving basic changes in mechanism. Result: A new product

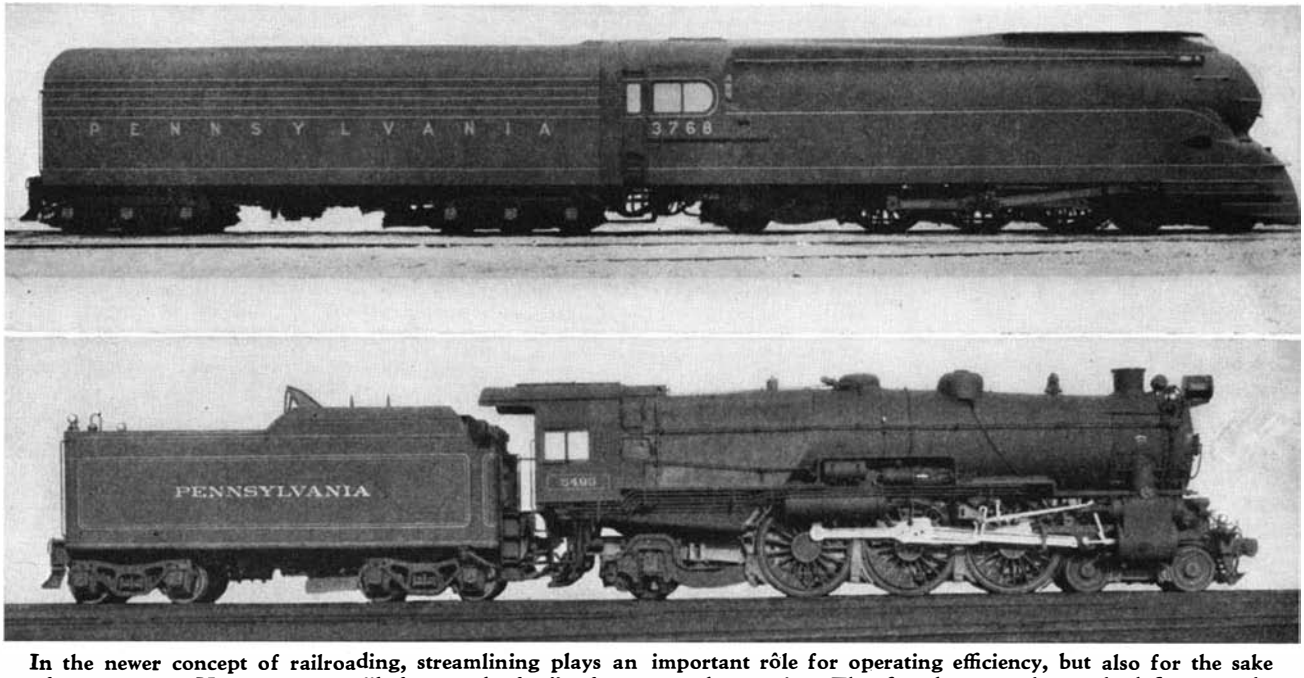
amine the upholstery and fuss about the color schemes. Much the same shift in attention applies to other consumer products today. Manufacturers now compete to catch your eye.

This new element of competition supplies the fuel to keep design fires burning and it is a fact which provides about all the proof we need that modern design is here to stay. When re-designing causes a product to jump out of line and forge ahead in volume of sales, there is little left for competing manufacturers to do but strive hot-footed for an even better design. This makes designing dynamic.

The basic aim of all design is to improve the efficiency of a product. All other purposes are incidental to this. When it is achieved, appearance will be improved and sales will mount. The product may be more expensive to make in its new dress, or it may be cheaper; it may weigh more or it may weigh less—the basic purpose is sales and this is true whether the sale is to be tickets on a railroad, the cake in a bake shop, or a vacuum cleaner. Such advantages as reduction of weight and upkeep expense, the use of more durable materials, and lower manufacturing cost are incorporated in the design as best possible.

A CHAIN of bake shops was recently re-designed with such success that the cost of store alterations was repaid within a year's time. An important factor in the ultimate success was the determination in advance of design of what it was that led customers to buy. It was discovered that a fulsome display of frosting could achieve wonders in getting people to enter a store. To increase the amount of such food on display was not a suitable solution because bake shops wish to keep stock at a minimum. Accordingly, mirrors were placed behind the display shelves at such an angle that they reflected the frostings to the passer-by, thereby doubling the display without addition to stock.

Every product which comes up for design consideration presents a unique problem and a different combination of purposes to be sought. It may require use of new materials to achieve the desired end, or it may need a re-designing of the inner mechanism. In the case of a well-known vacuum cleaner, the weight was reduced about three pounds through the use of magnesium alloy die castings and plastics. Another product, a mechanical refrigerator, which has won phenomenal sales success, features, among other things, a grill at the base where experience showed the enamel was most commonly injured, and a latch so placed that it is out of reach of youngsters. But to achieve the harmonious whole required a going over of the entire



In the newer concept of railroading, streamlining plays an important rôle for operating efficiency, but also for the sake of appearance. Here we see a "before and after" of a steam locomotive. The fin above smoke stack deflects smoke

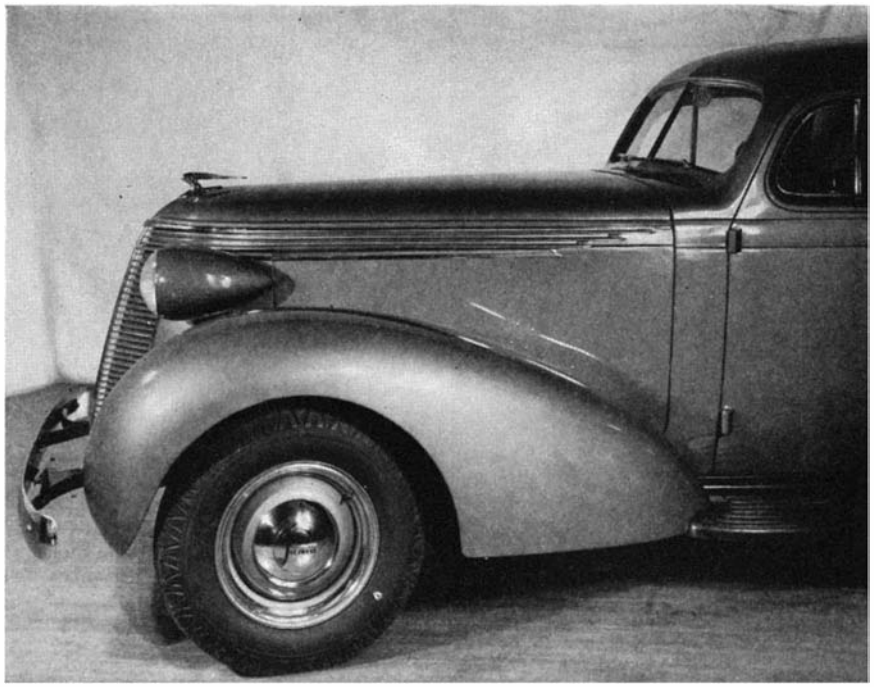
product from the standpoint of design.

Such designs are not made over-night. In fact, most of the highly successful products represent months and years of persistent work. A mimeograph machine, which has just been revealed to public view, illustrates this type of long-term designing. The smooth exterior lines, the simplicity and harmony, are not grafted on, but built in. The "works" have all undergone design treatment to make a strictly up-to-date and new product.

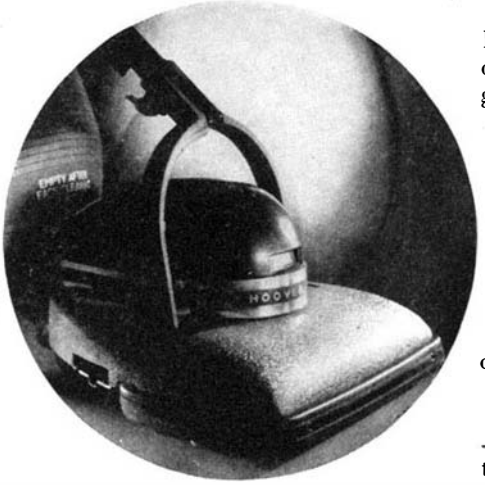
A similar building-in of design is found in a new portable X-ray machine, just going on the market. Here one of the many problems was to get better radiographic performance and the utmost in flexibility while retaining compactness and relatively light weight. To accomplish it meant laborious research to get better transformer design, improved insulating materials, and superior X-ray tubes. Design thought carried through from the basic materials to the final dress, so that the public sees the result as a sturdy, attractive machine, or as three zipper-tailored bags going to a patient's bedside.

Streamlining (which is a word so overworked that one hesitates to use it) probably tops all other designs in public interest, yet there are very few streamlined products in the true sense of the word. Unless an object has to encounter air currents, streamlines have no place. When the phrase is used to describe a saucepan, it is a misnomer. The true streamline has its highest development in the airplane where air friction must be reduced at almost any cost. Aircraft display modern design without parallel and for the reason that there was no tradition to overcome and the purely functional could be pursued relentlessly.

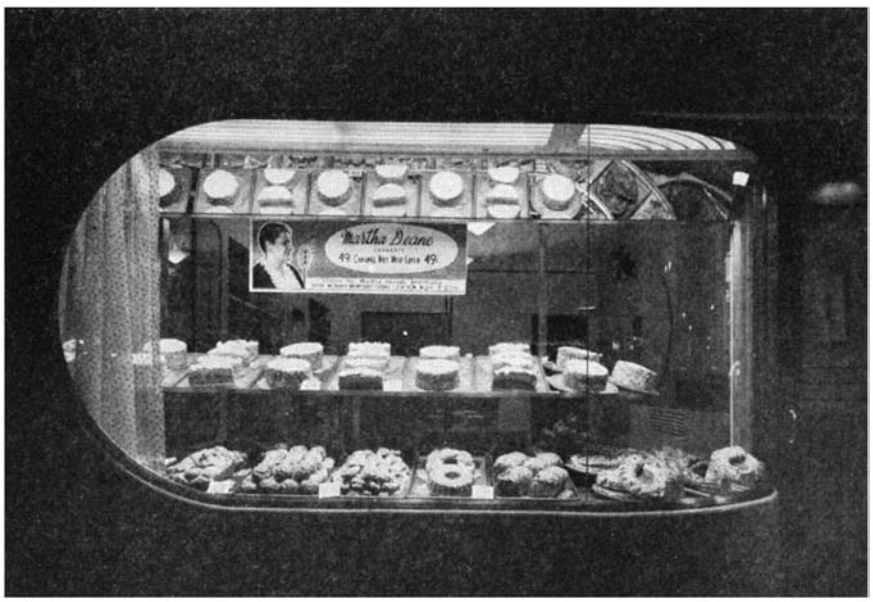
Automobiles and locomotives have broken very sharply with tradition in design, but both could be improved greatly with tradition entirely out of the picture. These two products present quite different design problems from the airplane when it comes to streamlining. If either were to be designed wholly from the standpoint of reducing frontal wind resistance to the minimum, they would probably meet with disaster, the reason being that they, unlike the airplane, have to take cross winds into consideration.



An exemplification of streamlining, variations of which are found on most modern motor cars. The flowing lines suggest power, the fleetness of the wind



Magnesium alloy die castings plus plastics cut weight, enhance design

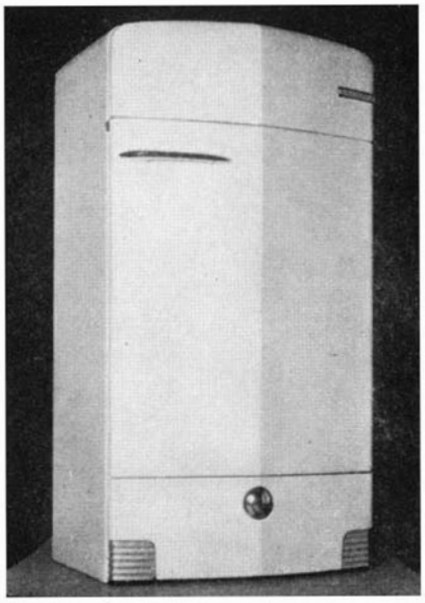


The front of a bake shop. Mirrors double the view of cake frosting in the window. Sales in such stores increased rapidly after they were re-designed

AN enormous amount of engineering has gone into the modern locomotive and streamlined train. In designing an exterior for a steam locomotive now in use by one of the large roads, exhaustive wind-tunnel tests preceded any work on paper. By the use of clay models, the factor of wind resistance could be studied in detail. Strange to relate, one of the most vexing problems was to get a satisfactory design from the appearance standpoint which would at the same time deflect the smoke above the engineer's cab. After many experiments, a solution was found in a fin, or wing-like structure.

It might be thought that the streamlining of a train could be handled satisfactorily by a simple treatment of the nose and tail, but actually skin friction is a greater deterrent to speed than head resistance when a train is long. Here again, wind-tunnel tests are used to reveal air currents set in motion by small projections.

If industrial designers employ any particular theories in their work, they will not admit it. The most famous exponents of the art declare that the essentials to success are an open mind as



The refrigerator which was designed for service as well as appearance

well as designing ability. Engineering training can be enormously helpful, but if a designer does not have it, its advantages can be had from staff men either in his own organization or in the concern for which he is designing. Competency requires a very complete knowledge of materials—their possibilities and limitations—and a comprehension of what is being done in all fields. But if designers will not admit to theories, they do hold to a definite technique in approaching a design problem. The technique of different designers may vary, but there is a striking similarity none the less, and it is well worth examining how they work because it reveals much about the art.

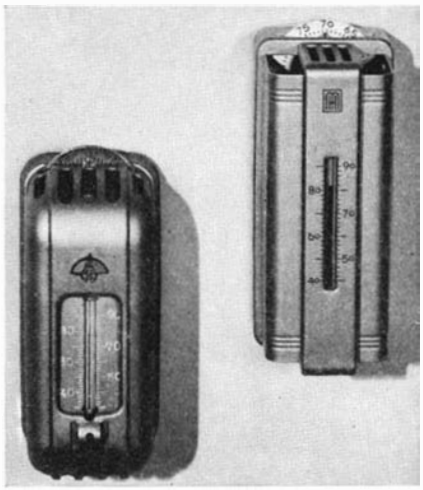
ONE of the most prominent designers declares that there are three objectives in making a problem more desirable and hence a bigger seller. These aims are: improving the appearance, improving serviceability, and increasing economy. Of the first aim he says:

"Appearance must be built in and not applied; has nothing to do with decoration; is essentially a look of efficiency, competence, stability, durability, simplicity, and honesty, revealed with grace and charm." Appearance is "placed first because efficiency and economy are primarily the engineer's responsibility, but the designer must also achieve them."

Economy is striven for but is rarely the prime consideration of modern design. It sometimes happens that the cost of making a product is lowered by redesigning, but this is incidental to getting the best design possible. What the designer expects is to produce a product which will sell in a volume more than sufficient to offset any factor of higher cost. When he succeeds, you find examples like the one of the gas range which sold in 300 percent greater volume in six months, although prices were 15 percent higher; and the re-designed gas heater which established a 400 percent sales increase within a year, despite a 12 percent higher sales price. In both these cases the attractiveness of the product drew to the fold retailers who hitherto had refused to carry the lines.

There have been instances where the simple fact of re-designing has lifted a product out of its competitive class and placed it in a position where any competition was negligible, even with cost and sales prices advanced.

When aims have been established, the next consideration is the method to be employed to attain them. This involves preparatory study to become thoroughly acquainted with the use of the product, the way it is now being made—that is, its structure—and finally with the manufacturer's facilities. Still other studies must be made of sales and competition. The public will accept some things and not others. Therefore, if a design is to be successful, it must be executed



Mechanical limitations of space and form were factors in this design

with full understanding of what it has to face when it is released to the consumer.

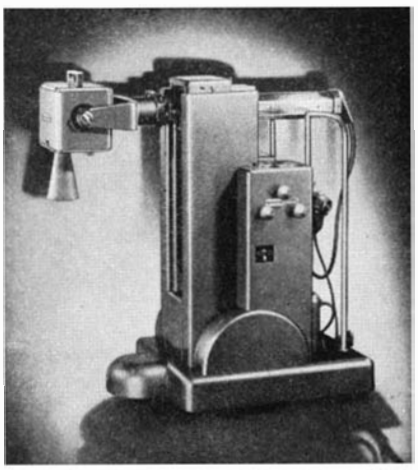
Once a factual background has been obtained, the mechanics of designing can begin. Many drawings will be made and these will be followed by models which can be studied to see how well they achieve their purpose. When a design is settled upon, it must not only represent the basic aim, but be capable of being produced with available plant facilities or such new equipment as the manufacturer feels is justified. Essentially, then, designing becomes a cooperative endeavor between designer and producer.

It may be asked why industrial design is not undertaken by the engineering and designing staffs of manufacturing concerns? Is it necessary to go outside for talent? Staff-designed products are issuing from plants every day of the year, but the outstanding commercial successes, which have made modern design a striking feature of contemporary products, are the work of specialists in the field. The reasons for this are not far to seek. The rank outsider brings a fresh viewpoint. He comes to the problem armed with a broad knowledge of what has been done in other fields. The staff engineer or designer, on the other hand, is often too well acquainted with limitations; long association has schooled him in what cannot be done and his vision too often has become narrowed. What modern designing demands is freedom to express the machine age as we see and feel it. The slavish adding to, or subtracting from, long established designs will not achieve a similar result.

IF it is true that the machine has ushered in a new era, and there seems to be little doubt about it, then modern design is here to stay because the machine will continue to serve us. Design will not remain static, but will alter slowly in accordance with development of the machine conception. Any professional designer can sit down and sketch out his idea of the refrigerator, the automobile, or the radio of the future, to suggest the lines of progress. The ultimate has not and never will be reached. Progress is of necessity slow, and particularly in those fields in which tradition is strongest, such as housing and interior decoration.

At the moment, modern design forges steadily ahead because it pays in dollars and cents. The manufacturer adopts it because he cannot ignore a vital commercial success, not from altruistic or esthetic reasons. Competition has become, therefore, the life of modern design.

Photographs courtesy of: The Hoover Co., Minneapolis-Honeywell Regulator Co.—Henry Dreyfuss, designer; Revere Copper & Brass, Inc., The Studebaker Corp.—Helen Dryden, designer; Cushman Bakery, Pennsylvania Railroad, Princess Anne Bay Steamer, Sears Roebuck & Co.—Raymond Loewy, designer; A. B. Dick Co., Westinghouse X-Ray Co.—Walter Dorwin Teague, designer.



Appearance was an integral part of the design of this X-ray machine

OUR POINT OF VIEW

Air Crashes

IS the pilot to blame for the crash of his airplane? Crash investigations of the Department of Commerce more often than not find in the affirmative--when the pilot is not alive to tell his story! In fact, out of 27 recent airplane accidents, 16 were blamed on pilot-error.

Why this high percentage? Would it be radically lowered if the pilots could speak for themselves from the grave? Or is it due to the fact that, as has been declared, every member of the investigating board is a "party in interest"? Does politics have as much to do with the findings as has been claimed?

At present, no one knows the answers to these questions. We can, however, be rather positive on one point: Pilots are not so generally to blame as we are asked to believe. Air-line pilots, in addition to being average human beings like you and me, who own their homes and have families and have as much desire to go on living as the rest of us, are highly trained, carefully picked, professional men. It is not reasonable to believe that they take any more chances than an equally expert automobile driver of long years experience. Yet that automobile driver has probably had his engine die for various reasons a number of times; if he had been piloting a plane, such engine or equipment failure would have meant disaster. Yet the pilot must rely, for the perfect functioning of his plane, not so much upon himself as upon a host of others.

No; the pilot is surely less often at fault. The blame may actually lie in several directions but when no definite clue can be found, it is easy enough to say that the pilot must have erred. This is easiest for the operator, for the plane and engine manufacturers, for the Department of Commerce—all prejudiced parties to any crash-investigation. And the Department of Commerce, having approved plane and equipment, supervised operation, built and maintained airway beams and other safety and operational features, and having made all the air rules and regulations, sits as judge and jury in the investigation!

Congress had before it, in the spring, legislation that would take air transportation out of politics, put it under a separate section of the non-political Interstate Commerce Commission. Air-line pilots think that within this section there should be created a five-man Air Safety Board (not political appointees) whose sole purpose would be to consider first, last, and all the time the safety of air travelers. With such a set-up, and especially in view of the Interstate Commerce Commission's past record, it is the honest opinion of many that a great advance in air safety can be made. If such is the case, all those interested in the air lines should heartily endorse both the legislation and the pilots' suggestion for the Air Safety Board. So far they seem to comprise the best solution to an important problem that has come to our notice.

Trailer Troubles

ALTHOUGH the development of the house trailer has not lived up to the expectations of certain optimistic prophets, still its growth has been ample to bring in its wake a series of troubles that cannot be overlooked if even more serious difficulties are to be avoided in the future. In the reports from those who have tried life on the open road with a trailer—whether the trailer be used for vacation trips or as a permanent home—we find a great diversity of opinion regarding the desirable features of this method of living. Possibly the greatest drawback to trailer travel today is the lack of satisfactory and safe camping facilities. It is all very well to talk about "pulling up alongside the road wherever night overtakes us" but actual practice is a far different matter. Certain conveniences must be available if life in a trailer is to be anything more than a succession of bad dreams. First and foremost, there must be available an adequate supply of pure water. Second, there must be some type of sewage disposal. It is these two points in particular that must be very carefully worked out if a trailer camp is to be comfortable for its users and safe for the country at large. An epidemic starting in a trailer camp could spread to the four winds with incredible rapidity. As soon as a case of communicable disease breaks out in such a camp, there can be no doubt that every member of that camp will leave in haste, possibly acting as a carrier of the disease and spreading it throughout the country.

The "footloose and fancy-free" character of trailer travel lends itself admirably to the spread of contagion and not at all to checking it. Departing from a camp at dawn, a trailer and its occupants may well be 400 miles away by dark, ready to settle down in another camp for the night. Unless some system of registration is employed, other than a possible casual check on license plates, there is no way of knowing whence came the trailer or whither it may be going.

A trailer camp can be a decided asset to a community, but unless it is properly planned and the plans are adequately carried out, it can be a decided detriment. Some of the camps now available in Florida and California—to cite only two examples—are indeed worthy of study by any community planning to develop such a camp. In any event, such a development is not a thing which should be gone into without serious consideration of all the problems involved, and without provision for the health and comfort of those trailerites who will be the guests—and paying guests, at that—of the community in the future.

Teach Taxation

IGNORANCE of the very fundamentals of the taxation system is so widespread as to be appalling, particularly in view of the activities of the present administration and the amount of space devoted to the subject in the daily press. It is not at all uncommon to hear, during a discussion of some piece of public work, the statement made by an otherwise intelligent and well-educated person that: "This work is being paid for by the Government; the money does not come out of my pocket."

It is not the purpose of this discussion to attempt to delve into the ramifications of hidden taxes that hit the pocketbooks of each and every individual in the country, regardless of age or financial position. Rather, it is to make a plea for more general education in the simple fundamentals of taxation. If in every school throughout the country there could be instituted a simplified course in the principles of taxation, such a course to be compulsory with every student, it would be possible to lay the foundation for a far better understanding of such functions of the Government —and from such understanding would grow a greater interest in, and hence a more careful selection of, our public officials by the voting body.

With such knowledge inculcated in each successive generation, the citizens of the country would be in a far better position to dictate the course of government, rather than leave such dictation in the hands of a few politicians who take advantage of the ignorance of those who elect them to office, and then turn to their own advantage public funds which are made up entirely of moneys contributed by those who put these same officials into positions of trust and who keep them there.

TWINS

By D. CECIL RIFE, Ph.D.
Department of Zoology and Entomology, Ohio State University

WHILE walking along the street one day, I spied the familiar form of a young man a short distance ahead of me. Catching up with him, I spoke and attempted to start a conversation, being certain he was an acquaintance. However, he acted very peculiarly, as if I were a stranger. Finally he said: "You must be mistaking me for my twin brother." His statement was correct, and subsequent tests of the twins revealed that there was only one chance in a quarter million that these young men could have been so similar in regard to certain traits, if they had not originated from the same fertilized egg cell. In other words, they were, almost beyond the shadow of a doubt, monozygotic or so-called identical twins.

The above-mentioned tests constitute a twin diagnostic formula developed in the genetic laboratories at Ohio State University, and include blood group, finger patterns, eye color, stature, certain taste reactions, and I.Q. The twins are compared with each other, and with their parents and brothers and sisters in respect to each trait. The chances of the twins being so similar if they originated from different fertilized egg cells are then computed.

The previously discussed young men belong to the same blood group, have no noticeable differences in hair or eye color, vary less than a quarter inch in stature and a pound in weight, and have finger patterns so similar that only an expert can distinguish between them. Both are red-green colorblind, to exactly the same degree. They sometimes sing duets, one tenor and the other bass. Occasionally, while singing, one will nudge the other, and they will exchange parts, very few of the audience being aware of the change. According to the Stanford-Binet test, they have the same I.Q. At the age of 20 each was bothered with a toothache, the troublesome teeth corresponding exactly in position. Each went to a different dentist, but in both instances the tooth was filled.

ALMOST everyone knows of identical twins, and similarities such as we have mentioned are not at all uncommon. While there is always a chance that any particular pair of extremely similar like-sexed twins did not originate from the same fertilized egg cell, the odds are many thousands to one against such a possibility. You can be reasonably sure that twins who are so similar as to be constantly confused by relatives, teachers, and friends are actually monozygotic or identical (the latter term being literally correct for genetic makeup alone).

The illustrations on these pages show a pair of identical twin girls studied in our laboratories. When five years of age they were operated on for appendicitis, within two days of each other. Their appendices, when removed, were found to be of practically the same size and in the same condition. There are six pictures of each girl, each vertical pair of pictures showing both girls. However, the same girl is not always in the top or bottom row. See if you can find which pictures are of the same girl, marking one *A* and the other *B*. A key is given at the end of this article.

About 20 to 25 percent of human twins are identical. Fraternal twins are derived from different fertilized eggs, and are no more alike in hereditary makeup than brothers and sisters. Triplets, quadruplets, and quintuplets may consist of all identical, or various combinations of identical and fraternal individuals. Siamese twins are identical twins that have not completely separated.

The occurrence of these two types of human twins gives us unparalleled material for the investigation of the relative importance of heredity and environment in the development of various

To the Science of Genetics, Having to do with the Effects of the Different Materials Received from our Parents, Twins are an Invaluable Aid, Revealing Much Concerning the Oft-debated Question of the Effects of Heredity and Environment

traits. Any differences which occur in a pair of identical twins must be due to factors other than hereditary make-up. If identical twin brothers should marry identical twin sisters, any resulting double cousins would be as similar in genetic makeup as ordinary brothers and sisters. It does not necessarily follow that traits which occasionally show intra-pair differences in identical twins may not have a hereditary basis. Reversal in handedness, for example, occurs in some, but not in the majority of identical twins, yet there is evidence that handedness has a genetic basis. The explanation for this phenomenon lies in the fact that the prenatal environment of identical twins is different from that of single born individuals, and the position *in utero* may counter-balance the inherent tendency. Fraternal twins give us controls for our identical twin investigations, as, broadly speaking, twins reared together have similar environments. Those similarities which are greater in identical than in fraternal twins must have a genetic basis, provided the two groups of twins have equal environmental similarities. It should be remembered, however, that fraternal twins, while not having identical hereditary potentialities, are as similar as brothers and sisters. Thus, by comparing the two types of twins in similar environments, we obtain only a partial measure of the part played by hereditary factors.

Numerous scientists have taken advantage of this method of research. For example, Diehl and von Verschuer, of Germany, have just completed a study, covering a period of years, of 205 pairs of twins with tubercular tendencies in one or both members of the pair. Of these, 80 pairs were identical and 125 pairs fraternal. The identical twins showed similar tubercular tendencies in *both* members of the pair in 80 percent of the cases, whereas among the fraternal twins such similarities were observed in only 25 percent of the cases. Such findings definitely establish the existence of genetic differences in susceptibility to tuberculosis, although infection is of course necessary before anyone can contract the disease.

MANY diseases have been investigated in a similar manner by various scientists. Certain types of hernia, goiter, epilepsy, and dementia praecox, show a high degree of intra-pair correspondence in identical twins, and low correspondence in fraternal twins, indicating that heredity is an important factor in their occurrence. On the other hand, measles and whooping cough show about the same frequencies of intra-pair correspondence in both types of twins, indicating that genetic makeup has little to do with an individual's susceptibility to these diseases.

Numerous striking similarities for less common diseases have been reported and observed in identical twins. We recently discovered a pair of identical twin men, 52 years of age. For 25 years they have lived apart at a distance of approximately 100 miles. One is a railway engineman, the other a dock worker. One day in April, 1933, the railway engineman became ill and was operated on for gall stones at 6:00 P.M. About midnight of the same day, his twin brother became ill, and was also operated on for gall stones. Less than a year ago a well known magazine reported a similar case in regard to cancer of the stomach. A man over 70 years of age became ill and was taken to a hospital. Diagnosis revealed that he was suffering from cancer of the stomach. Within less than a week his identical twin brother, who lived some distance away and knew nothing of his brother's condition, likewise became ill and was sent to a hospital. It was found that he, too, was suffering from cancer of the stomach. Obviously, such similarities in twins in later life, after years of separation, are more significant than when occurring in twins who have always lived together. Particularly enlightening is the following case, reported by Champlin in 1930, for the *Journal of the American Medical Association:* One member of a pair of identical twin boys was struck with a board, and subsequently developed sarcoma of the right testis at the age of 24, and died two years later. His brother had no such

injury, but developed sarcoma of the right testis at the age of 31. Thus the injury apparently did not cause the sarcoma, but simply hastened its onset.

Of especial interest are twin comparisons in regard to mental deficiency. In identical twin pairs, in which one member of the pair was feeble-minded, the other member was also found to be deficient in approximately 96 percent of the cases, whereas in fraternal twins both members of the pair were affected in only about 25 percent of the cases.

Several years ago, Lange, in Germany, studied twins from the standpoint of criminal tendencies. Of 13 cases of identical twins, where one of the members of a pair had a criminal record, in all but three pairs the other member also had a criminal record. Only three out of 18 pairs of fraternal twins showed similar criminal tendencies in both members of the pair. These results were so significant that similar comparisons were made by later investigators. A total of 66 pairs of identical, and 84 pairs of fraternal twins have been included. In 68 percent of the identical twins, both members of the pair had criminal records, whereas both members of fraternal pairs had criminal records in only 38 percent of the cases.

A number of anthropological traits, such as blood group, hair color, eye color, skin pigmentation, and various hereditary abnormalities, including polydactylism, albinism, harelip, pattern baldness, and colorblindness, never show intra-pair variation in identical twins. Finger and palm patterns, tooth conformation, features, gait, voice, and mannerisms never show great intra-pair differences in identical twins, but may or may not show considerable variation in fraternal twins. In some but not all cases, of identical twins, the finger and palm patterns of the two right hands, and of the two left hands, of the pair are more similar than those of the right and left hand of the same individual.

THE most fascinating phases of twin comparisons are, to the majority of us, those having to do with intellectual traits. The relative importance of heredity and environment in mental makeup has been for centuries, and still is, a topic sure to arouse a lively discussion in most groups of civilized mankind. Have twin studies shed any light on this question?

Considerable research has been done in this field, by numerous investigators. There are certain difficulties, however, which are not often encountered in the study of physical traits. We cannot be sure whether a given mental test measures only innate learning capacity, or whether part of the responses are the result of education and training. Then, too, the person tested may or may not respond to the best of his ability. There are certain tests, however, such as the Simon-Binet and its revisions, which have been thoroughly studied by psychologists over a period of years, and have been shown to be fairly valid measures of general learning capacity. When administered by trained testers, they have high coefficients of reliability. In other words, testers working independently usually obtain very nearly the same I.Q. for any particular individual, or if the individual is tested at intervals of several months or years, the I.Q. remains practically the same.

HUNDREDS of twins reared together have been given general intelligence tests, by various investigators. The average intra-pair difference obtained for identical twins is approximately five points in I.Q., an insignificant figure. On the other hand, fraternal twins show, on an average, intra-pair differences of from 10 to 12 points, which is a significant difference. The obvious conclusion from such results is that intelligence is, to some degree at least, dependent upon genetic makeup. Newman, in an attempt to determine to what extent environmental factors modify intelligence, has recently studied 20 pairs of identical twins reared apart, and finds that their intra-pair differences in I.Q. average about the same as those for fraternal twins reared together. The outstanding inference from such findings seems to be that heredity and environment are of about equal importance in determining an individual's I.Q. There are, however, some obstacles to a final acceptance of such an interpretation. Similar and dissimilar environments, are, after all, only relative terms. No two individuals ever have absolutely the same or totally different environments. Critics quickly point out that, even when both types of twins are reared together, the identical twins have more similar environments, because only close relatives and acquaintances can ordinarily distinguish between the members of a pair, and they are thus treated as a single personality. Fraternal twins are as unlike as ordinary brothers and sisters, and people react to each differently.

A logical method of ascertaining the merits of such a contention would be to obtain intra-pair comparisons of a fourth group—fraternal twins reared apart. Such comparisons would also be valuable as a final check on the other groups. If such measurements should show greater differences between the identical and fraternal twins reared together, than between those reared apart, we could safely assume this discrepancy to be due to the fact that identical twins reared together have more similar environments than fraternal twins reared together, as the genetic differences should be practically the same in both instances. If, however, the two types of twins, when reared apart, should show the same or greater differences than those reared together, we could assume the environmental differences of the two types of twins reared together to be insignificant from the standpoint of intellectual makeup.

IT is possible for two individuals to make the same scores on an intelligence test, such as the Simon-Binet, and yet to answer different parts of the test, or give different correct answers for the same parts. Anyone who has had much experience in testing twins knows that, when members of a pair of fraternal twins make the same total scores, they usually show differences in parts answered correctly; or, when both answer a certain part correctly, they are likely to do so in different manners, whereas identical twins show an amazing similarity in parts answered correctly, and in type of answers. Statistical comparisons have shown that there is a significant difference in the degree of similarity of responses in the two types of twins. In other words, identical twins reared together show qualitatively greater intra-pair similarities in type of responses than do fraternal twins reared together. We do not know whether the greater similarities encountered in identical twins are due to their having more similar environments than fraternal twins reared together, or to there being a genetic basis for the kind or quality as well as the total amount of intelligence measured by such tests. A comparison of fraternal twins reared apart with identical twins reared apart should give us the solution. If the same qualitative differences are found to exist between the two types of twins reared apart, then we can be quite certain that the kind as well as the total amount of one's intelligence is, at least partially, determined by heredity, whereas if such differences no longer exist between the two types of twins reared apart, we can assume the qualitative discrepancy between twins reared together to be due to the greater similarities in the environments of the identical twins.

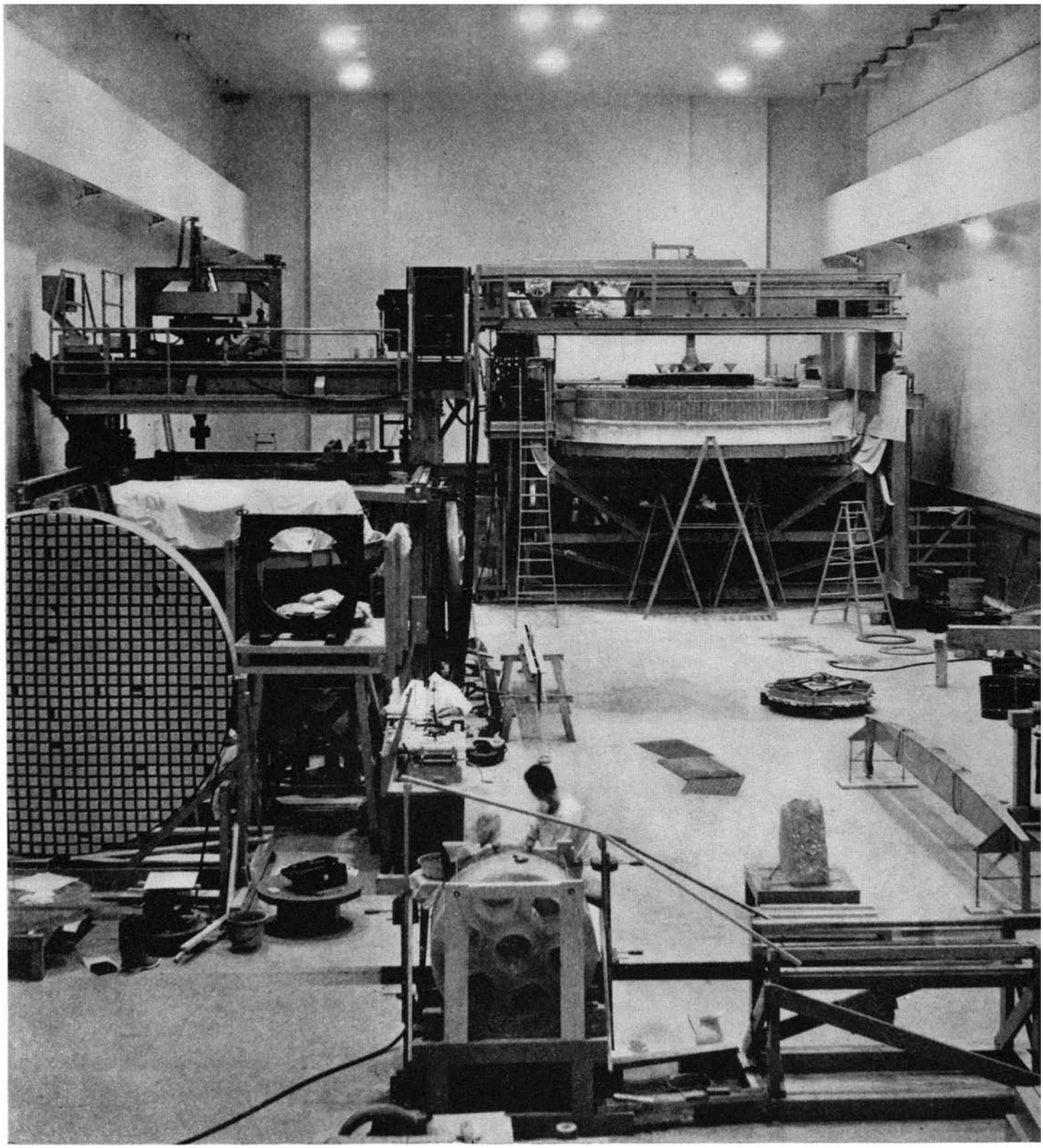
We have briefly outlined some of the advantages of the twin method of genetic research. It can readily be seen that we have only begun to take advantage of the possibilities. Any one knowing of twins reared apart, either identical or fraternal, will be rendering a real aid to genetic research by contacting interested investigators.

●

Key to illustrations on pages 74-75: If we use A *to represent the twin shown in the first picture in the top row and* B *to represent the twin shown in the first picture in the bottom row, then the order is as follows:*

Top Row: A—B—B—A—A—B

Bottom Row: B—A—A—B—B—A



The 200-inch Telescope Mirror Disk Under Initial Work

CONTRARY to a widespread impression, the 200-inch mirror disk, by the press often mistermed a "lens," which was made for the great California telescope, was not ready for use when shipped from Corning, New York, to Pasadena, but was simply a cast blank of glass, as ordered. The longer work of the opticians mainly remains to be done. If all goes well this lengthy precision job should be finished by 1940.

The photograph shown above was taken from the visitor's gallery at one end of the 162-foot Optical Shop at the California Institute of Technology, by Macpherson Hole, Jr., and sent by Wilson Hole. Its main feature is the big disk showing at right, just above the large A-shaped ladder. It lies on its face for the time, slowly rotating while two men seen in the bridge above it pour down abrasive grains. A tool which also rotates as it crawls back and forth across the disk, gradually reduces its back to a level surface. This is tested by means of a stretched piano wire on a beam showing in the right foreground—a sufficiently precise method for the back.

Tipped up at the left is a glass-faceted grinding tool 120 inches in diameter, and behind it on its own grinding machine and covered with a white cloth is a 120-inch optical flat. This was made for testing the still larger mirror after it has been turned over, ground to a curve nearly four inches deep, fine-ground, polished, and delicately "figured" within one millionth inch of perfection. Nor could all the king's money, men or machines speed up this long process of utmost refinement.

OLD PROBLEM—NEW PROGRESS

How a Century-old Obstacle Has Been Avoided in Dealing with the Astronomer's "Problem of Three Bodies"... Special Problem Just Solved

By HENRY NORRIS RUSSELL, Ph. D.

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington. President of the American Astronomical Society

ASTRONOMICAL calculations are a literary byword—everyone knows that they are of vast intricacy. A good many of us have heard that some of the worst of them deal with mysterious things called "perturbations"—but fewer of us could tell much more about them.

The trouble with the astronomers is that they can make their observations with great accuracy (which has itself become a byword); and they naturally want to predict the motions of the bodies which they observe at least as accurately as they can measure them.

This would be no trouble at all if we had to deal with only two bodies at a time—such as a planet going around the sun. Under the sun's gravitational attraction, it would pursue a fixed elliptical orbit, returning to the same place at exactly equal intervals. If the orbit were a circle, it would move uniformly in it, and prediction would be child's play. The more eccentric the orbit, the more uneven the motion; but the position at any time may still be calculated by formulas workable by anyone who knows a bit of trigonometry.

With three bodies present—say Jupiter, Saturn, and the sun—the problem becomes extraordinarily complex. More than a century of study by the most competent mathematicians has made it certain that, if any general formula could be obtained to take care of the case of any three bodies (whatever their masses and motions) it would be so intricate that it would be of no practical use at all for numerical calculation. Fortunately for the astronomers, they have to deal with cases of special types, in which solutions can be obtained by a succession of approximations.

The handsome exterior of the Optical Shop on the campus at the California Institute of Technology, in Pasadena, within which the 200-inch mirror disk is now being ground—as is shown on the preceding page

THE planets, for example, are so small compared with the sun that the attraction of one upon another is never as great as a hundredth part of the sun's attraction on it, and usually very much less. We start, then, by treating the motion of Saturn as if Jupiter were not there, and vice versa. This gives formulas for their motions (each in a fixed orbit) from which their positions can be approximately, though not exactly, calculated. Using these computed positions, we may now calculate the attraction of each upon the other, and then find the changes which their attractions will produce in their motions. These changes are the "perturbations." To compute them is by no means a simple problem, but one that has been solved. Armed with this information, and correcting our original calculations of the planets' positions at a given moment for the perturbations, we can use these corrected positions to get improved values of the perturbing forces. These again lead—after a great amount of labor—to more precise values of the perturbations themselves. A third similar step is necessary only for the most massive planets, Jupiter and Saturn.

The results of these vast calculations may be described rather simply. We may suppose the orbit of each planet to remain an ellipse, but very slowly to change its shape and shift its position in space—though its size and the period of revolution remain unaltered. The actual planet will never get very far from an imaginary one, which moves in this "mean ellipse" in accordance with Kepler's simple laws, though it may be nearer the sun, or farther off, ahead of the fictitious planet or behind it, above the orbit plane or below it. The amount of these deviations may be represented by the sum of a great number of "terms," each of which has a fixed range, or amplitude, and a fixed period. A single such term may be described geometrically by uniform motion in a small circle exactly like the famous epicycles by means of which Ptolemy, 1800 years ago, sought to calculate the planets' motions.

The modern "tables of the planets" indeed are a glorified collection of epicycles, far more numerous than Ptolemy's. What gravitational theory does is to enable us to calculate accurately the period and radius of each epicycle.

Theoretically, the number of these terms or epicycles is infinite; but in practice only a moderate number are large enough to have to be considered, even in the most refined work, so that the "planetary theory" is a practical success.

The lunar theory, which deals with the motion of a satellite under the attractions of its primary and the sun, differs widely in its analytical details, but ends with formulas of the same type—a slowly changing mean orbit, and a host of epicycles or periodic terms. Like the planetary theory, it succeeds in practice, though Brown has had to include almost 700 terms in his expression for the moon's longitude. But this success depends on the fact that the orbits of the planets, and of the moon, are roughly circular—having small eccentricities—and are inclined to one another by but a few degrees. The coeffi-

cient of each term (in plain words, its size) comes out of the analysis in the form of a power-series in the eccentricities and inclinations. For most of the infinite number of terms the coefficients involve such high powers of these small quantities that they are negligibly small. When precise perturbations are calculated for Pluto, with its high eccentricity and inclination, the number of "sensible" terms will probably be very large. (It will be many years before our knowledge of its orbit will be accurate enough to justify this heavy labor.)

To apply the same methods to a comet would probably be useless—it is very doubtful, to say the least, whether the series would be convergent. Fortunately, there are other, and much easier, methods for computing, as accurately as we like, the perturbations of a comet by the planets—step by step, and month by month, for as long as our patience holds out—and this suffices in practice, since no comet has yet been observed for as many as 40 returns, and only two for more than 20.

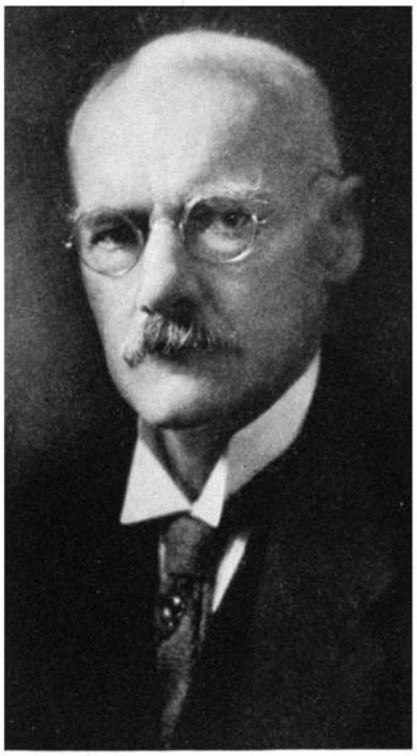
But there are other cases, of much theoretical interest, in which the step-by-step process would not work.

FOR a considerable percentage of the double stars, for which orbits have been computed, one of the components has been found to be a spectroscopic binary—a far closer double. For example, Castor consists of two close pairs, with periods of three and nine days, revolving about one another in some 300 years.

In such systems, the smaller orbit is often, and the larger one almost always, highly eccentric, so that the "classical" methods already described are not available. It is also impracticable to calculate the motion in the close pair, step by step, over thousands of revolutions.

Here is a new problem presented by nature, demanding a new method of mathematical attack, and the problem has just been solved, in a brilliant fashion, by the most experienced veteran in the field of celestial mechanics —E. W. Brown. Professor Brown starts from scratch—with the general equations of motion—but applies a new method of approximation. In all known cases of this sort the period of the close pair is but a small fraction of that of the wide pair. Call this fraction m. A general solution of the problem would involve terms containing m, m^2, m^3, and so on. A first approximation, and one quite adequate for the present purpose, may be obtained by neglecting the very small terms involving m^2, and so on. When this is done, he finds that the mathematical analysis is simplified to an unexpected and remarkable degree. It is no longer necessary to expand in powers of the eccentricities and inclinations; instead, general formulas are obtained, which hold good even for very large values of the eccentricities of both the large and small orbits, and of their mutual inclination.

Nothing like this has ever been met with before in the century and a half



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Professor E. W. Brown of Yale, a specialist in celestial mechanics

of past investigation. It is indeed a new case in celestial mechanics, and the most notable theoretical advance in many years.

The motion of the wide pair is not perceptibly affected by the duplicity of the close pair; but the orbit of the latter may change considerably. During each revolution of the close pair there are departures from simple elliptic motion—usually too small to be important. During each revolution of the wide pair the orbit of the close pair, and the position of the stars in this orbit, undergo periodic changes. Finally, there are slow changes. The point of closest approach of the stars (periastron) moves forward, the node of the orbit-plane on that of the larger orbit retrogrades, and both the eccentricity and inclination fluctuate by large amounts. These changes are themselves periodic, and require for their completion as many (or more) revolutions of the wide pair as there are revolutions of the close pair in one of the wide. These changes are illustrated by Professor Brown's calculations for the system of *Xi Ursae Majoris*—which has already been described in these columns. [June, 1936, page 315. —*Ed.*]

The wide pair with a period of 60 years has an eccentricity of 0.41 and an inclination of 57 degrees to the "plane of the sky" on which it appears to be projected. It has been well observed over nearly two revolutions. The brighter component is a spectroscopic binary with a period of 1.83 years and an eccentricity of 0.53. Precise photographic measures of the apparent separation of the wide pair show an oscillation which indicates that the smaller orbit is inclined 85 degrees to the "sky" and 38 degrees to the other orbit. The companion is too faint to see separately.

The other component of the wide pair is also double, with a period of four days; but this pair is so close that for all practical purposes it may be treated as a single body. The first pair, however, affords an almost ideal case for the application of the new theories. The periodic changes in the smaller orbit, which repeat themselves after 60 years, alter the eccentricity by a total range of 0.03, the inclination by 3 degrees, and the longitude in the orbit by a little over 1 degree. Could we observe the pair from close by, these changes would be conspicuous; but at its actual distance these effects are at the very limit of observation, if not beyond it.

THE gradual changes are much greater, but very slow. The forward revolution of the periastron takes 24,000 years to complete a circuit, the retrogression of the node, 4600 years. The eccentricity ranges from 0.54 to 0.19, and the mutual inclination of the orbits from 37 to 47 degrees. These changes repeat themselves after 1900 years.

Could we observe the pair long enough, we would therefore find easily observable changes. The orbit plane, in particular, may at times have an inclination—from our viewpoint—of 57–47 degrees, or only 10 degrees. At other times it may be exactly edgewise toward us, and it is possible that one star may eclipse the other. Unfortunately, this will not happen for many centuries.

Of all the known cases, this is the one in which the short period is the largest fraction of the longer one, and hence the one in which the perturbations are the greatest. For such a star as Castor, the periodic changes in the short period orbits must be far too small, and the progressive changes far too slow, to be detected by observation. In the triple star *Zeta Cancri*, a pair with a 60-year period has a slowly moving distant companion which must require several centuries for its revolution. There are several other such stars; and, when they have been followed nearly around their orbits, there will be a fine chance for the application of the present theory—which will then be some centuries away from being new. Until then, the problem may be regarded as closed. —*Princeton, N. J., June 2, 1937.*

RAIL FREIGHT'S MODERN

Freight Train Schedules Faster . . . Research Improves Cars . . . Shipments Protected . . . Larger Car Loads . . . Rail Service to Customer's Door

By S. T. BLEDSOE
President, The Atchison, Topeka and Santa Fe Railway Company

RAILROADING and romance are synonymous. That same unquenchable romanticism which drove bands of steel across the continent to weld millions of miles of raw territory into a mighty nation breathes today as America's railroads forge ahead.

Yesterday's pioneering railroader fought Indian battles, deserts, mountain floods, and blizzards. Today's pioneers carry on civilization's battle in hundreds of research laboratories. Less colorful and unsung, but heroes none the less, are the scientists who conquer unexplored fields of metallurgy, electricity, chemistry, and the many other branches of engineering having to do with railroads.

Ever-changing conditions of business and social life in this country make new demands upon the transportation world daily. Railroads long have occupied themselves with the job of keeping safe and dependable service abreast of the forward-moving tide. This work of American rail systems is well illustrated by the revolutionary improvements of freight service during the past five years.

Today, massive freight trains move on yesterday's passenger schedules. Mile-a-minute rail transportation of the world's merchandise is today's possibility and tomorrow's commonplace. Other links in the intricate railroad world are speeded up in rhythm with the modern trains. Rail service is extended to the customer's very door, and special facilities are provided daily for handling the complex products of an intensified civilization.

Painstaking laboratory research has removed railroad progress from the realm of hazard and experimentation. Safety and dependability have always been watchwords in railroading, yet they are doubly important today as thousands of tons of goods are rushed from producer to consumer overnight. Designers of new locomotives, cars, and other equipment are specifying strength far in excess of that actually needed for the anticipated service; they are demanding and getting greater factors of safety.

Until about 1930, railroads directed much of their research effort toward greater safety and economy. Millions of dollars were spent on roadbed improvement and signal systems. While this program was designed to, and did, reduce operating costs, it has proved of great benefit in the new speeding-up process. Much track curvature and steep grades were eliminated or reduced. Signal systems were improved to a point where they operate safely and efficiently under our ultra-fast schedules of today.

WITH scientifically tested rails in place on improved roadbeds, the railroads were ready to step up the tempo of their service when the demand came. Shifting economic trends forced merchants to carry smaller stocks. This necessitated immediate replacement and extra fast service on re-orders. Overnight service came with the depression. Harassed business men needed and demanded constantly increasing types of service.

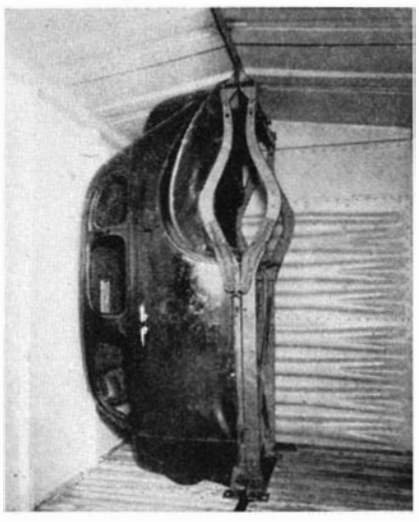
The store-door pickup and delivery system for less-than-carload shipments was pioneered by traffic experts who studied, tested, and perfected this new feature in railroading that has become an accepted service on all railroads.

In the Middle West, livestock is picked up in any quantity lots and carried to the central markets at carload rates, actual weight; it might be added that this saves the farmer the necessity of holding his livestock ready for market until he has accumulated a carload consignment.

Railways have made household words of air-conditioning and streamlining. Present-day passenger trains are being widely and favorably discussed because of their many modern conveniences. Parallel improvements in freight service have been keeping step. But, because the passenger service offers intimate personal contact with the public, much more has been said of it than of our job of transporting the nation's foodstuffs, fuel, and daily necessities.

It has been said that the railway refrigerator car has done more to widen distribution of food than any other agent except the tin can. This is understandable, realizing that today seafoods, vegetables, meats, and fruits are delivered fresh daily to markets from coast to coast by American railways. Ten years ago, it required eight days for a fast freight train to carry fresh meat from Kansas City to Los Angeles. Today, the Santa Fe operates a freight service over that route, making delivery on the sixth morning. California fruits were handled to Chicago on a 154-hour schedule in 1925 while today that time has been shortened to 130 hours.

Between Chicago and Kansas City



More automobile bodies per car by new loading system. *Left:* Automobile body on stanchions ready to be turned into place. *Right:* Body turned and fastened for shipment

TEMPO

there is a heavy traffic of goods from the Pacific Coast, Arizona vegetables, Texas livestock, Oklahoma petroleum, and Kansas wheat. Outbound from Chicago pours a vast stream of merchandise—automobiles, farm machinery, furniture, and all sorts of factory goods. Ten years ago the fastest freight service between these two cities required nearly 29 hours. Today, the usual operating time is around 20 hours. However, the Santa Fe sends a train over this route in 16 hours 45 minutes. I mention what we have done in these respects to typify what has been and is being done on many railroads today.

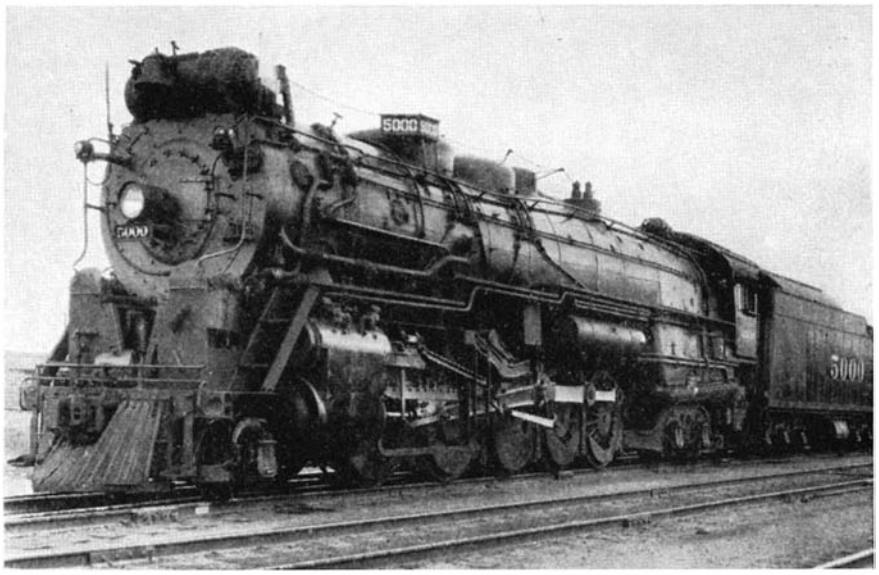
The schedule between Kansas City and Denver has been shortened by an entire day. The freight train run from Kansas City to Galveston has been cut from 78 to 48 hours. Between Kansas City and Amarillo, schedules have been shortened as much as 22 hours and 40 minutes. These schedules, however, do not tell the whole story of speeded-up freight service. Trains can and do operate ahead of their schedules in cases of emergency.

SINCE J. B. Sutherland, of Detroit, obtained the first patent on a refrigerator car in 1867, probably no other special-handling facility has been the subject of more experimentation than the railway refrigerator service. The Santa Fe reached California in 1885, and introduced refrigerator service to that country for the transportation of California fruits.

These early refrigerator cars, built along the lines of ordinary freight cars, except for ice bunkers holding 8000 pounds of cake ice and having about one inch or less of insulation, were mounted on the customary iron trucks. Today, these refrigerator cars are being built to carry 100,000 pounds. They have from 10,000 to 12,500-pound ice capacity, and they are insulated to a thickness of three inches and more. They are being mounted on cast steel trucks with both cast iron and steel wheels.

Special cars for the transportation of frozen fruit juices and other frozen products are insulated to a thickness of seven inches. Fresh meats are transported generally in cars equipped with brine tanks filled with ice and salt. These tanks are capable of reducing car temperatures to the freezing point.

The greater part of our perishable traffic originates in California or Arizona, and is handled for an average distance of 2500 miles. Standard refrigeration service is maintained along the system so that cars can be re-iced each 24 hours. However, in recent years, shippers have been pre-cooling their produce and icing it heavily in order to reach the markets with but one stop for re-icing. At the present time, 90 percent of the citrus fruit is marketed under these modified forms of refrigeration.



One of the largest locomotives recently built by the Santa Fe, a 2-10-4 type weighing 440 tons. Its tractive force is 93,000 pounds, its fuel capacity being 27 tons

Experiments are being made in the use of dry ice for refrigeration purposes.

Prior to 1930, development of freight motive power was aimed at increased capacity and economy rather than speed. Thirty-five years ago the well-known 1000 class Santa Fe type engines used compound cylinders and intricate driving mechanisms. This type of engine had a tractive force of 38,150 pounds and pulled 1200-ton trains at 30 miles per hour.

For the next 30 years, locomotive development simplified working parts, increased steam pressure from 180 pounds to 300 pounds, and produced the superheater which today delivers steam at a temperature of 720 degrees.

With old-fashioned lubricants, poorly treated water, and an excess of working parts, locomotives formerly ran from 150 to 180 miles and then were detained for two or three days in the roundhouse. Oil company laboratories have developed oils that will not break down under great heat; and chemists have given us modern treatment for foreign matter in water so that, instead of forming scale, this matter settles as sludge and can be blown off in the modern foam meter operation.

Incidentally, these foam meters have contributed no small item to the speeding up of trains. It was formerly necessary to wash scale and sludge from engine boilers after each trip. With meters in operation, engines sometimes run for 30 days without this cleaning.

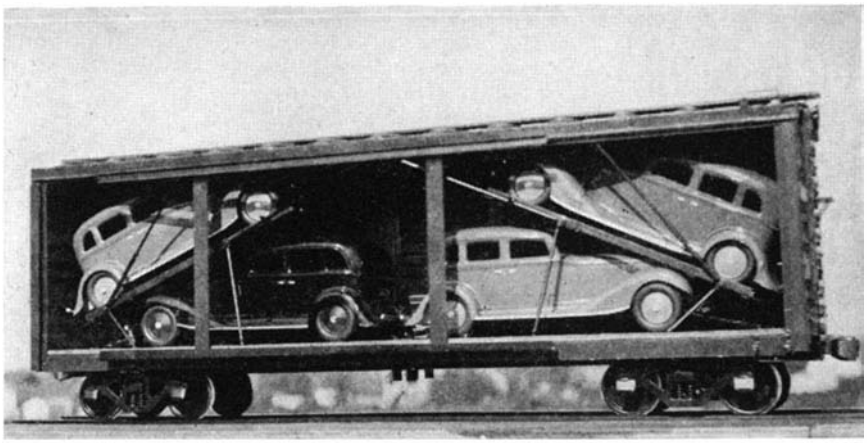
The meter operates from two electrodes of varying height protruding into the top of the boiler. As the water level rises due to foam in the boiler, contact is made with the electrodes, thus closing an electric circuit which, in turn, notifies the engineman that all is not well in the boiler, and opens a blow-off valve releasing the surplus water. As this water is blown off with some 200 to 300 pounds of steam pressure, it carries away the accumulation of sludge or other foreign matter which caused the foaming.

THE Santa Fe now is building new 5001-class, Santa Fe type locomotives that have a tractive force of 93,000 pounds. They have 74-inch driving wheels, are capable of pulling a 6000-ton train at 65 miles an hour, and weigh more than a half million pounds—538,000 pounds to be exact.

These engines can travel 100 miles between stops for fuel or water. They are designed to run 150,000 miles between trips to the repair shop. They are the conventional 2-10-4 type of engine that the road has used over a long period.

Terminal operations are keeping pace with other improvements over the wide range of railway operations. Diesel switching engines are replacing the steam switcher. These more compact power units can run for 24 hours a day and need not be laid up for cleaning and servicing to the extent necessary for steam engines.

Close co-ordination between the various railroads is much in evidence around the terminals. Ready interchange of cars and equipment from one line to another speeds steadily flowing traffic of the nation. Railroads are studying consolidation of terminal facilities where there is a possibility of effecting operating economies and at the same time ex-



The newest, most economical system for loading completed automobiles for shipment. The racks permit utilization of space hitherto a loss to shippers

pediting the steady movement of traffic.

In addition to reaching out to the merchant's place of business with store-door delivery, railroads are handling storage and marketing facilities at the metropolitan centers. In Chicago, the Santa Fe owns jointly with the Illinois Central a produce terminal that covers approximately 100 acres.

Many railroads have constructed grain elevators. This permits cars to be unloaded promptly upon their arrival at the terminal rather than serving as temporary storage for grain. This is an important factor during the rush of the harvest season when delays are costly to grain growers. At the Santa Fe's Kansas City elevator, more than 30 cars of grain can be emptied per hour. A large unloading rack picks up cars bodily, dumps out the grain, and wheels the cars back to a switch track where they can be shunted into a train returning to the wheat fields.

Within recent months, railroad car engineers enabled a major motor car builder to save both money and time on automobiles shipped from the factory to Pacific Coast assembly plants. Ten car bodies had been the maximum load the maker had been able to ship. Much dunnage—crating and blocking—had been required. Loading and unloading was a long tedious job, and claims for cargo damages were frequent.

Freight-car engineers went to the factory and studied the loading system. Returning to the railway shops, they equipped a car with steel tracks at bottom and top. A stanchion was designed to up-end the automobile bodies so they could be bolted to the tracks. Using this system, 18 bodies now can be loaded where only 10 were carried before. The number of men required for the loading job was reduced, and the dunnage has been entirely eliminated. The car bodies now can be shipped finished, upholstered, and fitted with their instruments. They arrive at assembly plants just as they left the factory, without damage.

THERE has been developed a technique for loading car frames in gondolas. Such gondolas are fitted with racks and braces so that factory cranes drop the frames into place, eliminating hand shifting. These special cars are being provided in numbers to handle this rapidly developing class of business.

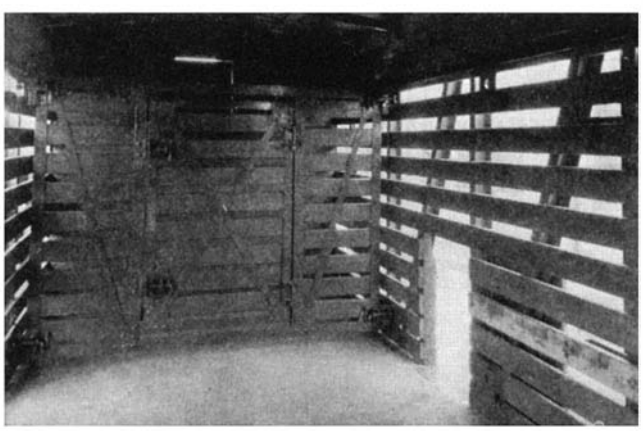
Many dry commodities and foodstuffs now are being transported in tank cars. These cars are of special design and equipment. They are closed to air and moisture while in transit. Expense of packaging and hand loading these products is eliminated since the "dry-flow" cars are filled and emptied by conveyors. Similar cars have been developed for handling cement, Fuller's earth, and other powdered clay products. Until recently these products were sacked and shipped in box cars.

Another development is a "closed hopper" car that can be loaded and unloaded pneumatically, eliminating damage and spillage, and saving time as well as handling expense. Powdered products are fed by gravity into air lines that force them up into storage bins several stories above the car track.

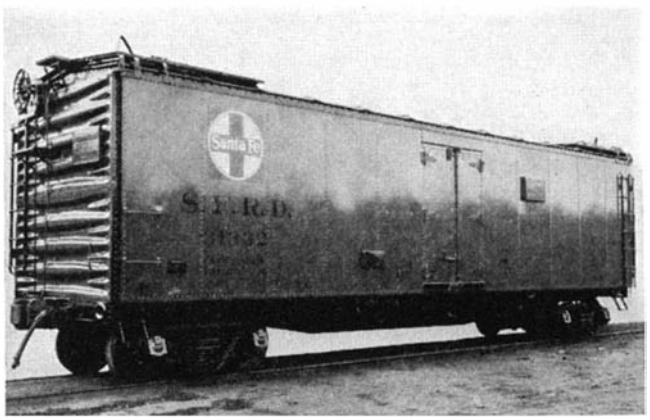
Endless examples of this type of service could be enumerated, but probably the most important factor in freight transportation remains the standard box car. This vehicle has been undergoing a constant evolution. Wooden box cars built for capacity loads of 40,000 to 60,000 pounds are rapidly disappearing from the rails of this country. Old fashioned brakes, light couplers, bolt-studded iron trucks and other items have been dropped from modern car building. New cars with steel underframes, steel ends, and steel sides can carry up to 100,000 pounds. They are equipped with better springs—snubber springs to reduce jolting—and some have an underframe which tends to make the car body "float." Steel roofs, riveted tightly to the walls, make the new car interior almost water- and dust-proof.

Unwieldy car doors that could be opened and closed only by main strength and strong language have given way to large close-fitting doors that move on roller bearings and that have special opening devices built in the fastening mechanism. Many other instances could be cited to show how freight service and equipment are keeping up to date. Everywhere along the railroad lines, new ideas are being tested and tried. As soon as they show merit in the saving of time, increase safety, or make for dependability, they are placed in service.

Today, research workers with pioneering urge are exploring new regions in scientific thought. Out of this exploration will come discoveries that will make the railway train of tomorrow even more attractive than it is today.



This car, with partition to be fastened at any point, makes possible safe shipment of less-than-carload-lots of animals



A rebuilt refrigerator car with a modern, steel superstructure and many other improvements, as described in the text

RADIUM—
NATURE'S ODDEST CHILD

Strange Experiments . . . Only One Chemist Survived . . . A Little Mistake that Cost $35,000, an Explosion, and a Sneeze that Cost $13,500

By JOHN A. MALONEY
The Museum of Science and Industry, Chicago

(*In Four Parts—Part Two*)

THE preciousness of the element radium is due in large part to the difficulties of extracting it from the parent ore (uranium) with which it is invariably associated. The wearisome labors of the Curies were not extraordinary when we consider that modern chemistry has made but slight progress in refining radium since the Curies pointed the way. Radium does not occur in great veins like coal or iron, but is found with uranium in what the chemist calls a state of equilibrium. This means that there is always a maximum amount of radium in proportion to the amount of uranium in which it is found. Contrary to popular belief, radium is found widely distributed throughout the lithosphere, or crust, of the earth, and there is good reason to believe that it occurs also abundantly within the interior of the earth.

Thus far, radium has been found in the earth associated with uranium itself or other ores containing uranium. Among these the most important is pitchblende, which is a blackish uranium oxide containing other metals in negligible quantities as impurities. Pitchblende deposits occur in Cornwall, England; in Jachymov (formerly called St. Joachimstaal) in Czechoslovakia; in the Belgian Congo; and in the Great Bear Lake region of Canada. Next comes carnotite, which occurs as a binder between the sands and has been found in Utah and Colorado. Carnotite bears the chemical name of potassium uranyl vanadate and it has played an important part in the history of radium in the United States. Autunite, a calcium uranium phosphate, occurs in Portugal and Australia, and has also been a source of radium production although not a very economical one.

It is impossible to predict how many more rich deposits of radium will be discovered, even in the very near future. In an age that is as highly mechanized as ours, it is difficult to conceive that any section of the globe has been left with stones unturned, but there are many. The machine age has tended to centralize population, and even the explorers seem to prefer spectacular trips to the polar regions to treks through the uncharted wildernesses that lie nearer home.

In addition to the original and crude method of detecting radium with a sensitized photographic plate, its presence within an ore can easily be detected by either of two methods—the electroscope and the scintilloscope (or spintharlscope). The electroscope usually consists of a metal chamber, in which is a

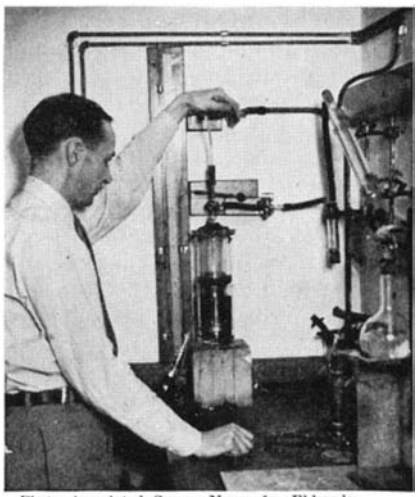


Photo Associated Screen News, for Eldorado Gold Mines, Canada

A laboratory worker transferring radium emanation to a cylinder for measurement by the electroscope

piece of metal suspended from an amber or sulfur insulator. Attached to the upper end of this strip is a piece of gold leaf. Ordinary electric charges will cause the gold leaf to fly away from the metal strip, and after the electricity ceases, the electroscope discharges and the gold leaf slowly returns to its original position. Bring a piece of radium-bearing ore near the electroscope and the rate of discharge is accelerated. Early electroscopes were not only crudely made but extremely delicate; modern instruments, however, are well adapted to the prospector's kit of tools. The scintilloscope consists of a closed brass cylinder with a lens at one end and coated on the interior of the other end with zinc sulfide. A radium bearing mineral brought close to the cylinder produces scintillations in the zinc sulfide that can be plainly seen within a few minutes—as soon as the eye has become accustomed to darkness. The result produced is most striking and can best be described as comparable with sitting on a vantage point far out in the Milky Way and gazing on a parade of brilliant planets and comets as they whirl by in a mad, dazzling, fascinating, and disordered array. It is as if the lecturer in a planetarium lost control of his "deus ex machina," allowing the starry firmament to run wild. It is a cosmic madness that cannot fail to entrance.

ALL of the radio-active metals affect a photographic plate by causing it to appear "light-struck," and that method of detecting radium has only rarely been used. It is not an infallible test because other radio-active materials, such as thorium, also transmit invisible rays to the plate.

But perhaps a more pleasant way to learn more about the methods of treating radio-active ore to obtain radium than an erudite discussion in chemical terms would be to follow some of the pioneers who came after the Curies; to share with them some of their experiences and, by thus projecting ourselves back into their ranks, really to appreciate the nature of this fascinating stuff called radium.

With the scenes shifted, then, from the shack of the Curies in Paris to Colorado, and the hands of time moved forward to 1920, we watch a burro train that moves like a lethargic side-winder rattlesnake over the narrow mountain passes. Joseph M. Flannery, President of the Standard Chemical Company, of Pittsburgh, has already explained in great detail the object of their quest to this crew of 300 men, who sit taut in

their saddles, eyes roving under perspiring brows over a horizon that dances in a maddening mirage, without even vestiges of vegetation to absorb some of the terrific heat. They all knew that they were going into that hot, arid country to pry loose as many tons of carnotite ore as the burros could carry back to the concentration mill 18 miles from the sand deposits—18 awful miles

Drawing by Percy Hale Lund

"The warning came too late. Thirty-two animals were hurled to an instantaneous death at the base of the cliff. The dead burros were relieved of their precious burden and most of the ore was recovered"

of waste that seared the souls of man and beast alike.

Throughout these stifling days these 300 men gnawed into the dust and loaded 300 pounds of it on the back of each burro. Then the train started back for the mill. The head driver decided that the burros must be roped together to keep them and their precious burdens from tumbling headlong into the gullies that were a half mile deep in some places. And roped they were.

What was the reason for all of this activity? The Austrian government had declared an embargo on pitchblende ore and, if the United States was to have its own supply of radium, these carnotite deposits must be tapped. No other region had given any evidence of containing radio-active material in paying quantities. And so we find the burro train moving back to the mill with 50,000 dollars' worth of ore upon their weary backs. All went well for the first few miles. Nearing a particularly steep cliff, the driver yelled a warning to the men to guide the burros with care—but the warning came too late. Thirty-two animals were hurled to an instantaneous death at the base of the cliff. Days and weeks went by as the dead burros were relieved of their precious burden and others brought up to transport it to the concentration mill. Most of the ore was recovered.

This procession kept up until 500 tons of carnotite had been dumped into the open maw of the concentration mill, where it was hand high-graded until but 100 tons remained. Then it was shipped in bags to the railroad depot at Placerville, and thence to Canonsburg, Pennsylvania, under special guard. At Canonsburg another crew of men awaited the arrival of the shipment and prepared the great tanks and tubs that would again begin the process of reducing.

It must be noted here, that, although the men engaged in this, the first attempt to produce radium in this country, were chemical engineers of the first order, they were in about the same predicament as were Pierre and Marie Curie in their shed. They were very unfamiliar with the substance they were refining and even less with the radium for which they were searching. It is not to be wondered at, then, that they went through some experiences which were almost as heartbreaking, and certainly more costly, than those through which the two pioneers had gone in France.

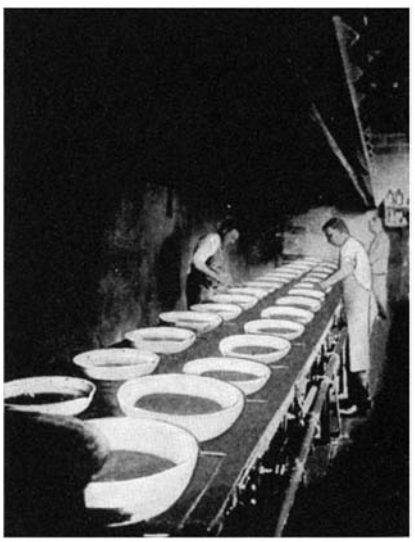
FOR experimentation and use, a gram of radium—one thirty-second of an ounce—is divided into 1000 parts, each called a milligram; these, in turn, are again divided into 1000 parts, each called a microgram. A unit of gas which emanates from a milligram is called a millicurie and $\frac{1}{2700}$ part of this gas unit is called a Mache unit. Seldom does even a Mache unit go astray in the laboratory. To demonstrate the activity of even a Mache unit, the chief chemist of the Standard Chemical Company one day placed a Mache unit in one of six pills and asked six laboratory assistants to swallow them during his absence. Twenty-four hours later he was able, by taking a drop of blood from the ear of each man, to identify the consumer of the Mache unit!

The length of life of radium is determined in a peculiar way. Suppose, for example, that a given pound of radium could be watched during its entire lifetime. After 1690 years had passed, it would have given up half of its energy. At the end of another 1690 years the remainder would have given up half of its energy. At the end of the third 1690 the remainder would have released half of its energy. If mathematics is your forte, you are welcome to continue until you can write *Q.E.D.* after the final ray leaves the last atom of radium and mere lead alone remains.

Strange experiments were tried in Canonsburg with this new plaything. In the course of the work it was found that willemite, an ore of zinc, glowed with a cold light under the influence of radium emanations. Ten men were placed chest to back, the first in line holding a piece of willemite. One hundred milligrams of radium were held behind the last man's back and still the willemite glowed.

Water was found to have that peculiar kinship, which the chemists of those days called "chemical affinity," for the emanations of radium. After drinking water which had been treated with a sufficient quantity of radon gas, these pioneers found that a metallic object in the waistcoat pocket could be photographed, using the rays from the water in the subject's stomach as a light-source. Mr. Luther S. Gable, the sole survivor of six chemists who met their death from radium in those days, and who now resides in Brookfield, Illinois, still retains the photograph thus taken of his own watch as a grim memento of the fate which he escaped. A strange and dangerous X-ray process, that! Water thus charged loses half of its energy in two and seven-tenths days.

Radium history in the New World was repeating itself, and misfortune seemed to follow misfortune with an uncanny persistence. After the burro in-



Rows upon rows of crucibles in the crystallizing department of the Standard Chemical Company's plant at Pittsburgh. At left is Dr. Krapf who died from radium

cident and the safe delivery of the ore at Canonsburg came days of boiling and testing in huge, covered vats. Again it was the old game of "the needle in the haystack." Somewhere in that great array of seething crucibles was radium, perhaps a part of a gram, perhaps a gram, but it was radium! Just where it was, only this tedious process of refining and cooking would tell. One day a test of the tanks indicated that the radio-active material was confined to one tank. Orders came through from the chief chemist to drain off the other tanks and thus make room for more ore. The workman who turned the

valves which allowed the useless ore to run down a drain and into the river must have been quite perturbed by the responsibility of his position, or else very absent-minded, for he proceeded to valve off the wrong tank and at least 35,000 dollars worth of radium-bearing ore (and perhaps more) slid merrily down the drain pipe and into the river. There was no chance of recovery here. It was gone and the next day so was the workman.

The first illuminated dials for watches and gages were made here during this course of experiments. The entire dial, with the exception of the numerals, was made iridescent. The cost of such treatment was prohibitive and a purchaser would have run the risk of being burned unless he wore a lead shield for protection. And so another "crazy notion" was shelved, until the Ingersoll Watch Company put its illuminated watch on the market with a dial whose numerals were treated at first with radium but later with meso-thorium, a cheaper substitute of the radio-active family.

NATURE was lavish in her endowment of the element radium. Three kinds of emanations come from it; first, the alpha particle which becomes helium gas; second, the beta particle, which is the electron, or negative charge of electricity; and third, the gamma ray which is similar to the X ray. The metal tungsten had been made to give off an alpha particle and this fact led to some speculation on the part of radio-chemists. Tungsten is 22 points lower in the periodic chart of atomic weights than lead, and so it seemed that lead might be giving off alpha particles, but so slowly that they had not been detected. If so, lead was disintegrating, they argued. Disintegrating into what? Into the metal thallium and then into mercury and finally into gold! Here again, is the age-old dream of the alchemist cropping up—the transmutation of base metals into gold. But chemistry has passed that stage of speculation. Chemists today are not worried much about this dream. To them lead is a precious metal in this age of electricity—far more precious than gold in some respects. The machine age has been on a lead standard for many years but the economist has not found it out yet.

One of the research chemists at the Standard plant who had been analyzing the ore in a test tube announced that he had retrieved traces of radium-bearing salts by watering the radium-barium-sulfide, and soda metal. If it worked in a test tube, he reasoned, it might also work in one of the great conical tanks. All agreed that it should be tried. Perhaps it would prove to be a short cut that would eliminate some of the time lag that existed in the refining process. And so water was dumped into one of the great tanks and the group drew back to await the results. The results came all too quickly. A great cloud of smoke, brilliantly illuminated with radon gas, issued from the tank, and then the whole thing blew apart, burying its great weight in the dirt floor. Every inch of soil and every scrap of debris had to be dug up, pulverized and chemically treated before the precious ore could be recovered. Most of it was recovered.

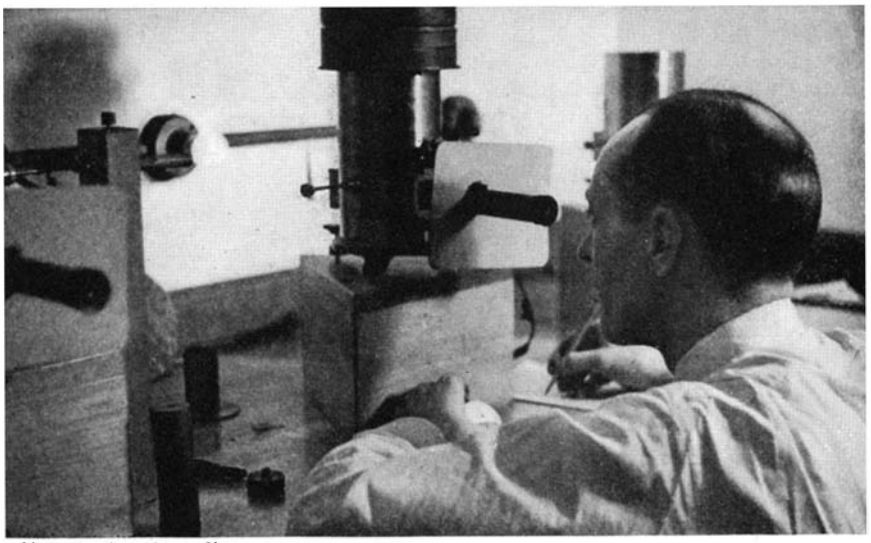


Photo Associated Screen News

A physicist at the Ontario refinery of the Eldorado Gold Mines, Ltd., measuring with an electroscope liquor containing only .00001 milligram of radium

Surely this was a train of costly accidents that was sufficient to try the patience of a Job. But Flannery was a man of great foresight and he kept his men at work and spent as much of his own time in the plant as did his most enthusiastic assistants. Radium was selling in the world market at this time for 125,000 dollars a gram, and Flannery knew that if the carnotite ore of Colorado could be made to produce enough radium every hospital in the United States could be supplied with it at a reasonable price. It seems, too, that the women of America were also demanding that Flannery produce radium enough for them to present to Madame Curie, who was coming to visit our shores. Madame Curie received her share of Flannery's radium, but the fates decreed otherwise for his radium clinics distributed throughout the United States. The demand for radium has always exceeded the supply, and doubtless always will, but in those days the needs of medical centers, universities and research laboratories whose researchers needed radium to help solve the atomic structure of matter, were large. Today, although radium is important in physical investigations, it has been supplanted, in the domain of the atom smashers, by high-speed particles shot from cyclotrons and giant static generators—the heavy artillery of physics today.

The day finally came when a minute amount of the elusive radium salts was cornered and placed with loving care in a watch crystal on a laboratory table. What a surprise for the boss, the men remarked to each other. Before the dust of the day's work had been completely swept away, a call was sent to Flannery to come to the laboratory at once. The staff waited with bated breath. In he came, and they pointed with justifiable pride to the watch crystal. Flannery leaned lovingly over it.

"How much is it worth?" he finally inquired.

"At the present market price", answered the chief chemist, "it is worth about 15,000 dollars."

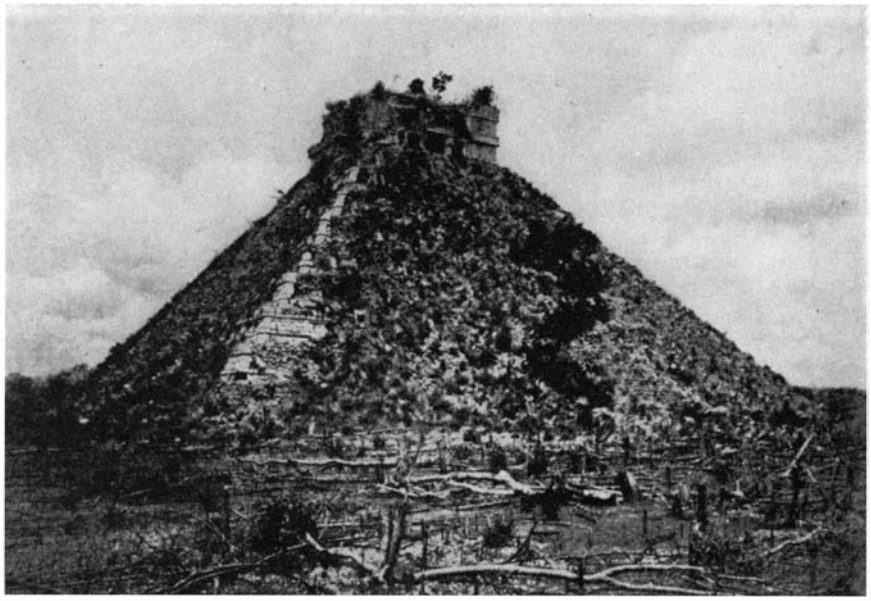
"And it cost us . . ." Flannery had started orally to compute the cost when some of the dust that was being swept up entered his nostrils. "Ka—choo!" he finished, and blew the 15,000 dollars worth of radium salts into invisibility. The watch crystal was empty. The situation did not seem as humorous then as it does now.

Everyone in the room was made to disrobe; every nook and cranny was swept with fanatical zeal; the floor was scrubbed with hydrochloric acid; and the collections of clothing, debris and dust were burned. All but about ten percent of the radium was recovered from the ashes.

Radium took its awful toll in those days, too. Dr. Emil Krapf, Dr. Alvin Krammer, Paul F. Hague and Dr. Charles H. Viol all died within a few years of each other, and all of them were in their thirties. Flannery, himself, met a similar fate, toppling over dead as he crossed the living room floor in his home. Gable, the sole survivor of this group, believes that Flannery may have inhaled the 10 percent of radium salts which could not be found the day he sneezed it away.

(To be continued)

PYRAMID TEMPLE



Before its restoration by the Mexican Government the old Maya pyramid was in a sadly tumbled-down outside condition. Trees grew over its damaged faces

The Most Spectacular Discovery of Archeological Specimens in Original Position Ever Made in the New World . . . The Jaguar Throne of Chichen Itzá

DURING the summer of 1936, archeologists of the Mexican Government, working at the Maya ruins of Chichen Itzá, Yucatan, made an extremely important discovery. They found that El Castillo, the most impressively dominant of the pyramid-temples of the famous site, embraces within itself an older pyramid-temple that has been completely concealed for centuries. When the chambers of this inner temple had been cleared of the rubble with which they had been filled, objects were revealed of the utmost value to the scientists who are trying to clear up the perplexities that have arisen respecting the Maya race, the greatest of all the pre-Columbian races of the New World.

El Castillo, built to honor Kukulcan, one of the members of the Maya pantheon of gods, stands near the center of a 45-acre terrace which is composed of rubble masonry raised a few meters above the level of the vast limestone plain which comprises almost the whole of the northern portion of the peninsula of Yucatan. Surrounding the pyramid lies a complicated agglomeration of temples, courts, arcades, colonnades, palaces, and mounds not yet excavated—an architectural complex so extensive, indeed, as to indicate that Chichen Itzá, when at the height of its development, must have truly presented an amazing spectacle.

The peak of this construction activity at Chichen Itzá was reached during what is known as the New Empire period of Maya history, a period which probably began soon after the middle of the 11th Century and which continued well into the last half of the 15th Century, almost to the time of the coming of Columbus. This period of three and a half centuries is often referred to as the period of the Maya renaissance, and it is indeed true that during this time Maya culture experienced a sharp revival which found its most fruitful expression in the design and construction of great buildings for religious and ceremonial purposes.

This awakening to exuberant architectural activity appears to have been due, in part at least, to the influx of an alien people from the west. There is uncertainty as to just who these people were, but there are grounds for believing that they belonged to the great Nahuan linguistic group of Mexico. At all events they profoundly affected the art, the architecture, and the religious and ceremonial life of Chichen Itzá, Mayapan, and Uxmal, the three city-states of Yucatan that, during this period of Maya history, formed the political confederacy known as the League of Mayapan.

The invaders from the west brought with them, for example, worship of Kukulcan, the feathered-serpent god, who was represented by a rattlesnake having a body whose scales were replaced by the feathers of the sacred quetzal bird and from whose mouth a human head frequently protruded. Everywhere in Chichen Itzá among the buildings of the New Empire period, representations of this all-powerful divinity of the earth and sky are to be found. In columns, cornices, façades, balustrades, murals, bas-reliefs, the Maya artists and sculptors employed the feathered serpent as an ornamental *motif* with unrestrained prodigality.

So, too, the immigrants from the west seem to have been responsible for the marked increase that took place in the performing of human sacrifices. Indeed, it is thought by some that they are rightly to be charged with having introduced the religious ceremonies that were associated with El Castillo and the sacred well near-by—ceremonies which culminated in casting the most beautiful of the Maya maidens into the well in a supreme effort to appease the rain-god who was thought to have his abode in the depths below.

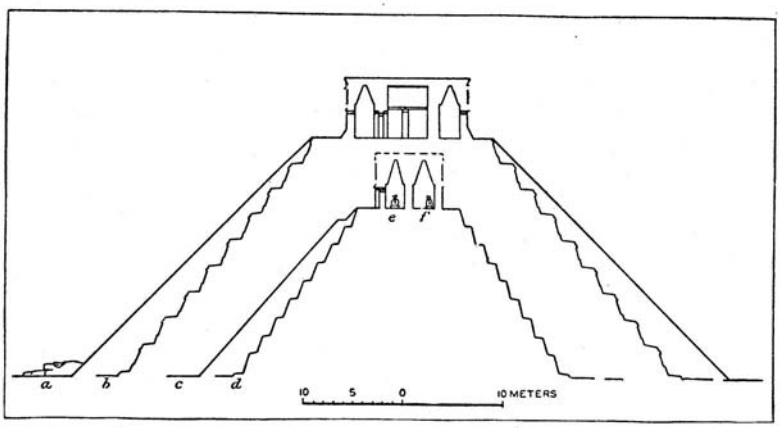
Such was the period of the New Empire among the Maya of Yucatan—a period during which the culture of this extraordinary race came into its final flowering. It was early in the period and in response to the renovating and rejuvenating tide of new life that flowed into Chichen Itzá, that El Castillo, the pyramid-temple of the great god Kukulcan, was erected. Abandoned soon after the coming of the Spaniards, Chichen Itzá and its magnificent structures quickly fell prey to the inexorable advance of the jungle. Indeed, the whole of this great Middle American civilization dropped out of human consciousness, became lost to human view.

In 1925 a Department of Monuments within the Ministry of Public Education was established by the Mexican Government and responsibility for supervision of the ruins in Chichen Itzá vested in one of its bureaus, that of Pre-Hispanic Monuments. Of this bureau, Sr. Ignacio Marquina has been the head for several years. With the creation of the Department of Monuments, steps were taken to protect the ruins and, in the case of El Castillo, to restore the missing stones to their original positions.

In planning and executing this work of repair and restoration distinguished engineers, architects, and archeologists were called upon for assistance.

OF KUKULCAN

The great pyramid, 79 feet high and 197 feet wide, as now restored, showing the northern face. Stone stairways rise to the summit on each of the four faces



A north-to-south cross-section of the pyramid showing: *a*, outer stairway; *b*, outer terraced face; *c*, inner stairway; *d*, inner terraced face; *e*, vestibule of concealed temple; *f*, sanctuary of concealed temple, with the jaguar throne

The restoration, so far as it could be carried with assurance that the original design was being faithfully followed, was completed in 1927. To give an idea of the state of the pyramid-temple before repair, one of its sides, the south side, has been left as it was. Pictures made in the last century show how disastrous had been the effect wrought by the forces of nature and by the inhabitants of neighboring villages, as well, who had removed much of the original facing for use in their own constructions. Comparison of the picture of the restored structure with the one at the head of this article will give some idea of the magnitude of the task undertaken by the Bureau of Pre-Hispanic Monuments and also how well that task was performed by this Mexican bureau.

Meanwhile, the Mexican Government entered into contract with the Carnegie Institution of Washington, effective as of January 1, 1924, whereby the Institution was permitted to conduct archeological studies at the ruins of Chichen Itzá. In 1925 the Institution staff began excavating a tree-covered mound of debris near El Castillo. As fallen elements were identified and restored to original positions, this structure, called the Temple of the Warriors, grew into one of the finest examples of New Empire construction so far found in the entire Maya area.

It was a year later, in 1926, that Earl Morris, in charge of the work at the temple, made a discovery about the way in which the pyramidal foundation had been constructed that suggested a new field of investigation which archeologists have been quick to follow up. He had almost completed work on this structure when a sculptured column block projecting from a corner of the supporting pyramid suggested that some exploratory excavation of the pyramid itself should be undertaken. As a result of the investigation which he made, it was found that chambers existed belonging to an earlier temple, and that they had been filled with rubble and had been incorporated, in their entirety, in the pyramidal base of the Warriors Temple.

Morris dug out the filling, shored up the walls with concrete piers to prevent collapse, and drove shafts to the surface for air and light and easy access. In the course of this work many features were revealed which have thrown important light upon the stage which Maya culture had reached when this early temple was erected.

Discovery that the pyramid builders of the Warriors Temple, instead of completely demolishing the older structure, had preserved a substantial portion of it by filling it up and covering it over, suggested that a similar practice might have been followed in the erection of other Maya pyramids, and this has proved to have been the case. Excavation of a pyramid-mound at Uaxactun, Guatemala, in 1928, by Carnegie Institution archeologists revealed that, while external appearances pointed only to a structure of rough rubble, actually a beautiful pyramid of uncut stone, faced with four stairways, each flanked by colossal masks of lime stucco, lay completely buried beneath the rubble covering. Again, during the past year, partial excavation of a mound near Guatemala City by Dr. A. V. Kidder, head of the archeological staff of the Institution, disclosed that it contains a series of no less than four superimposed pyramids and a like number of burial vaults, from the latter of which objects of rare archeological value are being taken.

So too, in 1936, archeologists of the Mexican Government, upon completing exploration of El Castillo, added another conspicuous example to the growing list of treasure-yielding pyramids, as we shall see.

Exploratory work on this great pyramid to determine what, if anything, lay concealed within it, was begun in 1930 under direction of Sr. Marquina. The first step taken was that of driving a tunnel at ground level straight in from a point at the center of the south face of the pyramid. Thirty feet within, the base of an earlier pyramid was encountered, whereupon the tunnel was turned to the left, or west, and driven along the base line of the hidden pyramid to reach the southwest corner. Turning the corner, the tunnel was continued northward along the western side of the inner pyramid to a point far enough

past the center to prove that no stairway existed on the west face of the inner structure.

Next, the attack was shifted to the north face of El Castillo and at a point at the base line just west of the stairway, selected to avoid damaging the stairway, a tunnel was run east until it was under the center of the stairway, then it was turned to the right and driven south toward the heart of the pyramid. Here, at a distance of about 30 feet, the base of the older pyramid was reached a second time, but, unlike their experience with the tunnel at the south face, the investigators encountered a stairway, apparently leading up the north face of the buried pyramid.

At the foot of the newly discovered stairway they came upon a rectangular limestone box, approximately 2½ feet long, two feet wide, and two feet deep. It was covered with a lid consisting of a single stone slab which had been fitted to the opening.

Outside the box lay the skeleton of a man. When the ponderous lid was raised, to the delight of the archeologists there were revealed: two turquoise mosaic plaques; three necklaces, one of coral, one of turquoise, and one of jade; seven heads of jade; five jade pendants, one of which was an exquisitely carved, iridescent piece representing the figure of Itzamná, the head of the Maya pantheon; a piece of jade with a fragment of cloth attached; about 2000 loose button-shaped beads of turquoise; and two unusually large sacrificial knife-blades of flint, four inches wide and more than a foot long.

Dr. Sylvanus G. Morley, of the Carnegie Institution staff, who examined the box and its contents soon after discovery, believes that it is to be regarded as a ceremonial deposit made upon the occasion of the commencement of work upon the new pyramid—a procedure suggesting the modern practice of laying corner stones and of depositing within them or under them boxes containing objects of probable interest to future antiquarians.

A year or so after discovery of the inner stairway and the box at its foot, Sr. Marquina and his colleagues began sinking test pits in the platform at the top of El Castillo to see whether the inner pyramid was surmounted by a temple structure. They soon found that such a structure existed; that it had been filled in instead of having been demolished; and that its top lay only about a meter below the floor of the outer temple. By means of tunnels run in different directions they learned that the temple surmounting the earlier pyramid contained two chambers, one directly behind the other, and that entrance was gained through a single doorway at the north side which, in turn, was reached by the stairway running up the north face of the inner pyramid of the two.

During the working season of 1935, the outer chamber of the older buried temple was cleared of its rubble filling. At the center of this chamber a stone statue was discovered which represented a recumbent human figure (the so-called Chac Mool figure) of which ten others have been recovered in Chichen Itzá. Unlike all the other statues of this type,

The jaguar throne found in the inner chamber of the buried temple. It was carved from a single block of stone and is painted vivid red, except the spots on the legs and the eyes, which are represented by inlays of apple-green jade, and the teeth and fangs, which are hard white stone. A mosaic turquoise was found on the seat of the throne

so far found, the ten toenails of this one, made of highly polished white bone, were still intact. Both its upper and lower teeth, made of the same material, were in position, as were its eyes which were also made of white bone. To represent the pupils of the eyes, circular pieces had been cut from the centers and replaced with a black material resembling pitch.

During July and August of 1936 the excavation of the inner chamber was pushed to completion and an amazing discovery made. The back wall of the chamber was found to have been studded at regular intervals with the heads of human femurs, presumably obtained from sacrificial victims. At the center of the chamber stood a box, made of squared limestone blocks, which was covered by two ponderous flat stone slabs.

Inside the box was a throne fashioned from a single block of stone, carved to represent the figure of a jaguar, and painted a vivid red. As the figure has been shielded within the pyramid all these centuries from the light, the color is probably almost as brilliant as when it was originally applied. The spots of the jaguar are represented by inlays of apple-green jade. The eyes also are made of jade, unusually large hemispherical pieces of excellent quality having been used for the purpose. The teeth and fangs appear to consist of hard white stone. The principal dimensions of the statue are: Greatest length, 33 inches; greatest width, measured through the shoulders, 12½ inches; greatest height, measured from the bottom of the base to the top of the head, 27 inches.

Resting upon the jaguar seat lay a mosaic turquoise plaque similar to the two found in the box at the foot of the stairway. On top of the plaque reposed a shell necklace, and a jade pendant, carved to represent a human face. Dr. Morley is of the opinion that this central object of the inner chamber may properly be identified as a jaguar throne. He points out, in support of this opinion, that double-headed jaguar thrones have been found in the ruins of the New Empire city of Uxmal; and that representations of it are to be found in the paintings on the walls of the inner temple chambers of the Temple of the Warriors and at two other sites.

It is not improbable that figures of the jaguar, the eagle, and other animals, as well, were employed by the warrior cults or societies of Yucatan very much as insignias are used by the various orders of modern times to identify particular groups. Neither is it improbable that the older temple buried within the pyramidal base of El Castillo was erected by the jaguar cult of warriors and used by them in ceremonial practices.

Although the contents of the box found at the foot of the inner stairway of El Castillo have been taken to the Museum of Archeology and History at Merida, the capital of the State of Yucatan, for safe-keeping, very wisely the Mexican authorities have decided not to remove the reclining human figure and the jaguar throne, with its turquoise mosaic plaque, from the chambers of the inner temple. Instead, they have covered them with protective varnish, glassed in the jaguar throne, and installed artificial lights.

It is therefore now possible for visitors to enter the tunnel at the base of the north face of El Castillo, to follow through to the foot of the inner stairway where the ceremonial box reposes, to ascend to the summit of the buried pyramid and thence, through the portal of the hidden temple, to enter its age-old throne room, and there witness, in imagination, the barbaric scenes that once took place in this sacred inclosure and to view, in actuality, what Dr. Morley has characterized as the most spectacular discovery of archeological specimens in original position ever made in the New World.

THE ENDOCRINE BRAIN

Hormones from the Ductless Glands . . . Problem of the Pituitary . . . Giants and Dwarfs . . . Thyroid Hormone for Stout People... Made a Rooster Broody

By DARWIN VEXLER

A SHORT time ago a demonstration of some new experiments with the ductless glands was given at one of the large eastern universities. At a signal from the lecturer one of the experimental animals was brought into the auditorium, as lively and happy an example of dogdom as one might wish to see. He jumped affectionately upon the attendant who brought him in, and barked away to the immense amusement of the scientists present. Yet that animal was minus a part of one kidney and two ductless glands. The only thing that kept him alive was a daily injection of hormone, an artificially prepared substitute for the products of the glands that had been removed from him. In that dog had been conquered two conditions that, until a few years ago, meant mysterious and certain death when they occured in humans.

The hormones are secretions produced by certain glands in the body and poured directly into the blood. In their action the glands are very close kin to the much less puzzling ones which have ducts, such as those which produce tears and those which form saliva. But, instead of sending their products to some very definite part, by means of a little tube which can be seen, they empty directly into the blood. The substances they discharge do not themselves perform visible actions, but they cause some bodily function to be performed—much as pressing the trigger of a rifle causes it to fire. These secretions are the body's messengers traveling along the roads of the body, the blood vessels—indeed it is from the Greek word for messenger that they have been christened hormones. The glands that produce them have been named the ductless glands or endocrines. Of them all, perhaps the most interesting and the most important is the pituitary.

Though it was discovered some 300 years ago, little attention was paid to the pituitary till 1886, when a French physician, Pierre Marie, discovered that the disease of acromegaly was due to it —and then himself died of acromegaly! A few years later two Englishmen found that control of the blood pressure was dependent on the pituitary, and called it the "brain of the endocrines." Later work has shown that they named more wisely then they knew, and that there is scarcely an action performed by the body which is not influenced by this organ.

A case of acromegaly, shown chiefly by the changes in the jaw. Some cases are considerably worse than this

The pituitary arises in the embryo animal as two little pouches, one forming in the floor of the brain near the forward end, the other from the roof of the future mouth of the animal. The little out-pocketing in the future mouth region becomes detached, forming a small sphere, and moves upward till it joins the part which has arisen from the brain. In the adult the pituitary, a small body about the size of a hazel-nut, is found to be made of three parts—a nervous part, which has come from the brain, and intermediate and anterior parts, both of which originated as part of the embryonic mouth region. The gland lies in a bony case at the base of the skull, and is richly supplied with blood vessels to receive its secretions. Three different cell types have been distinguished in the anterior part of the organ, but only one kind has been found by microscopists in the intermediate part. Six hormones are known to be produced by the anterior part. Of them the gonadotropic or sex stimulating hormone has been shown to come from one of the three types of cells, a kind which will stain in basic dyes, and the growth hormone from another, a variety which stains in acid dyes. Apparently also both of these kinds of cells can change into the third variety. Only one secretion has been isolated from the intermediate part.

Like most scientific problems, that of the pituitary is basically quite simple. We know that something is produced by it, and wish to know what that something does and what it is, so that we can make it ourselves and find out just how it acts. It is partly curiosity and partly immediate usefulness that dictate the study, and there is always the knowledge that the mere curiosity may lead into finding something of great immediate importance. The method of going about the work is almost self-evident: either remove from the animal all the substance which is to be investigated, and see what he does without it, or add more of it to a normal individual and see what that does. Then take it all away, and give this animal the artificially prepared substance. In actual practice, of course, this becomes complicated. There is the question of devising a method of completely removing the substance from the animal. That, in the case of the pituitary, involves an operation for the removal of the gland, which lies close to the brain in a well-protected bony box. The chemist is drawn into the work because his is the job of preparing the extracts and isolating the pure hormones. Different kinds of specialists have their fields in following the effects upon various systems of organs, the heart, blood-vessels, sex glands, and others.

The investigation of the intermediate part of the pituitary, simpler and of less general interest than the anterior part, illustrates pretty well how the work is done. A great deal of the research has

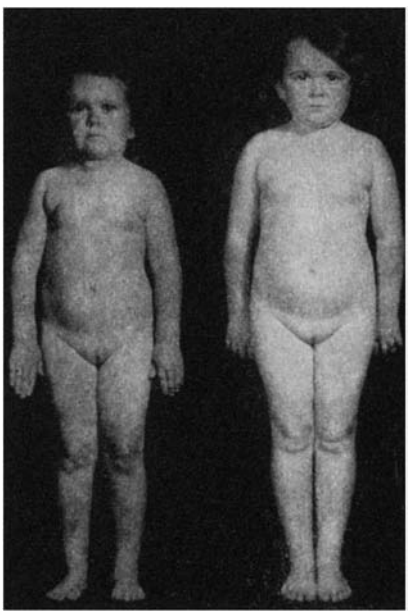
been done on lower animals—frogs, other amphibians, fish. This is due partly to the difficulty of working with mammals—removal of the pituitary in one may take as long as four hours and is dangerous—and partly to the remarkable effects of this part of the gland on amphibia. The operation is done under a low-power microscope, upon the tadpole, for example, when it is about one sixth of an inch long. At this time the pituitary is still being formed, and the brain part has not yet been joined to the mouth part. An interesting sidelight is the fact that cutting out the mouth part has been found to inhibit the formation of the brain part.

THE frog's skin carries two kinds of pigment, black and silver, arranged in a series of layers. When the pituitary is removed, the frog turns from a nondescript black to a beautiful silvery color. Close study has shown that this is due to the black granules of pigment becoming fewer in number, and agglomerating into small compact blobs, while the silvery pigment becomes spread out into thin layers and can easily be seen. Transplanting some of the silvery skin to an animal which has not been operated upon causes it to become black, and the reverse experiment will also work. Extracts of the intermediate part of the pituitary cause the skin of an operated animal to turn black when injected. Dr. Zondek, an endocrinologist whose pregnancy test is well known to physicians, has obtained a very potent extract which he calls intermedin.

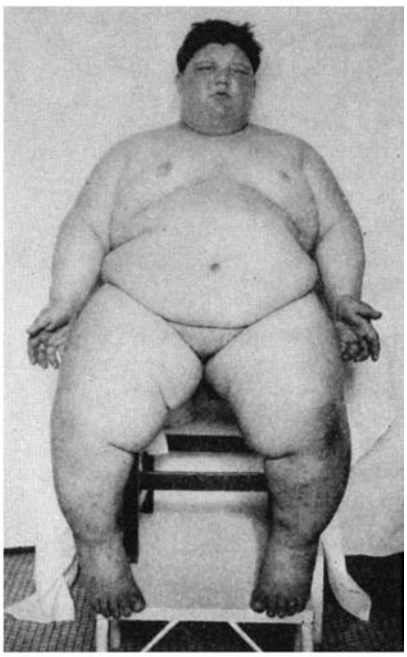
However, it is the secretions which come from the anterior part of the gland which most closely affect humans and are most interesting. Probably the best known of them all is the growth hormone. Dwarfs and giants are fairly common among humans, and the clinicians showed that these conditions were accompanied by abnormal pituitary glands. To investigate these conditions experimentally it became necessary to devise a method of operating on the pituitary of some mammal. Many scientists made attempts before Dr. Ascher of Berne University, Switzerland, performed the first successful operation on young dogs. There was complete absence of growth after the operation, and young animals never became sexually mature when the pituitary had been removed. Dr. P. Smith of Columbia University perfected the now most generally used experimental method. He used rats, which have the pituitary attached to the brain by a very thin stalk, making it possible to work quickly without injuring the brain. One hundred and five operations were performed in one set of experiments, and in each case the rat showed absolute failure of growth, not gaining a gram after the removal of the pituitary. They remained sexually infantile, and the sex glands degenerated. Yet, injection of an extract of the gland for one month caused the animals to become perfectly normal and to equal their unoperated brothers in size. Feeding the gland was without effect, the hormone being digested in the stomach. Also, by injection of pituitary extracts rich in growth hormone Dr. Evans has been able to produce giants in rats which in respect to size in this species of animal would be equivalent to humans 12 feet tall. Of course no human being ever attains such dimensions.

The human disease of acromegaly, discovered so long ago by Marie, has been found to be due to excessive production of the growth hormone. In adults the bones lose their ability to grow. Some parts of the skeleton can, however, continue to grow throughout life, the cartilages of the nose and chest, those between the vertebrae, the jaw, being among them. All these resume growth under the influence of the pituitary, stimulated to produce abnormal amounts of growth hormone by certain types of tumor. The victim becomes ape-like in appearance, with a tremendous chest, hunched posture due to the lengthening of the back-bone, long fingers and toes, and a prognathous jaw. The pituitary increases in size, presses on the brain, and causes headaches and blindness. The patient finally dies. An operation for the removal of the pituitary now brings relief.

One of the by-products of the investigation of acromegaly was the demonstration of the fact that heredity is a factor in the effects produced by the hormones. Bulldogs with large jaws could be made to grow even larger ones by giving them growth hormone, but this effect could not be produced in shepherd dogs. Dr. Evans injected the hormone into dachshunds. He was able to make the animals grow in weight, and could cause them to become so heavy that they could no longer walk, but the legs could not be made to grow. In man there is a kind of dwarf which has a normal body, but very short legs. It would be dangerous to attempt to bring this sort of dwarf to normal stature by injecting the extract, reasoning from the effects of the growth hormone on dogs, as this might make the individual all the more heavily torsoed without affecting the legs. This type of experiment has, however, been tried with a race of silver mice which is born with insufficient growth-hormone producing cells in its pituitary gland. These mice would correspond to the dwarf human who is



Showing 22-month gain of a child of nine under a pituitary extract



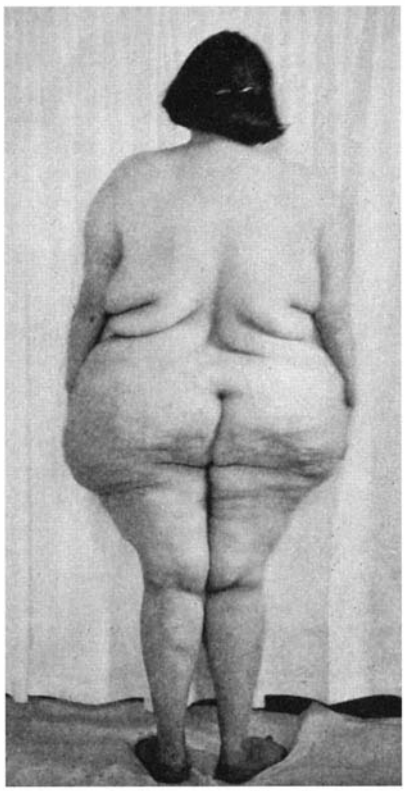
The bad results of pituitary deficiency in an eleven-year-old boy

Courtesy *Journal of the American Medical Association*

Left: **Hairiness in a woman of 43. Related to endocrine dysfunction**

well, but diminutively proportioned. The mice were made to grow to normal size.

Dr. Smith removed the pituitary from a tadpole and found that the thyroid gland did not develop. This was the experiment which led to the discovery of another pituitary hormone, the thyrotropic. The thyroid gland is another of the endocrines and is very important in determining the metabolism—the speed at which one lives.



The tragic result of pituitary deficiency in a woman aged only 27

Recently the thyroid hormone has been given to stout people. It causes them to use more energy, to live faster, and in the process they use up the fat they have accumulated. The same hormone has very marked effects upon the heart, speeding it up. In the frog it is necessary to the process of metamorphism from tadpole to frog. Smith's operated tadpoles would not change into frogs, though he had not directly touched the thyroid. In another experiment he removed the thyroid gland, leaving the pituitary, which immediately began to grow larger. Injection of pituitary extract caused the development of the thyroid in the first set of animals, but did not affect the second. Here was a substance produced by a ductless gland which acted on another ductless gland.

Similar experiments have been performed on mammals. When the pituitary was removed the heart rate and the basal metabolism—the amount of energy used when resting—fell. The thyroid degenerated and the animal could not mobilize its forces. Injection of pituitary extract containing the thyrotropic factor corrected all these symptoms. Too much of it caused the thyroid to grow to several times the normal size and the eyes to bulge, just as they do in certain types of goiter. The effect was that of giving enormous amounts of thyroid hormone. Very little has yet been done in applying these results to man. But there are diseases like cretinism, where dwarfism and idiocy are due to insufficient thyroid development, which promise fields for the use of them.

Photo Science Service

Normally, the pituitary makes all parts of the body grow the right size in relation to each other. One of these dogs, from the same litter, is imbalanced

Another hormone having a similar effect in the control of another of the ductless glands has been found. This is the adrenotropic, which exerts its effect upon the adrenal glands, two small bodies lying near the kidneys. The absence of these is responsible for the fortunately rare Addison's disease. Here, too, there is a promising field for medical application.

The disease of acromegaly, due to excessive pituitary activity, is often accompanied by a variety of diabetes. Dr. Houssay of Buenos Aires finds still another substance from the anterior part of the pituitary which is antagonistic to insulin, the controller of the amount of sugar in the blood. The pancreas produces insulin. If enough is present in the blood, there is a normal amount of blood sugar. If it is not, then the sugar accumulates in the blood and diabetes results. Dr. Houssay removed the pancreas from toads, and they came down with diabetes. If he removed the pituitary as well, the animal was only precariously healthy, but the smallest amount of pituitary extract would cause diabetes. Starving for a day would cause convulsions because the blood sugar had dropped too low. These convulsions could be relieved by feeding sugar, just as in hospitals today an overdose of insulin is counteracted by feeding sugar. Houssay named the pituitary substance the diabetogenic hormone.

A fifth hormone has been designated the ketogenic, and when it is present in too great an amount it prevents animals from utilizing fats. Instead of burning them completely to carbon dioxide and water, the abnormal animal only partially consumes fat and produces the so-called ketone bodies. These are responsible for the characteristically aromatic odor of a diabetic's breath. Like the smoke of an improperly burning lamp, they indicate waste and a pathologic condition. Just how the ketogenic factor acts is still a mystery. In man the discovery of this and the diabetogenic hormone may yet cause a change in the method of dealing with some cases of diabetes.

A great deal of recent investigation has been concerned with two other hormones from the anterior part of the pituitary. One is the lactogenic, by the correct administration of which it was possible in one hospital recently to permit 25 of 29 mothers who submitted to the treatment to nurse their children normally, as they otherwise would have been unable to do. The same hormone caused a normally not broody variety of hen, and even in one case a rooster, to brood.

THE sixth is the gonadotropic, the hormone which controls the functioning of the sex glands. In one striking example rats which normally produce ten to twelve ova or eggs at each cycle of sexual activity, produced as high as 40 after treatment with the hormone. In mammals it has been discovered that there are really two hormones, one of which causes the eggs to descend from the female sex glands, the other of which causes formation of the "yellow-body," the corpus luteum, in the ovary. This produces still another hormone, lutein, which allows the fertilized egg to become attached and form an embryo, besides aiding in causing the secretion of milk and preventing the production of more eggs during pregnancy. Many attempts have been made to cure sterility and to alleviate periodic pains by the use of these extracts.

The entire science of the pituitary gland is one of the livest corners of present-day medical physiology. New and important discoveries are appearing in every issue of the scientific journals such as *Endocrinology*, and this new work is being closely watched by both the physicians and the manufacturers of pharmaceutical products.

THE PERSISTENCE OF LIFE

By T. SWANN HARDING

LIFE frequently shows a strange power to resist destruction. Living things —bacteria, animals, and men—are much affected by their surroundings. Temperature and nutrition especially influence both the rate of living and the length of life of all organisms. Some organisms show almost incredible power to resist adverse conditions or to survive in the entire lack of food. On the other hand, some stories of the persistence of life under adverse conditions cannot be credited. Let us see whether we can separate truth from fallacy in a few accounts of instances where unusual persistence has been claimed.

One of these recent reports which amazed laymen, but rendered biologists distinctly skeptical, came from P. Kapterev of the Soviet of Sciences. It concerned the thawing out in the laboratory of chunks of frozen subsoil from a region where it is supposed to have been frozen for thousands of years. We were told that spores, grasslike plants, and a number of small animals emerged in a fine state of survival.

Thus far, this report has not been contradicted. But the average biologist, when interviewed about it, usually shrugs his shoulders and looks unconvinced. We are reminded that, but a few months back, Dr. Ira B. Bartle of California reported the persistence of certain microscopic dots of life throughout a period of 249 years. He claimed to have resurrected colonies of soil bacteria that went into suspended animation two centuries and a half ago in the four-foot adobe walls of an Arizona mission house.

THEN there was the even more famous case of Charles B. Lipman, who reported finding living bacteria in stony meteorites from the heavens. This appeared to confirm the theory that life on earth got its start via life-seed from the celestial regions. Lipman earlier claimed to have found living bacteria in pre-Cambrian and in Pliocene rocks, also in anthracite coal formed 250,000,000 years ago. Unfortunately, very careful repetition of Lipman's work failed to confirm his findings.

At some time or another, all of us have read about the remarkable mummy wheat which is said to have retained its power to germinate despite burial for centuries in the tomb of an Egyptian mummy. But plant specialists say that wheat grains could not even retain their shape and form after such a lapse of time, much less their power to germinate. Wheat does retain life, or power to germinate, for about 15 or 20 years, but that is all.[1]

On the other hand, when Captains Stevens and Anderson made their ascent into the stratosphere they found that many micro-organisms displayed remarkable resistance to adverse conditions. These were mostly tiny spores that cause a number of plant diseases. But, exposed to terrific cold, extremely reduced atmospheric pressure, and supposedly lethal ultra-violet rays—all unprotected—they retained their power to generate and grow when returned to the laboratory.

Female dog tick. After two years of starvation it apparently is as heavy as ever. Feminine readers on reducing diets will sympathize

There are also authentic records of the power of certain organisms to persist incredibly long times without food. Dr. F. C. Bishopp, of the United States Department of Agriculture, discovered that the dog ticks responsible for the spread of Rocky Mountain spotted fever are disgustingly hardy. In June, 1936, he wrote: "They can live from year to year with no food. Adult ticks put in vials without food on April 10, 1933 for observation, are still alive and vigorous." If this tick completes its career it eats thrice, gorging with blood as pupa, larva, and adult, and it can live a whole year without food between stages, while record longevity for an adult is 988 days. I have seen ticks in a glass tube, quite motionless, that had lived a year foodless. They do not move, when starved, unless disturbed or warmed up by holding the tube in the hand. They do not change in appearance. They apparently weigh as much after two years of starvation as when it all began. They do not have the kind of tracheal equipment that a true insect has, hence oxygenation is possibly minimum in any case and metabolism can be reduced nearly to zero; but they do finally die if starved persistently. Spiders will live foodless in a tube four or five years and be as spry as ever.

The life duration of the much-studied fruitfly is also rather considerable when no food is provided. It depends on what is called their "inherent vitality," that is, their power to live when starved. The life curves of a population of these flies are the same when they are completely starved as when they are fed, and they tend to die off at about the same rate. This is in part because complete starvation renders the density of population impotent to exert its usual bad effect on the life curve.

DR. C. M. McCAY and his associates have presented evidence to show that mild starvation in youth will almost double the life span of the laboratory white rat. Scientists at Brown University found the same thing true of the water flea, the insect averaging a life 50 percent longer when its food supply was reduced. Of course, many lower organisms change their size, shape, or even their general bodily condition radically when starved, and so adjust themselves to life at a reduced energy value. Thus, certain jellyfish become spherical when starved, while many other organisms dry out and persist as what might be regarded as dust until, months later, they are moistened again and live.

Temperature has a tremendous effect on life. Generally speaking, the warmer things are, the faster the organism lives and the quicker it dies. The normal range of temperature within which life is theoretically possible is surprisingly narrow, but certain organisms show a power just as surprising to surmount this little difficulty. Certain bugs and insects manage to survive fumigations with hydrocyanic acid if the temperature is low, as they go into a lethargic state which renders them resistant to poison.

Intense heat will also make some insects go into a sort of coma during which they are strangely resistant to

[1] One explanation is that, in some cases, tourist guides have "salted" the tombs with good modern wheat, then "discovered" it in the tourist's very presence. Such wheat will germinate, especially if the tourist pays well for it. —*Ed.*

lethal agents. At the other extreme, flies can be frozen stiff and solid, and left in the refrigerator some time, only to "come to life" when thawed out. As we shall see later, warm-blooded animals cannot withstand such drastic treatment.

Dr. Levi Noble, a student of volcanoes, reports that certain algae (single-celled lower organisms) manage to live in volcanic springs that are perpetually very little below the boiling point of water. Here is a remarkable adaptation to temperatures that are normally assumed lethal. Dr. Noble raised the question whether life might not occur on some of the hotter stars, now supposed to be lifeless, which would show a further adaptation to high temperatures.

Human beings rarely can resist a body temperature much above 105 degrees, Fahrenheit. Those reported to have higher fevers that persisted were ultimately found to be hoaxes. The proteins forming the vital tissues of human beings tend to coagulate at higher temperatures, somewhat as egg proteins coagulate on boiling. This process is not reversible and death ensues.

WHAT about the effect of lower temperatures? The British scientific journal *Nature*, in December, 1936, reported experiments wherein fish had not resisted cooling to one degree, Centigrade, below freezing—when the water around them was permitted to freeze. If the water could be supercooled to three degrees below zero, Centigrade, but still not permitted to freeze, the fish survived the ordeal. Hence it was concluded that the fish perished mainly because ice formed in their bodies, not simply from the effect of low temperature.

Lower organisms, like the afore-mentioned flies, definitely can resist phenomenally low temperatures. Dr. C. A. Magoon, of the United States Department of Agriculture, reports that many micro-organisms are not destroyed by freezing. Indeed, some microbes resisted temperatures as low as minus 422 degrees, Fahrenheit, for a period of ten hours, a few survivors returning to full activity thereafter. Yeast and molds were used in this work.

The eggs of the roundworm develop and become infective, according to workers in the same department, after being exposed to minus 16 degrees, Fahrenheit. The eggs also survive burial for a year, immersion in strong solutions of powerful chemicals, and treatment with many of the commonly used disinfectants.

Reports that frogs have been frozen solid at the beginning of a lecture period, only to thaw out and hop in a sprightly manner around the professor's desk at its ends, are taken with a grain of salt. Dr. D. Fraser Harris, of Dalhousie University, reported such an occurrence in 1922, but the frog was surely not frozen clear through. Dr. Harris also reported that fish could be frozen quite solid, sawed in half while frozen and then, upon thawing the halves, these would show signs of latent tissue life. This seems scarcely credible and would make most biologists lift a quizzical eyebrow. The external tissues of the frog may have been frozen, but it is certain that the heart still functioned and that, if the heart ever froze stiff, the frog would be very permanently dead, for freezing breaks down the cell tissues of plants and animals; it destroys their protoplasm. It disintegrates and disperses the vital cell contents. Ice crystals have enormous power to destroy. It is true that modern quick-freezing processes result in ice crystals so small as not to damage the palatability of foods, but even this process would destroy life.

Government entomologists shipping insects in cold storage, so that they may be used to prey on other insects. This method is very common

There is no scientific reason whatever to suppose that any warm-blooded animal could survive through-and-through freezing. Life would be extinct after the thaw, no matter how rapid the freezing process. Hence it is just as well not to believe press stories about frozen monkeys which returned to full life and activity after being thawed out.

Temperature does, as was said earlier, affect the rate of living. Frog eggs develop into tadpoles and frogs much more quickly at higher than at lower temperatures. The duration of life of flies, from egg to death of the fly, varies greatly with the temperature; whereas it may be but 21 days around 85 degrees, Fahrenheit, it may rise to 177 days at 50 degrees.

An energetic scientist figured out that, if human beings reacted to temperature as do flies, the average healthy man would attain the age of Methusaleh, if his body temperature were but 60 degrees instead of about 98. If the body temperature could be reduced to 45 degrees the man could pursue his slow-motion life nearly 2000 years. As a rule, lethargy increases but life persists longer at lower temperatures.

A bacterium that causes intestinal trouble will grow actively at about 50 and also at 115 degrees, Fahrenheit, but it reproduces 30 times as fast at the latter temperature. If an actively growing colony at the lower temperature is transferred to the higher, there is a distinct lag before more rapid reproduction takes place. If the transfer is made the other way around, nearly all the bacteria die when first exposed to the lower temperature.

Meanwhile, the biologist's old standby, the fruitfly, has a larval period of only six days at 76 degrees, Fahrenheit, but the period expands to 18 days if the temperature be lowered to 58 degrees. Salamanders take 11 weeks to metamorphose at 76 degrees but require 22 weeks at 58 degrees. Broadly speaking, a colder life means a longer one among such organisms.

DEGREES of aliveness differ. There is a condition of "latent life" wherein even warm-blooded animals may hibernate while reducing their oxygen consumption enormously and evolving little or no heat. Small rotifers, many-celled aquatic organisms, will also seemingly die if dug out of the mud and dried but their life remains latent, for they resume it when returned to the mud.

Bacteria, fungi, and sea organisms can also survive drying and considerable heat, while entomologists tell us that Bobby Burns' inspiring louse could withstand freezing for seven days, retaining latent life. It has been suggested that East Indian trance experts voluntarily assume some such state as that of the hibernating bear, thus rendering life latent. Tortoises, hedgehogs, dormice, and marmosets have also mastered this art.

Stories of frogs found alive in walls and ancient rock formations are not credited by biologists but the stories show greater "persistence of life" than any animal yet known. A frog can assume a hibernating state for a few months or a year. In most cases the frog was "salted," like the mummy wheat.

We may conclude, then, that the lower the scale of existence the greater the resistance to lethal agents. Man and the warm-blooded animals pay for their greater complexity and their higher endowment by being more easily destroyed than certain cold-blooded animals, insects, and micro-organisms. All stories of phenomenal resistance to lethal agents displayed by higher organisms must be viewed very skeptically. Such things are possible, however, with lower organisms, though even then the strange tales told sometimes cannot be true.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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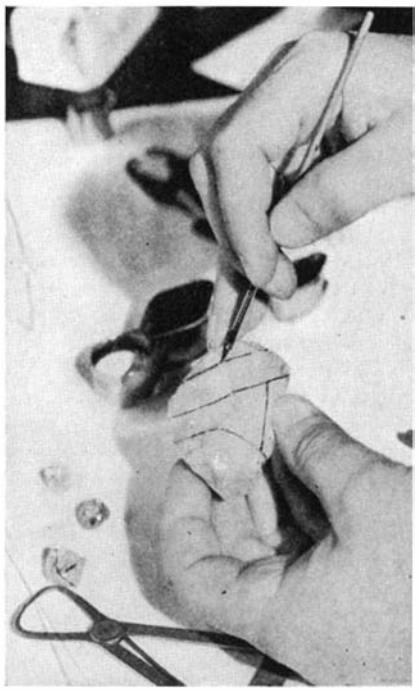
Cutting the Jonker

OF all the great diamonds in the world's history, the Jonker is the second to be cleaved. The other was the Cullinan, found in 1905. All other great stones from the beginning of recorded gem history were



merely trimmed, most of them crudely. In past ages, the tendency was to sacrifice beauty and workmanship for more weight; today weight is sacrificed for beauty, purity, and perfection of cutting.

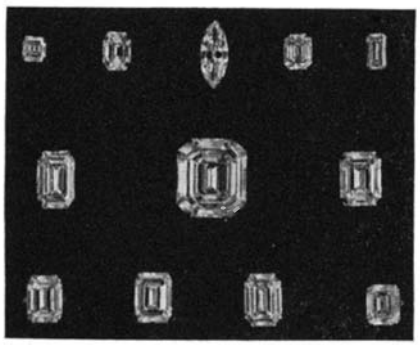
Jonker Diamond Number One, weighing 143 carats, will undoubtedly go down in jewel history, not only because of its size, but because of its perfection and its magnificent blue color. It is exceeded in size by the Star of Africa and the Cullinan Diamond, both in the British Crown collection, but in color it far surpasses both.

The Jonker Diamond weighed 726 carats in the rough and has now been cut into 12 perfect diamonds, the total weight of which is 375 carats. The other 351 carats has been polished away into dust of little or no value. Weight had been sacrificed at every turn to make each diamond a masterpiece. The dangerous operation of cleaving the Jonker diamond was done by Lazare Kaplan and his son, Leo, for Harry Winston, a New York jewelry dealer. After months of study of the cleavage planes the diamond was cut, and the Jonker luck tradition held. Then followed months of additional study, and then anxious months of sawing. The saw was a whirling phosphor-bronze disk which operated at 5000 revolutions per minute.—*Copper and Brass Bulletin.*

Dry Ice from Power Plants

A NEW method of purifying carbon dioxide from the dilutions ordinarily found in power-plant flue gases promises to make the manufacture of dry ice a profitable by-product of electric power production. Heretofore, the methods available for recovering carbon dioxide from flue gases have been uneconomical to use except where special coke fires produced the gas in high concentrations. The newly patented method consists in introducing a small amount of ammonia into the customary potash lye absorption system to act as a carrier in dissolving a larger proportion of the carbon dioxide in the lye. In this way ordinary power plant chimneys may be made to give up their carbon dioxide economically, and off-peak power can be used to convert the purified gas to solid form for use as a refrigerant. Production of dry ice by power plants near centers of population where demand is greater will save part of the large losses now incurred in handling and shipment from distant producing points.

—*D. H. K.*



Left above: **Marking cleavage lines on the rough Jonker diamond.** ***Above:*** **The 12 diamonds, weighing 375 carats total, that were cut from the Jonker.** ***Right:*** **Cleaving a piece of the diamond with a sharp blow**

HEALTHIER PLANTS

SEVENTEEN crops are now worth about 66,000,000 dollars a year more because disease-resistant varieties replaced older ones. Some of the more conspicuous cases of gains from disease resistance are found in wheat, flax, sugar cane and sugar beets, lettuce, and cantaloupes.

"Fish-Eye" Camera Studies Winds

A PHOTOGRAPHIC method of charting the night winds high above the earth, to determine direction and velocity for weather forecasting and aircraft operations, has been worked out in the meteoro-

A. Russell Bond

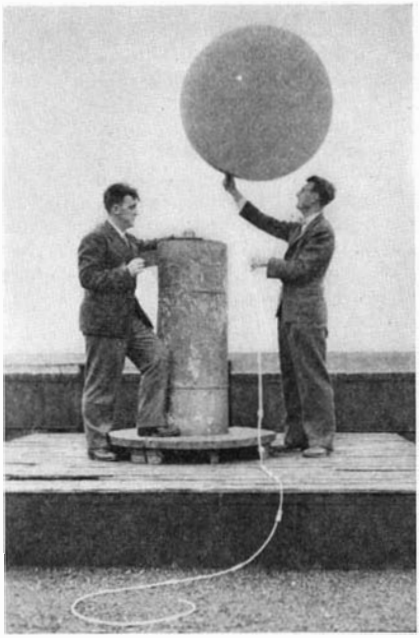
IT is with sincere regret and a sense of personal loss that we report the death in May of Alexander Russell Bond, patent attorney and an editor of Scientific American for nearly 20 years. A graduate of Princeton, Mr. Bond became Associate Editor of Scientific American in 1902 and ended his connection with this magazine as Editor of Scientific American Monthly in 1921. Since that time, he held a number of important positions in connection with patents and invention, and at his death was a practicing patent attorney. He was 61 years of age.

Mr. Bond wrote many books, some of which were published by Scientific American. Among the latter were several which enjoyed a large sale, including "The Scientific American Boy," "The Scientific American Boy at School," "With the Men Who Do Things," and "Pick, Shovel and Pluck." He collaborated with A. A. Hopkins, another editor of Scientific American, on the "Scientific American Reference Books" of 1904 and 1912.

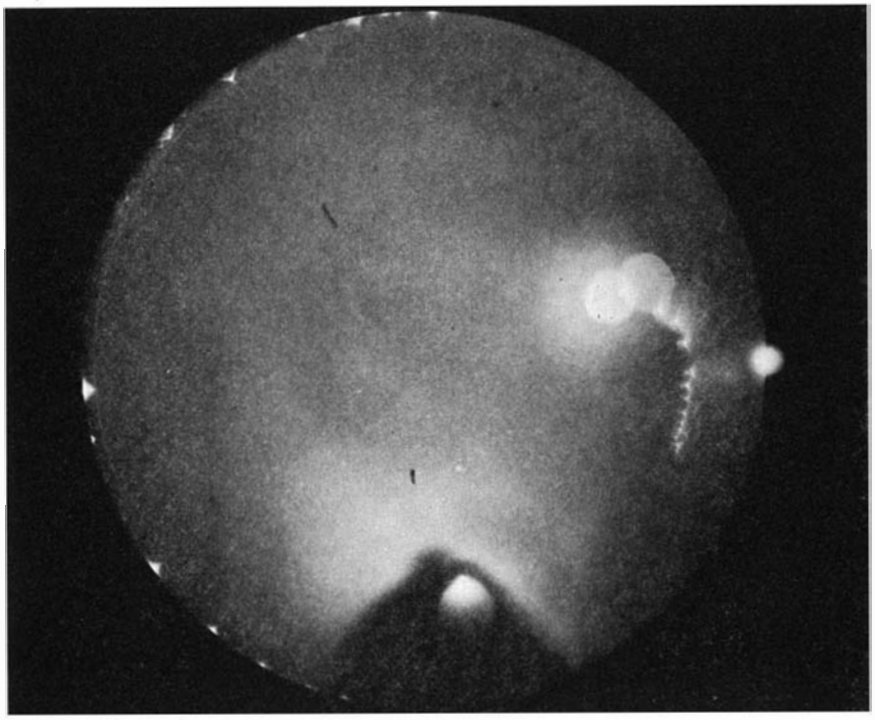
logical laboratory of the Massachusetts Institute of Technology.

Devised by Athelstan F. Spilhaus, of the Woods Hole Oceanographic Institute, who is now carrying on research at Technology, the photographic method of nocturnal wind soundings makes use of a "whole sky camera," which has a 180-degree lens, sometimes known as a "fish-eye" lens; a pilot balloon; and magnesium flares attached at intervals to a length of ordinary blasting fuse. From an observation point on the earth the camera lens is pointed upward and as the sounding balloon ascends, the flashes of the magnesium flares, ignited at known intervals, are recorded on the plate. The photograph taken by the 180-degree camera is circular, the circumference depicting the horizon all around, and the brilliant magnesium flashes are registered on the plate regardless of the direction in which the balloon moves. Thus, by measuring the angles of elevation and direction between the camera station and the flashes, and correlating this data with the rate of ascent of the pilot balloon, an accurate record of the wind velocity and direction is obtained.

At night, it has been the practice to suspend a paper lantern containing a candle from a balloon and to train a theodolite on the light. The disadvantages of this method, however, are that the light is extremely dim and is frequently lost in a short time. Observers have also been known to confuse the faint light of the lantern with stars. The Spilhaus method makes it possible to take readings photographically at very brief intervals and the apparatus may be used by inexperienced observers.



Preparing the night sounding balloon. The white spots on the blasting fuse "tail" are magnesium flares



Hold this picture above your head, with white spot at right to the south, to get a "fish-eye" view of the sky. The sounding balloon flares show plainly

A new flexible gasoline hose nozzle fits the filler tubes leading to the gasoline tanks of modern automobiles, and permits filling station attendants to serve gasoline with minimum danger of spilling. The nozzle is of Thiokol, a rubber-like material unaffected by gasoline

LIQUEFIED GAS

SEVEN years ago the national consumption of liquefied petroleum gases totalled about 18 million gallons per year. In 1936, the quantity used was 106 million.

Most Powerful Weapon Against Pneumonia

THE most powerful weapon the modern physician can use to fight pneumonia is specific immune serum, Dr. Edward L. Bortz, of the Post-Graduate School of Medicine of the University of Pennsylvania, recently told doctors at the Post Graduate Institute of the Philadelphia County Medical Society and the First District Councilor Meeting.

Describing the dramatic results obtained with serum in treating pneumonia, Dr. Bortz said: "From a desperate, acute, consuming illness with a dangerous temperature, chest pain, restlessness, paroxysms of cough, and approaching delirium, the prompt administration of the correct serum will sweep away the toxemia, the temperature will fall, the pain in the chest will disappear, the pulse and respiration will return to normal, the cough is quieted, and the patient finds himself practically a well man, emerging as it were, from an evil dream."

Turning to statistics, Dr. Bortz said that the high pneumonia death rate can be cut at least 50 percent by modern treatment, which means prompt diagnosis and treatment with the appropriate serum. Diagnosis in pneumonia means determining, by laboratory test of the patient's sputum, which of

the many pneumonia germs is causing the disease in a particular case. This test is called typing and the germs are known respectively as Type I pneumococcus, Type II pneumococcus, and so on for all the different members of the pneumonia germ family.

Unfortunately, curative serums have not been developed for all the pneumonias, but where they have, their use will save thousands of lives.

Nutrition, elimination, rest, and nursing care are other important factors in the treatment of pneumonia. Dr. Bortz said that oxygen is an important aid, but that its use "has unfortunately not affected the mortality rate."—*Science Service.*

STRONGER

STEEL chains seven-eighths of an inch in diameter, when alloyed with nickel and molybdenum, are three times as strong as unalloyed chains of the same size.

Drilling and Tapping Bakelite

MACHINING—especially drilling and tapping—Bakelite products, is hard upon milling cutters, drills, and taps. It is also difficult to get good threads, and clean, small-sized holes. Drilling and tapping sheet and molded Bakelite is greatly facilitated when carbon tetrachloride is used as a cutting lubricant. It is possible to tap 8–32 holes in ¼-inch laminated stock at a relatively high speed without stripping threads or producing ragged edges, when the tap is kept moist with carbon tetrachloride. Tap wear is very greatly reduced when this fluid is used. The chemical reasons why this should be a good cutting fluid are not understood.—*Shop and Laboratory.*

Car Driving in the Curriculum

BELIEVING that instruction in the theory of the rules of the road and actual practice in driving a car has a place in the curriculum of the present-day high school as a means of promoting highway safety, the American Automobile Association last fall sponsored a Driver Training Program which already has met with great success in ten high schools in various parts of the country.

Arrangements were made whereby Professor Amos E. Neyhart was granted a leave from Pennsylvania State College in order to direct this educational program for the AAA. Professor Neyhart has been developing this program for the last five years and today instructors in Driver Training Programs are selected as far as possible from 135 graduates who have specialized in driver training at Penn State.

Two sets of clutch and brake pedals are used for driving instruction

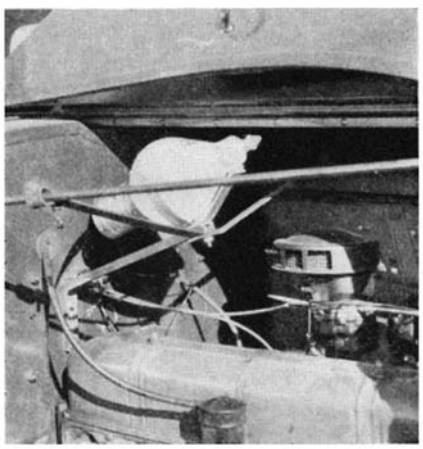
Actual automobiles are used to make the road instruction practical. In this phase of the program, Pontiac Motors has co-operated with the AAA, furnishing training cars for each high school. The cars are painted white with special "AAA Driver Training" lettering and a set of dual-control clutch and brake pedals is installed in the right hand front seat position for use of the instructor. These dual-control pedals are directly connected with the driver's regulation pedals.

With dual-control pedals mishaps are prevented while the student is driving as the instructor can throw out the clutch and apply the brakes instantly. Also, correct clutching, braking, and the proper shifting of gears are learned more rapidly by the student.

TRANSPORTATION SECTION

Versatility in Fire Extinguishing

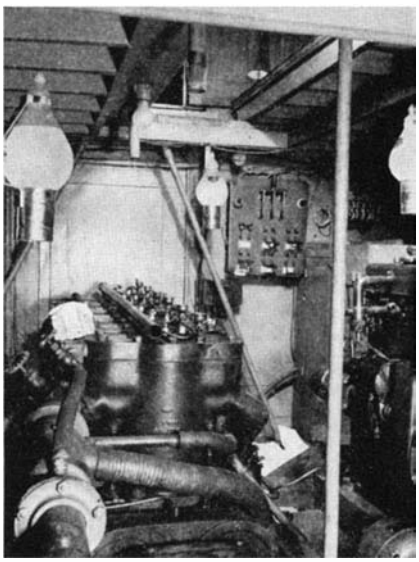
OF particular interest to the motor boat and automobile owner, but equally useful in the home, store, or factory, is a versatile fire extinguishing system that may be used manually or automatically, and



An automatic fire extinguisher installed under an automobile hood

which will set off a local alarm or a wired alarm at the outbreak of a fire. Essentially the AutoFYRstop, as this system is called, consists of a 14- or a 36-ounce glass bottle containing carbon tetrachloride and held in a bracket. For manual operation, the bracket is merely a holding device; for automatic operation, a thermo-responsive fuse in the base of the bracket releases a spring-impelled hammer mechanism when the surrounding air reaches a predetermined temperature. This hammer mechanism bursts the sealed glass bottle and releases the fire extinguishing carbon tetrachloride. At the same time a .32 caliber blank cartridge is fired, giving an audible alarm. If desired, the system can be equipped with an electric switch, which is actuated by the same means as the local alarm and which permits an entire installation of unit devices to be wired together in series and connected with a centrally located alarm and annunciator panel.

For manual operation, the fire extinguishing bottles are located at convenient points. At the start of a fire a bottle is removed from its bracket, the tip broken off, and the liquid sprayed over the fire. Alternately, the bottle may be hurled at the base of the flame where it smashes and releases the liquid. This same type of manual operation



New type fire extinguishers in the engine room of a large motor boat

may be used with the automatic device; the glass bottles are independent units. When one of the devices goes into operation automatically, nearby people may collect bottles from other automatic units and bring them to the point of fire, concentrating the action of the fire extinguishing fluid.

This fire fighting system has been approved by the Underwriters' Laboratories and by the Pennsylvania and City of Philadelphia Fire Control Authorities.

BRAKES

THE leading maker of coaster brakes for bicycles reports that 7000 brakes per day, or 2,000,000 brakes a year, are being turned out as against an average of 400,000 per year, the normal production rate until recently.

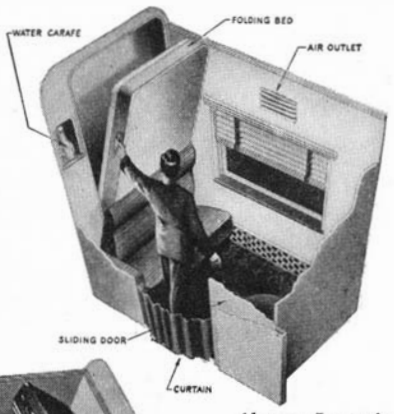
New Pullman Luxuries

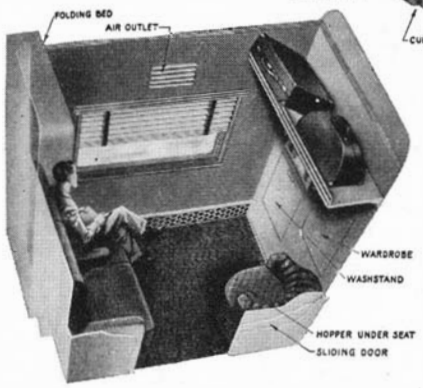
THREE new and radically different accommodations, all of the private room character, have been announced by the Pullman Company. All of these new-type accommodations will be found in the equipment now being built for the North Western-Union Pacific-Southern Pacific streamliners *City of San Francisco* and *City of Los Angeles*, the Santa Fe's *Chief*, the New York

Central's *Twentieth Century Limited* and the Pennsylvania's *Broadway Limited*.

Two of these accommodations will bear the drawing room and compartment designation familiar to Pullman patrons, but important new features have been devised for the new-type rooms. The third accommodation is called the "Roomette," and it is new from top to bottom, including the name.

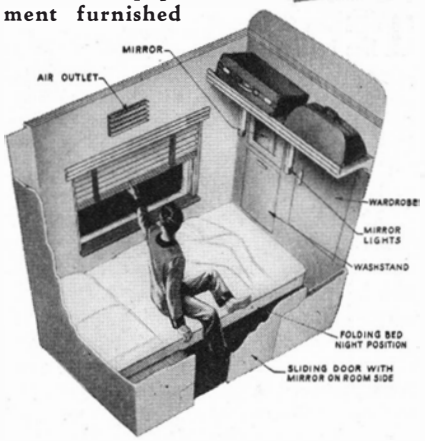
The "Roomette" is a small, completely enclosed, private room within the space of a section, containing one bed. Eighteen "Roomettes" can be placed in one Pull-





Above: **Lowering the bed in the "Roomette" is easily accomplished.** ***Left:*** **The room in use during the day, with bed out of the way**

Below: **The new Pullman "Roomette" made up for sleeping, showing convenient equipment furnished**



man car. In daytime, the bed folds into the wall at one end of the room, and the passenger has a sofa seat of the latest and most comfortable contour, with ample space for lounging, or for undressing before the bed is lowered for the night-time arrangement. For dressing, the passenger can make the whole room space and its complete toilet facilities available by returning the bed to its niche in the wall. The slightest effort will accomplish this, and a safety ratchet eliminates any danger of the bed falling during the operation. When the bed is made down for the night it is fastened at the foot by an automatic lock. This is easily released when the passenger desires to raise the bed, and the lock then reverses and holds the bedding in place. The size of the bed, 6 feet 5 inches in length, will appeal to persons of any height.

The door of the "Roomette" can be locked at night, or left open and a curtain drawn across the opening. The patron has many conveniences, such as individual regulation of ventilation, heat, and light; complete toilet facilities, with washstand folding into one wall, and above it a mirrored cabinet for toilet articles, with tubular lights on each side; a locker in which to hang clothes; a large rack for luggage; a vacuum water bottle in a niche at the bed head; and a box from which the porter can remove shoes without disturbing the sleeper. Ceiling and reading lights of new design provide ample illumination. One daytime novelty is an adjustable footrest that can be pushed aside when not desired.

As the "Roomette" is completely air-conditioned the passenger can enjoy his pipe, cigar, or cigarette, knowing that the smoke will be withdrawn almost immediately through a grilled outlet, and without discomfort to those in adjacent "Roomettes."

Most Powerful Passenger Steam Locomotive

M. W. CLEMENT, President of the Pennsylvania Railroad, announced recently that the company is now engaged in developing a new and distinct type of steam locomotive which will be capable of hauling 1200 tons—a 14-car passenger train—at 100 miles an hour. It is expected that this locomotive will combine power, speed, and economy of operation to a degree never before achieved and will anticipate railroad locomotive development for years to come.

The new locomotive will be known as "The Pennsylvania Type." It will be a development of the conventional coal-burning steam locomotive, which with improvements in design and efficiency will cost little more to build, operate, and maintain than present locomotives of lesser capacities. The design is being developed by a committee of engineers of the Baldwin, American, and Lima Locomotive Companies cooperating with the railroad company.

While designed primarily for passenger service, many of the improvements embodied in the new locomotive are expected to be readily adaptable to freight operations, where increased power and speed over present freight locomotives will be of equal advantage and where comparable improvements, efficiencies, and economies will be introduced.

Concurrently with this new forward step in the design and utility of motive power, the Pennsylvania is progressively introducing improvements in road-bed and track, in types of passenger- and freight-car equipment, in signals and other features of operation, all looking toward the inauguration of new conditions of safety, dependability, speed, and comfort in passenger- and freight-train service.

In contrast with the present heavy-duty passenger locomotive, "The Pennsylvania Type" will have four cylinders instead of two, each pair of cylinders providing power for two pairs of driving wheels. The locomotive will obtain coal and water from a tender mounted on two six-wheel trucks, carrying 25,000 gallons of water and 26 tons of coal.

As soon as one of the new type locomotives is completed the railroad plans to conduct exhaustive tests, both in test plants and in actual road service, to determine its practical adaptation to the Pennsylvania's varied transportation service.

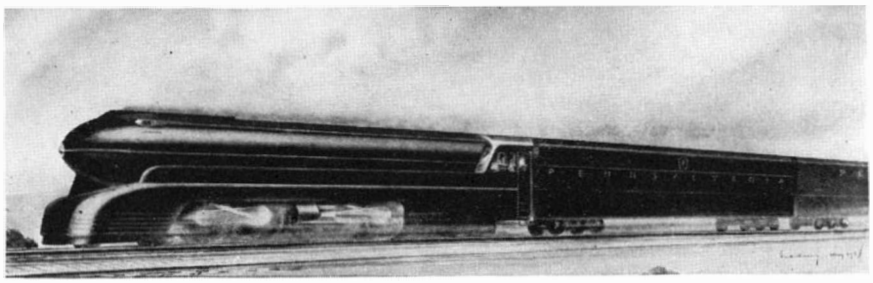
Vibrating Concrete Adds to Strength

VIBRATING concrete as it is laid in a pavement increases the strength 10 percent, according to a report by the Bureau of Public Roads of the United States Department of Agriculture; or, by vibrating, 10 percent less cement can be used, and the same strength maintained. Vibrators work on somewhat the same principle as those used in giving beauty treatments.

The report gives the results of an investigation recently conducted at Arlington, Virginia. Two hundred and seventy slabs of pavement, each ten feet wide and eight feet long, were constructed and tested. Four different types of vibrating equipment were used, their speeds varying from 3600 to 4000 vibrations per minute.

Slabs of similar composition were placed and finished by standard methods without vibration. Thus, differences in the strengths and physical properties were directly attributable to vibration. In every instance it was found that vibration increased the strength and density and decreased the amount of "honeycomb," or air pockets.

To investigate the effects of vibration further, the quantities of aggregates, cement, and water were varied in slabs finished by the vibration method, and their properties



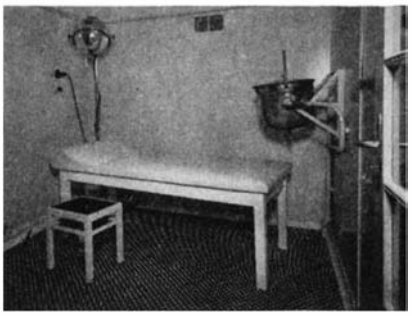
"The Pennsylvania Type" locomotive has four cylinders instead of two

were compared with those of non-vibrated slabs. Slabs seven and ten inches thick were placed, and the effects of surface vibration were found to extend entirely through both.

The report describes ways in which existing specifications for pavement concrete can be modified to utilize vibration to advantage.

Sea-Going Spa

THE newest thing under the sun and on the seas is now the floating spa offering on shipboard the baths and treatments of the world-renowned German health



resorts in addition to the natural curative properties of sea air in search of which so many make ocean voyages each year.

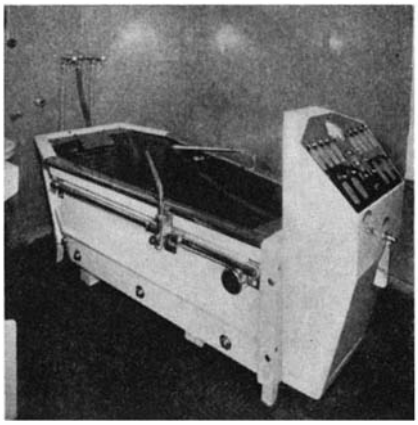
The motorship *Milwaukee*, operating in the Hamburg-American Line's cruise service out of Hamburg, voyaging south in the winter months and northward in the summer, has been equipped with the latest apparatus for hydro-therapeutic baths and treatments and has become a veritable health resort afloat, thus supplementing the pleasure cruise with the opportunity to improve one's physical condition still further.

The *Milwaukee's* spa comprises 10 distinct departments, and among the hydropathic treatments provided are Turkish baths, brush baths, medicinal baths of all kinds, and douches of various types. The massage treatments given include sub-aqueous pressure massage, Swedish massage, vibratory massage, and the like, while among the electric and ray applications available are ultra-short waves, Stanger baths, ultra-violet rays, cadmium light, blue light, Sollux lamps. The facilities provided also include a sub-aqueous intestinal or Suda bath, an inhalatorium, medico-mechanical treatments, and then, of course, physical culture and sports in the swimming pool, the gymnasium, and on the sports deck. In addition, there is a special dietary kitchen equipped to cater to as many as nine different diets, and the healing waters of Germany's most famous mineral springs are available at all times.

(End of Transportation Section)

A New Red Pigment

BY utilizing the ability of one substance to change the crystalline form of another, a new red pigment useful in oil paints and varnishes, nitrocellulose lacquers and printing inks, has recently been made by a process very similar to that yielding chrome yellows. In manufacture of chrome yellow, a mixture of lead chromate and lead sulfate is precipitated from a lead solution and by varying the conditions of the precipitation a variety of shades of yellow can be made. The reason for this has been found



Above and left: **Two of the rooms in the latest in sea-going spas**

by X-ray studies to be the influence of white lead sulfate on the crystalline form of the yellow lead chromate. Still further changes in crystalline form which yield deep orange to scarlet pigments are produced by simultaneously precipitating white lead molybdate with the lead sulfate-chromate mixture. Lead chromate crystals precipitated in the presence of lead sulfate vary from lemon colored rhombic to reddish yellow monoclinic types. The simultaneous precipitation of lead molybdate changes these to tetragonal form which becomes progressively redder.—*D. H. K.*

Free Flight in a Tunnel

THE tradition at Langley Field is that at least one piece of new research equipment shall be presented to the visitors at each Conference. This year there was adherence to this tradition in the form of a "Free Flight Tunnel" which is illustrated in one of our photographs. Air is drawn into a small and short tunnel of rather crude design through a fine mesh cloth to secure satisfactory air-flow. The whole tunnel is hinged at a point above the apparatus, and a vertical strut, placed below and operated by an electric motor and worm gearing, tilts the whole tunnel up or down.

When the tunnel is tilted upward, the air flow also has an upward component. Then, as the speed of flow is increased, a model which is placed on the floor of the tunnel rises and glides against the forward and upward flowing current. The model soars indefinitely in the tunnel, just as a glider soars indefinitely in the rising air current on the side of a cliff.

Control surfaces are actuated by small electro-magnets carried in the model; and the research worker, by manipulating the electric current, can move the controls and put the model through various maneuvers. Wind gusts are simulated by tilting the tunnel rapidly up or down. Photographic apparatus adds to the visual observations of the behavior of the model.

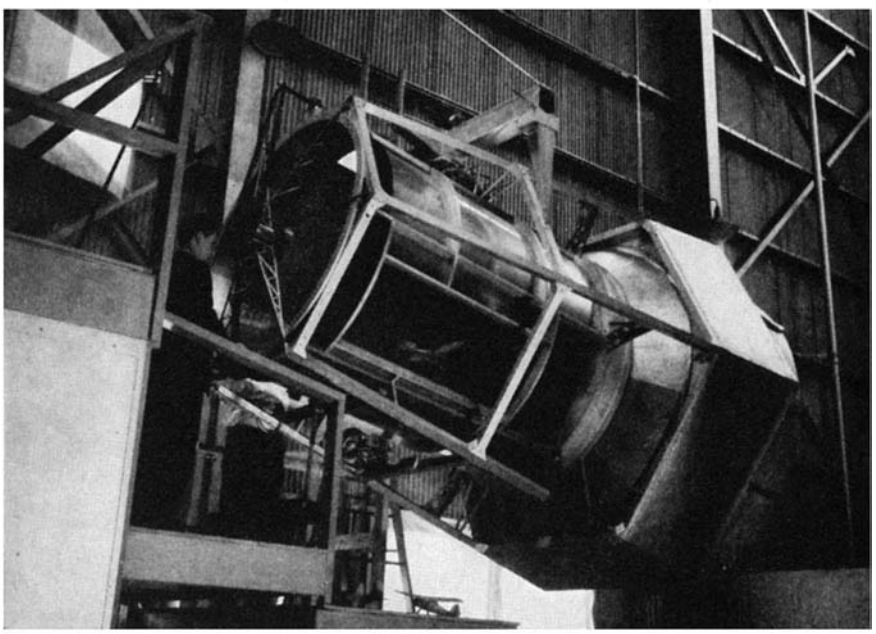
While the "Free Flight Tunnel" can never supplant the more scientific methods where the model is held stationary in a large tunnel on wires running to recording balances, nevertheless it will be invaluable for rapid study of stability and control, and should be most useful also for teaching purposes.—*A. K.*

Curtiss Electric Constant-Speed Full-Feathering Propeller

THE new Curtiss aircraft propeller, which has been in process of development for several years, has a name that is long, but necessarily so because it alone fully defines the functions of this interesting device.

Controllable pitch propellers as developed to date may be roughly classified as follows: 1. Manual, purely mechanical control; 2. Mechanical control, with a governor to provide constant speed; 3. Manual operation of a hydraulic control system; 4. Hydraulic actuation in conjunction with a governor, to provide constant speed; 5. Automatic variable pitch propellers, in which centrifugal force, aerodynamic forces, and sometimes springs have been combined to secure the required result. This classification is not complete but serves to give an idea of the various lines of attack which have been followed.

The Curtiss propeller combines electrical



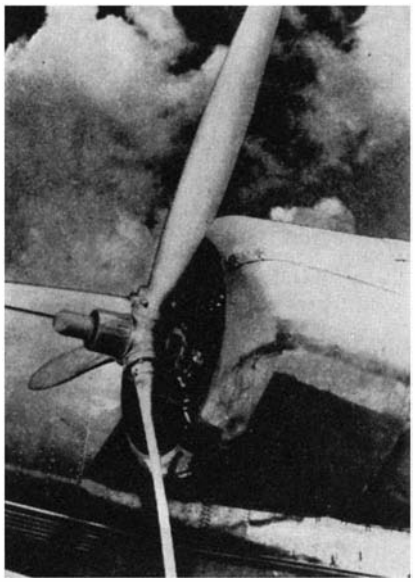
N.A.C.A. free-flight wind-tunnel in which the model is unrestrained and flies freely, making possible a new method of studying airplane characteristics

pitch-variation with constant speed obtained by the aid of a mechanical governor.

But it is not only in electrical actuation that the novelty of this device appears. There are two other valuable features: one is a flexibility which permits either automatic constant speed or selective manual control in the same installation; the other is the ability to feather the blade through a very wide range of operating angles.

The range of blade angles is helpful because of the very wide range of speed in the modern airplane, and also because when one engine of a multi-engine installation goes out of commission, it is advisable to prevent the propeller from windmilling. It should be "feathered" to 85 or 90 degrees so that it offers the least air resistance. Then the power unit which has gone out of commission takes the least possible drag power, and the remaining power unit or units can most readily keep the airplane going steadily forward. The hub construction and blade retention system of the Curtiss propeller are such that the blade angle movements are as great as 120 degrees, sufficient to cover all conceivable requirements on land, water, or in the air. It is a further advantage of the propeller that the pitch actuating mechanism is completely enclosed and protected from temperature changes, moisture, and icing conditions.

The general construction of the propeller is shown in the accurate, though partially schematic, diagram. The hub proper is of the one-piece type, machined from a high alloy steel forging. On its rear extension is mount-

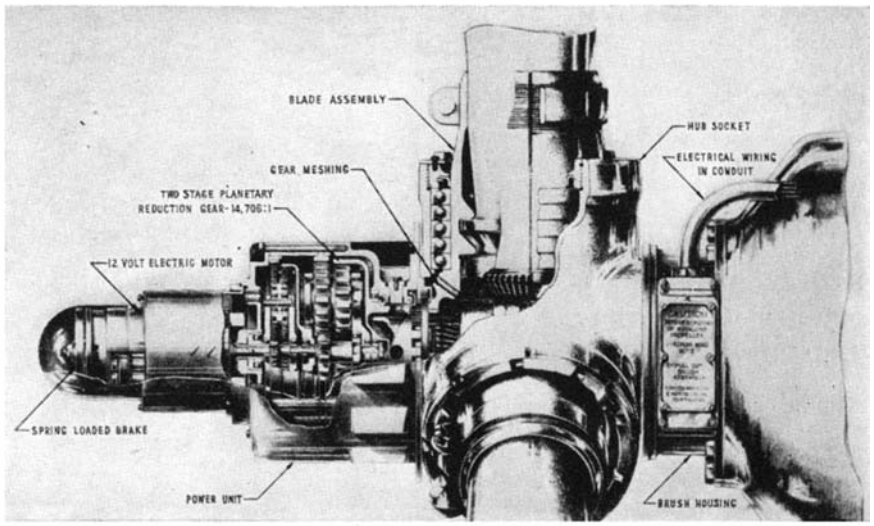


A Martin bomber with the new electric controllable-pitch propeller

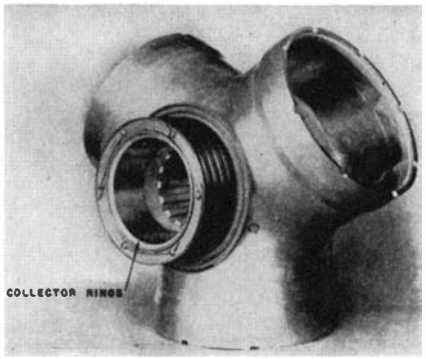
ed the slip-ring assembly which transmits electrical energy from stationary brushes to fixed contacts at the front face of the hub.

The fixed brush assembly consists of a pair of spring-loaded carbon composition brushes for each slip ring, mounted in a block of insulating material and supported by a light alloy casting bolted to the thrust cover of the engine nose. This casting completely houses the electrical parts.

Pitch change is effected by means of a 12-volt electric motor (series wound, reversible, direct-current type) mounted at the nose and operating through a planetary speed reduction unit to a bevel power gear



***Above:* A partial sectional drawing of the Curtiss electric constant-speed full-feathering propeller. *Below:* The propeller hub casting with slip rings on the rear extension**



which engages a bevel gear fixed to the root of the blade. The reduction gearing embodies the enormous reduction of 14,706 to 1. Thus, with the electric motor turning quite rapidly, the most delicate pitch change is imparted to the propeller blades, which are three in number in the installation shown.

The normal pitch range of the blades is controlled by electrical cut-out switches operated by a cam on the shaft with the power bevel gear.

The constant speed control consists of a conventional flyweight type governor driven at engine speed. The flyweight force is balanced against a spring, the initial compression of which may be adjusted by the pilot in selecting the desired engine speed. When the speed is balanced the pitch-changing circuits are open and no change takes place. When the speed is above or below that desired, the flyweights, through a plunger, actuate a switch to close the pitch-changing circuit.

The propeller has successfully passed both Army and Navy tests and has received the Approved Type Certificate from the Department of Commerce. It is a splendid addition to the resources of modern aviation. —*A. K.*

The Langley Field Conference

As usual, the Langley Field Annual Conference of the N.A.C.A. was well attended by representatives of the aviation industry, the Universities and the Government Air Services. And as in previous years a wealth of research information was offered to the visitors. Space will permit only the most concise presentation of the outstanding achievement of the Committee's staff.

The eight-foot diameter, 500 mile an hour wind tunnel is now in perfect shape, and with its automatic balance is remarkably rapid in operation. It will be invaluable in advancing the study of high-speed flight in general and compressibility effects in particular. We have several times mentioned in these columns the "compressibility burble" of wing sections. When the air stream passing over a wing has a speed of say 500 miles an hour, the local velocity over the upper curved surface of the wing may be much higher, approaching the speed of sound; that is, 1092 feet per second. When the local velocity does approach the speed of sound, shock waves are created and the phenomenon of "compressibility burble" lowers the lift and increases the drag of the airfoil. Therefore, wing sections for high-speed flight may have to be radically changed in form to compensate for this effect.

Recent tests in the high-speed tunnel indicate that the N.A.C.A. engine cowl is subject to the same compressibility effects. When the air stream reached 325 miles an hour, the local velocity over the cowl attained 710 miles, a shock wave was formed, and the drag was increased enormously. The engine cowl will, therefore, have to have its leading edge much better rounded if airplanes are to fly much in excess of 325 miles per hour. In fact, a new type of cowl along these lines has already been designed.

In the near future aerodynamicists, inventors, and engineers will be busy designing new aerodynamic forms to avoid these shock waves.—*A. K.*

Buying Used Airplanes

The *News Letter* of Aero Insurance Underwriters is always instructive, sometimes entertaining. The latest letter offers some sage advice on buying a used airplane. "When you purchase a used airplane be sure it has been inspected by a licensed mechanic who has certified to the condition and airworthiness of the airplane by signing his name in the log book. Be sure that the control surface bearings have not been reamed out until the remaining metal is dangerously thin. Examine the control wires for fraying, control tubes for wear at the bearings. Ask if the ship has

ever been in an accident and if so, see what replacements or repairs have been made. Look for corrosion under the soundproofing and especially at all important fittings. Try to get data on the history of the propeller; has it ever been bent and then straightened, and by whom?" Anyone who has ever bought a used automobile and lived to repent the purchase will appreciate the value of this advice!—*A. K.*

An Automatic Supercharger Regulator

AIRPLANE pilots have so many gadgets to manipulate and so much to think of, that the strain of flying is severe. Control of the supercharger for altitude flying is another onerous task, since close watch must be kept over the intake manifold boost or

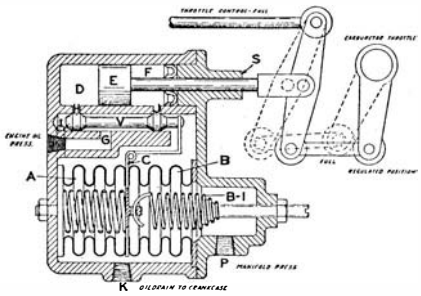


Diagram of automatic supercharger regulator, explained in the text

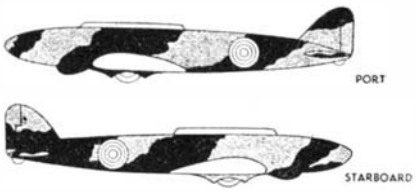
supercharger pressure to prevent the allowable engine output from being exceeded.

A two-position regulator developed by the Eclipse Aviation Corporation automatically maintains the maximum boost at take-off (when greater output is permissible and necessary for a short while) and also limits the boost under long cruising conditions.

The operation of the device is illustrated in the diagram. At take-off the pilot sets the selector lever in the cockpit at the "Take-Off" position and shoves the throttle full open. If the manifold pressure at full throttle on the ground is above the limit for which the regulator is adjusted, the manifold pressure, acting at P, expands the Sylphon B to the left against the action of the tension spring B-1. The sylphon B, when it expands to the left, carries the diaphragm C with it. The diaphragm in turn pushes the oil valve V to the left and admits engine oil under pressure through H into the servo cylinder D, forcing the piston E to the right, until the throttle setting is appropriately reduced. The converse operation when the manifold pressure is too low needs no description. The Automatic Regulator is functioning splendidly on many of our airlines.—*A. K.*

"Shadow Shading"

THE British name for camouflage of airplanes, an art which was developed so highly by the Germans during the World War, is "shadow shading." The first principle observed by the Germans was to paint the upper surfaces dark and lower surfaces light, closely following the natural coloring of animals and birds. A simple model of a bird painted dark on the top surface and brilliant white beneath, with light falling on it from above, is invisible when seen from a short distance. For upper surfaces, the Germans adopted a scheme of "cryptic



British "shadow shading"; a modern example of airplane camouflage

mimicry," painting the upper surfaces in streaks or patches of dark green, dark brown, or russet, in the hope that they would take the colors of the earth below.

The modern British form of "shadow shading," as illustrated in the sketches which we owe to the courtesy of *Flight*, is based on very similar principles. The upper surfaces are covered with irregular patches of dark green and brown. So are the sides. The lower surfaces of the aircraft are finished in dull black known as "night," with a view to deadening the reflection of searchlights.—*A. K.*

Screws Rotating in Opposite Directions

IN a single-seater fighting plane equipped with a powerful engine, the reaction torque of the propeller is so large, relative to the power of the ailerons, that there is considerable difficulty in maintaining lateral control at take-off; in flight the ailerons have to be set or the wings rigged to take up the torque, which is a source of aerodynamic inefficiency. Also, if a machine is trimmed to take up the torque, it is no longer in trim when the engine is shut off.

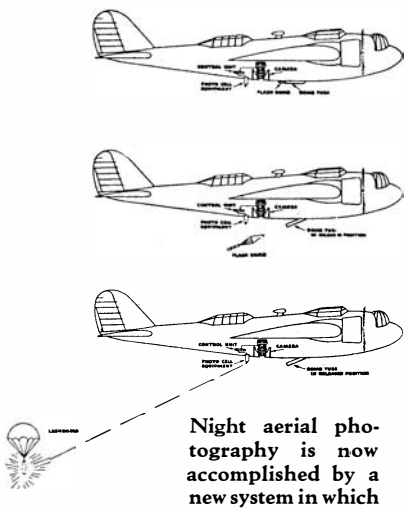
The remedy, frequently suggested, is to have two propellers rotate in opposite directions, so that torque effects are nullified. As our readers perhaps remember, one or two experimental machines along these lines have appeared in the United States. But none of these efforts has the perfect engineering finish of the Koolhoven Fighter, built in Holland, the mechanism of which is shown in the sketch.

A liquid-cooled 860-horsepower Lorraine Petrel engine is placed behind the pilot, and provided with a long extension shaft connected to a gear box. At the end of the drive shaft two gear wheels drive the rear airscrew in a counter-clockwise direction. By means of an intermediate gear wheel the front airscrew shaft is driven in a clockwise direction. It will be noted that the shaft of the front airscrew passes through the hollow shaft of the rear airscrew. The diagram indicates the simple mechanical principles involved. Mr. Koolhoven is of the opinion that the advantages of this airscrew system will more than compensate for the extra weight of the mechanism, the frictional losses in the transmission, and so on.—*A. K.*

Aerial Photography at Night

FOR many years the Fairchild Aerial Camera Corporation has manufactured night photographic apparatus for the Army Air Corps, but it is only quite recently that this development has passed from the "secret" stage.

The apparatus will take photographs in the black of night that compare favorably

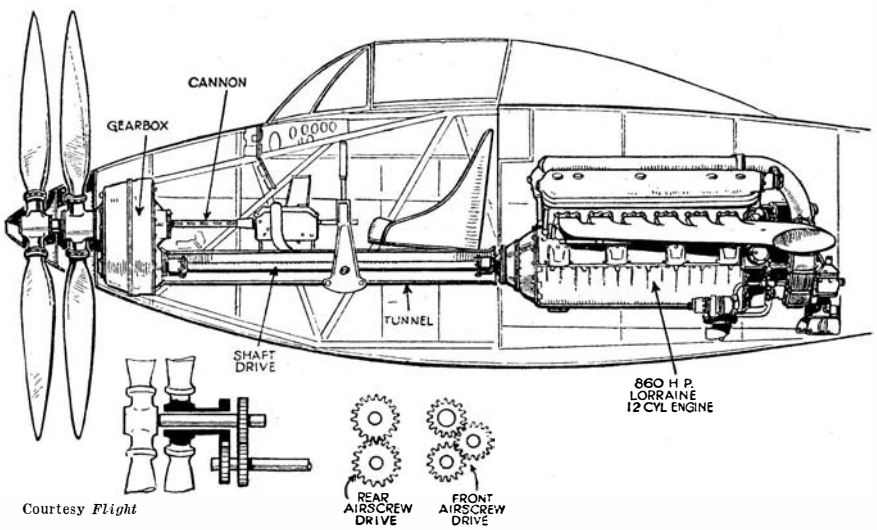


Night aerial photography is now accomplished by a new system in which the flash is automatically ignited and the camera shutter is actuated by the resulting light. Drawings indicate the steps of the action

with those taken under good daylight conditions, and is entirely automatic; pushing a button is the sole duty of the pilot or photographer.

The apparatus consists of a special aerial camera with roll-film magazine, a cell sensitive to light which automatically operates the shutter, and a photographic flash bomb producing a light intensity a million times greater than that of the ordinary Photoflash bulbs.

The process of night photography is car-



Courtesy *Flight*

Details of the twin airscrew drive for airplanes

The Editors Choose

A Few Outstanding Books That are Informative and Stimulating

1. NEW WAYS IN PHOTOGRAPHY—*By Jacob Deschin.*
The whole range of amateur photographs including such things as trick photography, photomurals, retouching, infra-red, and a number of other divisions that will not be found elsewhere discussed in as clear and concise a manner.—**$2.90** postpaid.

2. SHIPS OF THE WORLD'S BATTLEFLEETS—*Edited by Pay-Lieut. Comdr. E. C. Talbot-Booth, R.N.R.*
Essential facts regarding the principal ships in the navies of the important powers, with details of construction, silhouette drawings, and a large number of photographs.—**$1.65** postpaid.

3. UNSOLVED PROBLEMS OF SCIENCE—*By A. W. Haslett, Cambridge Univ., England.*
Covers those unsolved problems of science which are fully as intriguing as the things science has definitely settled—cosmology, geology, meteorology, anthropology, biology, physics, and mathematics.—**$2.15** postpaid.

4. THE BALANCED DIET—*By Logan Clendening, M.D.*
The widely known author of many medical features and books gives us here an ideal, popular book on diet—ideal because it is not too technical and not too superficial. A good book for most people.—**$1.65** postpaid.

5. FOOD, FITNESS AND FIGURE—*By Jacob Buchstein, M.D.*
A popular treatise on foods, their content and effect in our diet, also on beverages, food fads, vegetarianism, fasting, and weight control. Detailed 14-day diets—**$2.15** postpaid.

6. WHY BE TIRED?—*By Daniel Josselyn.*
Short and to the point, this book should be a tremendous help to all "office athletes"—those sedentary workers who work as strenuously as laborers but do not realize it except that they are usually "dog-tired."—**$1.10** postpaid.

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A revised edition of a book published three years ago, expanded to include many additional subjects. Crammed with short, pithy paragraphs describing various desirable inventions in a number of different fields.—**$2.65** postpaid.

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Electric phenomena with directions to perform the experiments that exhibit them. Simply written, this book has proved a source of enjoyment and mental stimulation to mechanically inclined individuals. —**$2.15** postpaid.

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11. ON YOUR GUARD!—*By Carl Warren, B.S., M.S.J.*
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12. THE ART OF CONVERSATION—*By Milton Wright.*
Inarticulate people will be tremendously helped by the reading of this book by a man who is a brilliant conversationalist. It will help remove that inferiority complex.—**$2.65** postpaid.

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Captain Edward V. Rickenbacker has written the introduction, in which he says "I believe it is the obligation of every car driver and owner to become acquainted with this book". It sets forth ways and means to inject a greater amount of safety into the ever-faster driving of our time.—**$1.15** postpaid.

19. HANDBOOK FOR THE AMATEUR LAPIDARY—*By J. Harry Howard.*
The latest book by the author of "The Working of Semi-Precious Stones". This newest book provides practical instructions in all kinds of gem cutting for the beginner and for the advanced amateur. It is a real shop-book.—**$2.15** postpaid.

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Aimed specifically at the amateur collector, this volume tells him how to go about collecting—what to do and what not to do. It includes a general elementary treatise on crystallography and mineralogy.—**$2.65** postpaid.

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ried out in three stages. In the first stage the aircraft is flown straight and level over the ground area to be photographed. The flash bomb is supported in the bomb rack of the airplane and is shielded against the slip stream and other air motion by an aluminum tube. At the appropriate moment, when the airplane is about 500 feet short of the center of the area to be photographed, the bomb-release mechanism is actuated and the flash bomb falls clear of the airplane, pulling a parachute with it. As the parachute opens, five or six seconds later, it offers greater resistance to the air than the bomb, and pulls an ignition tape while the slack lines are extending. Thereafter the parachute slackens the rate of descent. The fuse burns and at a predetermined instant the bomb explodes. This explosion occurs when the bomb is somewhat behind the airplane, which is continuing its forward flight. At the instant of operation, the bomb is outside the field of view of the camera but within the field of view of the light-sensitive cell. The cell thus actuates the shutter at exactly the peak intensity of the flash. With the short exposure coinciding absolutely with great light intensity, perfect photographs are achieved.

The artist's drawing illustrates the three stages of the process simply and accurately.—*A. K.*

A Secret Fuel Feed System

A NEW fuel feed system, replacing the conventional carbureter and developed by the Stromberg Division of Bendix Corporation, is to be placed in service by United Airlines.

The announcement reads that the new system will have its chief advantage in greater dependability, and will eliminate ice formation without the necessity of high intake air temperatures.

Practically no other information is available. We may make a variety of conjectures. Perhaps direct fuel injection into the cylinders is in contemplation; or perhaps a variable section carbureter venturi is to be disclosed. Our readers may have other solutions to suggest.—*A. K.*

Corn By-Products

CORN, which has been considered industrially as a source of starch, may yield important industrial by-products made from its protein constituents. At present the protein content of the corn finds its chief use in animal feeds, but attention has lately been called to the possible value of these important compounds in the manufacture of plastics, synthetic resins, and adhesives.

—*D. H. K.*

Osculate at Your Own Risk!

CASES of inflammation of the lips due to hypersensitivity to certain dyes in lipsticks were reported by Drs. Joseph Goodman and Marion B. Sulzberger of New York at the recent meeting of the Association for the Study of Allergy.

By making tests of the various ingredients of the lipsticks, it was possible to discover which dye was the offender in a particular

case, and to prescribe for the patient a lipstick which she could use safely.

Other cosmetics, notably powders and nail polishes, have also caused inflammation and skin irritation, the New York doctors found.

Dyes in wearing apparel, ranging from dresses to shoes and socks, frequently cause irritation in sensitive persons. This sensitivity is an individual matter, it appears from the cases reported. Some patients were sensitive to black, others to blue, and still others to brown.—Copyright 1937, *Science Service.*

Shrinking Business

ONE of the most spectacular technical developments of the depression period occurred in the textile industry. While a search for new technical contributions and a defensive publicizing of older developments was being conducted almost frantically in the textile trade, an agricultural machinery inventor and engineer has quietly met a major opportunity and in the last three or four years the yardage processed by his treatment has increased some 60 percent annually. The development has been compared with that of fast color dyeing in its significance to the consumer and to the trade.

Shrinkage has always been a problem in textiles, but as the English authority, F. Courtney Harwood, notes, it became serious when the public began to prefer the use of soap to pomades and perfumes. Washing reduces the stretch of fiber and yarn which is introduced when the cloth is made, the cloth becomes narrower or shorter, and the garment becomes smaller in size than when purchased. Shrinkage was formerly considered a necessary evil, and garments were regularly purchased oversize to allow for it. Cotton slacks or suitings were out of the question. The modern vogue for slacks is only one of the changed customs that may be traced for credit or blame directly to the engineer, Sanford Cluett. Quite properly, the term "Sanforized," best known of the trade names for pre-shrunk fabrics, is spreading as a symbol of a new major consumer benefit. Certain other names indicate shrinking for which recognized companies take responsibility, such as "Banco-Shrunk," "Sayl-A-Shrunk," or that used by the Bradford Dyers Association Ltd., of Manchester, England, "Rigmel Shrunk." These and other registered names have begun to have some meaning in the trade and with the consumer who can check their reliability. The term "pre-shrunk" itself and its several trade modifications, however, are unfortunately all but meaningless.

The Sanforizing process was first used on a large scale for cottons and is especially well adapted for them but can be used for other textiles. The problem with woolens is complicated by the felting property of wool fibers, such that no practical pre-treatment of a woolen fabric can insure against shrinkage from all types of later use and abuse. Some of the difficulty is overcome by treating the wool with chlorine, and a recent English modification of this effect using chlorine in the form of a gas is hailed by its sponsors as an "unshrinkable" wool process.

The Sanforizing process is mechanical and in principle almost absurdly simple.

(*Please turn to page* 114)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

LAST month in this department Professor Henry L. Yeagley, of the Department of Physics at the Pennsylvania State College, described his simplified equipment for aluminizing telescope mirrors. This month he completes his account with the actual working instructions, which are as follows—the "Figure 1, 2, and 3" he mentions below having appeared, of course, in last month's installment:

DIRECTIONS for aluminization: 1. Mount the rotary oil pump on four rubber "feet" (Figure 1) to prevent excessive noise.

2. Provide three ¾" upright supports topped with rubber cushions to hold the base plate (*I*, Figure 2) about 5" above the pump intake.

3. Assemble electrodes and exhaust port in position. Seal outer joints with vacuum wax. Place bottom disk in position and

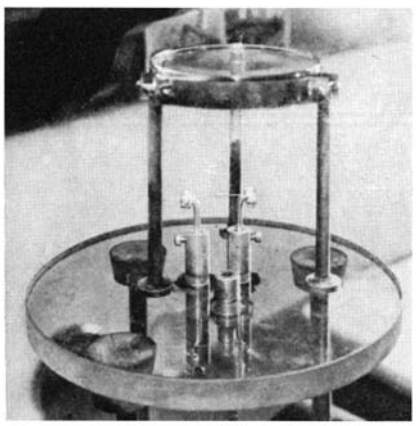


Figure 4: **Mirror on its supports**

connect exhaust port to pump with rubber pressure tubing (*G*), then seal with wax.

4. Insert the release valve through a 1/16" hole cut in the rubber connector. Also, insert small plug in end of valve and seal both with vacuum wax.

5. Clamp 40-mil tungsten wire in position in electrodes, with a 3/16" overlap at middle and with slight spring action of the wire holding them together. Wrap 3" of .04" aluminum wire on this overlapping portion. Be sure to wrap evenly, and in about two layers, to provide as much metallic contact as possible.

6. Clean the glass mirror, as previously described, and clamp it securely in the three-metal-strip holder. Tinned iron from a large tin can is heavy enough for a 6" mirror support.

7. Heat the feet of the three upright supports *N*, and cement to the base plate *I* with vacuum wax. Support the mirror, face downward, on these posts, as shown in Figure 4. If properly made, this assembly forms an extremely trustworthy mirror support.

8. Carefully dust the inverted mirror with a "camel's hair" brush until no particles can be sighted when glancing across its surface at a "flat" angle.

9. Lower the bell jar or cylinder over the whole assembly and seal to the base, as indicated in Figure 3.

10. Start the pump and record the time. After pumping for five minutes, impress about 2000 volts across the filament-exhaust-port space. The initial discharge should spread itself over the metallic surfaces and gradually soften into a patternless grey-blue glow. In about 15 minutes this should occupy the whole space inside the chamber. If by chance there be a leak, no discharge will be apparent or it will not progress as described. In either case the remedy is simple; *i.e.*, heat all wax seals gently with the soldering iron until the discharge indicates a vacuum-tight chamber.

11. After about 20 minutes from the time the pump is started, or after a possible leak has been healed, the discharge, as viewed in the dark, will cease for a 2000- or 3000-volt potential. Progressively increase this voltage, always keeping it just high enough to maintain the discharge. When the latter ceases to exist at 4000 to 4500 volts, the pressure is low enough for successful aluminizing. During the discharge period the electron bombardment of the mirror cleans away all adsorbed gas molecules which might prevent the aluminum coat from adhering properly. Although successful evaporations have been carried out after 20 minutes or less of evacuation, it is desirable to wait two hours or more to insure best results.

12. When the vacuum has been judged satisfactory, eliminate the high voltage and impress 5 volts across the filament electrodes *A*, *A*. Be sure to use heavy copper wire to carry the large current. As soon as the circuit is closed, adjust the primary coil rheostat to a point where the heated tungsten quickly melts the aluminum. Then increase the current so that the aluminum can be seen to boil vigorously. When the filament can no longer be seen through the top edge of the mirror disk, break the circuit and pull out the release valve plug.

13. Scrape away the wax around the cylinder base with a wood chisel. Then use the tip of a penknife to cut the wax seal at the cylinder-base plate junction. Jar the cylinder with a sharp slap of the hand and remove. If any difficulty is experienced, the method of increasing the inside pressure, previously described, is useful. The writer much prefers the latter.

AFTER each run the aluminum coat must be removed from the base plate between the exhaust port and the filament electrodes, otherwise the high-voltage discharge of succeeding runs would pass through this metal film instead of the low pressure gas molecules remaining in the chamber. It is a good plan to shield these areas with strips of glass which are easily removed for cleaning. The filament electrodes may also be protected from excessive coating by glass shields, as shown in Figure 3.

Since successive layers of aluminum on the metal parts tend to become porous and troublesome from the standpoint of vacuum technic, it is desirable to sandpaper the brass surfaces after each set of about five runs. It is impossible to do this to the inside walls of the exhaust port, as dirt and grit would get into the pump. To eliminate this difficulty, place a short piece of glass tubing around the exhaust port, as illustrated in Figures 2 and 3. No deposition of aluminum will occur on the above-mentioned surfaces, with this type of shielding.

WITH regard to the matter of volts in the high-voltage discharge and the amperes of the low-voltage discharge, I have purposely avoided the use of any ammeters or voltmeters in developing the technic and have proved by the results that they are not necessary or desirable.

I knew the approximate discharge voltage and filament current voltage, simply because the transformer ratings were stamped on the instruments themselves. I later measured them with meters to see whether they were about what I thought they were, which proved to be the case. This sounds like an old-fashioned housewife's method of cooking, but was right in line with my avowed purpose to simplify the method and avoid unnecessary complications. In order to improve the situation I will, however, give a more complete set of directions on the matter of knowing when the vacuum is good enough for aluminum evaporation.

In the high-voltage electrical circuit (Figure 5) the letters *a*, *b*, *c*, *d*, and *e* represent a number of possible settings on the high resistance rheostat. If, after the vacuum pump has been operating for 20 minutes, the full voltage (5000 v.) gives a soft grey-blue discharge (the purple or reddish color having faded out), increase the resistance in the rheostat *Rp* until the discharge is just able to persist. Each time it extinguishes, move the variable contactor *Cv* along from *a* to *b* to *c*, etc. At the end of two, three, or four hours the discharge should extinguish with the contactor well over toward *e*. This means that the primary coil is getting the full 110 volts, which in turn means that the filament-*B*-exhaust-port-*F* gap (Figure 2) is getting from 4000 to 5000 volts. (The impressed high voltage is to the reading of the voltmeter across the primary of the transformer as 5000 is to 110.) If the discharge ceases, *when viewed in the dark* at about 4000 volts, the vacuum is O. K. (night time or a dark room is best for studying the character of the high-voltage discharge during the clean-up period. I have often sat watching the final clean-up of a run, and the contemplation of the beauty and soft, soothing character

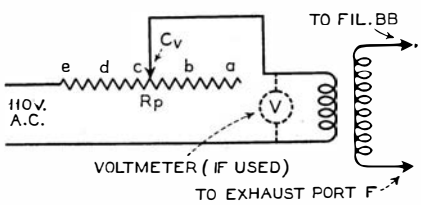


Figure 5: **High-voltage circuit**

of the discharge always gives pleasure).

The beginner should make several dummy runs before trying a mirror. Place in the vacuum chamber, for the test runs, small glass vases or other non-porous objects. When cleaned by the method described these trinkets will be more beautiful than silvered ones and will hold their polish indefinitely if handled only with cotton cloth.

I would strongly advise taking written records of each run, just as the mirror maker does when figuring. A set of five or six of these will be a gold mine when future runs are made.

THIS ends Prof. Yeagley's description. From A. F. Hoeflich, 626 16th Ave., San Francisco, Calif., we received, some time ago, the photograph shown in Figure

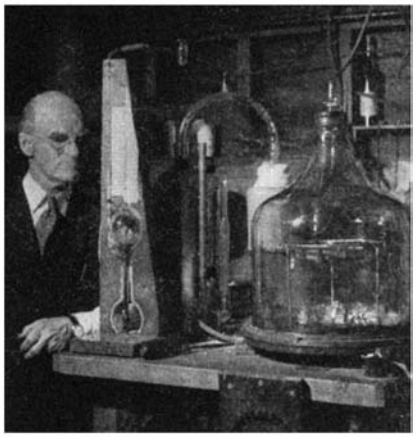


Figure 6: **W. M. Grant and his rig**

6. He writes: "This is photo of W. M. Grant and his aluminizing apparatus which will handle mirrors up to 14". The mercury pump is backed up by a Cenco. All equipment, gages, etc., home-grown. It turns out fine work, as is attested by members of San Francisco Telescope Makers, among whom Grant is leading authority on mirror figuring. A 6" disk is seen suspended on the tripod under the jar. This jar was being pumped to a high vacuum, after which the aluminum around the tungsten coils in the base was flashed. The finish in this demonstration before the club members was a perfectly coated mirror."

IN ATMA, page 296, are photographs of a fine dividing engine made a year or so ago by Vard B. Wallace, one of the original TNs (his picture on page 65 of the 1928 edition of ATM, was taken before his Vard Mechanical Laboratory, Inc., at 2980 East Colorado St., Pasadena, Calif., was organized). He now sends the photograph shown in Figure 7, and writes:

"Here is a picture of our new evaporating outfit. The diffusion pumps are our own design and built in our own shop. The bell jar has a 12" clear inside diameter. We have striven to make this a unit piece of equipment where everything is bolted to the table with nothing at loose ends. The mechanical pump is a Cenco Hyvac and is driven by a ⅙ H. P. motor. The box below is a low-tension transformer for heating the filament. The upper box is a high-tension transformer for testing the quality of the vacuum. The large steel plate on which the bell jar rests is provided with six electrodes sealed vacuum-tight. Each of

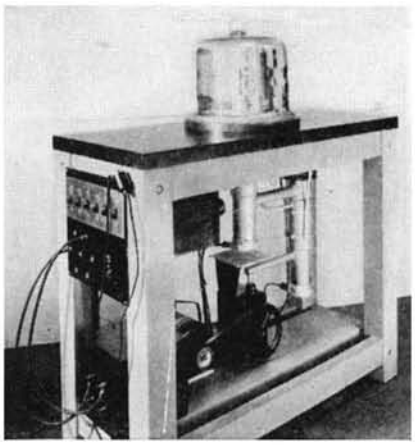


Figure 7: **Vard Wallace's rig**

these electrodes is connected to one of the six holes in the panel at the left end of the table. This arrangement permits setting as many as six filaments at one time, with the possibility of selecting the particular filament that will be fired at will. Practice has proved this arrangement very satisfactory. The push button switch on the end of the long cord permits a close control on the filament current although the operator be

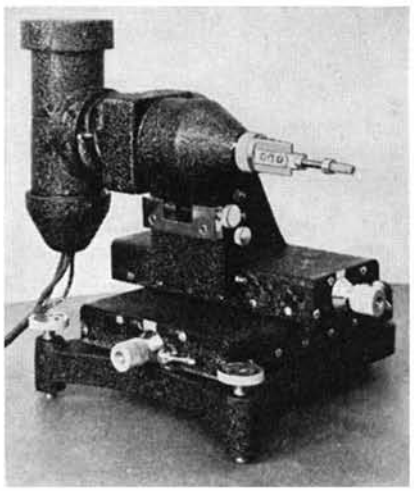


Figure 8: **Wallace's k-e tester**

moving about the jar to find the best position for watching the progress of the evaporating.

"About 17 minutes are required to pump the jar down to a black vacuum. It is possible to clean a mirror, place it under the jar, pump down, fire the coil and admit the air again in about 45 minutes.

"In contrast to the hours I have spent trying to make a good coat with silver, this method is pure delight."

AT our request Wallace also sent in a photograph (Figure 8) and description of his knife-edge testing dingbat. Of such rigs there are now many (this old-fashioned scribe still rooting for the simple hoss-and-buggy kind Ellison recommends). Wallace writes:

"The knife-edge tester was designed after looking at one used by Mr. Dalton at the Mt. Wilson Laboratories in Pasadena. A ribbon filament bulb is housed in the vertical cylinder. Light from this source passes through a pair of condenser lenses and focuses on a pinhole in a piece of foil on the side of a ¼" prism. Just clear of the prism is the knife-edge, which takes the form of an adjustable slit. This arrangement permits cutting off from either side. The separation between the pinhole and the knife-edge is about ¼". This whole optical system is supported by a rider on a vertical slide that can be adjusted for altitude. A tangent screw permits the system to be rotated a few degrees either side of normal. The vertical slide is supported in a horizontal plane on straight ball races and is controlled by a micrometer screw that reads to thousandths. This, in turn, is carried on a pair of lateral ball tracks and is moved by another micrometer screw.

"This may sound more complicated than it really is. Ball-bearing ways are very little more difficult to make than are the more conventional V ways, and their operation is a delight. The feel of the screws is smooth, yet there is no shake in the whole assembly. Leveling screws support the device at three points. There is some sentiment against equipment of this degree of elaboration, but our experience indicates that it has its place. There is classical precedent for the razor blade on a stick, but the above-described machine gives just as good results, and gives them quicker. And too, it was fun to build it."

Maybe that last sentence most nearly touches bottom. However, fun is fun—so what?—*Ed.*

PROFESSOR Yeagley sent us, a year or so before he sent the above aluminizing article, a description of his own pet knife-edge tester and this is a good time to fish it out and publish it. He described it thus:

"*A*, Figure 9, is a light house containing a 2.5-volt flashlight bulb. On one side is a 1/16" circular opening for use in lining up the mirror under test. Ninety degrees from this opening is a .001" slit, set on a ground glass, for use in the Ronchi and Foucault tests. The slit is made by aluminizing a small disk of glass and making a scratch across one of its diameters.

"*B* is an eyepiece containing a Ronchi grating (175 wires per inch, as indicated in ATM for optimum conditions), and a knife-edge parallel to but separated from the grating wires.

"*C* is a rack and pinion assembly for moving the eyepiece longitudinally.

"*D* is a millimeter scale and vernier which estimates accurately .01 cm.

"*E* is a screw adjustment for moving the slit source back and forth sideways, for quick shifting from the grating to the knife-edge."

FIGURE 10 brings us back to Vard Wallace again. (This thing seems to be becoming a duet, but that's only your

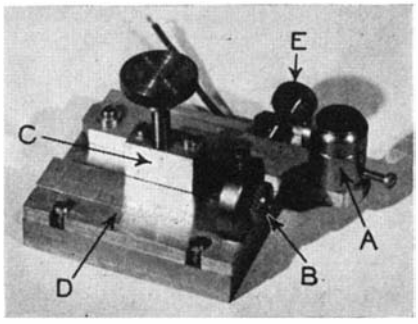


Figure 9: **Yeagley's k-e tester**

scribe's whim of the day. These items have accumulated over quite a long period and are now brought together at one time.) Vard Wallace next speaking:

"A pattern for the base of the circular dividing engine once described in these pages [and in ATMA, page 296.—*Ed.*] was dusted off, and an iron casting made that proved to be an excellent table for the polishing machine. Around this was built

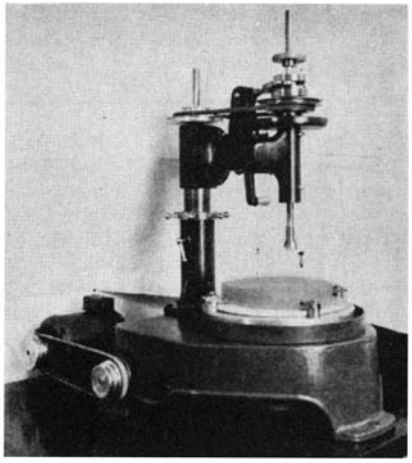


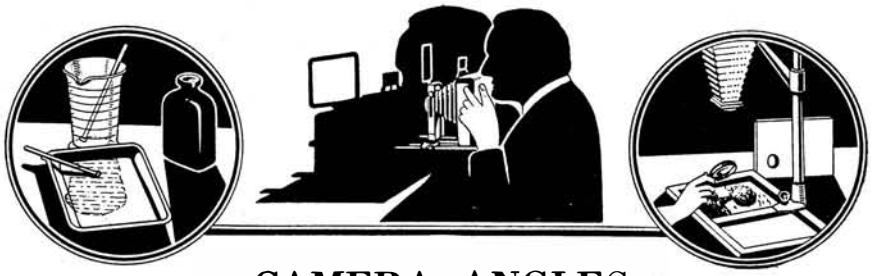
Figure 10: **Wallace's machine**

the rest of the engine. The other castings are of aluminum alloy. Central with the vertical column is a drive shaft on which is mounted a three-step cone pulley. From this runs a V belt to the shell of a clutch on the spindle. The cone of this clutch drives the spindle, and is so adjusted that when the lever control is pulled the spindle is stopped before the driving pin is lifted out of the depression in the polishing tool. This proved a big convenience, as it is not necessary to stop the whole machine each time new abrasive is added. The overarm and spindle can be swung to any position over the work and also can be inclined to the vertical for deep curve work.

"To date, two 6" parabolas, a 10" master sphere and a master flat have been made on this machine and the results have been excellent. The real way to appreciate equipment of this sort is to rub out several parabolas on the corner of a bench by hand. Then the delight of watching the machine work for a single hour will repay all the time and labor it represents." [But when it comes to character building, there is nothing like fighting a mirror 10, 20, 50 or 100 hours, by hand, and sticking to it till you lick it. Other tasks seem easy, after that.—*Ed.*]

NORBIDE is the name of an abrasive offered by the Norton Company. It is boron carbide, B_4C, and is the hardest material ever produced by man for commercial uses. It is made at very high temperatures in the electric furnace, from coke and boric acid. It is harder than SiC and the makers state that it will remove stock faster than Crystalon, their name for silicon carbide. And in one pound cans it costs about 18 times as much as silicon carbide!

TWELFTH annual convention of TNs will be held at Stellafane, atop Mt. Porter, near Springfield, Vermont, Saturday afternoon, August 14. Anyone interested is welcome. Many TNs and their telescopes, to "gam" with and look at, will be there.



CAMERA ANGLES

Conducted by JACOB DESCHIN

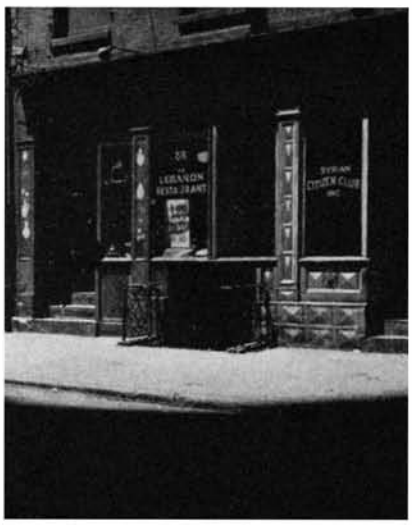
Covering an Assignment

ONE day you say to yourself: "I think I'll go down by the waterfront and take some pictures," or "I haven't seen a picture of our Main Street in a long while; maybe I can get something good." And so you head for the waterfront or towards Main Street and on the way you try to plan your self-assigned task so that when you get there you will have some idea of what kind of pictures you want to take.

Well, something of the sort is the routine experience of the photographer sent out by a publication to cover a particular assignment, and such was the recent experience of this department when requested by *The Christian Science Monitor* to make some photographs of certain foreign sections in New York City to illustrate an article on "Foreign Quarters."

Like the vague idea of photographing the waterfront or Main Street, an order to take pictures of foreign quarters leaves the responsibility of proper selection of material entirely up to the photographer. Picture-minded, as he is presumed to be, the understanding is that the photographer will know what subjects will best describe the appearance and atmosphere of a particular foreign section and that he will, moreover, have the craftsmanship and imagination to turn his notions into pictures that will adequately illustrate the particular article in question.

Foreign sections in New York suggested a number of characteristics generally associated with these parts of town. Cobbled streets, fire escapes, the ubiquitous "El," stores with foreign words on their signs, people hanging idly out of windows, men gossiping over coffee cups and newspapers in numerous cafes as they were wont to do in their native lands.



"Sunlight in 'Syria'"

"Syria in New York"

"Italy—With the 'El'"

"The 'Isles' of Greece"

We figured that the job cut out for us in this particular instance was to show the general rather than the particular—street scenes, buildings, the air and feeling of a foreign people adapting their ways to those of a new land yet withal retaining their identity. Syria, Greece, Italy transplanted in spirit to America. If the job called for pictures of the foreign types living in New York, the pictorial approach would have been altogether different. Then we would have tried, by persuasion, where possible, "candidly" where more desirable or convenient, to take portraits and small groups. The portraits would be of men, women, and children who seemed to typify the people of their native land, the small groups would show the people in normal, easy conversation or collective activity. The latter would preferably be of the "candid" picture type. Or the assignment might have covered some such special topic as foreign foods available in New York City. That would have meant concentration on the pushcarts, with their strange fruits and vegetables, invasion of the kitchens of foreign restaurants and private homes (the latter requiring some diplomacy and tact, of course), and close-up pictures of displays in food store windows and on counters of shops which are picturesque in themselves.

As it was, we had to generalize and that was something else again. Broad views, sunshine, and the cobbled streets, fire escapes, foreign shops and the shadow of the Elevated.

Some of the results are shown, greatly reduced, in the illustrations accompanying this piece.

Movie Exposure Meter

So small and compact that it fits the palm of the hand, yet so accurate that it gives correct exposure data at a glance for all film speeds and number of frames per second, the Cine Electrodrem, just announced by Photo Utilities, Inc., is justifiably called "the midget master of movie exposure." When using a normal camera speed of 16 frames per second and supersensitive film with a 23-degree Scheiner rating, the reading is direct. You simply point the meter at the object to be photographed and read off without any further adjustment or calculation. By pre-setting an adjustment, the meter may also be read directly for any other movie film used, including Kodachrome, to indicate quickly what exposure to give for speeds from 8 to 96 frames per second and for different lens stops.

International Salon

An opportunity to test the pictorial and technical value of some of your best photographs is offered in the announcement by the Oval Table Society, Inc., of New York City, of its sponsorship of The International Salon of Photography, to be held November 16 to 30, 1937, at the galleries of the American Fine Arts Society, 215 West 57th Street, New York City.

The entries will be submitted in two sections, Section 1 being devoted to Pic-

torial Photography, and Section 2 to Technical Photography, the latter comprising the fields of color, news, illustration, commercial, natural history, photomicrographs, aerial, medical and surgical, press, theatrical, geological, metallurgical, and record photography and radiographs. Each entrant is allowed to submit a maximum of four prints in each class. The entry fee is one dollar for each section; the last day for receiving prints, October 23, 1937. The Salon is open to residents of any country.

The society, which, as sponsor of the National Salon of Photography, held in New York City November 1 to 14, 1936, assembled the work of some of the finest photographic talent in this country, now ventures a more ambitious undertaking by reaching out for the best photographs available throughout the world.

The society is "a non-profit organization for the advancement of the art and science of photography." Its president is Pirie MacDonald, Hon. F. R. P. S., and its secretary, Joseph M. Bing, F. R. P. S. Entry forms may be obtained by writing to the Oval Table Society, Inc., 10 West 33rd Street, New York City.

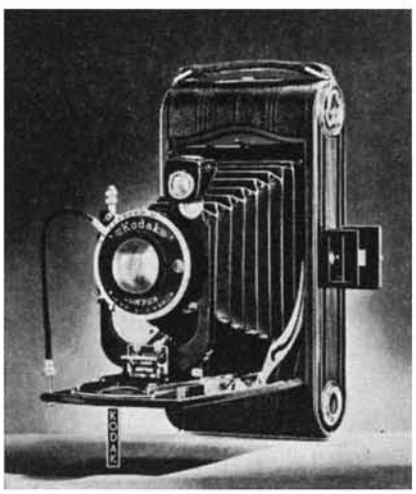
Special Argus film Spool

A SPECIAL film spool carrying an 18-exposure film strip and designed for use in the Argus 35-mm camera is announced by Agfa Ansco Corporation. The special daylight-loading spool uses the fast Agfa superpan, selected because of the desired combination of high speed, full color sensitivity, and fine grain.

New Camera Models

THE old favorite postcard-size 3A Kodak is back in a new dress and with a fast lens. It has just been placed on the market equipped with an F:4.5 lens and a Compur shutter, with built-in self timer. In addition to the eight speeds from 1 second to 1/200 second, plus time and bulb, exposures of intermediate speeds may be made. The new 3A has a rising front, so useful in taking pictures of buildings; diaphragm openings from F:4.5 to F:32; both reflecting waist-level view finder, and metal frame, direct-view eye-level finder; and other features.

Another Eastman announcement concerns a new series of Kodak Juniors in six models,

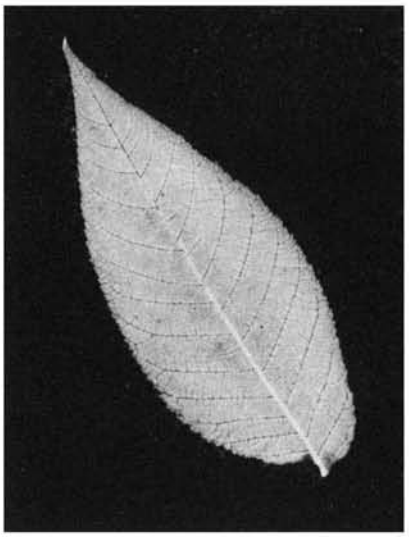


The revamped 3A

designated as Series II. These come in two sizes: Six-16 (2½ by 4¼) and Six-20 (2¼ by 3¼), each size with three different lens equipments—single lens, Kodak Bimat, and Kodak Anastigmat F:6.3. The shutters provide speeds ranging from 1/25th to 1/100th second, with time and bulb action. All models carry both waist-level and open frame, direct-view finders.

LEAF USED AS "NEGATIVE"

A SHORT while ago we had the opportunity of relaying to our readers the description of how the details of leaves could be photographed without a camera.



"Black Walnut"

This information was sent us by Bernard B. Whittier, meteorologist in charge of the Weather Bureau at Fort Wayne, Indiana, who later, complying with our request, had the kindness to lend us some prints of the results. One of these we are happy to reproduce here. The fine detail is ample proof of the success of the method. A sheet of photographic paper and the leaf to be "printed" are placed in contact, the emulsion facing the leaf, and locked in a printing frame. This is done, of course, in a darkroom by the usual printing dark-room light. The exposure is for 1 minute and 10 seconds, more or less, depending on the density of the leaf, with the electric light a short distance away.

PRINT PRESS

A DEVICE for flattening curled prints up to size 11 by 14 has been introduced by Willoughby's under the name Willo Improved Print Press. "Built to take plenty of abuse with nothing to get out of order," the press will take at one time two dozen 11 by 14 prints or a corresponding number of smaller sizes. Made of wood and metal, the press is said to be proof against warping. It is sold equipped with 18 blotters.

PRIZE CONTEST

ALWAYS happy to acquaint our readers of a chance to win fame and fortune in photographic prize contests, we here pass on the news that *Sports Afield*, America's oldest monthly outdoor magazine, are conducting a contest which will bring 50 lucky winners a total of 1100 dollars in cash and

camera equipment. The contest will continue to November 15 and is divided into two general classes, still and motion pictures, with three classifications in the still group. If you live in North America and are interested, you may secure entry blanks and full particulars by writing to Contest Editor, *Sports Afield*, Phoenix Building, Minneapolis, Minnesota.

Dark-Room Ventilator

IF you are one of those lucky ones who can afford to build yourself a special dark room or have one already, you may be glad to learn of a ventilator especially designed for dark-room use. A dark room can get pretty stuffy at times (ask the man who lives in one!), so this device may prove a godsend to some long-suffering worker. It is called the Ilg Dark-Room Ventilator and was, according to the makers, "designed particularly for the exhausting of foul air, dampness, and odors from dark rooms." The ventilator exhausts 750 cubic feet of air per minute, changing the air in the average dark room about once every two minutes; a scientifically designed baffle keeps out the light.

"The Ilg Dark Room Ventilator," the makers continue, "should be placed in an inner wall near the ceiling, opposite, if possible, from the door to create a circulation of air across the room. By means of a common extension cord and plug, the ventilator can be operated on a light circuit. Current consumption of the fully enclosed self-cooled motor is only 70 watts. No light can enter through the hood, whether ventilator is running or not. Furnished in 110 volts, 25 and 60 cycle, A. C. and D. C."

"In the Shadows"

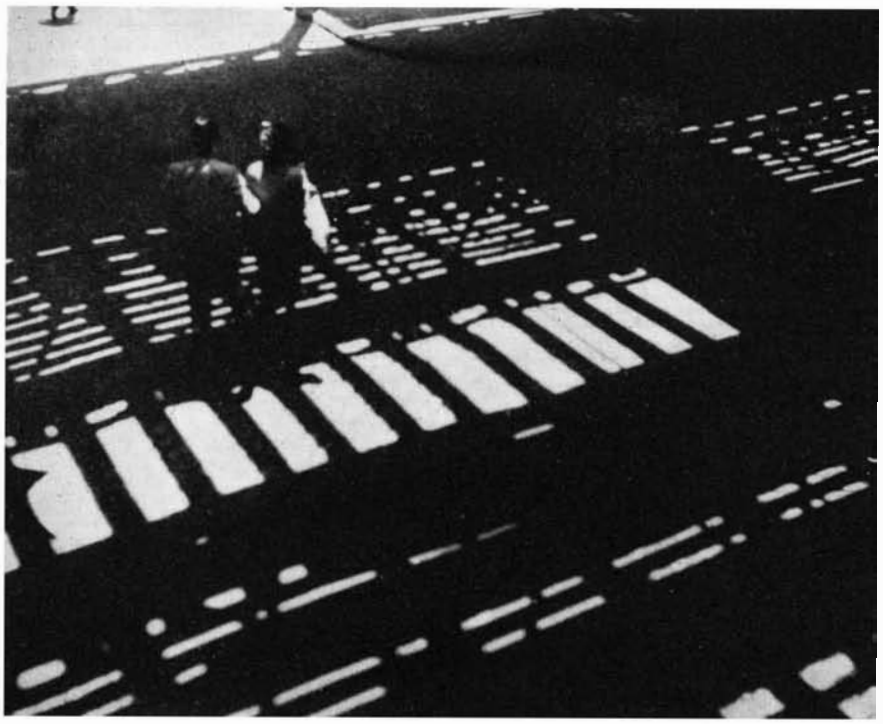
ONE of the delightful privileges of the photographer on his way toward a definite locale is to be on the alert for any possibility of a picture before he gets there. His mind is attuned to pictures and whether he takes them for a living or for pleasure, he is looking for pictures all the time. "In the Shadows" was picked out as one such opportunity as this department saw this shadow pattern from the top of the "El" stairs. Somebody walking across the square was essential to give the picture interest. When a young couple got into the picture, as shown, the time for the exposure was ripe. And here is the result.

Fine Grain

IN our June issue we published a review of Mr. Harry Champlin's fine book on the subject of fine grain development, entitled "Champlin on Fine Grain." In another part of the magazine there also appeared the Champlin #15 formula. At that time we should have cautioned our readers that a full knowledge of proper emulsion speed ratings, developing times, and the method for compounding the formula is essential for good results. We recommend that anyone who intends to use this remarkable formula should purchase the book mentioned above, for only from that source can the required full information be obtained.

What's the Rush?

TAKE your time. Someone once remarked —we believe it was H. Rossiter Snyder, the well-known photographic journalist— that the difference between the American photographer and the European is that the former will shoot 40 pictures in the time it takes the European to make up his mind to shoot one. As you may surmise, this dexterity of the American photographer is less commendable than the leisurely procedure of his brother across the sea, provided, of course, both photographers understand photographic technique and know what they are doing. Of what avail is it to shoot 40 on the chance of getting only one or two good ones; better to wait, to study the subject from every angle under various lighting



"In the Shadows"

conditions, and finally to make one excellent exposure. It is less wearing; it is a more artistic procedure, for in the process of eliminating this possibility and that, one develops the sense of selection, of "building up" the picture which will stand one in good stead when on occasion it is imperative to make a quick shot and to make that shot a good one. We waste altogether too much film, wear ourselves out too quickly, too much do we flit from this to that and then back again, so eager are we to make as many exposures as possible. It is costly both in money and in physical strength, but more important still is the injury we do ourselves as photographers. No need at all to rush; take your time.

Finopan Speed Increased

AN increase in emulsion speed to 21 degrees Scheiner in daylight and 19 degrees in Mazda light is announced for Agfa 35-mm Finopan. This, the makers say, has been achieved without the sacrifice of fine grain or Finopan's characteristic wide latitude, balanced contrast, antihalation protection, and scratch-proof overcoating. The new film may be obtained in 36 exposure cartridges or in 27½- and 55-foot rolls, notched and tongued for easy loading in any camera taking this size film, as well as in 100-foot unnotched rolls.

Print Folio

A HANDY container for carrying 16 by 20 mounts to the camera club, exhibition, or for general portability, is the Print Folio being distributed by the Fomo Publishing Company. The protection from soiling due to handling or accidental knocking is the chief virtue of this device. From one to 50 full-size 16 by 20 mounted prints may be carried in this folio, conveniently and with full protection. The folio is closed with snaps on one side, is made of durable seal grain artificial leather, and may be washed or cleaned inside and out in case of soiling.

Glossies From Matt Prints

MATT prints and enlargements may be converted into glossy surfaces by treating them with a waterproof finish now available under the name Marlac. A single coat of this solution, which is practical both for colored and black and white photographs, produces a surface equal to a glossy print, giving depth and richness. The liquid is applied with a high-grade varnish brush and the print then set face-in against a wall. Drying takes place in 12 to 24 hours.

Lens Cleaning Liquid

OUR chemistry friends will be interested to know that the so-called "lens oil" that is sold for the purpose of cleaning lenses is none other than propyl-iso alcohol, 98-99 percent. And if that means nothing to you or to our other readers, permit us further to divulge the fact that this formula, which is put out by the photographic chemists Mallinckrodt, is practically the same thing as that which is included in the Dallmeyer lens-cleaning outfit.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 103)

A sample of the cloth is measured, laundered and measured again. When the shrinkage is known, the cloth is mechanically crimped that exact amount so that when it is laundered, the straightening out of the crimping almost exactly offsets the shrinking, and the over-all measurements remain unchanged. To so adapt this principle that the "crimping" is taken up by the yarns within the fabric and is imperceptible on casual examination is perhaps not so simple as to be absurd. Some 60 or 70 plants now operate such a process, however, both here and abroad. Whether adaptations of older practice or other shrinking methods maintain or improve their present competitive position or not, it must be recognized that the great and rapid change in trade shrinkage practice, with its many ramifications, is due principally to this one process.—*Industrial Bulletin* of Arthur D. Little, Inc.

THE TENDER ONES FLOAT

TO separate peas of different qualities, some American canning factories use a brine solution of a density which allows tender peas to float and harder ones to sink.

HORSE SENSE

TESTS to measure "engineering horse-sense" in incoming students have been adopted by the Cooper Union Engineering Schools, New York, it was announced recently by Dean George F. Bateman. The tests will be included experimentally in the aptitude examination to be taken in the fall by more than 2000 applicants, less than one seventh of whom can be admitted, owing to physical limitations of the schools.

While the "horse-sense" tests will have no bearing on the success or failure of the candidates this year, the results will be used as a guide for devising future quizzes taking into account inherent fitness for the engineering profession as well as intellectual aptitude.

"In the past we have had too many tragic experiences with boys who came to the school with brilliant records in secondary school work, and who scored among the leaders in the mathematics aptitude test for entrance, only to crack up badly before their first year was completed," declared the Dean.

"Possession of a brilliant mind is not necessarily indicative in itself of engineering promise. A boy may have a quick mind, but lack the mechanical flair and the ability to visualize engineering problems that an engineer must have. Again, the brilliant boy frequently lacks the plodding sort of stamina that is essential to successful work in a good technical school.

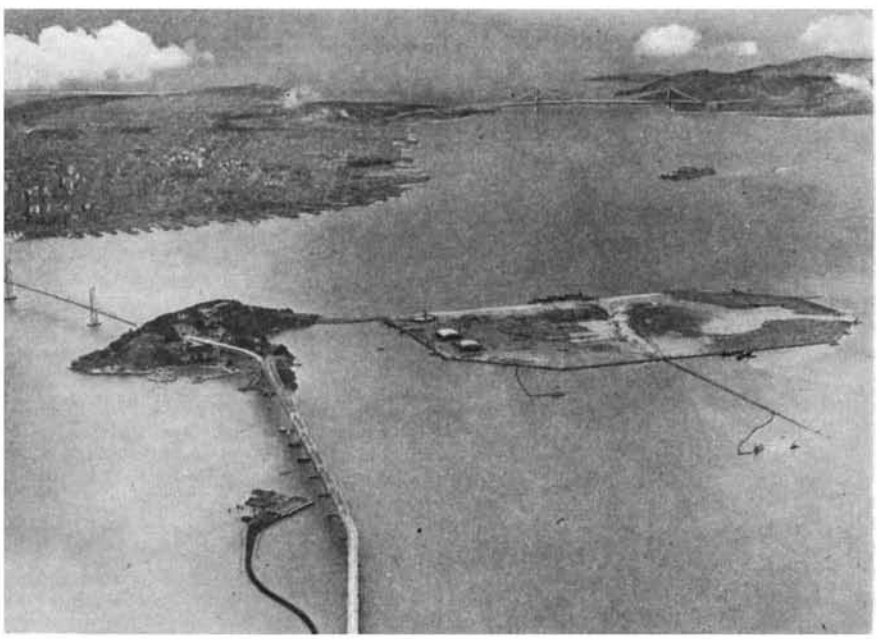
"Balance, above all things, is required of the good engineer, and balance is what the brilliant boy often lacks. It is not enough to be able to arrive swiftly on paper at a solution to a problem. The engineer does not build on paper. The solutions to his problems must work as he visualizes they will work.

"It is this balance, this practical sense of engineering, whatever it might be called, that we want our admissions to have. Our academic casualty rate is too high, despite the unusual selectivity we exercise. Approximately one applicant in seven can be admitted to the Day School of Engineering, and of those admitted, only 65 percent, and in some classes as few as 45 percent, can be expected to graduate."

NEW ISLAND CAUSES NEW CURRENTS

THERE have always been strong tidal currents in San Francisco Bay, greatest landlocked harbor in the world. Ferry boat pilots, shuttling back and forth day and night, have learned them and learned to use them; port pilots, bringing in the liners and the tramps, know them too.

But a new island has loomed up in this harbor—the largest island ever built by man, 400 acres dredged from the bay bot-



"Treasure Island," in San Francisco Bay (right), is changing tidal currents

The San Francisco-Oakland Bay Bridge is another cause of current changes

tom by United States Army Engineers to serve as the site of the Golden Gate International Exposition in 1939 and later as an airport, municipal and trans-Pacific.

It is conceded that this island, more than a mile long and 3400 feet wide, has changed the currents of San Francisco Bay, but even veteran San Francisco Bay pilots and tugboat captains disagree on the extent of these changes. Some describe them in strong terms, others are not much more than aware of them.

To determine exactly the extent and effect of these "Treasure Island" current revisions, the United States Coast and Geodetic Survey is arranging for observations with the co-operation of the Engineers. Results will be incorporated in current tables and charts covering the area, as information needed by pilots.

Several days of continuous half-hourly measurements of velocity and direction of current will be taken at each of three selected stations near the exposition site. An anchored vessel, equipped with especially devised instruments, will be employed.

The great San Francisco-Oakland Bay Bridge and the Golden Gate Bridge, largest in the world in their classes, also have had their influence on tidal set, for their huge piers rise directly from ferry lanes or harbor entrance. In connection with the same survey it is planned to secure, if possible, a series of current observations at the bridge sites themselves.

From such observations, precise values for velocities and directions of new currents may at any time be predicted for the use of navigators, engineers, or other technically interested persons. Pilots are awaiting publication of the new data with considerable interest.

Are the new currents beneficial or detrimental? That is the question, the answer to which will be engraved upon the fine-lined sheets in a thousand Pacific chart-rooms.

Silver Ages Brandies

TRACES of silver added electrically to brandies have been found to effect changes similar to those produced by aging, but to accomplish these results in days rather than in months or years. The amount of silver added is too small to be detected by ordinary methods of analysis and chemical tests show insignificant changes in the composition of the brandy itself. However, a change in flavor can be produced within five to seven days by the treatment. No ruling on whether such treatment will be permitted under the food and drug laws has yet been made.—*D. H. K.*

BROMINE

THE plant at Kure Beach, North Carolina, for the recovery of bromine from the sea was enlarged recently so that now 137,000 gallons of sea water are pumped through per minute. This is a volume great enough (were it fresh water) to supply the drinking water requirements of two cities the size of New York, allowing each inhabitant 10 gallons daily.

Electric Water Heater at Boulder Dam

WHAT is, in effect, the largest electric water heater ever devised by man is in use at Boulder Dam in connection with the testing of the huge 115,000-horsepower generators now being put into operation there by the Bureau of Reclamation, Department of Interior.

In principle, this heater, which is really a water rheostat of high capacity, is comparable with the small household heater used to warm junior's milk bottle in the wee hours of the morning. But, instead of using a mere 110 volts as does the average household heater, the Boulder Dam unit absorbs current potentials up to 18,600 volts.

The purpose of the rheostat is to absorb the current generated during tests of the generators. The rheostat consists of three poles to conduct the current of the three-phase cycle into the water of the power-house tailrace which furnishes the resistance required to absorb it. The farther the poles are submerged, the less the resistance

set up, thus affording the engineers the opportunity for observing the behavior of the generating unit under all conditions.

In order to accomplish this purpose with precision a chemical analysis of the water was made to determine its conducting properties and the resistance it would have under varying conditions.

Fish swimming into the field of the rheostat are apparently electrocuted and float to the surface, but once the current is turned off or they float out of the charged field, they regain life and swim away quite unaffected by the experience of having tangled with the electric energy generated by the largest power plant in the world.

MASS PRODUCTION PRECISION WEIGHING

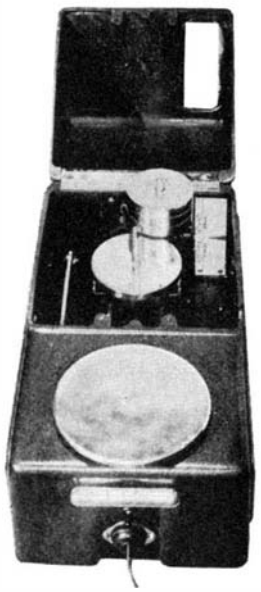
OF all systems of weighing, the most efficient is, of course, the balance, a system in which the weighed material is evenly balanced by weights on the other end of a pivoted arm. This principle has been applied to a compact precision instrument which has been developed for use in predetermined precision weighing. A product of The Exact Weight Scale Company, this instrument does not have the usual tower, is completely self-contained in a dust-proof cabinet, and indicates exact weight by means of a light beam, so that there is no possibility of parallax. This light beam and the shadow it throws give the name Shadowgraph.

Simply stated, the Shadowgraph is a weighing unit composed of an even balance scale mounted on a common base plate. Indication is derived from a needle mounted on the load-receiving end of the scale. This needle intercepts a single light beam, thus projecting a pointed shadow onto a reading dial, graduated either to certain values or for center indication only. Weighing is done against actual sealed weights, deposited on the weight platter inside the housing. For delicate weights, precision weighing is possible because of the long indicator travel; a 1/8-inch lever movement produces an indicator travel of 4 inches. Our illustrations show the machine in closed position, and open so that the stacked weights, weight rack, weight platter, and part of the beam are visible.

The Shadowgraph is built for either alternating or direct current operation. Parts are mounted in rubber to eliminate noise and jolting; bearings are agate; pivots are hardened tool steel; and the commodity container is a six-inch round plate. The scale capacity is either five pounds avoirdupois, or 2500 grams metric, and the beam is graduated to read one pound by half-ounce graduations, or 500 grams by five gram graduations.

For predetermined weighing in mass production industries the Shadowgraph has already found wide use. It is particularly adaptable to such operations as the balancing and selecting of automobile connecting rods, for small parts selection, chemical packaging, and so on. It can be used by glass manufacturers, instrument makers, food packers, and all types of general industrial plants where selective operations can be more efficiently met by weight.

A light beam is used to indicate balance in this new weighing scale



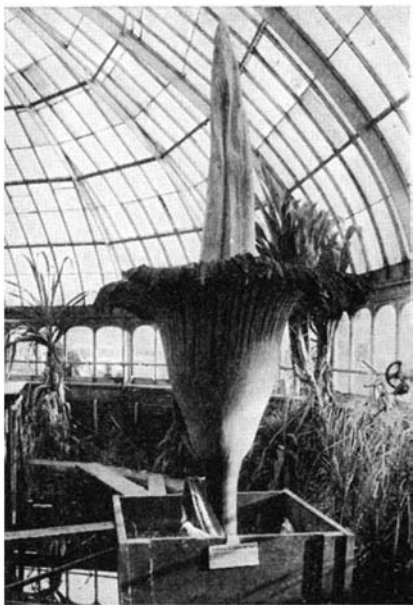
Interior of the balance, showing commodity container (front), weight platter, stacked weights, and the light-beam indicator (right)

CHEMICALS

EVERYONE knows that he must eat proteins and carbohydrates but few know that there are ten chemicals with tongue-twisting names which must be present in the diet if we are to prevent nutritive failure. They are: lysine, tryptophane, histidine, phenylalanine, leucine, isoleucine, methionine, valine, threonine, and arginine.

AMORPHOPHALLUS TITANUM BLOOMS

THE world's largest flower, seen for the first time in America, bloomed on June 8 at the New York Botanical Garden. Because it is such a rarity, as well as a monstrous curiosity, crowds were attracted to the Garden for the event. Previous specimens which have been brought into flower in cultivation (one at Kew Gardens, England, in 1889 and another in 1926) have grown at the rate of three or four inches a day, but the New York Botanical Garden's vigorous specimen grew nearly a foot a day



***Amorphophallus Titanum* in bloom**

from the time the flower bud first appeared above the soil. This *Amorphophallus Titanum* flower was the largest one on record in cultivation, being 8½ feet tall and four feet in diameter. It is related to the calla-lily and jack-in-the-pulpit.

A long, thick, greenish-yellow column, called the spadix, stood erect above the stem. It protruded above the pale green ruffled and fluted spathe, which opened and spread to a diameter of about four feet. Its turned-back edges wore a lining of rich chocolate-brown.

Within this protecting spathe, massed in close rows around the columnar spadix, innumerable small flowers were borne, the males in one group and the females, like carmine-red cherries, in another group near the base. The spadix turned butter-yellow when the inflorescence was mature, and when the spathe began to open, a nauseous odor, worse than decaying fish, was emitted. On the tropical mountain slopes of Sumatra, where the plant is native, carrion flies which pollinate the flowers are attracted by the smell.

The New York Botanical Garden imported the tuber from which the flower has sprung, directly from Sumatra in 1932. It then weighed sixty pounds. Now it has increased to 100, but is expected to lose about ten pounds as a result of the energy used up in producing the inflorescence.

The flower lasted only a few hours after opening. While the specimen which flowered at Kew in 1926 was in good shape for two days after opening, the previous flower crumpled and toppled to the ground less than half a day after opening.

Plastic Lenses

MOLDING has been found to be a satisfactory method of making optical lenses from the very clear acryloid resins. By using molds of extreme precision and carrying out the molding operation with the greatest care, it has been possible to make satisfactory lenses for cameras, telescopes, and spectacles, as well as other optical instruments, which do not require the tedious grinding and polishing necessary with glass. Demonstrations of these lenses in England and Germany have shown the new technique to be satisfactory for most purposes. The extraordinary optical quality of the resins themselves and the great accuracy with which they can be molded are the basis for this new development. For spectacles, lack of brittleness is an important characteristic as it reduces the possibility of breakage of lenses.—*D. H. K.*

Air Conditioning in 1852

EXACTLY 85 years ago on May 15, Scientific American published an item which gave essentially the features of present-day air conditioning. It is most interesting to note that despite this comment, which is reprinted in full below, air conditioning as such is only about 25 years old. The item follows:

Cooling Air in Hot Climates

In the East Indies, and all tropical climates, Europeans suffer severely with the intense heat. To keep apartments bearable at all, fans are kept going continually, and wet mats are hung in the windows, from which the moisture evaporates and leaves the air somewhat cool. This plan, however, has been found very unhealthy, because rarefied air containing moisture has too little oxygen in it for the healthy action of the lungs. A Dr. Piazza Smith has recently published a pamphlet in England, upon a superior plan for supplying rooms in tropical countries with dry cold air, freed from moisture. His plan is to compress the air by mechanical means, then rob it, while so compressed, of its heat, and when cool, allow it to expand into the rooms, for which the apparatus is intended. If he can take air at 90° of temperature, compress it, and extract 30° of heat, he will have air at 60° to enter a room, which will thus be kept at a pleasant temperature. His cooler is to be formed of a pipe under water, and a pump is to force the air in at one end of it (the pipe) and out at the other, which is to have a weighted valve placed upon it. This plan appears to us simple and rational. If a copper pipe were laid in a stream of cool running water for some distance, and hot air forced through it into apartments, there can be no doubt but it (the air) would be rendered cool and healthy. A gentleman of wealth might employ such means to cool his house in a hot climate. A pipe, like the worm of a *still*, if placed in a deep well, would also answer the purpose of an air cooler, but in every case it would be well to have a valve on the exit end of the pipe. An iron pipe would answer as well as a copper one, only it is not such a good conductor of heat and cold as copper.

Wealth Thrown Back Into the Sea

POTENTIAL wealth valued at 96,379,460 dollars at current prices was contained in 158,735,000,000 pounds of ocean water pumped through the bromine plant of the Ethyl-Dow Chemical Company at Kure Beach, near Wilmington, North Carolina, during the past 12 months.

Of these riches from "nature's greatest storehouse of raw materials," only a small part was recovered in the form of several thousand tons of bromine to find its way into the gasoline tanks of millions of auto-

mobiles and tractors as an important component of Ethyl fluid. The remainder, including 42,000 dollars' worth of gold, 29,300 dollars' worth of silver, enough magnesium to build 100,000 modern airplanes, and a quantity of common salt sufficient to lay a paving 26 feet wide and a foot thick from New York to Washington, together with millions of dollars worth of mineral salts and other basic substances, flowed back into the sea via the Cape Fear River.

Two giant electric driven centrifugal pumps lifted a square mile of seawater 89 feet deep into the plant during the year. Possible by-products, which science has as yet made no serious attempt to extract economically from the ocean, occurred in the water as follows:

Sodium chloride, or common salt, 2,140,000 tons, worth 33,200,000 dollars at present market prices. Epsom salts, 542,500 tons, worth 18,050,000 dollars, enough to give every man, woman, and child in the United States nine pounds. Calcium chloride, 118,000 tons. Potassium chloride, 61,000 tons. Magnesium, 48,000 tons, worth 33,600,000 dollars, enough for 1,500,000,000 photographers' flash lights, 100,000 modern airplanes, or 250,000 stratosphere gondolas. Aluminum, 139 tons. Strontium carbonate, 160 tons. Iron, 145 tons. Copper, 9.2 tons. More than three tons of iodine. Enough gold to make a five inch cube valued at 42,000 dollars. Silver to make a ball twenty-five inches in diameter, worth 29,300 dollars.

In addition to the substances listed, practically every known material is dissolved to a greater or less degree in ocean water, according to Ethyl-Dow chemists. Besides providing an inexhaustible source of bromine, extraction of which constitutes science's first major step in recovering chemical wealth from the sea, the ocean forms the greatest storehouse of raw materials on the globe, it is said.

Tuberculosis Among College Men and Women

TUBERCULOSIS is more prevalent among college men than among college women. It occurs more frequently among college students in the east and far west than in the middle west.

Dr. Esmond R. Long and Florence D. Seibert of the Henry Phipps Institute, University of Pennsylvania, report the results of the tuberculin test on 18,744 college freshmen in 1935-36 in the *Journal of the American Medical Association.*

Accurately completed tuberculin tests were given to new entrants at 20 colleges. From 40 to 60 percent of students showed tuberculous infection in the eastern and far western colleges, and from 20 to 30 percent showed infection in the central states. Since the majority of students were residents of the general region of their college, Dr. Long and Miss Seibert believe they reflect the incidence of tuberculous infection in the population of these regions.

Denser populations in the east, imposing more frequent contact and in the long run more exposure, are thought to account for the high rate in the east. In rural Idaho almost no students react to tuberculin, while in the mining districts of southern Idaho there are many positive reactors.—*Science Service.*

University physicians have noted a much greater percentage of tuberculous students when they systematically tested them all, than are noted in places where the student is left to come in for examination only when he becomes aware of active symptoms. This, in fact, is the chief argument in favor of systematic hunts for incipient cases, both in colleges and high schools; for an individual may go far into serious involvement with tuberculosis without ever suspecting he has it. The test is very simple: a drop of tuberculin is injected, and if no reddened area develops around the spot, tuberculosis is not indicated.—*The Editor.*

ANTIMONY

SEVENTY percent of the world's antimony comes from China. Since January, 1937, the supply of that metal has been under Chinese Government control.

Relic-Grabbing Attacked by International Congress

AN international mass attack on relic-grabbing, endangering the world's buried history, is being pushed by archeologists.

The recent international congress of archeologists at Cairo, Egypt, strongly urged standardized laws throughout the world to curb "pot hunting," American delegate Dr. Frank H. H. Roberts, Jr., of the Smithsonian Institution, stated on his return from the congress.

Most European countries have severe laws against so-called pot hunters, who wreck archeological ruins and burials merely to gather curios. The United States has a particularly hard task to keep irresponsible diggers from despoiling Indian sites, Dr. Roberts pointed out, because each of the 48 states handles the problem in its own way. —*Science Service.*

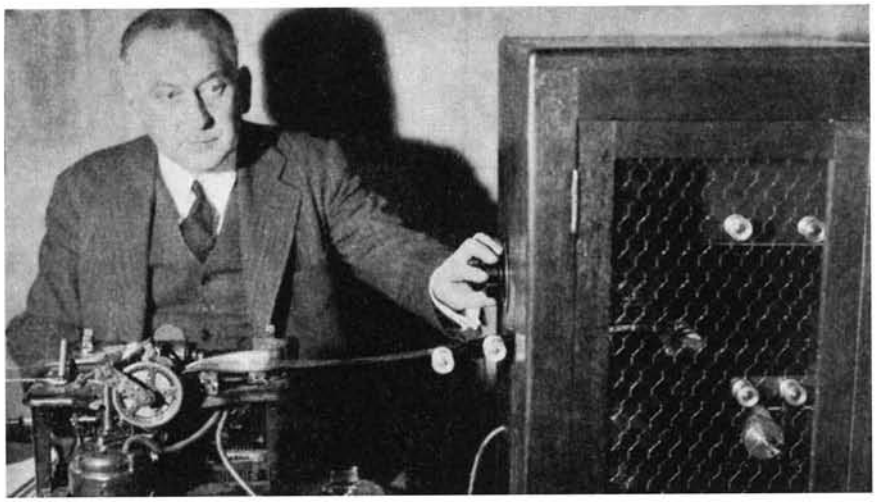
Nonflammable Transformer Oils

IMPROVED life and performance of liquid insulating materials in electrical equipment have been realized by the substitution of nonflammable synthetic materials for the mineral oils now generally used. One of the faults of petroleum oils as insulating materials in electrical equipment is their tendency to oxidize and form sludge in service. By using the more stable chlorinated derivatives of diphenyl, diphenyl oxide, diphenyl ketone, and diphenyl methane, not only are sludge formation and dielectric deterioration avoided, but fire and explosion hazards are eliminated. The dielectric characteristics of the new compounds are particularly favorable.—*D. H. K.*

No Secret to Pyramids

NO use trying to read mystic secrets from Egypt's pyramids by numerology or any other theories, because the pyramids have no secret, according to the emphatic view of a German Egyptologist, Dr. Georg Steindorff, professor emeritus of Egyptology, University of Leipzig.

Egypt's pyramids were simply royal tombs, and the evolution of the pyramid form from flat-topped tombs is well understood, Dr. Steindorff explained. Yet popular



Above: **Special cellophane tape being fed into the television news transmitter.**
Below: **The shadow-box of the receiver, showing how bulletins are reproduced**

notions persist that the pyramids had mathematical or astronomical significance. The most popular theory, the German Egyptologist said, assumes that the Egyptians knew the relation of the circumference of a circle to its diameter, that is, the value of π. However, they had no such knowledge in the pyramid era.—*Science Service.*

Electrical Behavior of Paints

PIGMENT particles in paint vehicles assume electrical characteristics which depend upon the nature of the vehicle. Recent studies of what happens when paints are placed in an electrostatic field are expected to lead to important improvements in methods of compounding ready mixed paints. It has been found, for example, that a zinc oxide pigment may be attracted to either of the two poles of an electric field or may be dispersed between them, depending upon the character of the oil in which it is ground. Aging also changes the electrostatic response of pigment particles.—*D. H. K.*

News by Television

NO super-power tubes, but an automobile headlight bulb and a whirling reflector-lens disk are the heart of a new television receiver, developed by William Hoyt Peck to show moving news bulletins on a 6 by 30 inch screen, large enough and bright enough to be readable at 150 feet or more.

The transmitter utilizes a specially constructed typewriter, which prints ⅜-inch characters on a strip of cellophane tape. It has an electric feed, making carriage return unnecessary, and holds about a half-mile of tape at one "loading."

The tape goes from the typewriter platen directly into a transmitter cabinet about the size of a four-drawer file. There it is scanned by a beam of light projected onto it from a reflecting-lens disk optically interposed between it and an automobile headlight bulb. The light then passes through the tape to strike a photo-electric cell connected to a local pre-amplifier. The signal thus produced is further amplified and transmitted.

At the receiver, the signal is amplified and fed into a Peck light-modulator tube, which modulates the beam from another headlight bulb as it passes through the tube to strike a receiver reflecting-lens disk, from which it is projected onto a two and one half foot screen at the end of a foot-deep shadow box about six feet from the floor.

Ice Cream Packed in Dry Ice—Wool Cleaning Process

BECAUSE Robert M. Greenleaf, Los Angeles mechanic, took his family on a picnic some five years ago, the wool industry now has a new method of cleaning wool—the "frosted" process of wool cleaning. Wool cleaned by this process is whiter, fluffier, and stronger, and dyes deeper and brighter than wool cleaned by the more expensive conventional soap, water, and picking processes. Already, reports *Science Service*, over a million pounds of wool have been cleaned by "frosting."

In this method, burs, thistles, and vegetable matter which become entangled in the wool as the sheep browses, are literally frozen out of the wool by passing it on conveyers through a large "ice box" in which the temperature is kept from 30 to 50 degrees, Fahrenheit, below zero. Grease also is removed.

The "ice box" is a room 40 feet long, 12 feet wide, and 12 feet high with walls, ceiling, and floor made of nine-inch thick cork.

The low temperature freezes solid the burs and grease on the wool. Strangely, in such frozen state, their hold on the wool is loosened so that when the "frosted" wool is beaten or shaken, the dirt and impurities readily drop away. The whole process takes but a few minutes. About 1500 pounds of wool can be cleaned in an hour. The cost

is less than four tenths of a cent per pound.

At the time Mr. Greenleaf went picnicking, he was trying to design a machine that would get the spiral burs, so common in California wool, out of the raw wool directly.

At the picnic, a woolen blanket was spread on the grass for a table cloth. There was ice cream for dessert, packed in dry ice. In unpacking the cream, Mr. Greenleaf threw the dry ice on the blanket. That was a lucky pitch, for later when picking up the blanket preparatory to returning home, he noticed that the vegetable matter on the ground was frozen to the blanket and when he shook it, the sticks and leaves dropped away like icicles. Instantly the idea of removing burs from wool by freezing entered his mind.

He dashed home to try it; packed dirty, raw wool in dry ice. It worked. Later a wool manufacturer became interested, as did certain engineers. A corner in an ice-making plant was rented to carry out large-scale research.

Samples of frosted wool were sent to eastern wool manufacturers. Soon the Lowell Textile Institute of Lowell, Massachusetts, set out to perfect the frosting process on a commercial scale. Today one of the largest worsted wool mills in that state is using the process.

Transfusions of Own Blood Aid Mothers

BLOOD sucked mechanically from the mother's body and injected back into her own veins has helped 38 women recover from child-bearing that was dangerously complicated by development of the baby outside of the womb, Dr. Arthur J. Wallingford of Albany reported to a recent meeting of the Medical Society of the State of New York.

Dr. Wallingford hit upon the idea of this auto-transfusion when he noticed, during the operation to save the patient's life, that large amounts of blood had escaped from the veins into the peritoneal cavity in these mothers, and that the women were in immediate need of more blood in their veins and arteries.

The advantages of the auto-transfusion, which is performed before the patient leaves the operating room, are that there is no need for another donor and that the blood is immediately available when it is urgently needed.

No untoward reactions have occurred with this procedure.—*Science Service.*

Light Without Heat

PRODUCTION of light without wasting energy as heat has long been a problem to which physics has devoted itself. Although the ideal is still impossible to attain for commercial purposes, there are many chemical reactions which release energy in the form of light instead of heat. It is possible with relatively little equipment to demonstrate this striking phenomenon. In a recent issue of the *Journal of Chemical Education*, Evans W. Cottman gives directions for doing this. His method depends on the oxidation of lophine in solution and his directions may be summarized as follows: crude lophine is prepared by shaking together 25 cc of benzaldehyde with 100 cc of strong ammonia water and allowing the mixture to stand for three days. A white cake of hydro-benzamide forms. This is broken up and washed with water, then with alcohol and heated gradually in an evaporating dish with constant stirring until it forms a dark brown liquid. When cool, this crude lophine forms a glassy solid. To produce chemi-luminescence four solutions are prepared:

A. Two grams of lophine are dissolved in 100 cc of alcohol (either ethyl or methyl alcohol may be used).

B. Hydrogen peroxide solution is made by mixing 10 cc of ordinary commercial 3 percent hydrogen peroxide with 90 cc of ethyl or methyl alcohol.

C. Alcoholic potash solution is made by dissolving 5 grams of caustic potash in 75 cc of water and adding 25 cc of ethyl alcohol.

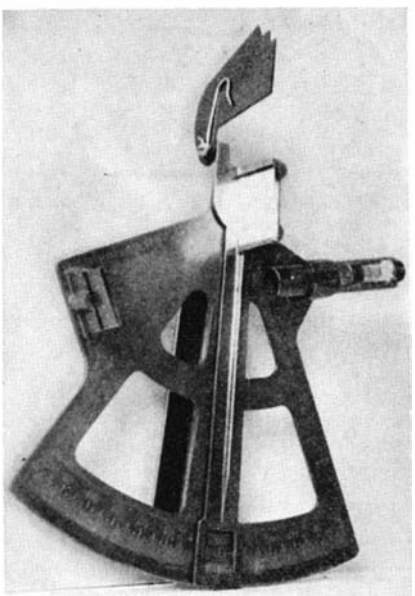
D. Sodium hypochlorite solution is made by mixing 10 cc of "chlorox" (commercial bleaching solution) with 90 cc of water.

For the demonstration a mixture is made of 10 cc of solution A with 25 cc of solution B and 20 cc of solution C. In the dark, this mixture is poured into 25 cc of solution D to produce a yellow luminescence. The light produced by this reaction in many ways resembles that of the familiar lightning bug.—*D. H. K.*

Simple Sextant for Amateurs

NEARLY everybody has seen pictures of sailors "shooting the sun" with a sextant. Few persons, however, have had the fun of using a sextant themselves and seeing just how it works. A simple, inexpensive sextant enables young boat-owners, aviation enthusiasts, steamship passengers, and others interested in navigation to expand their hobby to new horizons.

First invented about 1730 simultaneously by Thomas Godfrey of Philadelphia and Captain Hadley of the British navy, the sextant has always been a high-priced instrument, because of the difficulty in precise assembly of the parts. With the use of recently developed production methods, the mirror holders and other parts requiring precision in this low-priced instrument are cast to within .001 inch.



Close-up of the simple sextant

The simple sextant in use

An engraved scale is graduated to ½ degree and a vernier attached makes possible readings to 1/20th degree. Green celluloid sun-shades are used as a safeguard when shooting the sun. The sighting device has a simple form of artificial horizon consisting of a bubble level, so that persons indoors or inland may use the instrument for demonstration and instruction purposes.

The sighting tube does not have a telescope but is a modern adaptation of earlier sextants which had a flat perforated disc for a sight.

Anybody can readily measure angles in a horizontal or vertical plane by pointing toward one of two distant objects which can be seen through the clear glass opposite the sighting tube. By adjusting the movable arm, the image of the second object is reflected from the rotating mirror into the mirrored part of the fixed glass opposite the sighting tube. When the first object and the image of the second object are in line with each other, the reading is then taken on the graduated scale.

STEEL

A BILLION tons of steel in all forms was in use during the past year in this country. This total represents an average of 17,800 pounds in use for every man, woman, and child.

Hippocampus—Odd Fish

PERHAPS in no other animal have been packed so many anomalies as in the little hippocampus, popularly known as the seahorse, a systematic study of which has just been completed at the Smithsonian Institution by Mr. Isaac Ginsburg of the United States Bureau of Fisheries.

These fantastic animals are almost worldwide in their distribution through ocean waters where there are growths of sea vegetation. They have provided the models for some of the nightmare monsters of the human imagination. Actually they are small, feeble, almost defenseless creatures.

The head is unquestionably similar to that of a miniature horse in general outline. The neck, however, is not a neck at all. Fishes have no necks, and hippocampus is no exception. What looks like a neck is the front part of its abdomen, considerably contracted.

The body of the animal is covered with a jointed, chitinous shell, like that of many insects. This feature left early naturalists in doubt as to whether it actually was a fish or some sort of monstrous water bug. It is, of course, a true fish, with no insect affiliations.

This hard shell makes it a feeble, inefficient swimmer. It can bend its body only sideways. It is able to swim at all only because of a large air bladder so delicately adjusted to the specific gravity of the animal that if a gas bubble the size of a pinhead is let out by a puncture the seahorse sinks to the bottom. There it can only move clumsily until the wound is healed.

Since it is so poor a swimmer, the hippocampus must have other means of adjustment to its salt-water environment. This is afforded by a prehensive tail which it can wrap around the stems of water plants. This kind of tail is found among a few mammals, notably the smaller monkeys. So far as known, no other fish has anything of the sort. The animal is most frequently observed in a state of rest, its tail wrapped around a plant and its body standing nearly erect in the water.

Its food consists of tiny crustaceans and other sea organisms, usually minute. Because of its poor powers of locomotion, it must wait for those that come within reach of its jaws, which work with lightning-like speed, or for those which will accommodatingly wait for it to come and get them.

Hippocampus can move its eyes independently of each other, thus looking backward and forward at the same time.

Probably the greatest anomaly of the hippocampus family is its way of reproducing the species. The male actually gives birth to living young. The process, so far as is known, is unduplicated in nature. Unfertilized eggs are laid by the female. She places them, a few at a time, into a pouch-like organ on the under side of the male's body. In some manner still unknown to biologists they are fertilized in the transfer.

Within this pouch, the eggs are incubated and remain for some days after they are hatched. Then the living young, fully equipped to take care of themselves, are expelled into the water. So far as ever has been observed, there is no further parental interest in them. This male pouch might be considered as filling the double function of the womb of a placental mammal and the pouch of a marsupial like the kangaroo.

The seahorse also has the distinction of being one of the species of fish that "talk." It makes almost inaudible, snapping noises with its jaws which seem to serve as a means of communication.

Insecticide Improvement

LIMITATIONS on the use of insecticides containing arsenic and lead on edible farm products have encouraged and stimulated the search for materials for protecting crops against insects which will not leave toxic residues. More than one thousand compounds believed to be useful for this purpose have been carefully examined in the United States Department of Agricul-

ture, but only four of those offered show apparent value at present. In a research report by Lee A. Strong, Chief of the Bureau of Entomology and Plant Quarantine, the four now offering the best possibilities are noted as phenothiazone, nicotine in new forms, pyrethrum, and rotenone. In addition, certain compounds of sodium with aluminum and fluorine have shown promise of controlling the coddling moth in relatively dry areas, but, because of the toxic nature of fluorine compounds to man, this type of insecticide is looked upon with less favor.

Phenothiazone, a compound made from diphenylamine and sulfur, has been found very effective against insects but unfortunately it is highly irritating to the skin of a person applying it as ordinarily used. Efforts are being made to find improved methods of application which will avoid this difficulty.

Nicotine extracted from tobacco scrap can be made to adhere to foliage only with difficulty. Combinations of nicotine with bentonite, a colloidal clay, and with peat, as well as oil emulsions of nicotine sulfate, largely overcome this difficulty.

Improvements have been made in the extraction of rotenone from the plants in which it occurs and these are expected to increase the usefulness of this valuable material.

Efforts to synthesize the active principle of pyrethrum have so far been unsuccessful. Despite these advances, the search for the ideal insecticide continues and a vast amount of research is in progress both in government and other laboratories.—*D. H. K.*

Clarifying Grape Juice

ARGOLS, the crude cream of tartar which occurs in grape juice and which continues to deposit in the bottle, has been the cause of one of the serious troubles of manufacturers of grape juice and wine. At the New York State Agricultural Experiment Station tests have shown that grape juice can be clarified permanently by freezing. The procedure is to place the juice in a sharp-freezer at 0 degree, Fahrenheit, for a length of time depending upon the container. Glass carboys require four days and barrels seven in the sharp-freezer. For thawing, the containers are moved to a room at 45 degrees, Fahrenheit, equipped with ample air circulation and left until all ice has melted. By siphoning off the clear juice from the undisturbed containers it can be bottled and pasteurized without fear of clouding.—*D. H. K.*

Lake Mead Does Not Alter Weather

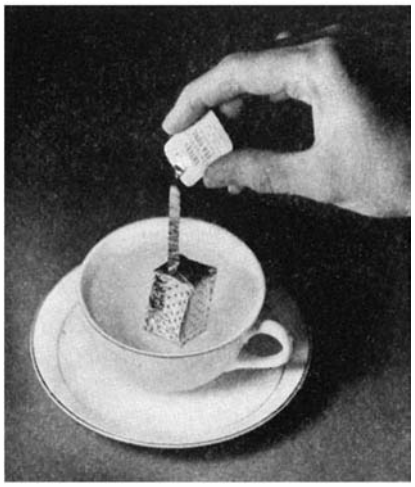
HAS Lake Mead, more than 100 miles long and the largest man-made body of water in the world, exerted any influence on the weather and climate of America's driest desert, in the heart of which it was created by construction of Boulder Dam in the Colorado River? This question, about which there has been much speculation, now can be answered: "Emphatically, no."

"Lake Mead was not expected to influence the weather of the Southwest," John C. Page, Acting Commissioner of the Bureau of Reclamation, said recently. "It has not done so and it will not."

An investigation was begun last summer when unauthoritative statements were circulated that perceptible changes in the climate and weather were resulting as Lake Mead grew behind Boulder Dam. The Bureau of Reclamation had calculated in advance the rate of evaporation from Lake Mead which could be expected. These calculations indicated that insufficient moisture would be lost to cause a noticeable alteration in weather conditions.

J. Cecil Alter, meteorologist for the Weather Bureau at Salt Lake City, summed up the evidence obtained with this observation:

"By comparison, the water in a pitcher on a speaker's stand is about as effective in air-conditioning an auditorium as Lake Mead is in modifying the climate."



Sanitary and easy to use are perforated aluminum tea "balls" that come packed ready for use and are discarded after the tea is made

Tree Growth is a Trick Question

WHERE and how does the growth of a tree occur? One of the trick questions of Professor Quizz is that if you drive a nail in a tree when the tree is five feet in height will the nail in the tree be any higher when the tree is 100 feet tall? After the first year's growth on a tree occurs, that portion of the tree never grows in length. The tips of the branches put on new shoots each season, and by the end of that year's growth that part of the tree is never extended in height. It does, however, grow larger around with the passing of the seasons.

The growth of a tree occurs almost entirely just beneath the bark. During the growing season a row of cells called the cambium layer multiplies and adds a thin layer to the outside of the wood of the trunk and a still thinner one to the inside of the bark. This new growth has been compared with a glove pulled on over the old growth.

So, a nail driven in a tree four feet above the ground will never be any farther above the ground or any closer to it as long as the tree stands, regardless of how tall the tree becomes or how large around it may grow. The nail may eventually disappear as new rings of wood grow over it but it will never change its distance from the ground. —New York State College of Forestry.

CURRENT BULLETIN BRIEFS

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

INVESTIGATION OF SUMMER COOLING IN THE WARM-AIR HEATING RESEARCH RESIDENCE, by Alonzo P. Kratz, Maurice K. Fahnestock, and Seichi Konzo, Bulletin No. 290, is a comprehensive report covering investigations of warm-air furnaces and furnace systems, and investigations of general problems in heating, ventilating, and air conditioning, undertaken in a residence type of building which may be considered as typical. Thoroughly illustrated. *Engineering Experiment Station, University of Illinois, Urbana, Illinois.—$1.00.*

BEER IN THE AMERICAN HOME, by Eloise Davison, is a 34-page brochure giving the facts on the brewing industry in general relation to the public welfare. Some of the typical divisions are: At Home With Beer, Beer—The Liquid Food, Beer's Care in the Home, Beer in the Menu. The last-mentioned chapter presents a series of suggested menus. *Write for Bulletin 837A, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

EVOLUTION is the name of a journal about evolution, written for the layman and contributed to by outstanding men of science. Address *Evolution, 77 Albemarle St., Hempstead, New York.—$2.00 per year.*

COOPERATIVE ENTERPRISE IN EUROPE is a large report on an inquiry made by a corps of government investigators who traveled in ten European countries studying cooperative enterprises. *Superintendent of Documents, Washington, D. C.—65 cents, cash.*

TRI SODIUM PHOSPHATE—A CLEANER describes this white crystalline chemical, almost instantly soluble in water, and its multitude of uses as a cleaning compound. These uses cover such a diversity of applications as cleaning dishes and bath room fixtures in the home, soda fountains, as a boiler compound, in laundries, and for removing oil and grease from metal parts in manufacturing plants. *Grasselli Chemicals Department, E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware.—Gratis.*

THE PHYSICAL STATE OF THE UPPER ATMOSPHERE, by B. Haurwitz, is a 96-page reprint of a series of articles from the *Journal of the Royal Astronomical Society of Canada*, on meteors, ionization, terrestrial magnetism, auroras, ozone, and so on. *Blue Hill Meteorological Observatory, Harvard University, Milton, Massachusetts.—50 cents.*

THE ITINERANT PHOTOGRAPHER, by George H. Chappell, is an authoritative guide on the subject by one who has tramped the roads for years and who now, out of his fund of intimate knowledge based on successful experience, "tells all." His contention is that in this field a man "can start on a shoe-string and work up to big money." In his fact-crammed book, said to be the only one on this subject, he lists the necessary equipment, tells how to take and sell various types of pictures and what prices to charge, and includes many other helpful bits of advice. *Schoenig & Company, Inc., 8 East 42nd Street, New York City.—50 cents.*

INVESTIGATION OF ORGANIC COMPOUNDS AS INSECTICIDES, Bulletin 206, by H. G. Guy, is a comprehensive report of a thorough-going study of both toxic and non-toxic chemical compounds for the control of insects. *Agricultural Experiment Station, University of Delaware, Newark, Delaware.—Gratis.*

PICTURES TELL THE ARMCO STORY was originally prepared to instruct representatives of an industrial organization in the proper method of taking photographs to illustrate phases of their work. The instructions given, however, are so clear and concise that they will be of value to any amateur photographer. *Write for Bulletin 837B, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

NATIONAL ARCHAEOLOGICAL NEWS is a new monthly journal for the amateur archeologist. Address *National Archaeological News, 1014 N. Christian St., Lancaster, Pennsylvania.—$2.00 per year.*

VIBRATION STUDY AND OTHER INDUSTRIAL APPLICATIONS OF THE NEO-BEAM OSCILLOSCOPE describes and illustrates a portable oscilloscope and accompanying accessories. It also gives general directions for making vibration measurements, and suggestions for uses of the oscilloscope in various industrial plants. *Write for Bulletin 837C, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

SOLUTION CONTROL FOR ELECTROPLATING is a brief review of the subject, discussing the present need for scientific analytical control. *Grasselli Chemicals Department, E. I. du Pont de Nemours & Company, Wilmington, Delaware.—Gratis.*

TRACTOR AND IMPLEMENT TIRE HANDBOOK includes 22 pages of data that will be of value to any user of automotive farm equipment. It deals specifically with the advantages of pneumatic tires for this type of work. *Write for Bulletin 837D, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

A TRIP THROUGH MELLON INSTITUTE is a comprehensive description of the new building that now houses the many activities of this co-operative institute. *Mellon Institute of Industrial Research, Pittsburgh, Pennsylvania.—Gratis.*

SHINGLED HOMES describes a method of treating wood shingles so that their beauty is preserved for many years. The treatment successfully eliminates the constant repairing of shingles which is necessary when untreated shingles are exposed to the elements. The treatment not only

renders the shingles water-proof but also makes them fire-proof. *Roof Coating Corporation, 392-394 South Orange Avenue, Newark, New Jersey.—Gratis.*

NEW HAM CATALOG was compiled exclusively for the radio amateur and short-wave broadcast fan. It lists complete lines of short-wave receiving and transmitting accessories as well as factory-built receivers and transmitters. Every nationally-known manufacturer is represented. *Write for Bulletin 837E, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

IF I ONLY HAD THAT BOOK is a comprehensive catalog of technical books of all American and British publishers. Thousands of books are listed and each is fully described in an attractive, spiral-wire bound catalog. Request Catalog #4. *Chemical Publishing Co. of N. Y., Inc., 148 Lafayette Street, New York City.—10 cents.*

HARVESTING AND MARKETING TIMBER is a bulletin of particular interest to the owner of timber land, in that it shows how he can make more money by selling the timber rather than by getting out rough forest products or manufacturing lumber for sale. Particular emphasis is placed on the difficult problems of marketing. *New York State College of Forestry, Syracuse, New York.—75 cents.*

A BALLOON, THE DEVIL AND A DROP, by G. D. Andrews, is a popular discussion of the technical problem of building insulation. It deals first with heating, air, and moisture, the three factors that are of particular interest to the home builder. It then shows how these three elements can be controlled to the best advantage to the home owner and his pocketbook. *The Celotex Corporation, Chicago, Illinois.—Gratis.*

RADIO EQUIPMENT PROTECTION describes a new type of combination switch and circuit breaker, available in ratings from 50 milliamperes to 35 amperes, for the protection of tubes, transformers, condensers, and other radio equipment. *Heinemann Electric Company, Trenton, New Jersey.—Gratis.*

RESERVE ILLUSTRATIONS is a collection of a large number of non-exclusive photographs, reproduced in small size, which are available for use by publishers and advertisers at a reasonable price. Anyone concerned with the production of articles or advertisements for publication will find in this spiral-bound book a convenient source of illustrative material. *Underwood and Underwood, 321 East 44th Street, New York City.—$1.75.*

GRASSELLI ARSENATE OF LEAD is a folded circular describing in detail the application of arsenate of lead as a spray for the protection of fruit trees. *Grasselli Chemicals Department, E. I. du Pont de Nemours & Company, Inc., Wilmington, Delaware.—Gratis.*

CARNEGIE INSTITUTION OF WASHINGTON, YEAR BOOK, 1936, is a large volume reporting on the many pieces of research done last year in archeology, biology, chemistry, genetics, meteorology, nutrition, paleontology and geology, physics, physiography, psychology, and seismology in the various nationwide laboratories of the vast Carnegie Institution. *Office of Publications, Carnegie Institution of Washington, Washington, D. C.—One Dollar.*

POISON IVY, Circular No. 154, is a four-page pamphlet telling how to recognize the poison ivy plant, how to treat cases of ivy poisoning, and how to eradicate the plants. *New York State Agricultural Experiment Station, Geneva, New York.—Single copies gratis. Two or more copies 3 cents each.*

SCIENCE AND SOCIETY, by David Sarnoff, is a reprint of an address given before the American Physical Society. It deals specifically with the developments in technology and the effects which they have had upon public welfare. It reaches its climax in a plea that freedom of both science and society must be safeguarded. Published in the June issue of the *Journal of Applied Physics, 175 Fifth Avenue, New York City. —70 cents per copy.*

ARMCO MULTI PLATE BRIDGES is the title of an attractive 16-page booklet, presenting a number of views of single, twin, and triple arch bridges, many of the illustrations being in full color. The text emphasizes the durability, strength, and ease of installation of these large corrugated structures. *Armco Culvert Manufacturers Association, Middletown, Ohio.—Gratis.*

SOLAR ENERGY AND ITS USE FOR HEATING WATER IN CALIFORNIA, by F. A. Brooks, is a detailed study of the construction and performance of solar water heaters as successfully employed in the more sunshiny states. *Secretary of Publications, University of California, Berkeley, California.—Gratis within the United States.*

DRIVER RATING MANUAL is a small pamphlet that outlines in detail a testing program for motor-car drivers, and indicates the principal factors which may cause or avoid accidents. The booklet will help anyone who is trying to do something about avoiding trouble and accidents on the highway. *American Automobile Association, Washington, D. C.—10 cents.*

AMERICAN SEAMLESS FLEXIBLE METAL TUBING, Bulletin SS-3, describes the method of fabricating this type of tubing and illustrates many of its forms and industrial applications. *American Metal Hose Branch, The American Brass Company, Waterbury, Connecticut.—Gratis.*

TIME RULES TRANSPORT is a specific discussion of speed and roadway safety, with particular attention to the so-called "streamlined" trains that are becoming increasingly popular throughout the country. *Bureau of Public Information, New York University, Washington Square, New York.—A limited number of copies are available for distribution gratis.*

ACCIDENTS—YOUR LEGAL RIGHTS AND HOW TO PROTECT THEM, by George Ward, is a manual for the victims of various types of accidents. It contains information, nowhere else available, by which you can determine what damages are legally due you and effectively direct the negotiations or law suit which will secure them. *The Research Press, Ocean Grove, New Jersey.—50 cents.*

LEGAL HIGH-LIGHTS

Patent, Trademark, 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

Too Warm

IN a recent suit for unfair competition the plaintiff, Burns Brothers, sought an injunction restraining the defendant from using the name Bruns Brothers. The Court found that the plaintiff was an established and well-known concern and that the defendant had only been organized within the past month for the purpose of engaging in the same business as the plaintiff. The Court then stated: "The defendant's name is obviously so similar to that of the plaintiff that it is calculated to deceive and mislead the public. The transposition of the two letters 'ur' is clearly a subterfuge."

Apparently in the course of the proceedings the Court had inquired as to how the defendant happened to select the name "Bruns Brothers" and in reply was advised that it was a "pure coincidence." In commenting on this reply the Court stated: "There is nothing coincidental about it and certainly the word 'pure' in connection with this transaction was entirely out of place."

Celestial and Terrestrial

YOU may not register the map of a country as a trade mark under the Federal Trade Mark Act of 1905, but, according to a recent decision of the Court of Customs and Patent Appeals, you may register the representation of the terrestrial globe. As pointed out on this page under the heading "Cartography" in the May, 1937, issue of Scientific American, the Trade Mark Act of 1905 bans the registration of a trade mark which is "merely a geographical name or term" and under this provision the Court of Customs and Patent Appeals sustained the Commissioner of Patents in his refusal to register the map of Canada as a trade mark for ginger ale.

In a more recent decision the Court had occasion to consider whether the word "globe" and the representation of a terrestrial globe are merely geographical within the meaning of the statute and therefore not the proper subject matter for trade-mark registration. The Court first concluded that the word "globe" is not merely a geographical name or term and pointed out that "a geographical name or term to our minds signifies a nation, state, country, city, municipality, river, lake, or the like." The Court also concluded that the representation of the terrestrial globe was not merely a geographical name or term and elaborated on its former reasoning as follows: "The same reasoning leads to the conclusion that a figure of the globe representing the earth is not in the sense of the statute a representation of merely a geographical name or term; it is of the terrestrial body. 'There are also celestial bodies and bodies terrestrial * * *'. The Congress in the Trade Mark Registration Act did not ban the celestial nor the terrestrial but stopped with geographical names and terms."

From the above opinion we suppose that the conclusion logically follows that a geographical name or term may not be registered as a trade mark but that a celestial or terrestrial name or term may be registered. We trust that none of our readers will have to consult a geographer to distinguish between "geographical" on one hand and "celestial" and "terrestrial" on the other.

Notice

WHY should the owner of a patent affix to the patented article which he manufactures and sells the patent notice required by law? Will he be benefited if he affixes the notice? Will he be penalized if he omits the notice?

The patent statute provides that "it shall be the duty of all patentees and their assigns * * * * to give sufficient notice to the public that the same is patented" either by affixing to the patented article the word "Patent" together with a patent number or by attaching to the article or the package in which it is contained a label bearing the same notice.

It is quite clear that it is the intention of the statute that all articles made and sold under a patent should bear the patent notice. Frequently, however, through choice or neglect a patentee omits the notice from the patented article. What is the effect of this omission? The statute provides that where the patentee fails to affix a notice to articles manufactured or sold by him or with his consent, in a suit for patent infringement he shall not recover damages unless he proves that he actually notified the infringer of his infringement and that the infringer continued the infringing acts after he was notified. Under this provision damages have frequently been denied to a patentee because of his failure to affix the proper patent notice to a patented article.

In a recent case in the Federal District Court for the Eastern District of Pennsylvania the owner of a patent for a loose-leaf book was denied damages in a suit for infringement of the patent because his licensee had failed to affix the statutory patent notice to books made under the license. Accordingly, it will be seen that affixing the statutory patent notice to a patented article lays the groundwork for collecting damages in a suit for patent infringement. The penalty for omission of the notice is that the patentee is deprived of the right of collecting damages in a suit for patent infringement unless he proves that he gave actual notice of infringement to the infringer and that the infringing acts were continued subsequent to such notice. In the latter case the courts have held that the patentee's damages are limited to the infringing acts occurring after the notice.

In seeking to obtain the advantages of the statute providing for patent notice a patentee should be careful not to become over-enthusiastic and falsely mark unpatented articles with a patent number. Another section of the patent statute provides for a penalty of 100 dollars where an unpatented article has a patent notice affixed thereto for the purpose of deceiving the public. The penalty for applying a false patent notice to an unpatented article is penal in nature. In those cases where a person flagrantly falsely marks an article with a patent notice for the purpose of deceiving the public, the penalty will be applied.

Insubordinate?

IT is frequently assumed that a decision of the United States Supreme Court sustaining a patent is binding upon all inferior courts of the United States and that no inferior court can thereafter declare the patent to be invalid. As a general rule, the validity of a patent is not seriously questioned after it has been sustained by the Supreme Court. However, there are cases where a federal district court or circuit court of appeals can declare a patent invalid after it has been sustained by the Supreme Court.

A recent example of such a case is to be found in the proceedings involving the infringement of patent No. 1,262,860 for a Method and Apparatus for the Incubation of Eggs. This patent had been extensively litigated and in 1935 the United States Supreme Court held that claims for the method of incubating eggs were valid. Thereafter in another suit on the same patent the United States Circuit Court of Appeals for the Second Circuit held that the same claims were invalid. The decision of the Circuit Court of Appeals holding the claims invalid was recently reviewed by the United States Supreme Court and was sustained. In reaching this decision the Supreme Court pointed out that new evidence relating to a prior use of the invention was introduced in the second proceeding and that the new evidence clearly showed that the invention had been used prior to the date of invention by the patentee.

The prior use of the invention was by a man named Hastings and the court pointed out with regard to the first case: "But in that case the Hastings prior use was not presented or considered." It then stated: "In view of the definition given to the patent by our decision, the Hastings defense assumed an importance in these suits apparently not attributed to it in earlier litigation, and it has been developed in the records now before us more fully than in any earlier case."

Thus while a decision of the Supreme Court sustaining a patent is normally binding upon all district and circuit courts of appeals, in a suit against a different infringer in which new evidence has been introduced clearly showing the patent to be invalid, the inferior court may on the basis of the new evidence declare the patent to be invalid.

Books SELECTED BY THE EDITORS

GENERAL PHILIP KEARNY

By Thomas Kearny

"A DASHING dragoon, the Murat of the American Army" is the title given Kearny in a classic tale of his exploits by the well-known author Captain Mayne Reid. He was this and more. Having been sent to Europe for advanced cavalry study, he took part in the Algerian campaign with the French and was with the French and Italians at Solferino. It is granted that had he been allowed to complete his famous cavalry charge at Mexico City during our Mexican War the American Army would have entered that city almost a month earlier than it actually did. During the Civil War he served brilliantly and was on the point of taking over command of the Army of the Potomac when he was killed by Confederates in a reconnoitering expedition. This long biography of General Philip Kearny therefore covers considerable history of the United States with references to military campaigns and political maneuvers which led up to and continued during the Civil War. Many reports and letters throwing light on various incidents, and military operations are necessarily included. Kearny shines through many of these as the saver of battles for the North and he was brusquely outspoken in his criticism of McClellan on several occasions when General McClellan ordered retreats when victory was in sight. This book is vital and interesting but its style is so explosive and exclamatory as to be very difficult to follow in places.—$4.20 postpaid.—*F. D. M.*

MEN OF MATHEMATICS

By Eric T. Bell, Prof. Mathematics, California Institute of Technology

A LIVELY, most readable account of the lives, some of them eccentric, of the great modern mathematicians of the world, with accounts of the more outstanding and intrinsically interesting parts of their mathematical discoveries. Descartes, Fermat, Pascal, Newton, Leibnitz, Euler, Lagrange, Gauss, Riemann, Poincaré, and 17 others are dealt with. The mathematics included is of high-school grade, but may be skipped without loss of continuity if the reader wishes merely to enjoy the biographical accounts. Bell's style of writing is notable: he has a flair for speaking out of turn, and making no discreet omissions, which doubles the fun of reading his works. If there is a sore, touchy spot, that is where he puts a finger. He is also slyly humorous. Fine reading.—$5.25 postpaid.—*A. G. I.*

THERMODYNAMICS

By Professor Stanton E. Winston

A PRACTICAL text covering the fundamentals of thermodynamics that are basic to the engineering field, this is in reality an advanced textbook of 178 pages, illustrated.—$1.65 postpaid.—*F. D. M.*

MARINE GAME FISHES

By Lionel A. Walford

COVERING the western coast of the Western Hemisphere from Alaska to the Equator, the author has gathered scientific and popular information on all of the game fishes that inhabit these waters. In an excellent arrangement that makes for easy reference, he has presented this data for the student or the sportsman who wants to know all that is available about these fishes. A comprehensive text, illustrated with small drawings, is supplemented by 69 plates, many of them in colors, showing not only the fish themselves but giving additional data about them and illustrating some of the equipment with which they are taken by angling. It is a beautiful book in every respect—typography, paper, printing, and illustrations. 8¼ x 11¼.—$5.20 postpaid.—*A. P. P.*

PRESS AGENTRY

By Charles Washburn

A BROADWAY press agent tells how it is done, from first primer to stunts and ballyhooing. His book is breezy, chatty, and practical. Read it to learn how to do likewise, or else to acquire wisdom concerning the methods by which press agents work on you and the world and his wife when you are off guard. Good reading.—$2.15 postpaid. —*A. G. I.*

JANE'S FIGHTING SHIPS 1936

Edited by Francis E. McMurtrie

ABANDONMENT of the principle of quantitative limitation of the world's navies by treaty makes this newest edition of a famous old authority decidedly more interesting than others in recent years. The volume as usual contains data concerning the naval vessels of all naval powers of the world, large and small; includes photographs of most of the important ships—profiles and plans of others. Included also are data concerning the dimensions, displacement, armor, and armament. Some data are given on new construction, and the editor discusses in a foreword certain specific details regarding building programs, treaties, and so on. This edition is exceptionally well done.—$22.50 postpaid.—*F. D. M.*

INTRODUCTION TO THEORETICAL CHEMISTRY

By Meldrum & Gucker

IN modern science, theory supplies the framework which relates vast numbers of facts into a unified whole. This book, intended primarily as a text book for those already familiar with the elements of chemistry, presents the important theories of chemistry. It is in no sense an experimental work, but does provide illustrative problems to bring out the applications of each theory as discussed. It is of special value to those who find themselves confused by multitudes of facts.—$3.70 postpaid.—*D. H. K.*

THE SPECTACLE OF A MAN

By John Coignard

THE man who is here called Arnold Harvesting was driven to seek help of a psychoanalyst for the extreme shyness and torturing jealousy which were dominating his life. This is the story, told in novel form by his doctor—and at the patient's own suggestion—of what took place inside the doctor's office and in the world without, during the dramatic days which witnessed the unraveling of his problems.—$2.65 postpaid.—*A. G. I.*

PERFECT PRINT CONTROL

By Laurence Dutton

THERE is more to turning out a perfect photographic positive than just making a good negative and printing a picture. Whether you are working with contact prints or project enlargements, there are many variables that can have a definite effect on the finished product. How to achieve a certain desired tonal quality is the one main lesson that this book endeavors to teach. The author presents a printing and enlarging technique

which, if carefully followed, reduces the variables to a minimum and enables the amateur to turn out photographic prints of which he can be proud. The book is written in non-technical language and includes a vast amount of tabular and factual information on negative densities, paper emulsion speeds, and illumination control. The text may be considered as a very satisfactory approach to the problem of printing technique.—$2.65 postpaid.—*A. P. P.*

MACHINE SHOP OPERATIONS

By J. W. Barritt

EVERY operation of the machine shop from the care and use of tools to precision grinding and drilling. Composed of 13 sections averaging 30 to 50 pages each, this volume is of loose-leaf type in leatherette covers. It is essentially a student's volume, but would be an invaluable aid to the machinist, the foreman of a machine shop, or the owner of the business.—$5.20 postpaid.—*F. D. M.*

THE WORLD OF ATOMS

By Arthur Haas, Ph.D., Professor of Physics, University of Vienna

A COMPACT, succinct statement of the general content of modern atomic physics, for the reader who prefers to study rather than merely read, and who already has a fair background in physics. This is the second and revised edition of an earlier work. The author is at present professor of physics at Notre Dame.—$3.15 postpaid.—*A. G. I.*

GIRL AROUND THE WORLD

By Dorothy Kilgallen

NEWSPAPER readers undoubtedly remember the "'round the world race by air" in which three newspaper correspondents took part during October 1936. One of the correspondents was a young lady, author of the present book, and here she gives the complete story of the mad, pell-mell dash. She did not win, but she apparently had a lot of fun. This fun, with some of the breathless, rushing spirit of the race, is ably transferred to the pages of this book. With a series of photographs and a few drawings, it makes excellent and entertaining reading.—$2.15 postpaid.—*A. P. P.*

WHO'S WHO AT THE ZOO

Edited by Ralph De Sola

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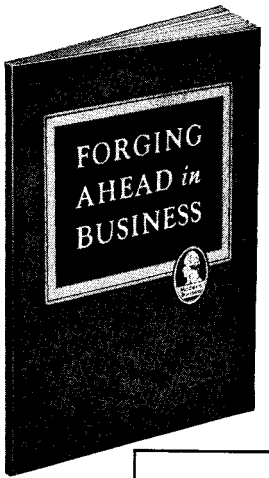

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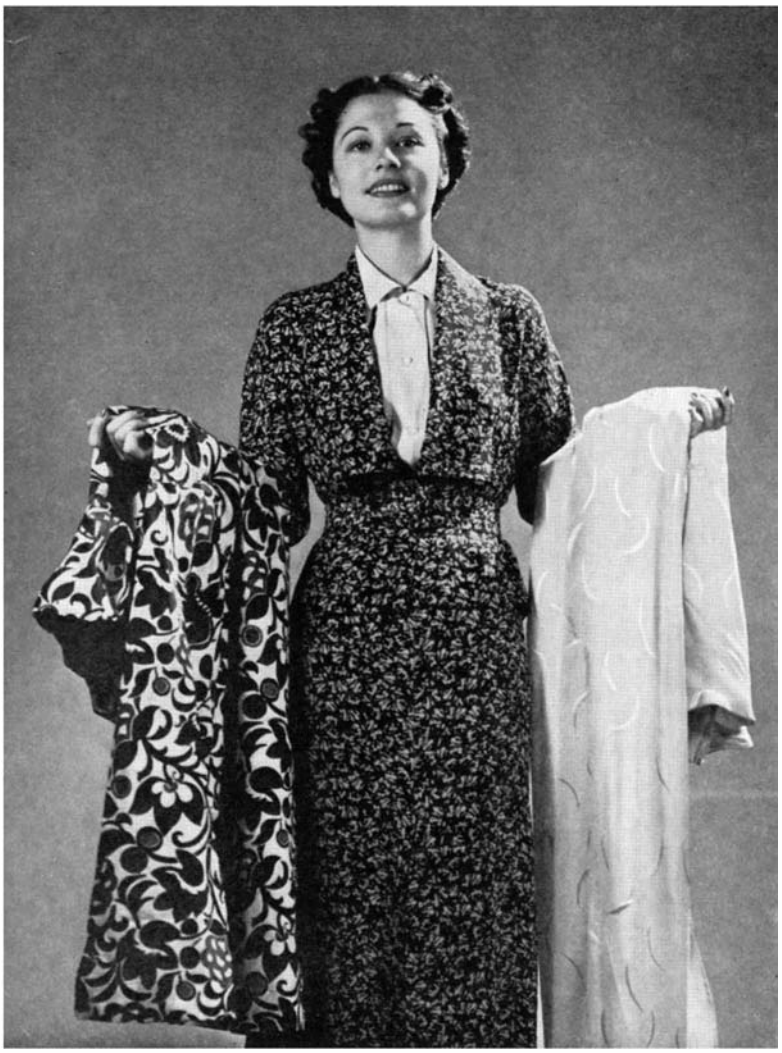

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