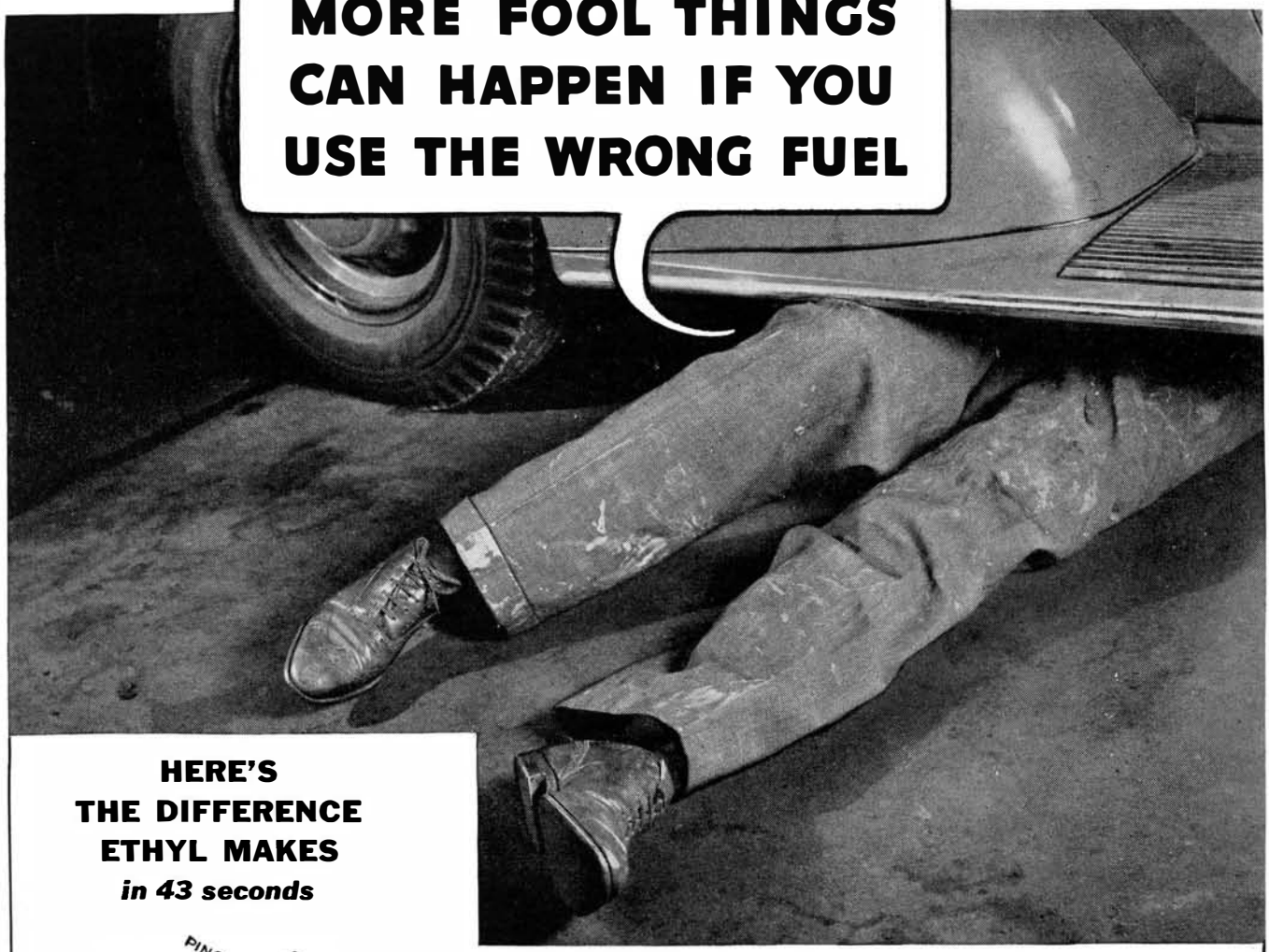
ARE MODERN CARS SAFE? Prof. Klemin Says "Yes!"

SCIENTIFIC AMERICAN

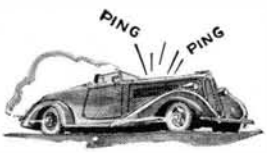
August · 1936

35c a Copy

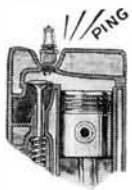
MORE FOOL THINGS CAN HAPPEN IF YOU USE THE WRONG FUEL



HERE'S THE DIFFERENCE ETHYL MAKES *in 43 seconds*



BEWARE a "pinging" sound this summer when you "step on the gas" for pick-up, or hills. It is your engine's way of saying: "I feel hot weather, too. I'm *losing* power, *wasting* gas and *overheating*. Give me better gasoline."



KNOCK is the name of that warning "ping." It occurs when a gasoline breaks down (burns too quickly) under the heat of a modern high compression engine.

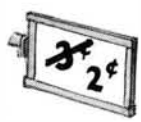
Cars built in recent years have high compression engines. And in summer the knocking evil is at its worst because hot weather increases engine heat.

THE CURE—and preventive—of knock is better gasoline. That is why most oil companies now improve gasoline by adding anti-knock fluids (containing tetraethyl lead) made by the Ethyl Gasoline Corporation.

They recommend, as their *best* fuel for summer driving, special gasoline sold at pumps marked "Ethyl" on the base or on the globe.

YOU GET at the "Ethyl" pump:

- *Enough anti-knock fluid to stand up under the highest engine compression on the hottest day.*
- *All-round quality that is* double-checked — *by the oil companies and the Ethyl Gasoline Corporation — at the refinery and at the pump.*



DOWN TO 2¢ a gallon over regular gasoline—and high above it in anti-knock (high compression) value.

Give your car the *coolest* fuel this summer. Avoid the evil of knock, with its power loss, gasoline waste and overheating. Get more power from each gallon of gasoline you buy! . . .

NEXT TIME GET ETHYL

The SCIENTIFIC AMERICAN DIGEST

SCIENTIFIC AMERICAN

Owned and published by Munn & Company, Inc.; Orson D. Munn, President; John P. Davis, Treasurer; I. Sheldon Tilney, Secretary; all at 24 West 40th Street, New York, N. Y.

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

CONTENTS · AUGUST · 1936

COVER

MODERN industrial plants furnish a rich source of dramatic material to the photographic illustrator. An outstanding example of this work, by Robert Dudley Smith, is reproduced on this month's cover. The scene is in the plant of the Alan Wood Iron and Steel Company. In the foreground is a ladle train which carries molten metal from the furnace to the molding machine from which the pigs are dropped directly into railroad cars for shipment. These "runs" of iron are made about every four hours in this plant.

SCIENTIFIC AMERICAN, August, 1936. Vol. No. 155, No. 2, entered at the New York, N. Y. Post Office as second class matter June 28, 1879, under the act of March 3rd, 1879; additional entry at Greenwich, Conn. Published monthly by Munn & Company, Inc., 24 West 40th Street, New York City.

Subscription price $4.00 per year. Canada $4.50. Foreign $5.00. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage.

50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of August, 1886)

PHOTO-ENGRAVING—What was apparently the first half-tone photo-engraving to appear in Scientific American depicted, on page 101, August 14, 1886, a log jam on the St. Croix River. The illustration (it cannot be reproduced here) forms a striking contrast to the wood engravings ordinarily used at that time. Thus was marked a significant transition period in the publishing world.—*The Editor.*

SUBMARINE—"For some time past Lieutenant Zalinski has been experimenting with a novel submarine torpedo boat, the invention of Mr. John P. Holland. The boat can be sunk to any desired depth below the surface of the water, propelled in any direction, and brought to the surface at any time. The boat has a wooden hull, is cigar shaped, and measures 50 feet in length by 8 feet in diameter at the largest part. The floating surface, under ordinary conditions, is 30 feet long. . . . The propeller is driven by a petroleum engine. . . . When fitted for actual service, the bow of the vessel will be provided with one of Lieut. Zalinski's compressed air guns for throwing cartridges charged with nitro-glycerine."

Fig. 2.—TORPEDO BOAT IN POSITION FOR FIRING.

CRUISERS—"It could scarcely have been expected that the [Naval] Board would originate a new system of marine architecture or otherwise revolutionize naval warfare. The most that could reasonably be hoped for was that it would intelligently examine the best models of the Old World naval constructors, who have had large and varied experience of recent years, while we have been standing still, and discover which were best suited to the purpose Congress had in view."

FIRE FIGHTING—"A novel system of fire extinguishing, just introduced in London, consists of a tricycle with which are embodied the following: 1. A hose reel carrying a large quantity of specially constructed hose for winding in a small compass. 2. A light double-pump fire engine, capable of throwing 25 gallons per minute, to be worked by two pumpers. 3. A simple fire escape, with descending ropes and bag. The machine is run at full bicycle speed by two men."

MILK—"Alarming results may be produced in both children and adults by the use of milk taken from improperly fed cattle. There have recently been a number of mysterious poisoning cases that after a great deal of random speculation have finally been traced to diseased milk. In spite, however, of these warnings, the subject has not yet received the sanitary attention to which it is entitled."

HOT WATER—"A remarkable example of the increase of temperature in the earth toward the center has been presented at Pesth, where the deepest artesian well in the world is that now being bored for the purpose of supplying the public baths and other establishments with hot water. A depth of 951 meters—3,120 feet—has already been reached, and it furnishes 800 cubic meters—176,000 gallons—daily, at a temperature of 70 degrees C.—158 degrees Fah."

LUMINOUS STONE—"Messrs. W. C. Horne and E. Ormerod, of London, England, have recently invented a method of utilizing the luminous powder prepared mainly as a sulphide of calcium, for admixture with cements, plaster of Paris, and concrete, the object being to prepare the articles with a self-contained phosphorescent property instead of coating them with luminous paint."

BALLOON VOYAGE—"M. M. L'Hoste and Joseph Mangot have lately made a balloon voyage from Cherbourg, in France, to Tottenham, a suburb of northern London, near Alexandra Palace. The main object was not so much an experiment, to prove the power and accuracy of steering, as to ascertain the possibility of maintaining an equable altitude above the waves in crossing the water. This was done by means of a pipe extending into the waves, and by means of which water could be drawn up to be used as ballast in counteracting the condensation by rarefaction of the gas which causes balloons to shoot upward."

EMERY—"The particles of material removed from solid bodies by the abrasive action of dry emery wheels are always more or less heated. Dust from metals is often fused, and sometimes dissipated altogether. Fused globules of metal are frequently found in emery wheel dust, but the stalagmitic formation consisting of particles welded together, as shown in our engraving, is not common."

PLANER—"When finished, a new [planing] machine will weigh 35 tons, and it is to be capable of planing the edge of a plate of 38 ft. in length by 5 ft. wide. It is specially intended to be employed in connection with the preparation of steel plates for the girders of a railway bridge which is about to be erected across a river in New South Wales."

OIL ON WATER—"Another instance of the marked benefits resulting from the use of oil on troubled seas was afforded by the recent experience of the steamship *Werra*, of the North German Lloyd's Line, which was disabled in mid-ocean during her last transatlantic voyage. The steamer had been taken in tow by the *Venetian* when a strong gale prevailed and heavy seas were constantly breaking over the bow of the *Werra*, endangering the tow lines, and threatening the loss of the tow. The captain of the *Venetian* caused an oil bag to be hung from each side of his vessel and dragged some distance astern. The result was almost immediate, and the sea became comparatively smooth around the disabled ship."

CREMATION—"Next month the Parisians will be able to burn their dead in four crematory furnaces, which have just been finished at Pere la Chaise."

AND NOW FOR THE FUTURE

¶How Modern Aerial Photography Aids the Archeologist

¶Frog Farming—Its Present and Future Possibilities

¶Science and Paper, by Philip H. Smith

¶The Black Widow Spider—Still Increasing

¶Bridges as a Menace to Highway Safety

¶Up To Date on Cosmic Rays—More New Knowledge

GRIFFITH OBSERVATORY AND PLANETARIUM, AT LOS ANGELES, CALIFORNIA

ON the south slope of Mount Hollywood, overlooking a panorama of the Los Angeles coastal plain, is the Griffith Observatory and Planetarium. The large south dome houses the planetarium, where the famous Zeiss instrument is daily put through its paces. The smaller domes contain respectively a 12-inch refracting telescope and a solar observatory. The entire institution is devoted to the ends of public education.

	NUMBER OF ACCIDENTS	PER CENT	PERSONS KILLED	PER CENT	PERSONS INJURED	PER CENT
Exceeding speed limit	121,460	22.8	7,240	30.7	161,550	22.9
On wrong side of road	85,770	16.1	3,940	16.7	111,400	15.8
Did not have right-of-way	135,840	25.5	3,580	15.2	191,880	27.2
Cutting in	17,580	3.3	420	1.8	23,980	3.4
Passing standing street car	2,130	.4	70	.3	2,820	.4
Passing on curve or hill	8,520	1.6	400	1.7	11,290	1.6
Passing on wrong side	2,130	.4	50	.2	2,820	.4
Failed to signal and improper signaling	27,700	5.2	260	1.1	35,980	5.1
Car ran away—no driver	3,200	.6	280	1.2	4,230	.6
Drove off roadway	55,940	10.5	3,390	14.4	64,190	9.1
Reckless driving	51,670	9.7	3,020	12.8	67,020	9.5
Miscellaneous	20,780	3.9	920	3.9	28,220	4.0
TOTAL	532,720	100.0	23,570	100.0	705,440	100.0

Table and illustrations courtesy Travelers Insurance Company

How hasty, needless, and careless actions of drivers piled up the accident record in 1935

ARE MODERN CARS SAFE?

The Driver is Usually to Blame . . . Engineering Developments Promote Safety and Comfort . . . How Streamlining Fits Into the Scheme of Things

By PROF. ALEXANDER KLEMIN
New York University

IT is fashionable in certain quarters to attack the modern streamlined car as unsafe. The most common criticism is that these efficient cars are too highly powered, and therefore tempt drivers to excessive speeds and to "squeezing" through traffic. Another criticism is that streamlining and lower passenger seating decreases visibility. It is also claimed that modern cars have poor roadability and that light coupés and runabouts attain speeds at which they "wander" on the road. High steering ratios are said to produce sluggish control. Low ground clearances are held to be a source of danger to the transmission and exhaust systems. Poor ventilation and exhaust gas fumes are stated to be the direct cause of frequent accidents. These are serious indictments and deserve calm, impartial consideration.

A careful statistical study made by the Travelers Insurance Company seems to refute these views, and to place greater blame on the driving public than on the design or condition of automobiles in service.

For the year 1935, there were 826,690 recorded automobile accidents in the United States. Only 5.7 percent of the fatal accidents were due to non-collision. The remaining 94.3 percent were divided among the following types of collisions: with pedestrians, 36 percent; automobiles, 45.3 percent; horse-drawn vehicles, 0.6 percent; trains, street cars, and other vehicles, 3.2 percent; bicycles, 2.4 percent; fixed objects, 6.5 percent; and miscellaneous, 0.3 percent.

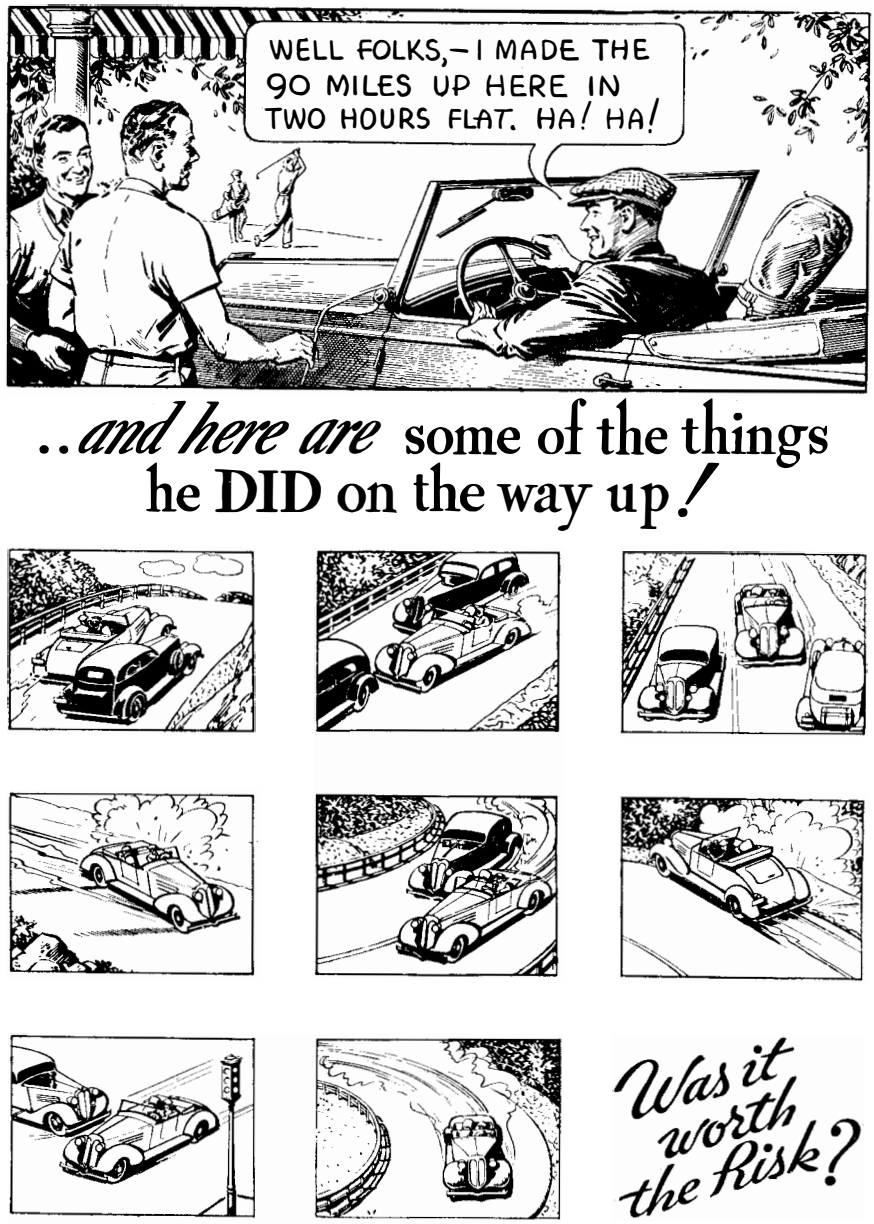
These figures are quoted because of their general interest; it is more significant that 532,720 accidents—approximately two out of every three—last year involved mistakes by drivers! Exceeding speed limit accounted for 22.8 percent of accidents due to driving errors; did not have right-of-way stood for 25.5 percent. Other errors—on wrong side of road, cutting in, passing on wrong side of road, reckless driving, and so on—made up the remainder (see the table above). And, while total deaths last year exceeded fatalities of the year before by about 300, mistakes of drivers figured in nearly 1500 more deaths than in 1934. Drivers seemed in particular not to consider the possibility of children suddenly appearing on the roadways.

IN 95 percent of all accidents causing injury or death, cars were apparently in good condition.

If these statistics, compiled by so reliable an agency, are given credence, then the human rather than mechanical elements appear more to blame.

There is a curious, and perhaps unfortunate, pyschology which causes a driver to delight in the high speed, power, smoothness, and comfort of modern cars. The same man on foot will make little or no allowance for the high speed of an approaching car and will fail to observe elementary precautions. When pedestrians in cities cross against signals and in the middle of the block, they indulge in practices that are extraordinarily dangerous. As an example: the rate of death last year per pedestrian accident involving crossing against signals was 55 percent higher than when crossing with signals. Jay-walking is even worse. Last year's record also shows that the death rate where pedestrians crossed in the middle of the block was 200 percent higher than when crossing at intersections with the "Go" signal. Pedestrians who have to use the traveled portions of highways should also protect themselves as far as possible by walking against traffic rather than with traffic. The rate of death per pedestrian accident under such circumstances was 278 percent worse last year than the average of all pedestrian accidents.

It is on the score of high power and speed that critics of the modern car are most vehement. They have this fact to support their contentions: 30 percent of all fatal accidents in 1935 occurred when cars were driven too fast; the rate of death per accident which in-



volved exceeding the speed limit was, for 1935, 35 percent greater than the average death rate for all accidents due to improper driving practices.

It is a matter of simple mechanics that the energy of impact, the distance required for stopping, and the centrifugal force on a turn are all multiplied four times when the speed is doubled. It is also perfectly true that drivers do not often use the maximum power and maximum speed that are made available to them.

Then why install high-powered engines in light cars? The answer is in three parts: (1) everyone likes to get going just as quickly as possible; (2) if the bare minimum of power just sufficient for good speed on a level road were provided, hills would become an intolerable nuisance; (3) engines or other machinery operating at the highest pressure will never work with the same perfection and reliability as when working well within maximum capacity. By building into the car the ability to operate at high speeds, engineers make it safer and more practical to run at reasonable speeds. Also, anyone who has driven a car for any length of time can recall emergencies successfully met by virtue of reserve power.

Another important fact to emphasize is that 77.2 percent of all accidents occur at low or moderate speeds. Governors to limit automobile speeds have frequently been suggested. The idea appears to be almost ridiculous. Will all cars in a given state or in all states have governors set at a given limit when some cars are perfectly safe at 80 miles an hour and other old-time designs are positively dangerous at 50? Will the same governor which provides reasonable limits for congested roads near a great city, such as New York or Chicago, be used on the long, clear, level roads of the West? Will anything please a mechanically minded public as much as a little tampering with the spring control of a governor? Will not the governor, by robbing the autoist of reserve power when this is vitally needed, actually reduce the safety on occasion?

A much more reasonable suggestion is to introduce a warning signal—a buzzer or a red light—to be actuated by the speedometer at a predetermined speed. This would have the advantage of warning a driver preoccupied by watching traffic or other tasks. A precedent exists for this less brutal precautionary measure in the red light which warns the airplane pilot that the landing wheels are not fully set down prior to a landing.

But, whether some such warning device is adopted or not, we believe that high speeds have come to stay, that to limit or reduce the speed of which a car is capable is a retrogression, and that education of the driver, stringent regulations, and penalties against dangerous speeds constitute the better approach to this problem.

THE critics seem to think that in the new modern streamlined cars, low seating, sloping windshields, and small windows have impaired the vision. To a certain extent this is true, and there is undoubtedly room for improvement. Automobile engineers might well follow airplane practice in this regard. In the design of the airplane adequate vision is secured no matter what structural difficulties or additional expenditures are involved; the windshield is made wide, high, and clear, with no corner posts to interfere with vision; the engine is brought down as low as possible in relation to the pilot; and windows are placed in the roof and in side doors.

In some respects, however, the streamlined car—the Airflow for example—embodies improvements in vision which were not available in its predecessors. The long, high engine hood has disappeared and in its place we find a smaller, lower and more rounded nose. The driver's seat has been moved closer to the windshield. Both changes have improved vision. Highly polished surfaces which reflect light used to bother the driver by their glare; in the new cars many such light reflecting surfaces have disappeared, others have been dulled.

Another phase of the recent attacks is related to sluggish steering. Power in steering has been sacrificed to extreme ease of operation, and with the present steering ratios, it is impossible, so the critics say, to correct a quick side slip, or to "feel" the vehicle, or to control properly in deep sand, snow, or mud. Now this question of steering ratios is thoroughly understood by engineers, and they could just as readily build in a more powerful but more fatiguing system. Ease of steering is in itself a measure of safety, since it les-

sens fatigue on long journeys and thus permits the driver to act more quickly in emergencies. We are convinced that automobile engineers have reached just the right compromise between power of operation and ease of operation.

Perhaps it will not be out of place to emphasize here some of the other excellencies of the modern steering gear. In many of the designs, for example, the gear is in front of the axle, and axle movement does not in any way affect the "geometry" of the steering mechanism. Thereby it is possible to give the wheel the comfortable rakish angle which drivers appreciate so much. The steering wheel then falls into a position which allows a perfectly normal grasp, and permits it to be turned with a simple fore-arm movement instead of the shoulder action which was formerly unavoidable. Modern design has also eliminated the transmission of road shocks to the steering wheel; the driver no longer has to brace himself against tearing of the wheel from his grasp. If the steering mechanism is dispassionately considered as a whole, it will be adjudged one of the finest achievements of the engineer.

IN a recent engineering paper we read the extraordinary statement that, with the vehicle weight forward as in modern cars, high-speed braking is only 60 percent as effective as on cars having the power plants placed behind the front axle. An intelligent schoolboy would refute this statement by pointing out that, with four-wheel brakes, the braking effort is substantially independent of the weight distribution, since the effort is applied to all wheels simultaneously. As a General Motors pamphlet points out, modern brakes are very powerful—a 100-horsepower car has 500-horsepower brakes, if compared with earlier practice. Moreover, the introduction of four-wheel brakes not only doubled the applied ground friction but has also reduced skidding tendencies. The hydraulic brake now gives perfect equalization of pressure, reduces loss of power to a minimum, and reduces possibility of misadjustment. Of course, the public may be at times careless of brake maintenance, or brutal in their application, but the engineers may well congratulate themselves on the modern automobile brake.

The next phase of the attack on the modern car deals with roadability. It is asserted that power and speed have been developed far in excess of road-holding power, that cross-winds and bumps are likely to throw the fast car completely out of control, that weight distribution adopted for easy riding makes road-holding faulty; that comfort has been gained at the expense of stability and control.

Considering first the effects of cross-winds, it should be pointed out in fairness to the streamlined car that cross-winds or quartering winds actually have less effect on a streamlined car, relative speeds and quartering angles being equal, than on an unstreamlined machine. It is perfectly true that at very high speeds, wind effects are likely to become more important than at low speeds, but streamlining and the lowered position of the center of gravity are precisely the required correctives.

Rather than abandon the advantages of streamlining, in a "defeatist" attitude, engineers should intensify their aerodynamic researches and seek greater stability against cross-winds by even more advanced external forms. Sir Malcolm Campbell and the airplane designers point the way to what can be done in securing great stability at high speeds by placing more lateral area behind the center of gravity.

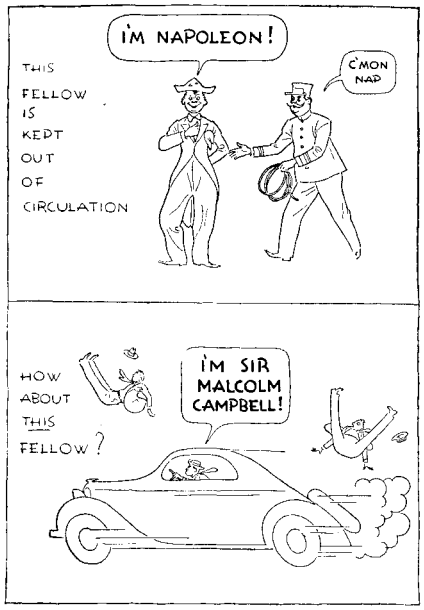
WHEN Chrysler engineers introduced streamlining to the American public, they coupled their advance with re-location of the passengers and engine, and lowering the center of gravity. There followed, besides a great increase in passenger comfort, many indirect advantages from a safety point of view. Common sense indicates that the lower the center of gravity the greater the restoring moment to act against turning over. It is almost unbelievable that technicians should have overlooked this important and desirable safety feature for so long. A low center of gravity also decreases swaying and increases stability on the road. The re-location of the weights so that they are distributed farther away from the center of gravity increases what the engineers term "the moment of inertia" and thereby again increases the stability.

Space will not permit us to deal fully with the dynamics and stability of the modern automobile. Strange as it may seem, it is only recently that there has come an understanding of automobile dynamics, although airplane dynamics have been intensively studied for 20 years.

It is extraordinary that, just as the moment when automobile engineers are giving such intensive study to dynamics, and to better equalized spring suspension, to decreasing the unsprung weight, to knee-action wheels, to "Floating Power," to rubber as a means of lessening vibrations, and so on, the critics should launch their attack on roadability and stability.

What do they want the car builders to do—abandon all their efforts for higher efficiency and power, admit defeat, and go back to the era of the Model T? Do these critics imply that the only roads we shall ever drive on will be full of bumps and ruts? Do they imply that the driving public is completely bereft of common sense and insists on driving at 70 miles an hour over the roughest roads and in strong winds coupled with driving rain?

Perhaps the only point that we are willing to concede is that, by placing



more weight on the front wheels, something has been sacrificed in tractive power under difficult road conditions—but such difficult conditions may be considered quite exceptional.

It is also asserted, as mentioned before, that, because of low ground clearance, exhaust systems, steering mechanisms and other parts in a like position are subject to damage because of obstacles, ruts, and bumps in the road. The answer here is that a low center of gravity is such a great advantage from a safety point of view, that to raise it would be a decided retrogression, and that on good roads such low clearance difficulties do not occur. With the enormous taxes paid by the motorist, he surely has a right to expect good roads!

TO attack the builders of automobiles in the public press makes good "copy," and to attack them in engineering and safety societies meetings creates a mild sensation and subsequent notices in the newspapers. Another curious fact is that criticisms of the automobile from a safety point of view generally come from engineers who are concerned with the teaching of automotive engineering or the testing of automotive equipment. It is easier to criticise a play than to write one, and, we may say with a little malice, that these highly informed and well meaning authorities on the side lines might take an entirely different point of view were they required to design and build cars to please and accommodate the public, and to meet severe competition. They would then, perhaps, recognize the necessity of certain compromises. Perhaps they would not overlook, also, what automobile engineers have already done for safety.

For example, in the last two or three years, we have seen the introduction of the all-steel body in which chassis frame and body are really integral with one another in a combined girder of immense strength. This type of construction eliminates squeaks, removes the danger of wood splinters in a crash, and provides a rugged strength which would have been deemed unattainable a few years ago. The recent installation of safety glass as standard equipment by the Ford Motor Company is an advance in safety which is highly and rightly appreciated by the public.

CREDIT for automatic engine control devices may be attributed to the automobile industry as a whole. These automatic devices act as guardians of the engine's life and give that extra power and acceleration which are so greatly needed at times. Engines fail and cars stall very rarely today. Such reliability is taken for granted, but it certainly is an element of safety. Tires to-day are expected to last as long as 10,000 miles without a puncture; another interesting item in the Travelers Insurance Company's pamphlet is that only 0.6 percent of all motor car accidents in 1935 were due to tire failures.

Safety campaigns, more polite but more determined police officers, strict enforcement of regulations, and public backing for the work of the authorities will do wonders for safety. Milwaukee gave last year a splendid example of what could be done along these lines. Evanston, Illinois, where a real effort by the authorities was backed by civic resolve, scored the safety record for all American cities of more than 50,000 population. It has been estimated that the Evanston methods universally applied would save the country approximately 25,000 lives annually.

There is but one reservation to be made in advocating rigid law enforcement. Let rules and regulations be severe, but also reasonable. For example: the Uniform Vehicle Code prepared by the National Conference on Street and Highway Safety provides for a speed which is reasonable and prudent—which is as it should be—but then promptly recommends an absolute limit of 45 miles per hour. Surely this limit is a retrogression and one which would be exceeded—and quite reasonably so—under certain conditions of clear sky, open level road, and little traffic.

Mental and physical tests for drivers should certainly be stiffened. Safety education for children has shown remarkable results in decreasing accidents and fatalities. Adult pedestrians, jay-walkers, and stubborn optimists can profit equally by educational campaigns. More careful inspection of cars, as practiced in Pennsylvania, for example, is thoroughly worth while.

The principles of highway engineering are now clearly understood and have been successfully applied in many instances. We know perfectly well that, with a road of a certain curvature, the centrifugal force and the overturning moments due to centrifugal force increase with the square of the speed, but there are few attempts to bank the road on a turn proportionately.

Two lane highways in congested areas are definitely dangerous, and three lane highways are in some respects even worse because they actually tempt the motorist to hazardous passing. Head-on collisions can be effectively prevented by narrow parkways or walls that separate traffic moving in opposite directions. Collisions with parked cars may be avoided by marginal guards at the outer edge of the road, with parking prohibited within the guards. Intersection collisions can be prevented by the traffic circle, or by grade separation in clover-leaf crossings.

These principles are elementary; what is lacking is their more general application.

SUMMING up all the arguments, it must be admitted that higher automobile power and speed inevitably entail certain hazards. But to abandon such power and speed would be a step backwards, which the American public will not tolerate. Automobile safety is a complex matter involving education of the driver and pedestrian, stricter law enforcement, better highway engineering, and safety design of the vehicle. To lay all, or even a great part of the blame on the modern streamlined car is but a fad analogous to the writing of "debunking" biographies of great men. Of course, the modern car is susceptible of improvement from a safety point of view, and serious suggestions for "safety improvement" should be considered at all times. But our engineers and manufacturers are all doing everything humanly possible along these lines, expending money, time, and engineering skill without stint for increased safety.

OUR POINT OF VIEW

Science in Advertising

ONE doesn't ordinarily expect to find the subject of advertising discussed in an editorial in a scientific journal. Yet there is provocation and reason for an exception. Long have our thoughts on the subject rankled because science *is* concerned; and we have figuratively torn our hair and stifled public utterance. We refuse to continue this tacit admission that science has nothing to do with advertising. It has—or should have.

Having published some time ago an article on a widely used product, we were surprised when an advertising man telephoned to ask where he could get more such facts. He explained that they would provide new "copy" angles and said he was unaware that so much was known concerning the product he was handling. He was dumfounded when we told him there were volumes of material on the subject in the public library across the street. To us, this was the rankest form of something—heresy or *laissez faire* or ignorance or just plain laziness. Whatever it was, it stirred us as nothing has since the passing of Barnum. Any product on the market today, if it be "worth the powder," will have a history of research upon which the finest kind of selling copy can be written—copy that often is irrefutable.

The civilized world is science-minded. People see on every hand and use almost every minute of the day something that is better made, something that is magical because of science. Accepting these things as necessities, and reading about the science behind them in scientific journals or even the daily papers, as well as of new achievements of science, the public has become more concerned with the technical excellence of a product than with the glittering generalities in a bought and paid for statement from someone who does not even use the product.

We believe advertisers know this. It can't be that they've been asleep these past 50 fruitful years, these years that science has used to such advantage, these years in which the scientific press has done so much to educate people and point to future progress. Yet many advertisers (who should know better and certainly have a wealth of scientific facts on which to draw) go blithely on yodeling nonsensical ballyhoo.

To be specific, to show what can be done, let's look at some exceptions. The General Electric advertisement in our July issue, headed "How You Profit From This Discovery," is perfect scientific copy to sell electric-furnace brazing and, incidentally, an enormous research institution. Another example is an advertisement of the General Motors Corporation signed by President Alfred P. Sloan, Jr., which appeared recently in newspapers. Headed by an emblem bearing the splendid slogan "Who Serves Progress Serves America" and by huge display letters: "Millions of Jobs in the Rebuilding of the Nation," this copy told of the part Winton Diesels have played in the rebuilding of railroads on a streamlined basis. "They . . . vividly demonstrate that *opportunity has no ceiling in America.*" There are others—most of those in this journal, of course—but there are too few in the general magazines.

We congratulate most heartily those who have the understanding and foresight to take this long step forward, as the two mentioned above have done. May they have many emulators.

Sc. D.

WE scientific scribes write so continually of the achievements of others that it comes as a distinct and happy surprise when our own efforts in disseminating scientific knowledge are honored. Such was the case recently when Oglethorpe University, through its President, Dr. Thornwell Jacobs, bestowed an honorary degree of Doctor of Science upon our editor, Orson Desaix Munn ". . . . in recognition of your many great services to, and your high achievements in, scientific research."

Mr. Munn declares that the recognition comes, not to an individual but to an "institution of learning"—to Scientific American which, now in its third generation in one family, has interpreted and inspired scientific research.

The editorial staff, therefore, take this opportunity to express to Dr. Jacobs our gratitude for this signal honor he has accorded our associate and friend whom we heartily congratulate.

Movies Catch Criminals

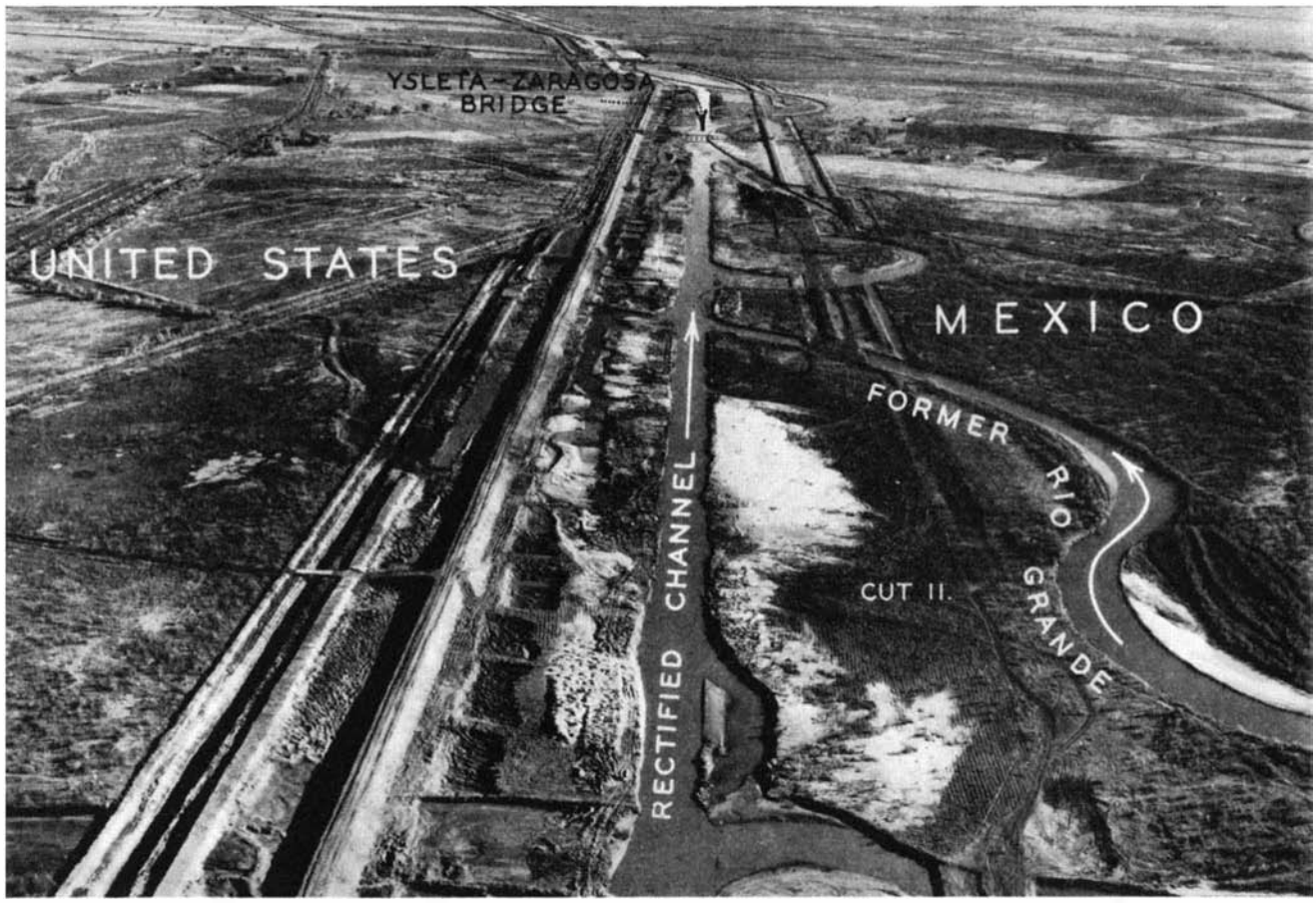
WHEN a crime has been committed, detectives know what to do in studying every scrap of evidence to determine, if possible, the identity of the criminal. When fingerprints are found at the scene, these often point to the guilty one; if he is a known offender, his record and photographs may be broadcast to peace officers everywhere.

An habitual criminal is keenly alive to the odds against his capture. He knows all the tricks of eluding arrest. Sometimes he "holes up" until the "heat" is off. Sometimes he tries simple disguises or he might even have his face altered by plastic surgery—though this is a far from effective disguise. Some wise ones, not too well known by sight to policemen and detectives, lose themselves in crowds in the Loop, on Tremont Street, or Broadway. Bertillon measurements and fingerprint records then mean nothing—until he is caught. He may even walk into a theater and sit next to you or me for all he cares about those records; Dillinger did and would have been "in the clear" had he not been "crossed" by a woman.

It seems a bit strange, therefore, that the aid of the public has never been seriously enlisted in the job of apprehending felons. Police forces are relatively small; the public is 125 millions strong. And the public loves movies.

Colonel H. Norman Schwarzkopf, until recently Superintendent of the New Jersey State Police, has drawn upon the facts in the preceding paragraph and worked out a solution. At Trenton recently he demonstrated a scientific method of making every movie-goer a potential crook-catcher. He would take movies of known criminals, walking, sitting, standing, talking, gesturing, smoking, and show these in theaters everywhere.

Genius — nothing less — adequately describes this development, for with it, not merely a picture but a living, breathing personality confronts the observer. A patron of a movie house, whether he is a tired business man in the city or a farmer attending a Saturday night show in a nearby village, will know the face, the gestures, the peculiarities of the crook's walk and talk. If he sees that combination of characteristics later, he is expected to call peace officers to make the arrest. But the system has other possibilities. Local police forces, even town constables, when asked to be on the lookout for some notorious bad man, will have, instead of a lifeless "front and profile," the same living person the public sees in the theaters. It is, therefore, like giving that one glance at the crook himself which is worth 20 rogue's gallery pictures.



Partially constructed works in the vicinity of Ysleta, Texas, of the rectified Rio Grande channel

STABILIZING THE RIO GRANDE

Meandering International Border Is Being Straightened . . . Canals, Levees Involved . . . Two Countries Exchange Territory . . . Prevent Future Damage

By L. M. LAWSON
American Commissioner, International Boundary Commission, United States and Mexico

MEXICO and the United States are trading territory. Three thousand four hundred sixty acres of Mexican land are being made a part of the United States and an equal American area is being transferred to Mexico. This is, however, no simple "horse trading" but an incidental result of the straightening and canalization of that section of the Rio Grande between El Paso and the Box Canyon below Fort Quitman, Texas. The rectification of the river at this point is one of the principal projects of international engineering now being administered and constructed by the International Boundary Commission, United States and Mexico.

The project plans and actual construction work represent the culmination of joint diplomatic and engineering negotiations between the United States and Mexico under authority and provisions concurred in by the two countries in the form of an international treaty on February 1, 1933, covering the stabilization of the boundary line and the rectification of the Rio Grande. This treaty also includes the construction of a flood retention dam and changes in present irrigation and drainage works ". . . to relieve the towns and agricultural lands located within the El Paso-Juarez Valley from flood dangers." Its aim is to secure ". . . the stabilization of the international boundary line, which, owing to the present meandering nature of the river, it has not been possible to hold within the mean line of its channel."

Previously existing treaties established the center of the Rio Grande, except in isolated cases, as the international boundary line. The channel, with excessive length, was produced by natural conditions which no longer exist. At the present time the bed of the Rio Grande between the two cities of El Paso and Juarez is at a higher elevation than some of the streets and improved properties of the two cities. Accumulations of sediment continue to aggravate this condition and it is the consensus of all engineers who have studied the situation that the correction lies in the plan of straightening and confining the channel. One of the principal requirements to permit of such artificial rectification is the equitable adjustment of the areas which would necessarily be detached from one side of the river and attached to the other in the straightening process.

The treaty of 1933 states: "Each Government shall respectively secure title,

control, and jurisdiction of its half of the flood channel, from the axis of that channel to the outer edge of the acquired right of way on its own side. . . ."

The location of the proposed channel has been so chosen and located in the field as to equalize the areas which will necessarily be segregated from one nation with those that will be cut from the other, with the result that neither nation will gain or lose national area. The acquisition of the private rights existing on such areas provides a feasible means for their exchange. The total cost of the project is estimated at 6,106,500 dollars and its construction will be completed in a year and a half from the present date.

THE general engineering features of this project involve: the reduction of river length from 155 miles to 88 miles; the establishment of a floodway between levees, with a capacity of 11,000 second-feet; and the increasing of the gradient from a slope of 1.82 feet per mile to a slope of 3.2 feet per mile. The levees require the placement of about 9,000,000 cubic yards of earth, their average height being 7.5 feet. Approximately 5,000,000 cubic yards of earth excavation is required to provide the artificial channel.

The areas required for right of way for the channel itself are 4075 acres from the United States and an equal acreage from Mexico, while the proposed location of the rectified channel segregates 3460 acres from the United States and an equal acreage from Mexico. In straightening the channel of the river, 59 separate tracts of land with areas varying from .25 acre to 377 acres will be cut from Mexico and 65 tracts will be cut from the United States. The treaty further states: "For the sole purpose of equalizing areas, the axis of the rectified channel shall be the international boundary line. The parcels of land that . . . shall remain on the American side of the axis of the rectified channel shall be the territory and property of the United States of America, and the territory and property of the United Mexican States those on the opposite side, each Government mutually surrendering in favor of the other the acquired rights over such parcels."

The results of the completed project will be the elimination of the flood menace throughout the El Paso-Juarez Valley in both the United States and Mexico; the prevention of channel changes and flood-caused detachment of areas from one country to the other; the reclamation of low-lying areas; and a more satisfactory enforcement of the immigration and customs laws of both countries.

The gross area of valley land in both countries, between El Paso-Juarez and Fort Quitman is 165,000 acres, of which 96,000 acres are in the United States and 69,000 acres in Mexico. Estimated values existing in the cities of El Paso and Juarez and their valleys, including irrigation and drainage works and improved roads, are in excess of 100,000,000 dollars.

Notwithstanding the fact that the present total amount of sediment annually carried through this valley by the Rio Grande is only a small percentage of that carried previous to the construction of the Elephant Butte Dam, the absence of the former large scouring floods has resulted in the silting up of the river channel to a point where rainfall-discharges from arroyos, entering the river between Elephant Butte and El Paso-Juarez, menace the improved and developed properties of both cities and the valley lands. Only large floods of destructive proportions are capable of eroding accumulations of sediment such as now occur in the meandering channel.

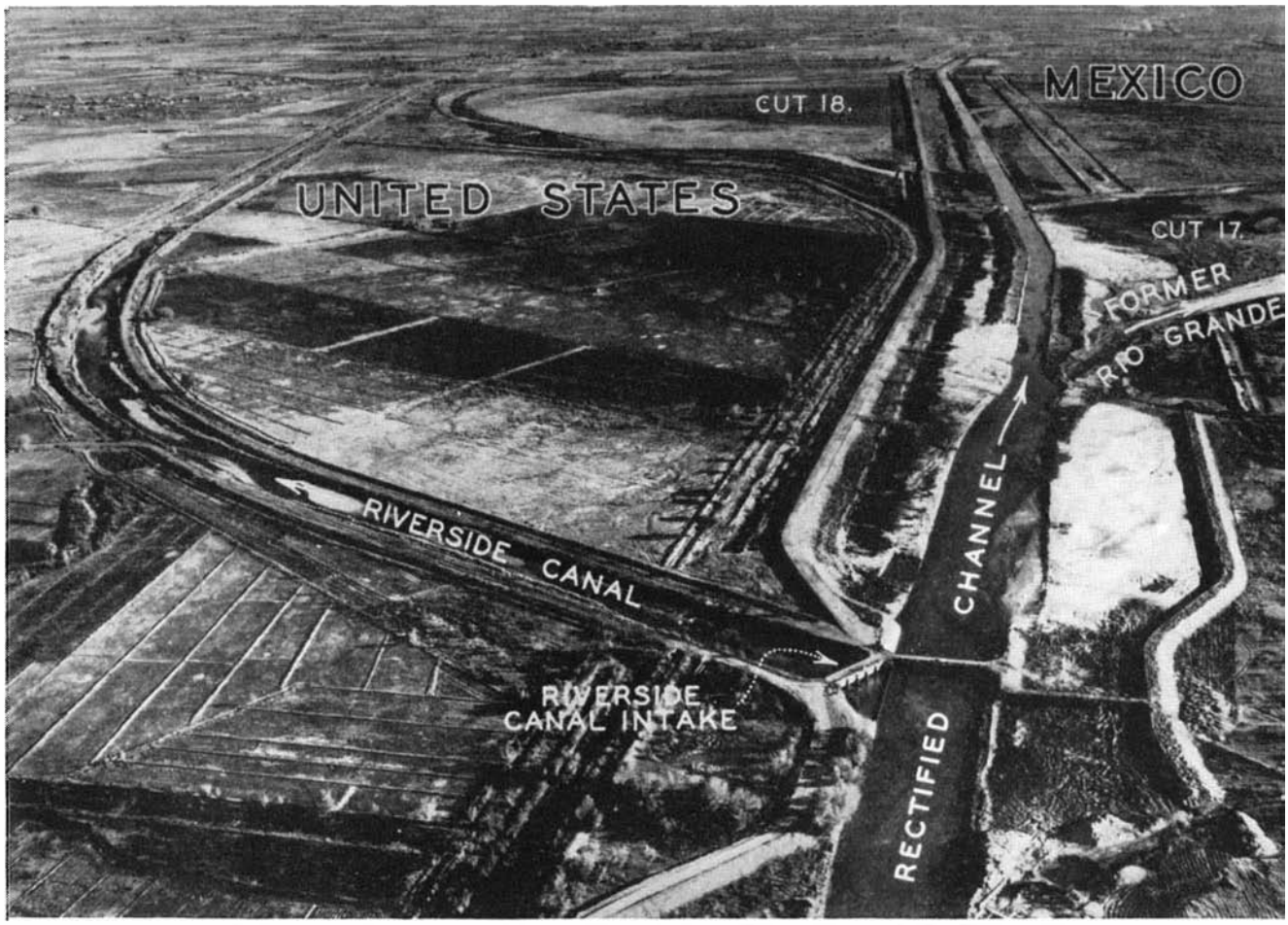
The city and county of El Paso and the Mexican Department of Communications and Public Works have expended in the last few years over 750,000 dollars to protect the cities and valley lands from floods. These works consist largely of levees built along the banks of the meandering channel, and require constant strengthening and repair because of the raising of the river bed.

The Rio Grande is a sediment-bearing stream, and as such is constantly building up its bed, and would from this cause, in time of flood, change its channel to a lower location where it would again start building up its bed and repeat the cycle at some future stage. The river has occupied at some time in the past every portion of the valley area. This phase of changing channel is now largely prevented through the El Paso-Juarez Valley by the construction of artificial works, such as railroad and road grades, canal and drain banks, and, in late years, levees. Under these conditions, the river bed has been continuously elevated. The Elephant Butte Dam was completed in the year 1916, and as a result of its function of providing an irrigation supply during years of low runoff, it stores the large floods which, previous to its construction, passed on down the river. The action of these floods was to scour the river channel, partly by carrying deposits on through the valleys and partly by making deposits upon the valley floor whenever bank overflow stage was reached. Although large floods have been controlled behind Elephant Butte Dam, smaller ones from the runoff area lying between Elephant Butte and El Paso-Juarez are of annual occurrence.

El Paso, Texas, and Juarez, Mexico, showing a portion of the new river channel. The limited work here has already improved seepage conditions in these towns

WITH the first release of clear water from Elephant Butte, a limited scouring of the river channel began immediately below the dam. The clear water picked up the finer particles of silt and sand and carried them downstream. This effect has reached some 40 miles below Elephant Butte, and might eventually reach El Paso and degrade the river through the valley, were it not for the annual increment of sand, gravel, and silt brought into the river channel from the many side arroyos which debouch into the stream along its course between the dam and El Paso. Even this annual increment of sand might be carried through were it not for the need of diverting the flow onto lands for irrigation. Three diversions are made above El Paso, one each at the Percha, the Leasburg, and the Mesilla Dams.

The Caballo Dam, a feature of the Rectification Project, will be located in



One of the principal canal intakes from the new channel for irrigation in the El Paso Valley

Sierra County, New Mexico, on the Rio Grande about 22 miles below Elephant Butte Dam. Studies of the Caballo Dam and the resulting reservoir have been made. The cost of this dam, including the purchase of the lands to be submerged, has been estimated to be 1,250,000 dollars for a capacity of 100,000 acre-feet.

The volume of water passing the proposed Caballo damsite during the large flood of September, 1925, was approximately 25,000 acre feet. Storage in excess of this amount must be provided to take care of possible larger floods and silt depletion. Provision must be made to store the probable spill from Elephant Butte during times of flood runoff below the dam. Fifty thousand acre-feet are allowed for this item and would probably store three or four days' spill. This would permit the floods entering below Caballo to recede.

In actual construction, levee heights will vary from zero, where bench lands are encountered, to 15 feet where the old river channel is crossed. The levee section proposed has a 16.4-foot crown with side slopes of two to one. This will permit of the use of the levee top as a road for inspection and repair. The normal flow channel is designed with a bottom width of 66 feet as this channel width seems best fitted for the present channel width of the river. The estimated capacity below the two-foot freeboard varies from 10,700 second feet to 11,500 second feet.

The total right of way is 8160 acres. This is equally divided between the two countries. In addition to the land actually occupied by the works, a strip 49 feet wide outside the land toe of each levee has been included for levee maintenance or possible future widening.

ALL earthwork of both channel excavation and levee embankment is being secured from the channel excavation in building the left levee from the lower end of San Elizario Island to the mouth of Quitman Canyon. At practically all the other locations the material is being secured from discontinuous borrow pits located on the channel side of the levees.

The sum of 225,000 dollars is carried in the estimate to cover the cost of rebuilding all constructed irrigation and drainage works where they will include the rearrangement of the irrigation systems on both sides of the river. Present bridges will either have to be lengthened or moved, depending upon how they fit with the new plan; probably several more will have to be built. The estimate of the amount of this item is 300,000 dollars. Because the effects of the introduction of steeper gradients in the river channel are problematical, and considerable scour may therefore develop, and because the irrigation supply must be diverted at certain places, there has been set up in the estimate an amount to meet the cost of grade control.

An allotment of 2,800,000 dollars was made January 3, 1934, by the Federal Emergency Administration of Public Works for commencement of Rio Grande rectification and construction works and also for the necessary acquisition of property. The American Commissioner received authority from the Secretary of State to begin construction on February 3, 1934. The Mexican Department of Communications and Public Works is carrying out the work on the Mexican side under the supervision of the Mexican Section of the Commission.

To date approximately 50 percent of the actual river rectification work has been accomplished, using long boom dragline excavators which have handled over 6,000,000 cubic yards of material. By transfer of funds to the Bureau of Reclamation, Department of the Interior, and the addition by that department of 1,000,000 dollars, storage capacity of 250,000 acre feet has been added to the proposed Caballo Reservoir, which will make possible the development of firm power from water released through penstocks at the Elephant Butte Dam.

A Weapon For Inventors

Who Was First? . . . Inventors Rights Must be Backed by Legal Evidence . . . How to Obtain It

By ORSON D. MUNN
Editor and Publisher

IT is a general principle of American patent law that the first inventor of any given invention is entitled to receive a patent for his invention. On its face this principle of law would appear to be simple enough. However, in applying and interpreting this principle considerable difficulty frequently arises.

Where two or more inventors are seeking patent protection for the same invention, each claiming to be the first inventor, the question naturally arises: At what point in the development of an invention does a person become the "first inventor" so as to be entitled to receive a patent as against all subsequent inventors? Is it when he first forms the mental concept or idea of the invention or is it when he first discloses it to others or makes a written description and drawings of his invention? Or, again, is it when he first reduces the invention to practice, making an actual working model which he successfully operates? Or, finally, is it at the time that he files his application for patent?

There is no definite and unequivocal answer to the above questions; the factor that determines which one of two or more claimants is the first inventor varies in accordance with the particular facts and circumstances. Suffice it to say for our purposes that all of the facts inquired about in the above questions are important in determining when an invention has been completed. In every dispute between two or more claimants for the same invention every fact in the development of the invention must be taken into consideration in deciding which of the claimants is the first inventor and entitled to receive a patent.

Where two or more parties have filed patent applications for the same subject matter, needless to say the Commissioner of Patents does not permit each party to decide for himself whether or not he is the first inventor. The facts as to who is the first inventor must be proved to the Patent Office by competent legal evidence. Accordingly, the principle set forth above that the first inventor of any given invention is entitled to receive a patent must be modified to read that the party *who can prove by competent legal evidence* that he is the first inventor is entitled to receive a patent. It is apparent, therefore, that the entire history of the development of an invention should be preserved in such form that it can be proved at a later date, if necessary.

In preserving the record of the development of an invention two guiding principles must be borne in mind. The first is that, after a lapse of time, human memory as to specific facts such as dates is highly unreliable and accordingly a contemporaneous record must be made as to these facts so as subsequently to refresh the recollection. The second is that the inventor himself is an interested party and his testimony should be corroborated by competent outside evidence, preferably both documentary evidence and the testimony of disinterested witnesses.

MANY different systems may be adopted to preserve the history of an invention. We outline here a plan which in various forms has proved entirely satisfactory. It applies both to the individual inventor who invents on his own behalf and to an employee whose inventions accrue to the benefit of his employer.

Where an inventor is a technician engaged in research work he should keep a permanent diary in which dated and signed daily records of his work are entered. When an invention begins to take form in the mind of an inventor, whether he be a casual inventor or a technician engaged in research work, a file relating to this invention should immediately be opened. The first entry in the file should be a record of the date on which it was opened, together with a written description and, if possible, sketches of the invention no matter how hazy, dated and signed by the inventor and by one or more competent witnesses.

It is of importance that an inventor use reasonable diligence in perfecting his invention. Accordingly, to preserve evidence of diligence, complete written records should be entered in the file of each step in the development of the invention and these records should be dated and signed by the inventor and by the same witnesses if possible. When the invention has taken a definite and what appears to be final form a complete written description and drawings should be made, dated, signed by the inventor and witnesses, and entered in the file.

Wherever possible a full size working model of the invention should then be made and it should be successfully operated in the presence of witnesses. A record signed by the inventor and witnesses of the date of making and operating the model should then be entered in the file and if at all feasible the model should be tagged or otherwise identified and preserved for future reference. Instead of making a full size working model of the invention an inventor may promptly file a patent application, both having substantially the same legal significance in determining when an invention has been completed. Under any circumstances an inventor should not delay unduly in filing his application for patent. The file should also contain the full name and address of each witness and from time to time any change in address should be noted.

If the history of the development of an invention is preserved as outlined above, the inventor will have dated records to refresh his recollection and will also have corroborating evidence in the form of documentary evidence and the testimony of disinterested witnesses. In addition to being of value in aiding an inventor to prove that he is the first inventor in the event two or more parties are seeking patents for the same invention, such a file will also prove of value where the inventor did not himself seek patent protection and where someone else, having secured a patent without knowledge of the inventor, brings suit against him for patent infringement. The file will then be a material aid in preparing a defense to the suit and in proving that the patentee was not the first inventor and accordingly not entitled to the patent on which the suit is based.

A carefully preserved record of the history of an invention is accordingly both a shield and a sword. It is a defensive weapon in unjustified suits for patent infringement and an offensive weapon in aiding to establish the patent rights of the real inventor.

GRANULES OF THE SOLAR

Why the Sun's Surface Looks as if it Were Bumpy . . . Granules Found to be About 2200 Miles in Diameter . . . 100 Degrees Hotter Than the Remainder

GALILEO was daring when he first turned his telescope on the sun, for he discovered the spots upon its surface by looking at the dazzling disk directly without any device for weakening the intolerable brilliance. Though positive evidence appears to be lacking, it is only too probable that this zeal in the cause of observation led to his eventual blindness.

Galileo's telescope, with its concave eye-lens like that of an old fashioned opera-glass, did not permit of the simple device so familiar to the modern observer of projecting an image of the sun on a white surface held a foot or so behind the eyepiece. With a convex eyepiece a small change in the focusing screw brings this image of the sun into sharp definition so that sun-spots and all the principal features of the disk may be seen by several onlookers at once. It is strange, however, that the simple device of smoking the outer surface of the telescope objective with the soot from a candle flame did not occur to Galileo. With reasonable care to avoid injuring the lens by heating it, this works fairly well with a small instrument like a binocular, and the soot can be wiped off clean afterwards.

This is, however, a poorish makeshift —Herschel did better by putting at the eye-end a sheet of plane-polished glass set at an angle of 45 degrees. More than 90 percent of the sun's light and heat escape through this, and a shade glass of moderate density will reduce the brightness of the reflected light so that the eye can bear it without danger of breaking the dark glass by over-heating.

FOR more serious work, polarizing devices may be used which permit the reduction of the apparent brightness of the photosphere at will. When the sun's light is thus enfeebled and its surface viewed with a fair-sized instrument under steady air conditions, it is found that, in addition to the conspicuous spots which appear here and there, the general background of the solar disk is not featureless—it appears as a matte surface with a fine and nearly uniform "granulation," so that it looks rather like rough drawing-paper. These photospheric granules have been known for more than a century, but little more than the fact that they exist was understood till within the last 20 years or so. The granules are so numerous and so much alike that it is practicable to follow the fate of individuals only by taking photographs of an enlarged solar image in rapid succession.

The work of Janssen in France, Hansky in Russia, and Chevalier in China, has shown that the average life of a particular granule is only two or three minutes—new ones appearing as the old vanish. They are roundish spots, a few seconds of arc in diameter, and shift but little on the sun's surface—the observed apparent motions of two or three miles per second resulting probably from changes in the relative brightness of various parts of a nearly stationary object. They are found all over the sun's surface, from the equator to the poles, and present substantially the same appearance whether sun-spots are few or many.

A very interesting study of this peculiarity of the solar surface has just been published by Professor H. H. Plaskett of Oxford. He begins with a new and accurate determination of the difference in brightness of the granules and the background between them. It has long been known that this is small, so that careful measures are required; and it is of importance to make such measures with light from regions of the spectrum which are clear of absorption lines, or as nearly so as possible, to avoid the complications which would arise if the lines were stronger in one region than another. Using specially selected regions in the violet, blue, and yellow, and working on photographs taken with powerful instruments at Victoria, B. C., and at Oxford, Dr. Plaskett finds that the extreme range in brightness from the most luminous granules to the dullest parts of the background does not exceed 10 percent. His description of the precautions employed to eliminate the various errors which beset photographic photometry and to allow for the blurring of the image due to imperfect seeing, occupies six pages. The actual measurements and calculations represented by these pages probably took as many weeks.

It appears also that the contrast between the granules and background increases toward the violet, and that it is as great if not greater close to the sun's limb as at the center of the disk. The diameter of the average granule is about five seconds, corresponding to 2200 miles.

Having these facts, it remains to interpret them—which is the main feature of Plaskett's work. The simplest explanation is the correct one: The sun's surface is not equally hot all over and the hottest parts look the brightest. Taking 6000 degrees absolute as the temperature of the background, that of a bright granule comes out 6100 degrees. With such a difference, the contrast should be greater in violet light than in yellow, as it appears actually to be.

SO far, so good: But why should some parts of the sun's photosphere be hotter than others? We can understand easily why the temperature of the gas near the surface of the sun or any other star should increase steadily with depth below any given level, but why it should change laterally is harder to account for. The great flow of energy from the deep interior should be steady, and without some special modifying influence we should expect the apparent surface of a star to be a uniform and featureless blank of dazzling light. But in this case there would be not merely no granulation on the sun's surface but no sun spots. Everyone is familiar with the accepted interpretation for the latter—that they are rising streams of gas ascending from the sun's interior which are cooled by expansion and so appear dark. The belief that a very much milder circulation occurring generally all over the sun's surface may produce the granulation is strongly supported by this latest work.

To produce vertical convection—as such motions are called—in a layer of fluid, some source of power is necessary. In the laboratory this can be secured by gentle heating of the bottom of a wide dish full of fluid. In the earth's atmosphere it is produced on a large but more irregular scale by the heating of the ground by the sun's rays. When the air near the ground gets so hot that an ascending column of it, despite the cooling due to expansion as it rises to regions of lower pressure, will still be hotter and lighter than the surrounding air, the upward motion will go on of itself if the least accident starts it. A

PHOTOSPHERE

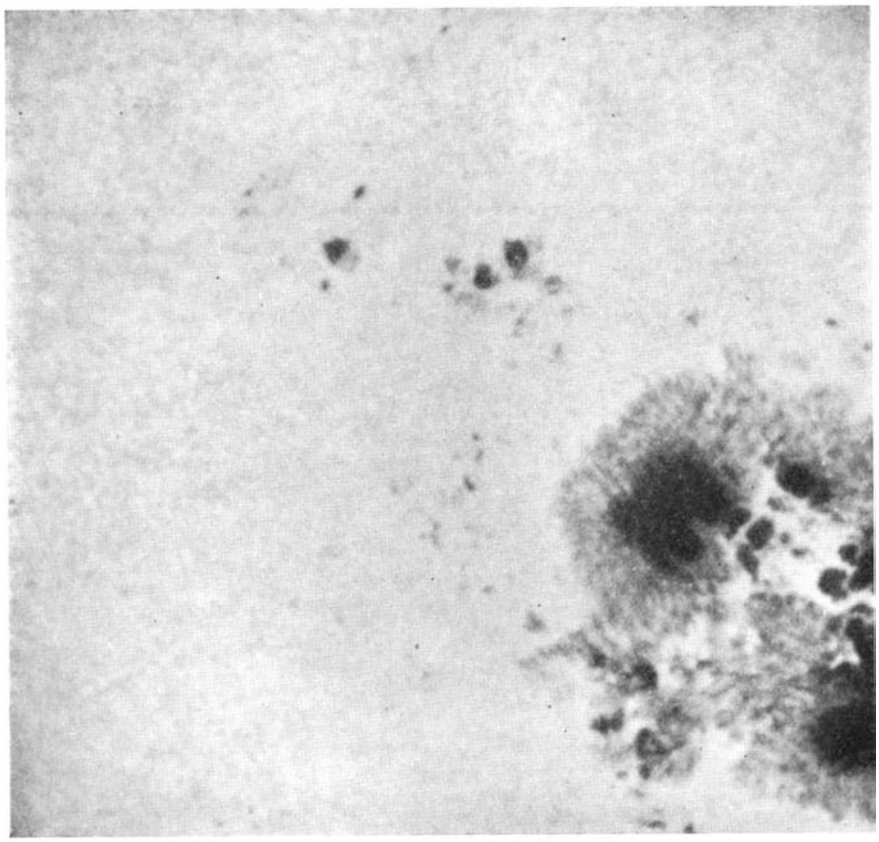
By HENRY NORRIS RUSSELL, Ph. D.

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.

very familiar example is found in the huge ascending columns of damp air which, as the moisture condenses, form our cumulus clouds or "thunder-heads." More violent and fortunately rare motions occur in tornadoes.

Under uniform conditions in the laboratory the convective motion, when gentle, tends to break up the fluid into cells, roughly equal in size, with upward flow in the center and down-flow at the edges, and with diameter about 1½ times the depth of the convective layer. In the air above us we may often see the same thing happening in somewhat less orderly pattern, when the sky is full of isolated, dome-shaped, cumulus clouds. Viewed from far above, such a patchy layer of terrestrial clouds might give a tolerable imitation of the solar granulation except that the latter changes much faster and is on a vastly greater scale, indicating that the layer in which it is produced is about 1500 miles deep.

This depth measured inward from the visible surface of the sun would reach a region where the temperature was very much higher than the 6000 degrees already mentioned. Though we cannot observe such a region directly, we can calculate what would happen there. This was first done by Unsöld, who found that, a thousand miles and more below the surface, the atoms of hydrogen—which form by far the greatest part of the sun's atmosphere—are practically all split up into protons and electrons—that is, ionized. Rising by calculation to higher levels where the pressure and temperature are lower, he found that more and more of the protons and electrons would combine to form neutral atoms, till, at the visible surface, more than 99 percent recombination occurs. Now the combination of the two charged particles to form a hydrogen atom liberates a large amount of energy. In an ascending column of gas, this would produce enough heat to supply the driving power for convection and cause the upward current extending to the level where the recombination was substantially complete. This level is below the visible surface, but the upward motions would persist by mere inertia and might carry the effect well into the directly visible layers. Here and there, in sun-spots, such motions occur on a tremendous scale and with great violence, producing tornadoes thousands of miles in diameter which last for weeks. Ordinarily the effect is mild—a sort of gentle simmering instead of explosive boiling—but even so it reveals itself by the gently mottled character of the sun's whole surface.



A study in contrasts. The umbra of the sun-spot is as much as 2000 degrees cooler than that of the background photosphere, which is at about 6000 degrees absolute, and the contrast is therefore strong. But the difference between the same background and a bright granule is only 100 degrees, and the contrast is not nearly so strong. Even then, much of it is lost in reproduction

IN the sun, of course, there are no clouds—only the gradually increasing haziness due to the presence of electrons and positive ions in the gas: but, nevertheless, the hotter regions look brighter and reveal to us what is happening. Near the sun's apparent limb where our line of sight meets its actual spherical surface obliquely, we cannot see as deep into the atmosphere for our gently-sloping line of sight meets with practically complete obscuration from the haze before it has got to any great depth measured vertically. We therefore get light from cooler regions on the average than we would do if we were looking straight down at the middle of the sun, which explains why the sun's center looks brighter and also bluer than its edge. From exact measures of this "darkening" toward the limb, Professor Plaskett, by another piece of laborious calculation, finds that in general there is a steady fall of temperature outward as the sun's surface is approached from within. Just at the depth from which light begins to escape fairly freely to space through the haze, however, this decrease almost stops, and for a moderate distance the temperature is almost constant, then it falls off rapidly to the boundary value. This is just what might be expected if the heat-carrying streams of gas extended well into the observable levels where the haze is thin. There is good reason to believe that, when highly precise measures of the distribution of brightness over all parts of the sun's disk have been made with light of many wavelengths, it will be possible to work out the properties of the outer layers of the sun much more accurately than we now know them, and extend the calculations to levels far too deep in the haze to be seen directly.—*Lake Minnewaska, New York, June 3, 1936.*

Courtesy American Airlines

AIRCRAFT GROW LARGER

Efficiency Increases With Size . . . 55-Ton Flying Boats Designed . . . 80-Ton Next . . . Promenade Deck in Wings . . . Daily Service to Europe

By REGINALD M. CLEVELAND

ONE of the most significant developments of air transport is the increasing size of units and the definite certainty that still larger planes will shortly find their place in the air lanes, both over land and over sea. Having fledged their wings to a point which makes possible a high degree of reliability of operation coupled with speed at least three times that of surface transportation, passenger liners for the overland route and flying boats for the overseas services, which, before the year is out, will bring both major oceans into the scheduled airline map, are ready to expand in dimensions for increased comfort and increased economy.

This step has had to wait upon the development and satisfactory testing of larger power units than have heretofore been available. Now, however, in the engine factories of the United States and Europe, air-cooled engines of single- and double-row radial types, developing in excess of 1000 horsepower, are ready to be mounted in more widely spreading wings. On the Continent and in Great Britain much progress has also been made in liquid-cooled engines developing 1000 or more horsepower. In Germany, Diesel engines of more than 800 horsepower are flying, and larger sizes appear to be imminent.

Diesel experimentation is by no means at a standstill in the United States. At the eleventh annual engineering conference of the National Advisory Committee for Aeronautics, held at Langley Field, Virginia in May, a four-cycle Diesel cylinder was demonstrated, operating at 2000 revolutions per minute and showing cylinder pressures per cubic inch of displacement closely comparable with those of the newest 1000 horsepower spark ignition engines. There is also heartening progress quietly being made towards the utilization of steam reciprocating and turbine prime movers for aircraft.

In the United States, the availability of 1000 horsepower air-cooled engines has already put air transports of increased size and roominess into the air. American Airlines is now operating some of its fleet of expanded Douglas twin-engine transports, designated as DC-3 when used as 24-passenger day planes and as DST when used as 16-passenger sleepers. For this company, these planes are powered with 1000 horsepower single-row Wright Cyclone engines. United Airlines has purchased eleven similar ships, powered with the new Pratt and Whitney 14-cylinder double-row Hornets, which are rated at 1000 horsepower for takeoff and have pro-

duced 1150 horsepower on the test stand. The line will emphasize the comfort made possible by the increased fuselage dimensions of this ship by carrying only 14 passengers as a day plane, and providing them with completely revolving arm chairs and a sense of spaciousness not heretofore attained on the airways of the United States.

More significant in its implications for the scale of the air vehicles which we are soon to use than this transition twin-engine craft, however, is the still larger Douglas DC-4. After about a year of consultation, five major airlines—United, Transcontinental and Western Air, American, Eastern Air Lines, and Pan-American Airways—have combined to write the specifications of this four-engined giant.

Seeking a plane in which passenger capacity and range at speed would make possible an economic operation, even without the uncertainty of airmail contracts, these groups decided to pool their interests, called into consultation Edward P. Warner, former Assistant Secretary of the Navy for Air, and noted authority on airplane design, and produced requirements for a super-liner which needed nearly 200 typewritten pages of specifications to describe. Under these specifications, a contract for a prototype plane to cost about 500,000 dollars was let with the Douglas Company. Should its performance characteristics live up to expectations—and there is no reason to believe that they will not—it is anticipated that about 60 planes, representing a total investment of around 12,000,000 dollars, will be ordered.

THE DC-4 will be a low-wing monoplane with four engines, of at least 1000 horsepower each, streamlined into the leading edge of its wings. It will be able to cross the continent with 20 passengers in comfortable staterooms by night with a single stop or, as a day plane for 40 passengers, to make the crossing with two stops for fuel. Its cruising speed is expected to exceed 210 miles an hour, but emphasis has been placed upon extreme comfort, spaciousness and soundproofing, coupled with range, rather than excessive speed. Twelve-hour crossings from coast to coast in either direction should be readily attainable and it is held that true dinner-to-breakfast service between any of the major cities of the United States is sufficient to meet all reasonable demands for rapid transportation. The first plane of this class will probably be delivered for tests early next year and may even get into the air before the end of 1936, while deliveries on duplicates are expected in impressive quantities in 1937.

Not only are the five members of the Air Transport Association of America who combined in this striking project convinced that true economy of airline operation lies in larger units, but they feel that every reasonable device for safety, dependability, and passenger comfort which could be anticipated during the next five years, has been incorporated in their specifications. For this reason they believe that one of the costly bugaboos of air transport to date, namely quick obsolescence of perfectly good and flyable equipment with the appearance of some new type—only slightly improved in some minor characteristic—will be eliminated.

The idea of larger aircraft is not confined to the United States. The ill-fated giant, *Maxim Gorky*, is to be repeated in Russia; France has successfully flown a comparatively slow but efficient flying boat of 70,000 pounds; construction is progressing on the Dornier DO-20, a flying boat of 58 tons gross weight. This is an eight-engined monoplane with the interesting innovation of having each pair of engines drive a single three-bladed air screw.

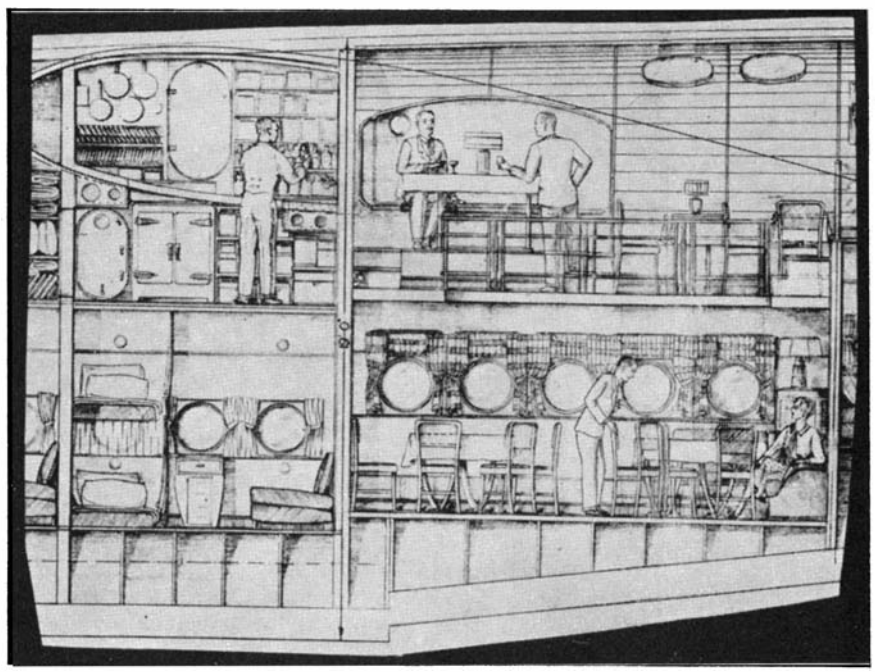
Aerodynamic research recently carried forward by the N.A.C.A. and other scientific bodies shows indisputably that the efficiency of aircraft increases rather than decreases with size. Lift and drag characteristics are definitely better proportionately for large aircraft than for small, and the limit of size from this point of view is by no means in sight. The economic argument for large craft may be presented somewhat as follows: The complete useful load per horsepower and per cost of plane has a tendency to remain reasonably constant, but bigger ships, under identical conditions of distance, will be faster and therefore produce a greater traffic turnover; in the long run, the reliability of operations, and therefore the dependability of service, is better with two engines than with one, and still better with four than with two.

As time goes on, the number of crew and cost of equipment needed for ground operations of any size of aircraft tends inevitably to grow. A crew equipment of less than three is already little considered for long hauls; over land, a pilot, co-pilot, and steward or hostess; over water a pilot, navigator, and radio man. In the last named case, this is less than the minimum on long-haul operations, and Pan-American, in the Pacific, is operating with a crew of six. However, the same crew can with equal efficiency operate a plane for 40 passengers as for 14, in land operation at least, plus the possible addition of a steward, and it is evident that the crew cost per passenger goes down with an increase of passenger accommodations.

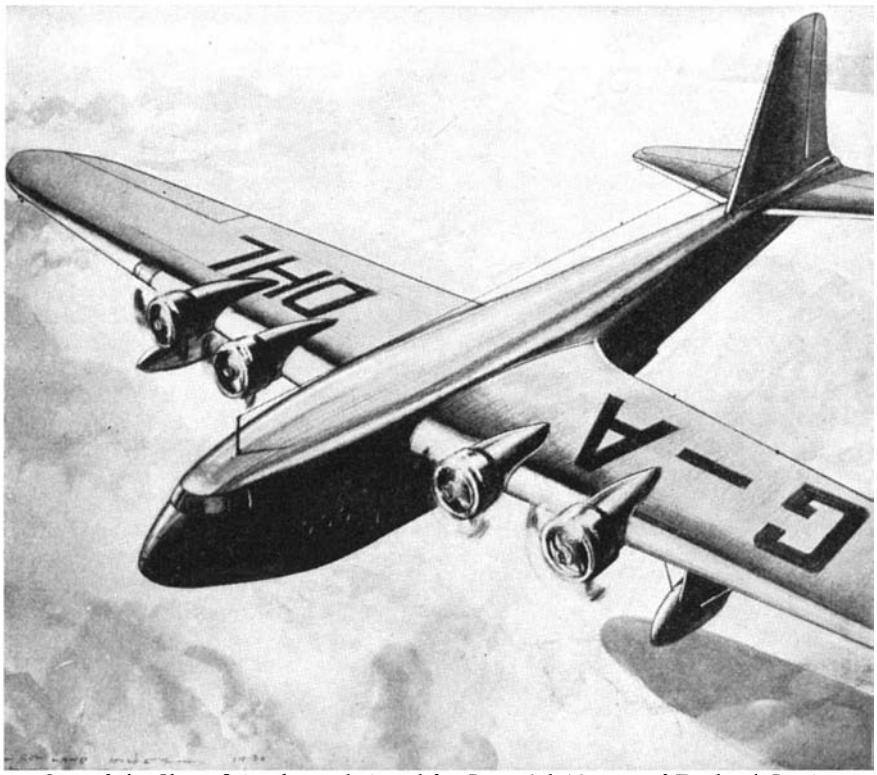
FOR long range overseas operation—for example, non-stop flights between the United States and Europe—it is evident that a double shift of crew must be provided, so that fresh watches may be maintained. This obviously presupposes a large ship, accommodating many passengers.

Finally, it goes without saying that the bigger ship offers the higher degree of comfort and is therefore the more attractive to passenger traffic.

It is in the field of the ocean-going plane that increases in size are likely to be felt the most. Both Glenn L. Martin and Igor I. Sikorsky, designers of the Clipper ships for the South American and Pacific services, are ready with complete plans for flying boats at least twice the size of their present flying product. Both believe that such craft are indi-



Part of the interior of the proposed Sikorsky 55-ton flying boat, showing the double-deck arrangement, staterooms, the galley, and storage space forward



One of the Short flying boats designed for Imperial Airways of England. In size this four-engined ship is between the present Martin and Sikorsky Clippers

cated by the demands of the ocean services, especially in the Atlantic, and fully justified by the traffic in sight.

Mr. Sikorsky has worked out to the last detail the structure of a 55-ton six-engined flying boat, capable of carrying 48 passengers in extreme comfort and a crew of ten or eleven non-stop between the United States and Europe in 24 hours. Indeed, wind tunnel tests of many of the elements of this ship have already been made. With two decks, its roomy hull would include not only staterooms of adequate size and restful furnishings, but a dining and dancing room 15 by 15 feet, from which a circular stairway leads to a hanging balcony above. Here the root sections of the thick wings are used to give additional beam to the apartment and form alcoves in which are a bar and settees. Windows let into the lower surface of the wing make it possible to look directly downward at the sea.

IN this design there is already sufficient headroom in the wing to provide ample working space within the nacelles behind each motor so that minor adjustments, such as those to fuel lines, ignition systems, and other accessories —which, after all, are the things which need adjustment in 99 cases out of 100, rather than the major elements of the engines themselves—can be made on any engine during flight. A narrow gage track bearing a small sliding car runs out into the wings and facilitates access even to the outboard motors.

The famous Russian designer does not believe, by any means, that ocean-going aircraft will stop at 55 tons. When a weight of 80 tons is reached, leading edges of the wings, he says, will already be so thick as to provide space for a promenade deck, and he is firmly of the conviction that flying boats up to 150 tons or more will be the product of this generation, and up to perhaps 500 tons the product of the next.

One basis for this opinion, and the equally firm conviction of Mr. Martin and other designers of large boats that craft will increase in size, is the fact that water operations lend themselves particularly well to big craft. The limitations upon land, it is admitted, lie not so much in the design and construction of huge aircraft themselves, but in the landing and takeoff facilities at airports, more especially those at high altitudes. Water-going craft have the advantage of taking off and landing always at sea level, which means slower speeds for both these critical operations. Ample room is at hand in the principal harbors of the world for craft of any size.

The principal desiderata are range, which is plainly in sight with the increased aerodynamic efficiency of big craft and will be further extended as soon as oil-burning power plants have reached the stage which is shortly foreseen; reasonable ceiling, so that operation may take place above the normal storm area at approximately 18 to 25,000 feet, where the complications of pressure cabins will not be necessary and slight additions to the supply of available oxygen in the cabin will make passengers thoroughly comfortable; and cruising speed of around 200 miles an hour which can link the Old World with the New between sunrise and sunrise, and bring within the span of a week a return trip from New York to almost any seaboard city in the world.

When it comes to the question of flying boat as against airship operation for Atlantic service, Mr. Sikorsky is naturally very much in favor of the large, heavier-than-air craft. As to the comparative cost in capital outlay and in personnel required for the two types of services, he postulates the following figures:

	Airship	Seaplane
Number required for daily service	8	8
Total cost of equipment	$32,000,000	$6,000,000
Main Terminals	2	2
Cost of main terminals	$2,000,000 each	$750,000 each
Auxiliary terminals	4	4
Cost of auxiliary terminals	$100,000 each	$25,000 each
Flight crew	320 total	80 total
Main terminal crews	100 to 200 men each (200to400total)	50 men each (100 men total)
Auxiliary terminal crews	100 to 200 men each (400 to 800 men total)	5 men each (20 men total)

"Thus we may easily see that the first cost of a daily airship transoceanic service would greatly exceed that of a daily seaplane service," he said. "The capital outlay for equipment and operation terminals is estimated roughly at 36,400,000 dollars for airship service against some 7,600,000 dollars for a seaplane service. Operating personnel including flying and ground crews is estimated between 920 and 1520 men for an airship service against 200 men for a seaplane service.

"The seaplane service indicated in the table is satisfactory for two daily departures," Mr. Sikorsky declared. "In both cases it would thus be possible to have a daily operation carrying 60 passengers across the ocean in both directions. While it is claimed that the dirigible will have a greater capacity for carrying mail and express, we believe that the 4000 to 5000 pounds of mail that could be carried by the daily flying Clippers appears sufficient, and that considerable advantage in speed would more than compensate for the loss in carrying capacity.

"TO make a transoceanic airmail service really valuable it must be a daily service in both directions. After an airmail letter is mailed in New York any day before noon, it should reach Europe the next afternoon and be taken within a few hours by local airmail to almost any of the important cities. If this is not the case and an airmail letter may happen to wait several days before departure of an aircraft, the service across the Atlantic would lose most of its value with respect to pioneering and study.

"The airplane service is certainly more flexible and faster than an airship service," he concluded, "and from an economical viewpoint would appear more practical."

Fighting Fungi With Fire

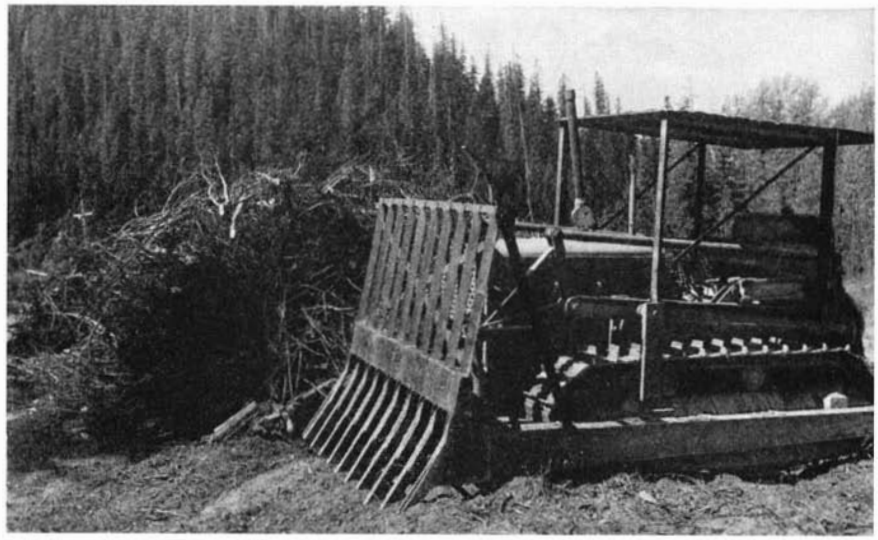
ONE of the most serious menaces to our pine forests is white pine blister rust. This fungous disease, which kills both white and five-needled pines, cannot spread directly from pine to pine, but passes an intermediate stage of development on currant and gooseberry bushes. These bushes may be infected by spores traveling distances up to 200 miles, but, fortunately, pines can be infected only by the spores from these host bushes within a distance of a few hundred yards. To protect stands of pine from this menace is, therefore, relatively simple; it is necessary only to destroy such bushes in proximity to pine forests.

The Civilian Conservation Corps has done considerable blister rust control work, for the most part by the hand-pulling method. In the west, however, this method was found to be impracticable in the dense masses of bushes growing in heavy brush along streams where the most susceptible species of currant and gooseberry bushes are found. Chemicals were tried, but while the wild black currant could be killed in this manner, no chemical was ever discovered that would satisfactorily control the white-stemmed gooseberry.

THE eradication of this species, found especially in the Coeur d'Alene and Kaniksu National Forests in North Idaho, proved quite a problem. This was solved by development of the bulldozer method of eradication. A blade was designed especially for brush removal to be attached to a bulldozer on a tractor. This blade is pushed into the ground just below the surface and, as the tractor moves forward, the brush is uprooted. Piled into windrows, this brush is burned after the danger of forest fire is passed. Cleaned areas are then sown to grass in order to inhibit the recurrence of the white-stemmed gooseberry bushes. Experience has shown, however, that there is very little tendency for these bushes to come back in the cleared area between the windrows. Any bushes which recur where the brush was burned can be readily pulled by hand.

While the bulldozer method is more expensive than either the hand-pulling or the chemical spray method, it is most efficient in areas where the white-stemmed gooseberry occurs in large numbers and where the brush is too heavy for effective eradication by any other method.

Area of brush-host to white pine blister rust before being worked



The tractor and bulldozer with special brush-removing blade

Same area shown above after being cleaned up but before brush is burned

Bronze Age Blondes

Ancient Wooden Coffins in Denmark . . . Buried for 3000 Years . . . Dress, Art, and Customs Revealed . . . Tannic Acid Kept the Treasure Intact . . . Priestess?

By SOPHIE WILDS

A FEW months ago an old, hollow log, buried for thousands of years, was excavated at Skrydstrup, a little hamlet in the south of Jutland, Denmark. Today this yawning tree trunk (Figure 1), a veritable treasure chest, lies in the National Museum at Copenhagen, still unexplored, although its contents are known to be of inestimable value. It awaits the skilful but very busy hand of an expert in the museum, to be opened and examined. The lid has been removed, disclosing the general outline of a figure—a woman with fair hair, held in a net of woven ribbons, the shape of whose face and body can be distinguished. It will be some months before authorities can reveal the details.

I came upon a similar coffin (Figure 2) that had been opened and was recently on view in the new wing of the Copenhagen Museum. The body which had lain in that black log was clothed in garments also on exhibition. They were perfectly preserved. Because they seemed the last word in sport styles I doubted their authenticity. Was it possible that this simple costume, almost unimpaired, had actually been worn hundreds of years before the dawn of history. This is the story that archeology has managed to piece together.

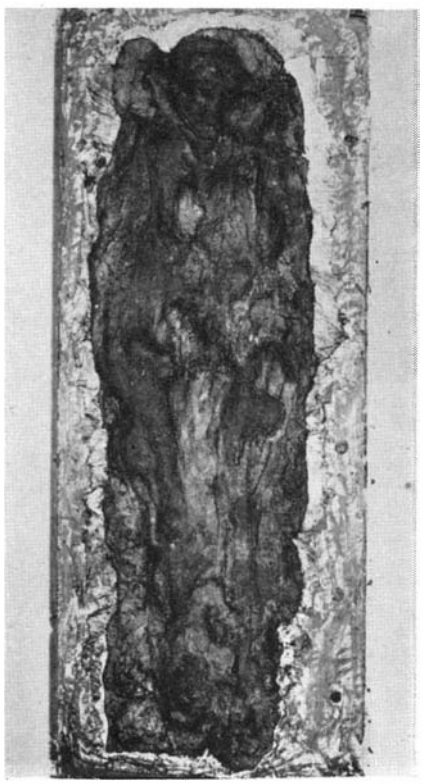


Figure 1: **The intriguing Skrydstrup find which remains to be unwrapped**

Nearly 3000 years ago on the peninsula of Jutland, a blond, slender, bobbed-haired young woman died. They laid her to rest in that skilfully hollowed oak tree trunk. On a foundation of small stones the chest rested. Upon it was heaped a high mound of loose meadow ground and sandy earth. Since about 1000 B.C. this 14-foot barrow at Egtved (a small village in the southeastern part of the peninsula), like innumerable other such monuments, had guarded its secret. When the burial mound was cleared away and the box was opened that dim Bronze Age in which the young woman had lived was vividly recalled.

THE intelligent Egtved farmer on whose property the chest was found voluntarily consigned the precious box to museum authorities, who subsequently spent many days in unwrapping the bundle within—a job as difficult as it was exciting.

Above all other objects found in the chest the most remarkable is the woolen dress interwoven with stag hair, according to Dr. J. Broendsted, Curator at the National Museum in Copenhagen and authority on prehistoric times. To be sure, it is not the only wooden coffin to yield, Pandora-wise, dress of ancient date. It is, however, to the "one man" tombs of wood, built in the later Stone and the Bronze Age, that we owe the preservation of both men's and women's costumes. These are of an earlier date than any other clothing as yet discovered in Europe and the dress of the Bronze Age is the oldest preserved domestic dress in the world.

The excitement and enthusiasm attendant upon opening a chest can easily be imagined. The lid fits closely,

Figure 2: **Remains of the blonde from Jutland peninsula, Denmark**

an oak tree trunk having been dexterously split and scooped out to admit the reception of its contents which were then closed up and lost to view. With what care this cover is pried open and removed! Within the Egtved coffin, first to be seen were the loose hairs (all that was left) of a cowhide which had been originally fastened together around the body. The hide itself had completely disappeared. Spreading a retaining foundation over the easily scattered hairs, the museum authorities gently removed the first wrapping. There before their eyes lay the outlined figure of a woman's body under a heavy woolen blanket. She had been placed in the hollowed-out trunk on her back, resting on the fur side of the cowhide.

To those versed in archeological interpretations every minute detail is eagerly seized upon. So it was with enthusiasm that they spied a little yarrow flower just under the lid. Silently they blessed that wanton gust of wind which must have fanned the flower into the chest before it was closed, life's last protest against grim death. The tiny flower had now become a bit of reliable evidence. It proclaimed summer to have been the season of the year when interment took place.

Only a single wrapping now hid the body itself from the archeologists' sight. Tenderly, even reverently, this was now laid aside. This woman envoy from ancient days had blond hair, now stained

Figure 3: **The lady's woolen blouse must have been somewhat scratchy**

Figure 4: **The skirt, marvelously preserved and in the 1928 style**

by the tannic acid of the oak coffin. Cut short in a straight line across the forehead and slightly longer at the side, it had been held in a hair net of woven ribbons. Her brown woolen dress is in two pieces—elbow-sleeved blouse (Figure 3) reaching somewhat below the waist and knee-length skirt of fringes (Figure 4), twisted double, held together at top and bottom by bands. These, together with a beautifully woven belt at the waist and a chased, bronze belt plate, contrived to produce the effect of a startlingly modern costume, well adapted for sports. Nor did the lady lack shoes, crude and primitive though these rag ones were. For ornaments, besides the belt plate, she had a tiny bronze earring and bronze bracelets which clasped both wrists.

What was in that bundle at her side? The beaker at her feet, what had it contained?

Soberly, content to solve one problem at a time, the archeologist-detectives set slowly about their task of unraveling the mysteries before them. With so many well preserved objects to guide them, it was possible to recreate the past in some detail.

This young woman's age was easily estimated by the teeth and, although the bones had entirely disappeared, such objects of wearing apparel as were present lay in the original position which they had occupied centuries ago when enfolding her body. Thus her height could be computed. A belt, knotted around her waist, served to measure her girth.

Who she was, in what manner she had lived, cannot be accurately concluded. Archeologists do not hesitate to place the period in which she lived at about the year 1000 B.C. She was a lady of the Bronze Age. The belt plate decorated in spirals testifies to that, says Dr. Broendsted. But who has ingenuity enough to interpret the story of the dress? Was it a summer costume, an indoor garment, or had it some religious significance?

Other samples of clothing have come down from the Bronze Age; little bronze figures, too, representing women kneeling, standing, bending over backward, and wearing the short fringed skirt. It is thought that these figures may be small models of idols or priestesses and their costume a ceremonial garment.

If that be so, suggests Dr. Broendsted, then the Egtved woman may have been a priestess. He advises us that this is nothing more than conjecture, however, without adequate proof. There is just as much reason to believe that, far from representing some occupation or calling, the garment may simply be the kind worn in summer (the season in which the body was interred), or the style adapted for house wear. It is well known that Eskimos dress lightly indoors.

Material is too insufficient as yet to provide a key to the riddle. Possibly new clues will be found in the Skrydstrup bundle—new clues and perhaps also new problems.

THE birch bark beaker in the Egtved find had contained an invigorating drink to fortify the departed. Analysis of the remaining deposit revealed its ingredients to have been whortleberry, honey, and sweet gale. That was an easier puzzle to solve than the one posed by the other remarkable content of the chest, the cloth bundle which, when opened, was found to contain the burned bones of a seven- or eight-year-old child —the little daughter of the woman, perhaps? Who can tell? Why was the child cremated when the woman was buried? Insoluble problems.

Just as the transition from wandering nomad to settled farmer, which in Denmark occurred about 2500 B.C. to 2000 B.C., marked a significant period of history, so this change in burial customs represents a drastic innovation. From time immemorial primitive man, in his fear of death with its accompanying dread of complete oblivion, bent all his energies to outwit the enemy. Nothing was so abhorrent to him as the idea of obliteration, of being snuffed out and forgotten. Every known means was requisitioned to defy this horrible fate: food and drink placed by the body of the departed; the body itself carefully dressed as in life and interred, first underneath the earth to be near the living, and in later ages in monumental stone sepulchers which served as constant reminders of the dead—everything was done to impart at least the semblance of life to the remains of the departed dead.

How was it, then, that so startling a change occurred? This new custom of deliberately destroying the body by fire was diametrically opposed to the instinctive desire for its preservation so apparent up to that time. Dr. Broendsted reminds us that the dissolution of the body had meant the annihilation of the individual. Did cremation indicate a changed attitude, a disbelief in immortality? Surely the implication of such an iconoclastic view must be wrong. No, the explanation lies in a new and wholly different attitude toward death. Scholars believe that it marks the introduction of a new religious concept stemming from a southern invasion—namely this, that the soul is separate from the body and that the death of the latter does not end the everlasting life of the individual spirit. Quite the contrary, in fact, since by destroying the body the soul may be liberated. This must have seemed logical.

Due to this new faith the graves of the later Bronze Age people have been valueless, archeologists say, containing as they do nothing but ashes. Earlier people built better than they knew. Believing in the continuity of life they had so successfully demonstrated their triumph over death that many hundreds of years later their spiritual resurrection miraculously took place. When last year a young woman posed (Figure 5) in a newly made costume, constructed after the pattern of the original, and designed for the opening of the new wing of the Museum, intervening centuries rolled away: the Lady from the Bronze Age came to life, revealing what manner of people she represented by the quiet simplicity of her dress—a quiet simplicity still to be found in Denmark.

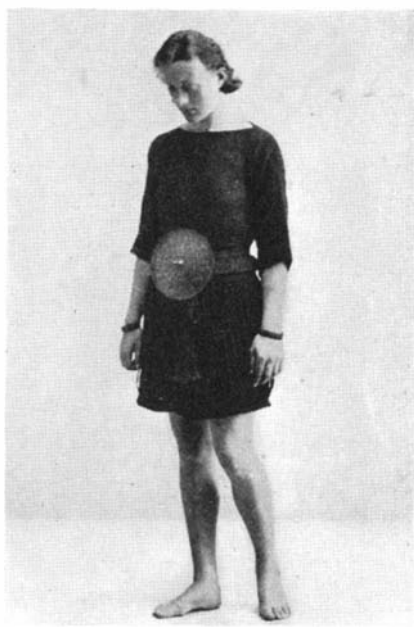


Figure 5: **A modern copy of the blonde's costume of 3000 years ago**

LIQUID-PROPELLANT ROCKET

THE author of the accompanying article is the dean of scientific experimenters on the high-efficiency rocket as a means of propulsion wholly independent of the air—a reaction motor. He began theoretical work in 1912 when an instructor in physics at Princeton, patented a "rocket apparatus" in 1914 (U.S. Patents No. 1,102,653 and 1,103,503), made actual experiments in 1915 when an assistant professor of physics at Clark University, and in 1919 the Smithsonian Institution published his first progress paper, "A Method of Reaching Extreme Altitudes," describing his preliminary experiments. He is now Director of the Physics Laboratory at the same university.

The accompanying paper is published by permission of the Smithsonian Institution, and is Dr. Goddard's second official progress paper on his work. It is conservative; the author never has been inclined to rush into print with hopes and great expectations, and even now he describes only what has actually been accomplished in his experiments. In a recent editorial comment, *Nature* (London), the world's foremost nonpopular journal of general science, states: "It is good to hear that such experiments are being carried out, and the sober objectivity of Dr. Goddard's work presents a sharp contrast to the unscientific imagination exhibited by those who seek to direct attention to the advent of interplanetary travel before the preliminary investigations that might throw light upon its possibility or otherwise have been completed." Some other writers on rocketry are far ahead of Dr. Goddard and almost, in fact, on Mars already—in books.—*The Editor*.

(*In Two Parts—Part 1*)

THE following is a report made by the writer to the Daniel and Florence Guggenheim Foundation concerning the rocket development carried out under his direction in Roswell, New Mex., from July 1930 to July 1932, and from September 1934 to September 1935, supported by this Foundation.

This report is a presentation of the general plan of attack on the problem of developing a sounding rocket, and of the results obtained. Further details of the work will be set forth in a later paper, after the main objects of the research have been attained.

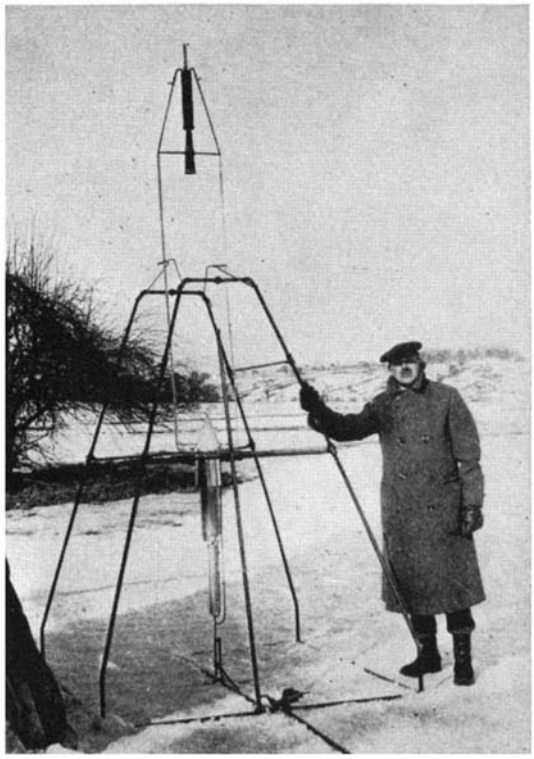


Figure 1: **The first liquid oxygen-gasoline rocket, in the frame from which it was fired**

In a previous paper[1] the author developed a theory of rocket performance and made calculations regarding the heights that might reasonably be expected for a rocket having a high velocity of the ejected gases and a mass at all times small in proportion to the weight of propellant material. It was shown that these conditions would be satisfied by having a tapered nozzle through which the gaseous products of combustion were discharged,[2] by feeding successive portions of propellant material into the rocket combustion chambers,[3] and further by employing a series of rockets, of decreasing size, each fired when the rocket immediately below was empty of fuel.[2] Experimental results with powder rockets were also presented in this paper. [Out of print. See at libraries.]

Since the above was published, work has been carried on for the purpose of making practical a plan of rocket propulsion set forth in 1914[3] which may be called the liquid-propellant type of rocket. In this rocket, a liquid fuel and a combustion-supporting liquid are fed under pressure into a combustion chamber provided with a conical nozzle through which the products of combustion are discharged. The advantages of the liquid-propellant rocket are that the propellant materials possess several times the energy of powders, per unit mass, and that moderate pressures may be employed, thus avoiding the weight of the strong combustion chambers that would be necessary if propulsion took place by successive explosions.

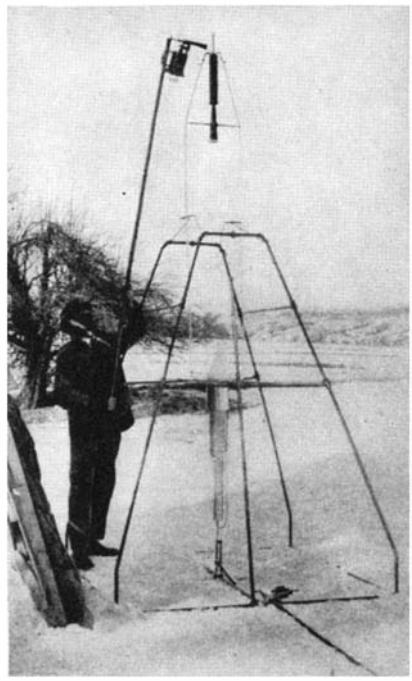


Figure 2: **An assistant igniting the rocket shown in Figure 1, by torch**

Experiments with liquid oxygen and various liquid hydrocarbons, including gasoline and liquid propane, as well as ether, were made during the writer's spare time from 1920 to 1922, under a grant by Clark University. Although oxygen and hydrogen, as earlier suggested,[4] possess the greatest heat energy per unit mass, it seems likely that liquid oxygen and liquid methane would afford the greatest heat value of the combinations which could be used without considerable difficulty. The most prac-

[1] Smithsonian Miscellaneous Collections, Vol. 71, No. 2, 1919.
[2] U. S. Patent, Rocket Apparatus, No. 1,102,653, July 7, 1914.
[3] U. S. Patent, Rocket Apparatus, No. 1,103,503, July 14, 1914.
[4] Smithsonian Misc. Coll., Vol. 71, No. 2, 1919.

DEVELOPMENT

Development Carried Out in New Mexico . . . The Fuel Was Liquid Oxygen and Gasoline . . . Col. Lindbergh, and Then Others, Became Interested

By ROBERT H. GODDARD
Director of the Physics Laboratory at Clark University

tical combination, however, appears to be liquid oxygen and gasoline.

In these experiments it was shown that a rocket chamber and nozzle, since termed a "rocket motor," could use liquid oxygen together with a liquid fuel, and could exert a lifting force without danger of explosion and without damage to the chamber and nozzle. These rockets were held by springs in a testing frame, and the liquids were forced into the chamber by the pressure of a non-inflammable gas.

The experiments were continued from 1922 to 1930, chiefly under grants from the Smithsonian Institution. Although this work will be made the subject of a later report, it is desirable in the present paper to call attention to some of the results obtained. On November 1, 1923, a rocket motor operated in the testing frame, using liquid oxygen and gasoline, both supplied by pumps on the rocket.

In December 1925 the simpler plan previously employed of having the liquids fed to the chamber under the pressure of an inert gas in a tank on the rocket was again employed, and the rocket developed by means of these tests was constructed so that it could be operated independently of the testing frame.

The first flight of a liquid oxygen-gasoline rocket was obtained on March 16, 1926, in Auburn, Massachusetts, and was reported to the Smithsonian Institution May 5, 1926. This rocket is shown in the frame from which it was fired, in Figure 1. Pressure was produced initially by an outside pressure tank, and after launching by an alcohol heater on the rocket.

IT will be seen from the photograph that the combustion chamber and nozzle were located forward of the remainder of the rocket, to which connection was made by two pipes.

Figure 2 shows an assistant igniting the rocket, and Figure 3 shows the group that witnessed the flight, except for the camera operator. The rocket traveled a distance of 184 feet in 2.5 seconds, as timed by a stop watch, making the speed along the trajectory about 60 miles per hour.

Other short flights of liquid oxygen-gasoline rockets were made in Auburn, that of July 17, 1929, happening to attract public attention owing to a report from someone who witnessed the flight from a distance and mistook the rocket for a flaming airplane. In this flight the rocket carried a small barometer and a camera, both of which were retrieved intact after the flight (Figure 4). The combustion chamber was located at the rear of the rocket, which is, incidentally, the best location, inasmuch as no part of the rocket is in the high velocity stream of ejected gases, and none of the gases are directed at an angle with the rocket axis.

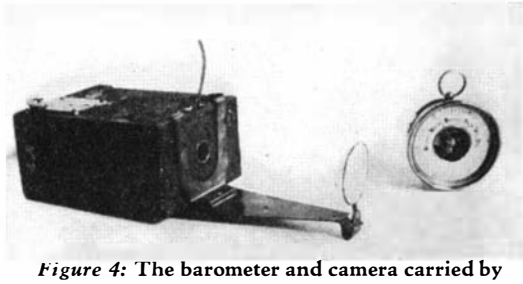


Figure 4: **The barometer and camera carried by the rocket and safely retrieved after the flight**

During the college year 1929-30 tests were carried on at Fort Devens, Massachusetts, on a location which was kindly placed at the disposal of the writer by the War Department. Progress was made, however, with difficulty, chiefly owing to transportation conditions in the winter.

At about this time Col. Charles A. Lindbergh became interested in the work and brought the matter to the attention of the late Daniel Guggenheim. The latter made a grant which permitted the research to be continued under ideal conditions, namely, in eastern New Mexico; and Clark University at the same time granted the writer leave of absence. An additional grant was made by the Carnegie Institution of Washington to help in getting established.

It was decided that the development should be carried on for two years, at the end of which time a grant making possible two further years' work would be made if an advisory committee, formed at the time the grant was made, should decide that this was justified by the results obtained during the first two years. This advisory committee was as follows: Dr. John C. Merriam, chairman; Dr. C. G. Abbot; Dr. Walter S. Adams; Dr. Wallace W. Atwood; Col. Henry Breckinridge; Dr. John A. Fleming; Col. Charles A. Lindbergh; Dr. C. F. Marvin; and Dr. Robert A. Millikan.

(*To be concluded*)

Figure 3: **Group that witnessed the flight of the rocket shown in Figure 1, except the member who took the photograph. The author stands between the other two**

CONDITIONED AIR?

What *is* Air Conditioning? . . . Newer Concepts . . . Present Status . . . Design Trends . . . Complex Problems of Heating, House Insulation Involved

By PHILIP H. SMITH

IT is still impossible to predict the day when air conditioning will be as commonplace as the bathtub in the American home. Air conditioning has made steady progress, but *sound* growth precludes a quick and unlimited expansion to create in this the new, major industry, new employment, and the boom times for which many persons hoped.

This failure to become an economic pick-me-up overnight is a good thing from every standpoint. Expectations of progress were based upon wild estimates rather than inherent possibilities and this is readily apparent to anyone who understands what a complex engineering problem air conditioning involves.

What is air conditioning? To you it probably means the cooling of indoor air. To the commercial producer of conditioning equipment it means almost everything but cooling, while the engineer regards it as a complex problem of treating air in relation to factors of heat, moisture content, and many others, with due consideration to a host of variables connected with installation and operation of equipment. Confusion as to terms is a notable feature of the talk about air conditioning; hence a sound definition is a required basis for any informative discussion.

Faced with the fact that a few opportunists were calling an electric fan an air conditioner, the National Better Business Bureau evolved a definition which is generally accepted. It declares that in air conditioning the minimum requirements for winter are: the heating, humidification, and circulation of air; for summer: the cooling, de-humidifying, and circulation of air; while year-around conditioning calls for a combination of both. As a further qualification, it is stated that the functions required by the seasons should be performed automatically and simultaneously to suit the requirements of the user.

THE Bureau's definition is excellent as safeguarding the consumer from buying equipment which does not condition, but it must not be assumed therefrom that an increase in physical comfort cannot be had from equipment which falls somewhat short of meeting the definitions. There are excellent devices on the market which will improve atmospheric conditions without contributing *full* conditioning. There is a new, if transitional, concept of air conditioning.

The public's first experience with air conditioning was a chill blast and that effect "conditioned" many people's conception of it. Conditioning became synonymous with lowering of temperatures, yet today, cooling is a minor phase of conditioning enterprise except in public buildings. Concurrently with the development of conditioning equipment has come a modification of the concept of conditioning from the theoretical standard of what a dwelling temperature should be, to what is actually required by the body for its comfort—comfort being a relative matter. This new concept has minimized the importance of cooling as a feature of air conditioning.

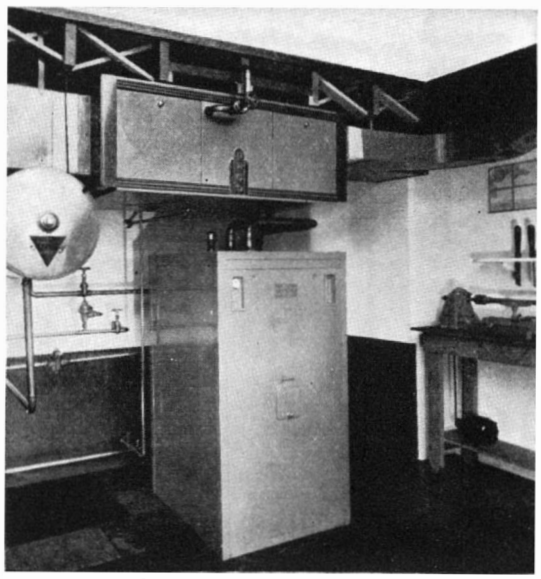
Air conditioning today lays stress on circulation, filtration, and water content of air, as expressed by the functions of humidification and de-humidification. Cooling has become an adjunct. The reasons for this newer viewpoint of air conditioning are threefold: technical, economic, and physiological.

Of the first reason, this much can be said: Full air conditioning, which embraces cooling, requires proper house construction for efficient and satisfactory performance. If a house is not properly insulated, there can be no adequate control of the air within it. Most houses are not so constructed and if equipment manufacturers and installators were to limit their efforts to designing and selling equipment for properly built homes, their market would be limited to the new construction field—an almost negligible market.

The economic angle permeates all considerations, but there is one slant on it which is outstanding. At the present time, to add cooling to the other functions of air conditioning increases equipment cost 50 percent and more.

A unit for conditioning the air of a single room. This small, compact type, similar to several produced by different companies, is simple in operation, needs little attention

A "conditioner" of a different type for a specific use, shown in the window. This one does a triple job of filtering and circulating incoming air and silencing outside or street noises



An "all-purpose" air conditioning unit including oil furnace heating

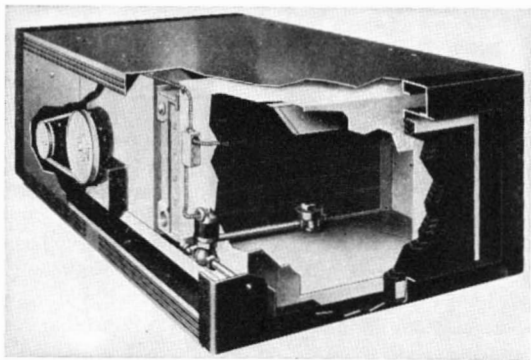
Now if we realize that a maximum use of cooling amounts to little more than 600 hours in the year, this demands that the consumer pay heavily for the slightly added comfort to be had in one-fifteenth of the year. Such facts discourage the consumer from pursuing cooling, once such facts are recognized.

Given the two facts—that most dwellings are not well suited for cooling and that costs are prohibitive for the vast majority of home owners—it is little wonder that cooling as a function of air conditioning is being played down commercially. While it is making the best of irrefutable fact, there is the physiological angle to give a certain validity to the new concept.

PERSONS who patronize theaters and other public places must have noticed, if they are observant, that temperatures are not as low today as they were when air conditioning was a novelty. This phenomenon results from the discovery that cooling for comfort must be relative and not absolute. Picking 70 degrees as a comfort point, regardless of outdoor temperatures, was comfortable only in theory and now we know that the maximum spread between indoor and outdoor temperatures should never exceed 15 degrees; that comfort is obtained within a zone and not at an arbitrary point, and that the zone fluctuates.

Coincident with this discovery of the gulf between the theoretical and the actual, experiments revealed that we really know very little about the body's air needs. Excessive cooling certainly seems to be worse than none at all. But it is known now that a considerable increase in comfort can be had by merely filtering, controlling the water content, and circulating air in enclosed spaces.

The realization that comfort rather than cooling *per se* is the objective seems a trivial one but it is vastly significant because it has enormously increased the desirability, possible scope, and use of air conditioning. If it is a departure from accepted definitions of what air conditioning should be, and only transitional, it has at least done this much—it has opened the way to make old residences more comfortable without excessive expense, it has brought relative comfort within the range of a larger public, and it has given the air conditioning industry something to go on while it works out the problem of designing full air conditioning equipment within a practical cost range.



Cut-away section of unit shown above illustrating the filter and humidifier

There are on the market today a great number of air conditioning devices. The simplest ones should be called "comfort makers" since they fall short of our air conditioning definition. Nevertheless, they belong in the discussion.

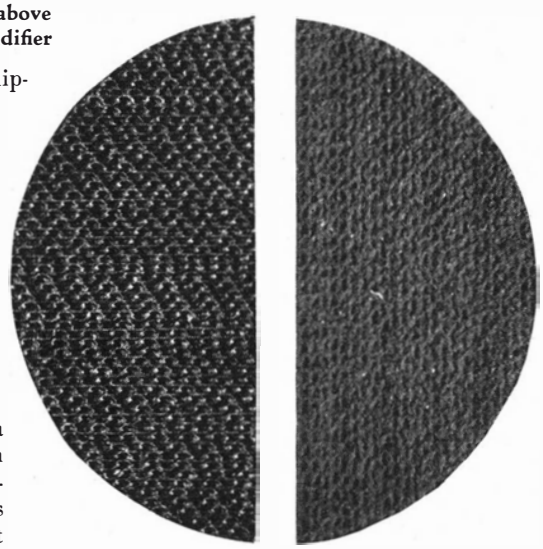
Probably the simplest device among many comprises a box-like structure which sets in the window much as does a ventilator. An enclosed fan draws air from outdoors, passes it through a filter and forces it through louvres into the room. There is no attempt at control of water content or temperature and the comfort contributed is solely one of providing a circulation of clean air which will help the body to rid itself of moisture. Such a device may also combine a silencing mechanism to shut out street noises.

Closely allied in type to the air circulator is a blower device designed to improve conditions in an entire house. It is nothing more nor less than a fan installed in the attic of a home, which draws air from below and expels it outdoors to create a steady circulation of air throughout the house. It is intended to prevent the accumulation of hot air in the attic during the day, while the circulation of the cooler night air tends to lower the temperature of the structure as well as its interior air with some lasting benefit during the day. In effect it does lower temperatures and helps to equalize them.

Approaching the definition of true conditioning there are devices for conditioning individual rooms. One type does a winter job of heating, filtering, humidifying, and circulating air, while a more elaborate type includes the features of cooling and drying to meet summer and year around requirements. These devices approximate an enclosed radiator in size and appearance and are operated by electricity.

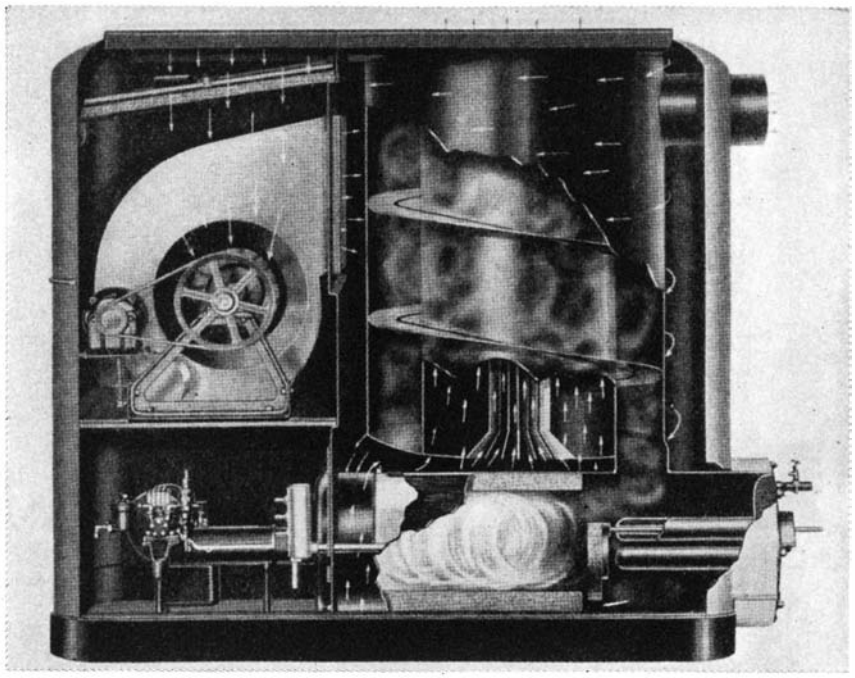
Also on the market are portable units, one type of which resembles a mechanical refrigerator, and functions in similar manner; another uses ice for the cooling.

Leaving behind the partial conditioners and single room units, there is equipment which is designed to handle the conditioning of an entire house. We find here a similar cleavage between cooling and non-cooling equipment with major emphasis placed on the other functions of conditioning. Indeed, the significance of cooling today is made plain by the absence of reference to it except in the most casual way, whether it be in sales literature or in announcements of devices about to be launched commercially.



The filter of the above unit: clean, at the left, and dirty after two months' use, at the right

The job of cooling an entire house is not one that air conditioners like to handle unless consumer funds are large. Installation and operating costs are a



Hot air heating—conditioned—is coming back! In this furnace unit, incoming air passes through filter, fan, and then over 36 linear feet of heating surface

sales deterrent. We all know something of the problem of mechanical refrigeration and its cost, so the refrigerator will illustrate the point. A typical refrigerator contains about eight cubic feet of space to be cooled, while a room 15 by 15 by 9 feet contains 2000 cubic feet. To make the latter comfortable with a drop of 15 degrees in temperature would require the equivalent of melting about one half ton of ice every 12 hours, and the current necessary to produce this amount of refrigeration is considerable.

THE use of ice as a cooling medium goes back many, many years. Weber and Fields once played at a New York theater where, for public attention, they competed with cakes of ice over which fans played to send forth a sort of arctic fog. From this crude device, development has led to equipment which uses the water of the melted ice, flowing through coils, as the cooling agent for the air which is passed over them. A number of ice installations have been made in private homes and presumably more of them would be seen if the ice industry were as aggressive as its competitors. Equipment for ice-cooled air conditioning is less expensive and simpler than the mechanical compressor type, but ice is more expensive than electrical current; hence, when equipment and power costs are considered together, ice is an economy only when operating time is short. It is best suited, for example, where large numbers of people gather, but where the period of use is too short to justify tying up large amounts of capital in equipment.

Air conditioning equipment manufacturers are in disagreement as to the desirability of making heating and air conditioning a single unit. Those who advocate a separation of the two base their contention on the fact that home owners may wish heating without conditioning and vice versa; and that division simplifies the problem of controls. Proponents of union declare that combining the functions makes for greater efficiency and simplification of equipment. Time alone will determine which camp wins. The governing factor at the moment is very largely the commercial one of expanding the type of business from which our manufacturers are projecting air conditioning. Merit in consumers' hands will settle the ultimate type.

Since conditioning involves air, it is no wonder that warm air heating has come back into vogue with the newest of designs, but this development by no means excludes other systems. Both hot water and steam heating systems can have air conditioning either as equipment for new houses or for modernizing old ones. Adaptation to both systems has been successfully achieved by using air conditioning on the ground floor and heating radiators on the floors above. The heating, therefore, remains the same, but the conditioned air is slightly warmed as well.

IN warm air heating systems the heated air is also the conditioned air, because functions are performed by a single unit. These are known as the direct fire type because the air comes into direct contact with the heating unit. In appearance the devices differ little from the modern oil- or gas-fired boiler, being both compact and automatic in operation. If cooling in such mechanisms is desired it must be had as a separate piece of equipment.

Although air conditioning apparatus varies greatly in design, there is a striking similarity in fundamental operation. Air is drawn from outdoors by fan or blower; it is filtered, humidified or dried, warmed or cooled, and discharged into living quarters through some form of duct. The most common type of filter comprises a two-inch pad of hair-like material saturated with oil to trap the dirt particles. There is also one of corrugated design which forces the air to turn a corner and pass over a sticky substance. Another type is constructed of minute glass strands laid criss-cross and graduated in mesh so that large particles are caught first. One conditioner is equipped with a signalling device to announce when the filter has become clogged beyond use. It sounds complex, but is really very simple. When the filter becomes choked, the air flow is reduced and the resulting change in pressure is utilized to raise a signal so that a new filter can be slipped into place.

A humidifier may be a simple evaporating pan located in the furnace; it may be an air washer or spray through which the air passes; in the case of warm air systems, it can be a steam vaporizer. Proper operation demands that it be capable of humidifying a given amount of air in a specified time, predetermined by the volume of the space to be conditioned and the amount of air to be circulated through it. Full comfort is impossible unless the proper humidity is established. The converse process, de-humidifying, is an accompaniment of cooling and follows naturally from the precipitation of moisture from the air as it becomes cooler; drying the air with coils is also practiced.

THE problem of circulating air is mainly one of seeing that a sufficient volume of air is handled to provide repeated changes in rapid succession; that this air enters and leaves the room through ducts in such manner as to provide movement in all parts of the room; and to do this without drafts or undue noise.

Air conditioning is very simple, but actually very complex when carried out on a commercial scale. We have already pointed out that construction is of prime importance because air cannot be controlled in a structure which is a sieve. Then there is the factor of dwelling design which makes every installation unique if it is to function with maximum efficiency. The floor layout affects the air volume required, rate of air flow, and positioning of ducts. The number of persons to use a room and their activities also influence the solution.

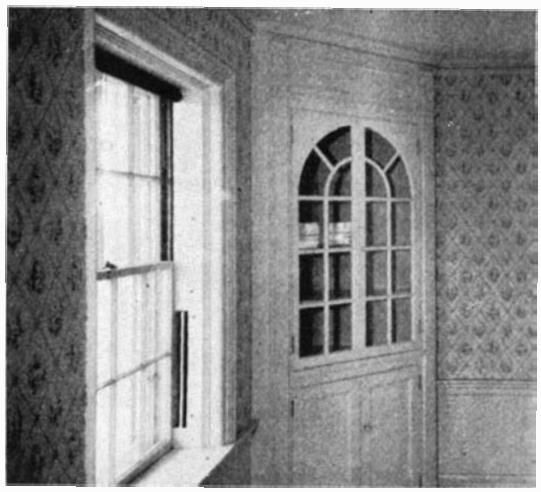
Individuality of structures, which makes for specialization in equipment,

retards the standardization of equipment and hence delays a mass production which would lead to a lowering of cost. Until the engineering is standardized to a much greater degree there can be no mass market, or mass installation, not alone because of high initial cost but because of the skill required to install with satisfaction.

The progress of the past few years has been in the direction of this requisite standardization. Conditioners have been simplified, made more positive and automatic in action, more efficient in operation. Ducts have been designed so that there is less hand shaping and cutting required on the site. Requirements for comfort have been worked out so that what is needed can be told in advance and the consumer is assured of getting the service that he seeks. But this still leaves the problem of cooling very much as it was before.

The fact that cooling is subordinate for the moment does not imply that it will be so always. Cooling is a major part of comfort needs: it is the function of air conditioning which the public is most consciously wanting, and that alone is reason enough for further research and development to obtain it at reasonable cost. De-humidification, which is needed for conditioning in summer, is being tackled along different lines already, the new angle being the use of moisture-absorbing chemicals through which the air can be circulated, but actual cooling may have to find its ultimate solution along lines not yet contemplated.

A hint of developments yet in store is given by one enterprise now entering the commercial stage. It involves a new conception of house construction, but steers clear of the windowless tomb of which we have heard so much already. This house is built of steel, brick, and cement and is thoroughly insulated with cork, but its unique quality arises from the manner in which these materials are assembled. This will be described best by tracing through the air conditioning plan.

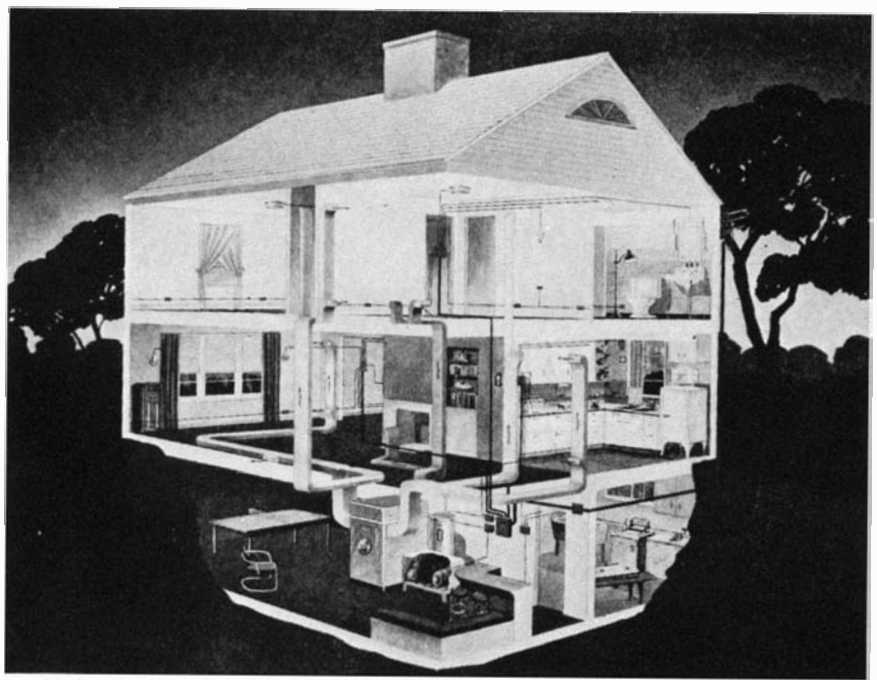


During the summer, the slot beside the lower sash of window of "The House That Breathes" is the air inlet while the outlet is a grille high up on the wall of the room. In winter, the direction of air flow is reversed

Air enters under the eaves and passes down through a section of the hollow wall—lined inside with cork, on the outside with a brick veneer—to a duct which conveys it to a warm air furnace. Having been filtered, warmed, and humidified, the air is forced up through ducts and injected into the room through a grille near the ceiling, and then returned to the basement through slits in the window casing which permit it to fill the remaining hollow wall areas on its way. Upon reaching the basement, the air is expelled through a chimney, not to be reconditioned. Exhausting the warm air through the walls in winter time is claimed to aid in maintaining an even distribution of heat.

In summer, the process is reversed by shutting a damper. Air is drawn from outdoors at the foundation level. This entrance is nothing more or less than a cellar window of double construction with the air passing between sashes. The air passes through the hollow walls where the brick surface tends to de-hydrate it and cool it (a temperature drop of about 12 degrees is claimed). It enters the room through the window frame slits, exhausts through the wall grille and is again dispersed through a flue in the chimney. Because the heating system is of the warm air type and air is drawn from outdoors with a natural conditioning process, the only necessary extra equipment is a blower. In summer even the blower may be shut down because of the natural air circulation through the house.

This particular solution to the air conditioning problem involves construction with conditioning in mind and it is probable that most other solutions will place heavy emphasis upon the fundamental building design. Certainly, it moves in the right direction for it answers the problem of cost which now stands squarely across the path of further development. It also regards heating, insulating, and air conditioning as unified problems and there are many authorities who believe that there can be no final solution which is not so based.



Skeletonized house showing a typical air conditioning installation. From basement units, fully conditioned air is distributed through ducts, summer and winter

WE can't get away from it. Satisfactory air conditioning is inseparably linked with insulating and heating, two factors which are as yet in a primitive stage of development. Their joint study and joint solution are called for, and when this has been achieved the home owner will perhaps save enough on fuel costs to get his air conditioning as "velvet."

Photographs courtesy American Radiator and Standard Sanitary Corp., Borg-Warner Corp., General Electric Co., and The House That Breathes, Inc.

MISINTERPRETED

Things which Have Been Considered Detriments in Protective Coloration are Actually Protective in the Highest Sense—to the Helpless Young

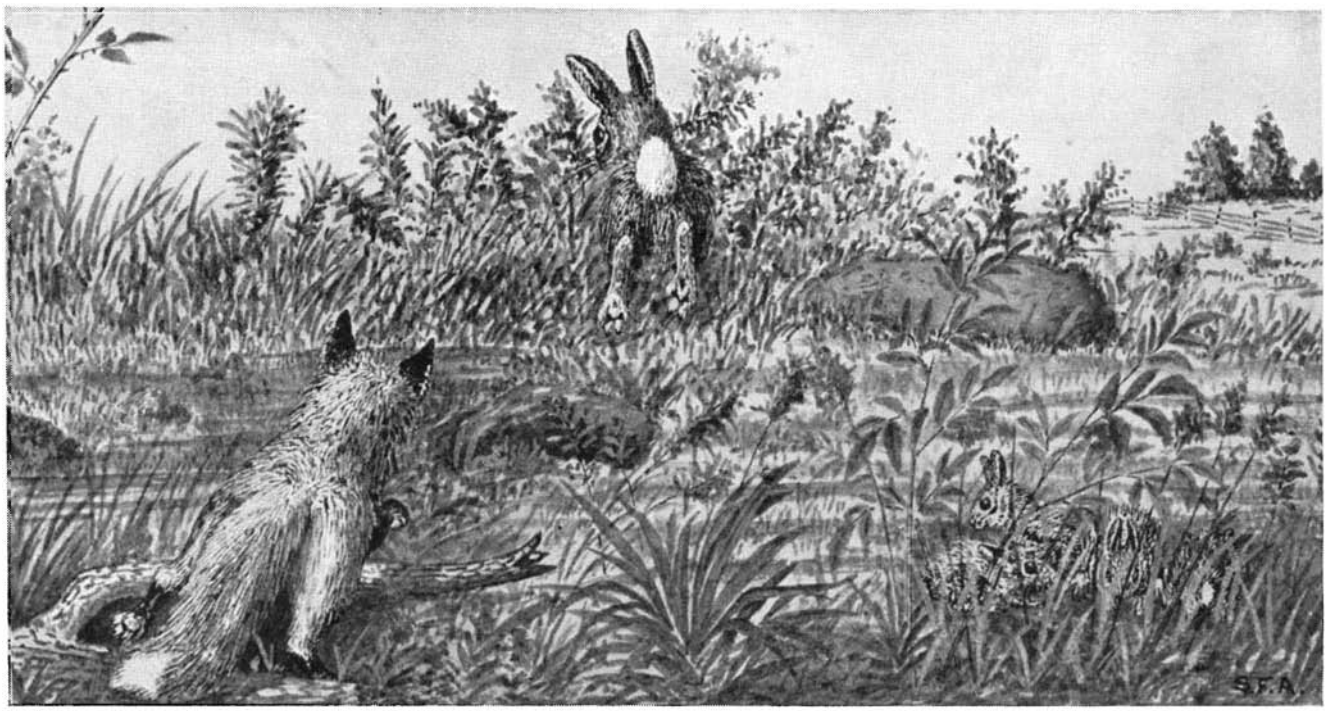
THE long-discussed evidences of natural selection, combined with De Vries' mutation and supposedly in contradiction to the practically inapplicable Mendelian heredity, have so confused many natural scientists that some of the compelling influences which govern development appear to have received too scant attention. At least small mention is made of certain striking influences that bear directly upon the evolved characteristics of protective coloration apart from resemblances to surroundings. Not until very recent years, if at all within the minds of many observers, have these well-proved features been understood or accepted. Even so, there will be, as always, dissent from new discoveries, no matter how fully convincing the evidence.

My friend the hunter-naturalist sees Molly Cottontail leap away through the grass and, were it not for the flash of her white fluff glaringly disclosing her rapid retreat, the shot that laid her low would not have been so unerringly directed. Hasty comments follow: There are many white-tailed creatures that thus signal their presence to their enemies and that might otherwise escape notice; can it be that natural selection, commonly unerring for the perpetuation of species, would so reverse its influence? Doubt of the entire process often results.

THE long-held theory that these features serve as signals to others of their kind, or as recognition marks, would seem by observation to be impractical. Metcalf in his admirable, non-technical "Outline of Organic Evolution" says: "Birds and mammals especially display these" (recognition signals). He cites the common rabbit, the white-tailed deer, the western antelope, and African gazelles with similar white rump patches, and he quotes Alfred Russell Wallace as interpreting that "the white outer tail feathers of birds and the streaks and spots about the head are recognition marks by which the individuals of the same species identify one another." Metcalf adds: "Probably this is a true explanation of one use of such marks," and he quotes C. Hart Merriam's suggestion that the white colors mainly conspicuous upon certain insects, birds, and mammals when in motion are but to give a confusing comparison to the obliteration of these markings when the creatures alight or crouch, thus giving the effect of a sudden disappearance.

Surely the theorists have been hard put to it for an explanation of features that for a long time were most completely misunderstood and also misinterpreted through lack of knowledge and comprehension. If characteristics showed in any way an actual disadvantage instead of protection there could not be a selective influence, and to that the immutability advocates heartily agree, taking a great number of willing sheep with them over the fence into barren pastures and some of the overestimated philosophers and nature students too eagerly joined the flock. Leading the van, a great nature writer pronounces Darwin completely repudiated—a rather pitiful position when the facts are displayed.

But how can the objectors be other than right? With hardly an exception those beasts and birds that are commonly preyed upon by terrestrial predatory animals, and are the least able to defend themselves or their young, are in some way especially attractive to



Molly Cottontail flashes her signal and hungry Reynard does not stop to discover the young bunnies hard by. It is the instinct of the predatory animal, like some human beings, to take after the meal that attracts its most immediate attention

Animal Observations

By S. F. AARON
Illustrations by the author

their enemies. All the world's deer, antelope, and gazelles, all the darker colored goats and sheep, have great white patches on their rumps, displaying thus their get-away to pursuing enemies and to man; the rabbits and hares flash their white flags against the dark backgrounds of brown fur and herbage as signals to foxes, wolves, the cat tribe, the minks, and weasels. And there are the very numerous ground-nesting birds and some others, with flaring white tails to flaunt before hawks, owls, and many leaping, four-footed enemies. Has selective protection overlooked this apparent reverse to that which has been so universally claimed for it?

HOW simple and easy is the answer when we know the facts, substantiating rather than refuting the great law of development. It is dangerous to accept hastily a principle until all the facts are fully known and digested.

There is one period in the life of every preyed-upon creature when it is subject to far greater dangers than can assail it later. This, of course, is during extreme infancy when both escape and defense are impossible. But behold parental care: the development not only of mother love, but of physical characteristics widely distributed that, instead of endangering the races of creatures that possess them, commonly insure safety for the helpless young.

A hungry cat's nostrils are filled with a most delectable odor: rabbit—young, tender, hard by within a wide patch of long grass. Crouching, she begins a smell-directed hunt that in a moment must disclose the warren, deep set in the ground, containing six or eight helpless, half-naked little things that may easily be clawed out and dined upon. So sure is the eager huntress of a meal, following her unerring nose alone, she is about to leap into the midst of the grass when suddenly a form takes shape before her that a moment ago her round, staring yellow eyes could not discern and Molly Cottontail, on the alert to protect her young, leaps up and slowly away among the grass, her ground color not distinct, but the pure white bunch of a tail glaringly so, unmistakably alluring. Without hesitation the killer goes after the signal, leaping, but always a little short of the mark until the warren is left far behind and the cat finds herself no match in speed for the owner of that deceptive white flag.

The crouching, powerful puma anticipates mountain lamb, but the big cat's approach to the little creature hardly able to use its legs is interrupted by the more desirable mother big horn who offers herself and her white rump patch as a greater inducement; the big cat, with long leaps, going after her, only to find the mother sheep's speed the greater; the saved lamb, no doubt, wondering what all the scratching of gravel is about.

At night the vesper sparrow, brooding her clutch beneath a towering tangle of weeds, is awakened by a jostling of the grass around her and stares into the eyes of that sneak thief, the skunk, who loves bird eggs and young birds better than anything else. But he has not seen the nest yet, and he does see a slow-moving spread of white feathers. After that he goes, keeping on until the white feathers disappear in swift flight, yards away from the nest.

The male scarlet tanager boldly flaunts his colors and the sharpshinned hawk is tempted to give chase. Thereby he is led far beyond chance of discovering the brooding mother bird

SO potent is this developed signaling to a foe for the protection of the helpless young, and so universal is it among the creatures that are easily approached by many enemies, that it is as constant in character and habit as any other dominant trait. Nature has fixed this necessary habit so firmly that at all times do fleeing deer and antelope hold their tails aloft, making the white the most visible object about them; the black-tailed deer of the American northwest shows only the white under surface of the tail when retreating. Every mother ungulate that is not able with horns backed by superior weight to defend her young, as can the bison, buffalo, musk ox, and moose, possesses the wide white rump patch, or the white tail.

As for the ground-nesting birds, much the same may be noted, and a list of those that are so endowed would be too long to print here. These will also include some that nest on large branches or in holes in trees that may easily be reached by predatory creatures: the mourning dove, the robin, the wood-

peckers, the shrikes, the cuckoos, certain wood warblers, the nuthatches and the chickadees are examples, and all of these birds practice alluring actions.

Rarely need the birds nesting in vines, bushes, or dense herbage, or upon the outer branches of trees, find use for such protection for their eggs and young, as their climbing enemies cannot follow their deceptions. Hence, with the exception of the kingbird, few of these have any white about them except the under parts, which are not seen when retreating.

Except in daytime (and most of the enemies of ground-nesting birds and of the nearly defenseless mammals hunt at night), no color but white, no matter how bright, can well serve the purpose as a camouflage. It must be noted, however, that white tails and rumps are not the only very visible parts of retreating mothers; the white patches of head, body, and wings serve a similar purpose. The head markings of the white-throated and white-crowned sparrows are examples; the ducks, snipes, sandpipers, and plovers show many white patches that serve. It is only necessary to observe the remarkable antics of the kildeer in holding its white-patched wing aloft when its nest is approached, to be convinced of the value of these characteristics.

The white tail of the meadow lark draws the weasel away from the nest. Similarly mourning doves, robins, woodpeckers, shrikes, cuckoos and other birds carry flashy signals

WE also find exceptions to this protective coloration of tails, or other displayed parts, among ground-nesting birds. In every such example there are counter-causes and it must be borne in mind that development influenced by one certain cause may result in varying characteristics. Thus many of the sparrows and warblers, the brown thrasher, the veery and the hermit thrush and some others possess sufficiently bright colors, other than white, for attraction during the daytime. But all these species show other characteristics that may be as effective in saving the young as the commoner influence noted. It will be observed that loud notes of warning are uttered, with much excited fluttering about, close to the interloper.

Again it will be seen that, when many birds, especially among the bush and ground-nesting sparrows, are flushed from the nest they retreat a little distance, often the shortest to be safe, and invariably turn toward the intruder, exhibiting their white breasts. This may be the function of the white under parts of most birds, for what other purpose could such an almost universal feature serve?

In his "African Game Trails" Colonel Roosevelt clearly shows that among the hunted and some hunting creatures there is little truth in the idea of protective coloration to adult animals, and this finds substantiation everywhere from giraffe and zebra to the tiniest deer. Rather does the coloration of most species, as the observing naturalist proved, call ready attention to the many creatures in question.

But the value to these animals of their advertisement to their enemies is missed entirely and it must not be overlooked that the adults can depend upon their legs.

Nothing has challenged speculative evolution more than secondary sexual variation: the relative unessential differences between the sexes of highly organized creatures. Primary sexual development deals with the essential differences for purposes of propagation. Those that are non-essential have been termed secondary. Examples are the mane of the lion, the antlers of the stag, the horns of the billy goat, the plumes and brilliant colors of male birds.

Very naturally within our scope of better understanding come our feathered friends of garden, field, and grove. May I say, though with profound respect for those observers who have elucidated so much of value, that it is difficult to understand how the many biographers of avian life have failed to grasp certain salient facts. The greatest, most widely learned of all naturalists, in his eagerness to find an explanation for the secondary sexual differences in many birds, overstepped the bounds of possible animal intelligence when he ascribed to the females of the species an esthetic sense, an appreciation of the beautiful. Birds do contemplate nesting-sites and show wise selection of nesting materials, and they undoubtedly reason on ways and means and the overcoming of unforeseen handicaps, but there is very little reason to suppose that most of them at least are more attracted by what seems to us beautiful than that which appears to the human mind as dull. To quote:

"It appears that female birds . . . have by a long selection of the more attractive males added to their beauty or other attractive qualities," and farther on: "No doubt this implies powers of discrimination which will appear extremely improbable . . . but I hope to show that the females actually have that power." ("Descent of Man," Chapter VII.)

THIS idea of conscious and intentional selection fixed thus in the minds of observers who follow the lead of the learned promulgator of a dominant law, has simply been accepted and has persisted for over half a century without contradiction and to this day is confidently advanced. As an example, in a recent number of a popular periodical a worthy nature student charmingly sets forth the same idea. Professor Henry Smith Williams says: "We can explain the dangerously conspicuous costumes worn by many summer birds only on the ground that the females of the species love bright colors and persistently discriminate in favor of the males that are the most vividly adorned. . . . This may even jeopardize the race, but the esthetic eye must be served." He goes on to speak of "dangerous dandyism" as a possible cause of extinction.

And again, concerning sparrows: "They have been content to choose plain-coated husbands. No spectacular mates to advertise the location of their nests and menace the entire family by signaling their presence to enemies."

Now then, let us look at this really simple matter of selective development as it deserves, after a somewhat more careful observation; whereupon we may entirely deny the foregoing acceptance of purposeful selection.

In the first place, female birds do not select the more ornate or colorful males as the most attractive. Instances among domestic fowl abundantly prove this fact, and there is not wanting similar evidence concerning the wild creatures.

WHEN orchard orioles first return in the spring from the South the young males are olive green and dull yellow, much like the females, and their songs are generally inferior to the brighter-hued members of their sex; yet a lone female will often take up with these youngsters in preference to the black and red males of an earlier season. I have known two instances of this, and one where a goldfinch, mating unusually early, accepted as a husband a fellow no less proud, but which had not yet received his sulphurous adornments. I knew a jaybird that turned down one uniformed suitor for another without a tail, a cat having deprived the latter of his elegant possession.

Hens frequently accept only the attention of dull-colored roosters rather than of those bedecked with bright colors. Pigeons in mixed lots do the same, and fanciers well know this. Ducks, whether polygamous or singly mated, are absolutely indifferent to colorful beauty as man appreciates it.

Consider also the influence of voice and its sexual selection. Birds do not sing in a musical sense. In no instance, asking the pardon of the poets, do they mean to charm the female, nor is she the least affected. Just as chanticleer utters his challenge to all possible rivals, as the turkey gobbles or the grouse drums, so the birds sing. Even the sublime hermit thrush, the masterful mocking-bird, the softly cadencing field sparrow, the chanting cardinal, utter their so-called song notes as a defiance to whatever rivals may dare to invade their chosen precincts. This fact is beyond contradiction, as shown by numerous instances. At no time will a cardinal, a Baltimore oriole, a Carolina wren, a horned lark, nor a veery pour forth sweeter and more voluble notes than when engaged in actual combat with another male of the same species. Few, if any, birds sing around the nest or when courting. Mate two canaries and the male rarely sings; separate them and almost any harsh sounds excite his ire and start his trills. Throw a stone into a bush and the chat or the yellow-throat, like the English nightingale, not lacking imaginative suspicions, will at once pipe up to defy a supposed rival.

Much the same influence governs strutting, dancing and cutting capers as practiced by grouse, true pheasants, many water birds and grackles. The turkey tom struts and gobbles only when he wants to convince himself that he is monarch of all he surveys, never when he is importuning some coy hen.

What, then, has been the process of selection to bring about the bright adornments of many male birds? So distinctly in evidence is it that it must play an important part in the survival of many species, not their destruction, and it is indeed remarkable that its influence was not comprehended when the differences in plumage between the sexes was noted. For how very simple it is and how easily it may be interpreted.

Burroughs wrote that the best way to make intimate observation is to go into the woods and fields and remain quiet, as does the squirrel hunter. Who among us has not profited by that advice? At least the facts here set forth owe their discovery to its practice.

The female tanager is up there on her nest in "the heart of the ancient wood" and it will demand the eyes of a hawk to discern her green back within her bower of leaves. But a rapacious bandit appears suddenly, seeking the eggs or young birds, or, better, a well-fed adult. A little searching will surely disclose the nest and the mother bird. What, then, will suffice to protect them? Nothing more than the most effective appearance of the black and scarlet male at a little distance, flashing his gorgeous hues in direct defiance of the robber.

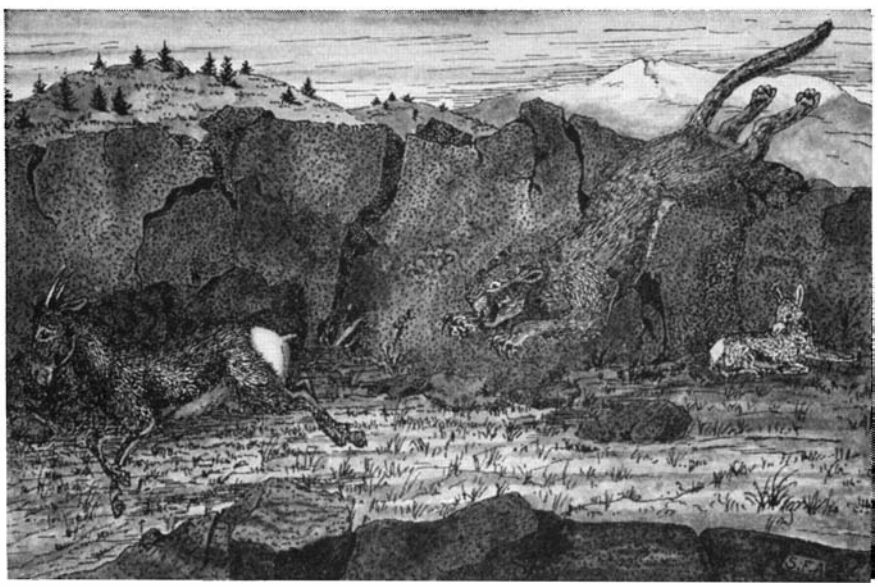
IMMEDIATELY the hawk goes after him, but he dashes away to thick cover and the would-be murderer is led afar, the brood saved.

But should the hawk capture the male the latter can be better spared in the process of perpetuation than the female or the young. Had the scarlet and black been replaced by olive-green would the enemy have been as quick to see and to follow the male?

I have witnessed, though but once, this very act and it required no great wit to interpret that which should have appeared conclusive long before, from seeing not quite fully enacted similar and suggestive behavior on the part of other species. I have watched a cat sneaking in the weeds and grass near a bobolink's cradle; whereupon the male bird eagerly displayed himself, undoubtedly to lure the cat away, which effort was accomplished.

Thus it is with the oriole, the goldfinch, the indigo bird, the Kentucky warbler, the cardinal and many others—approach the nest and you at once become aware of the near antics of the male to attract your attention. Remarkably is it true of the red-winged blackbird and of the rose-breasted grosbeak; the latter presents from a near limb his white and red-blotched breast in contrast to his inky black, and only the wisdom of man sees through the scheme; the hawk or day-hunting owl never can.

Thus the bright plumage of many male birds, instead of being a product of selective vanity and resulting from an estheticism altogether impossible, is really the result of a very evident need; and instead of being "a dangerous dandyism" is a distinct protection to the species and a large factor in its perpetuation. Far from advertising the nest, it provides a counter-lure to guarantee safety, as does also the pretense of injury practiced by many mother birds.



The puma goes after the mother big-horn's white rump patch. She draws the big cat on for half a mile or so and the lamb is safe. "Protective" coloration?

RECENT PROGRESS IN

What Actually Causes Earthquakes? . . . How Deep Do They Originate? . . . Is The Earth's Core a Solid or a Liquid? . . . The More We Learn the Less We Know!

WHEN a baby first learns to walk, it likes to look back from time to time to see how far it has traveled. Seismology is still taking baby steps and, in this article, I propose to look back and see how far we have traveled seismologically in the last few years.

In the matter of instrumental development, the most recent progress has been the perfecting of a new instrument especially adapted to the detection of local earthquakes. These local earthquakes are known to have an extremely short period. In contrast to the last short period instrument developed some ten years ago—the Wood-Anderson torsion pendulum with a mass of one fortieth of an ounce, shown in Figure 1 —the new Benioff instrument shown in the same figure has a mass of three-quarters of a ton and the extremely short period of one half a second. An idea of the sensitivity of the instrument can be had when we say that a ground motion of one two-millionth of a pinhead is easily discerned on the galvanometer. The magnification for extremely short period waves is of the order of 100,000.

Since the invention of this instrument, hundreds of local quakes are recorded annually that would otherwise pass unnoticed. But, though so admirably adapted to the recording of local quakes, its use is by no means confined to local disturbances. It has the added feature that it can be coupled to a long and short period galvanometer simultaneously, making it a two-in-one instrument for recording both local and distant quakes. The acquisition of this new detective to its staff makes seismology a veritable Scotland Yard. It will be hard for an earthquake to escape detection now.

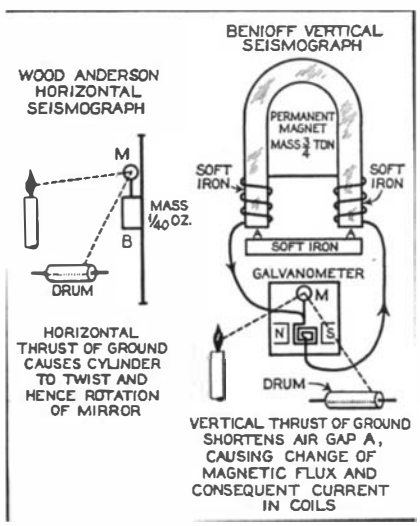


Figure 1: **The principles by which two earthquake instruments operate**

TURNING from the instrument to the records it produces, one type of record that has long puzzled seismologists is the record of micro-seisms (Figure 2). These micro-seisms are small vibrations with a period of a few seconds and a ground movement of about one three-hundredth of a pinhead, that continue periodically for several days at a time. They occur whenever we have a severe windstorm or whenever we have a sudden cold spell, and they are slight up and down motions of the ground extending down some depth and felt simultaneously over wide continental areas. Extensive investigations have been carried on to determine the cause of these baby quakes and, to date, three explanations have been offered. One explanation is that they are caused by the beating of the surf against rocky coasts. A second explanation is that the ocean imparts a vibratory motion to its bed which, in turn, imparts it to the entire continent. A third explanation is that they are vibrations caused directly in the continent by barometric changes above it. The majority of seismologists seem inclined to favor the latter.

Another question which the seismograph record is expected to answer is: "What is the nature of the core of the earth; is it solid or liquid?" One of the waves started by an earthquake is what is known as a shear wave which can travel only through a solid. Does this shear wave travel through the core of the earth? If it does, the earth is a solid. If it does not, the earth is a liquid. To date, there has been much dispute as to whether or not this shear wave has been proved to have passed through the core. Seismologists have looked for it on their records but it is not easy to recognize, since it always occurs, if it

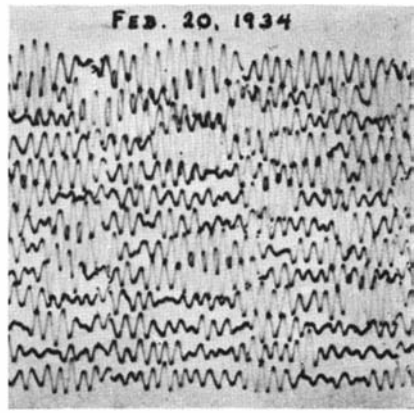


Figure 2: **Typical micro-seisms. What causes them remains a puzzle**

occurs at all, in the midst of a group of other reflected and refracted waves, many of which are stronger than itself. Seismologists in Japan, in America and elsewhere, claim to have positively identified this core shear wave on their records, but there are still some authorities who doubt their findings. The consensus seems to be that the shear wave does pass through the core and, hence, that the earth's core is solid. However, the decision to date is not quite unanimous.

Perhaps the most interesting topic discussed by seismologists recently is the depth below the surface at which an earthquake occurs. It was previously thought that earthquakes occurred comparatively near the surface—within a depth of about ten miles. In recent years, it has become apparent that earthquakes occur at much greater depths than this. We have reason to believe that they can occur at a depth of 500 miles. The first thing that led seismologists to suspect so great a depth for the origin of an occasional quake was their inability to locate some quakes. With plenty of perfectly good records obtained from well-equipped stations, occasionally it was impossible to locate the quake in a position which would satisfy the distances demanded by the records of the various stations. As an extreme case, a well-equipped station was occasionally found to place a quake as much as 400 or 500 miles away from the true location. This error I refer to was one of estimated distance —not of direction. (There is often an uncertainty of direction but rarely one of distance.)

Now the tables by which the distance of a quake is read off from the time difference between the arrival of the

EARTHQUAKE SCIENCE

By REV. JOSEPH LYNCH, S.J.
Director of the Seismic Observatory, Fordham University

longitudinal and transverse waves of a record were computed on the supposition that the quake occurred near the surface. The tables would be in considerable error if the quake occurred 500 miles down. It was suggested that these occasional errors of distances on the part of reliable stations were due

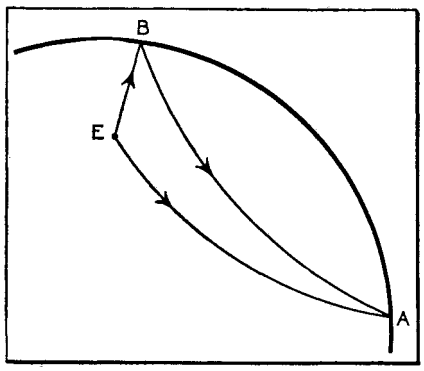


Figure 3: **A diagram to illustrate the argument outlined in the text**

to errors in the tables—or rather, due to the fact that the tables could not be used for such unusual depths of focus. For some such rebellious quakes, new values were computed for various depths of focus, and it was found that the supposition of a suitable depth of focus enabled the readings of the various stations to be brought into agreement and the quake to be definitely located.

Let us suppose now that a quake occurs at an unusual depth below the surface, at *E* in Figure 3. One wave should travel directly from the quake to the observatory at *A*. Another wave, starting out with the first from *E*, should travel up to the surface at *B* and from *B* down to *A*. It would arrive at *A* a little later than the first. Such a pair of waves were looked for in rebellious quakes, suspected of being at deep focus—and were found.

Suppose now, as in Figure 4, the observatory *A* were at the end of a diameter passing through the quake. Consider the two waves at *A*—the wave traveling directly from *E* and the wave going first from *E* to *B* and then from *B* to *A*. The time difference between these two waves is simply the time an earthquake wave takes to travel twice the distance from *E* to *B*, and hence the distance *EB* is known, since we know how fast an earthquake wave travels in the crust. *EB* is the depth of the quake below the surface, or the depth of focus. The wave traveling directly from *E* is called the *P* wave or "push" wave. The wave traveling from *E* to the surface and then to the station is called the *pP* wave, to distinguish it from the former. Tables have now been computed for the depth of focus corresponding to all possible time intervals between these two waves—the *P* wave and the *pP* wave—so that the seismologist is now able to determine not only the distance of the quake but also its depth of focus. In this way it has been found that many quakes have their origin at a depth of 500 miles or so beneath the earth's surface.

This discovery has brought up a further difficulty. An earthquake has usually been considered a fracture in the earth's crust. Is it possible for a fracture to occur at such a depth? The depth of the crystalline crust in which fractures might take place has been variously estimated from ten to 30 or 40 miles, below which is the supposed region of flow. By flow we do not mean that this glassy region is liquid—but that it admits of isostatic compensation or adjustment to varying loads above. A depth of 500 miles would seem, therefore, to be in a region where fractures do not occur.

TWO possible viewpoints arise, then, for these deep-seated quakes. (1) They are caused by fractures—but fractures occur at much greater depths than was formerly thought possible. (2) They are not caused by fractures at all but by some other cause. What is the other cause? A suggested cause is taken from thermodynamics. Quite recently it has been found that, at enormous pressure and only moderately high temperature, a change of state occurs in some substances with explosive violence. In the light of these experiments it has been suggested that a deep focus earthquake is the explosion resulting from such a change of state under the enormous pressure that exists hundreds of miles below the earth's surface. The matter has not been sufficiently discussed as yet to enable one to give the consensus among the seismologists.

In recent writings, both the fracture and the thermodynamical origin of earthquakes have been advocated. The weight of evidence from seismology seems to favor the fracture origin of earthquakes. Briefly, this evidence is: (1) In some deep focus quakes, the bulk of the energy is in the shear waves —not the compressional or explosive waves which one would expect, were the earthquake an explosion. (2) At the same location or epicenter we have both deep and shallow focus earthquakes occurring (at different times, of course). Since the shallow focus quakes are caused by fracture, it seems reasonable to attribute those of deeper focus from the same epicenter to the same cause. (3) Deep focus earthquakes so far have not been found off the beaten track of earthquakes—they occur only in definite earthquake regions. They would seem, therefore, to be brought about by the causes of earthquakes in general.

If the thermodynamics explanation were correct, one would expect an occasional thermodynamic explosion somewhere off the beaten track of earthquakes. Yet in a period of 20 years or so, no deep focus quake has occurred very far from the equator or outside the Pacific Basin, the usual home of earthquakes but perhaps after all, we now know far less than we did of the origin of earthquakes because we now know so much more—which reminds one of the popular glee club number:

The more we study the more we learn,
The more we learn the more we forget,
The more we forget the less we know,
So why study?

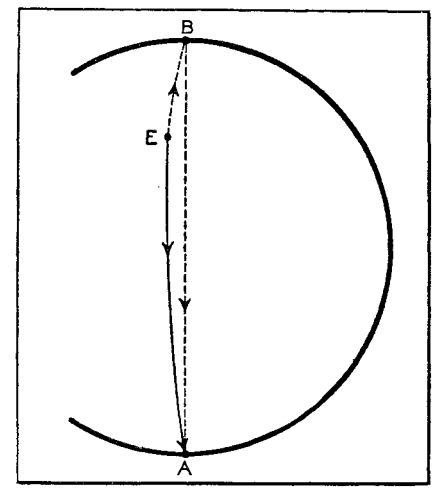


Figure 4: **For the sake of clarity the two paths were not superposed**

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

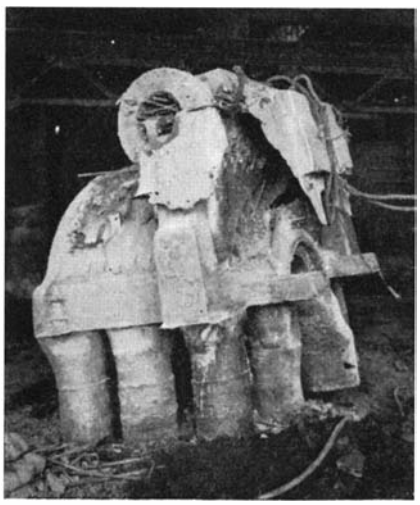
Contributing Editors

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

D. H. KILLEFFER
Chemical Engineer

A Steam-Driven Elephant

NO; to the contrary, foundrymen did not get facetious and attempt to mold an elephant, though the accompanying illustration may give that impression. Despite its resemblance to an elephant or



An "elephant" born in a foundry

some beast that roamed the earth in prehistoric time, the "monster" is in reality only the outer high-pressure shell casting of a steam turbine. The photograph was snapped in the General Electric works immediately after the casting was removed from the mold—before the cleaning, trimming, and machining operations necessary to make it a part of a powerful turbo-generator set had been performed. The turbine will be a 40,000-kilowatt unit when completed.

Selenium in Wheat

SELENIUM, the chemical element used in some light-sensitive cells, is absorbed from soil containing it by wheat grown on seleniferous fields. Not only is selenium absorbed by wheat and concentrated in the grain itself, but it is an active poison, according to W. O. Robinson, of the Bureau of Chemistry and Soils. The danger from this source can be avoided by careful examination of imported wheat since there are few areas in the United States where selenium occurs in the soil in quantities offering a hazard and these are already carefully mapped. There is, however, an added danger in the import of wheat from unknown areas which may contain selenium.—*D.H.K.*

BRITAIN'S MOTOR FUEL

NO less than 15 methods of carbonizing mixtures of coal and heavy oil to yield motor fuel have been practiced in Great Britain within the past six years.

Scratch May Produce Shock or Death

SCRATCH allergy has been added to the list of conditions of hypersensitivity, Dr. Williams W. Duke of Kansas City reported to the American Medical Association, according to *Science Service*.

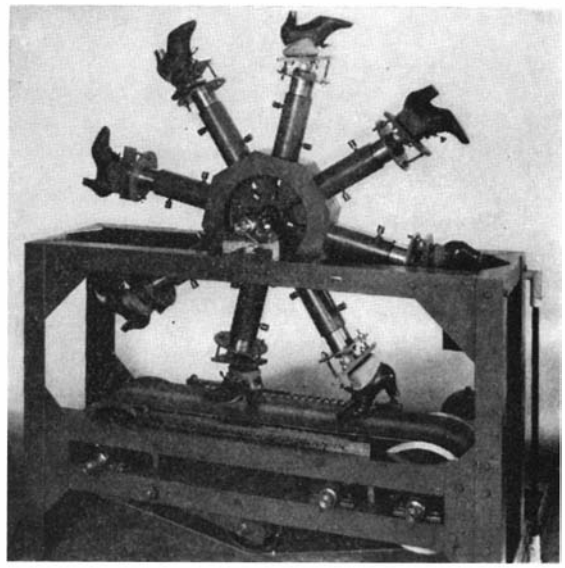
Besides persons who are sensitive to pollen, such as hay fever sufferers, and those sensitive to foods, heat, cold, and effort, Dr. Duke has now discovered patients who are so sensitive to mechanical irritation that a slight scratch may cause them to develop any reaction from hives to shock and possibly sudden death.

Such individuals can be desensitized, Dr. Duke reported, by scratching themselves thoroughly each morning and evening with a stiff hair brush or bath brush. Similar treatment by small exposure to the causative agent, whether heat, light, cold, or effort, will "cure" the hypersensitivity in the other patients.

"Rubber" to New Guinea

FOR the first time in history, a synthetic rubber has invaded a natural rubber-producing country to perform a function which the natural product cannot perform. Unlike "sending coals to Newcastle," the shipment of synthetic rubber to New Guinea, in the South Seas, was an actual necessity in this case.

This synthetic rubber is DuPrene. It goes to New Guinea in the form of an outer jacket for about 700 feet of heavy cable built by the General Cable Corporation, of Rome, New York. It is used as this outer jacket because natural rubber cannot stand



Simulating actual conditions of wear, the machine shown at the right was developed by the Bureau of Standards as an aid in preparing standards for shoemaking. The machine was designed at the request of the General Federation of Woman's Clubs. Motion pictures of people were studied in order to produce the proper foot action in the testing machine. The heel of the shoe first comes in contact with the moving belt, then the heel and sole both press on the surface. The load on the shoe gradually decreases as the belt moves along, the heel leaves the belt, and the toe is flexed as is done in walking. Courtesy ***Industrial Standardization***

the devastating sun rays of the South Sea jungle, where it is being used.

The Bulolo Gold Dredging Company is mining gold far in the jungles of New Guinea—in fact, so far from civilization that there are no roads and no surface transportation facilities. Hence all of the machinery used in the gold producing operations, including the cable, was transported by airplane, and the refined gold is brought out in the same manner.

As can readily be imagined, the heat is excessive and the direct rays of the sun are so severe that natural rubber for a cable jacket was found to break down quickly and completely.

Better Caustic

CAUSTIC soda, the most important of the strong alkalies, is produced in crystalline, anhydrous form more economically than by the customary fusion process by a new method developed by Autoxygen, Inc. Not only is all the water economically removed from caustic by the new method, without resort to fusion at high temperature, but the product is exceptionally free from sodium chloride and carbonate and is in an especially active form.

The old method consisted in evaporating as much water from the solution of the alkali as possible and finally heating the concentrated solution in heavy iron pots to the temperature of fusion of the caustic. Its product is a solid mass which must be broken up for use and which contains more or less impurities in the form of salt and sodium carbonate. In the new process, the concentrated solution from the evaporators is sprayed into a hot organic liquid, such as kerosene, which boils away with the water from the solution and thus yields caustic soda in fine, pure crystals. In this form caustic is very highly reactive chemically and it is expected that its use will greatly facilitate many important synthetic processes. Among the important applications of caustic soda are the manufacture of soap and many other valuable compounds.—*D. H. K.*

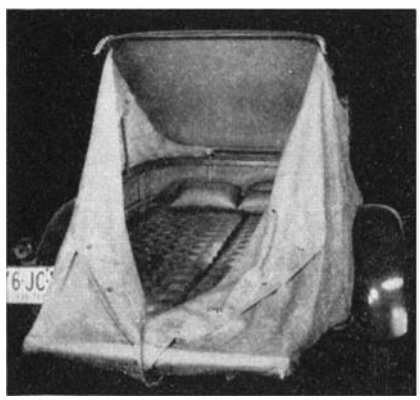
New Steel Trailer

PRODUCTION of an all-steel, low cost, utility trailer for passenger cars by the Mullins Manufacturing Corporation was announced recently.

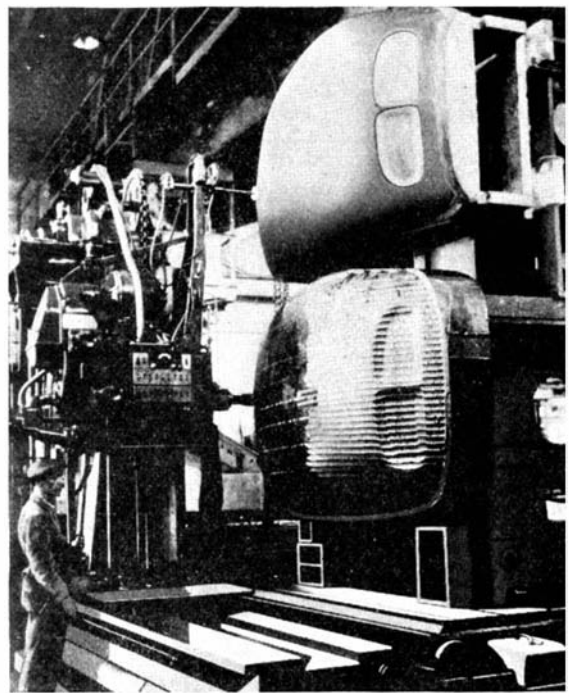
The trailer, which is of modern, streamlined design and will carry a maximum load of approximately 1200 pounds, is mounted on two standard automobile wheels and tires, and has the standard tread of 56½ inches.

All-steel, with hinged cover and tail gate, the lines of the new trailer conform to those of the modern automobile. It has unusual features of design and construction which are expected to appeal to tourists, sportsmen, merchants, vendors, salesmen, and farmers.

The trailer weighs about 485 pounds and has an over-all length of eight feet. The body is 47 inches wide and 16½ inches high, although the extreme height of the body and lid is 29½ inches. The end gate is 19 inches long and 34 inches wide. The wheels are stamped steel and the unit is carried on an eye-beam axle. The tire size is 17 inches by 5.25 inches.



Left: **A new pressed steel trailer for motor cars.** ***Above:*** **The trailer cover opened, showing how it may be fitted with two beds for camping**



Cutting nickel-cast-iron dies which form Hudson motor car tops is the job of the big Keller machine illustrated at the right by courtesy of *Nickel Cast Iron News*. The die-cutting machine first roughs out and then finishes the die, the cutting tool being guided in its path by the finger which passes over the master model shown above the die that is being cut. The corrugated surface of the die has only been rough cut, while the finishing operation is underway on the opposite end of the huge die

Lalor Foundation for Scientific Research

ANNOUNCEMENT was made in May of the Lalor Foundation, a Delaware corporation, organized for the advancement of scientific research and the encouragement of the arts. The Foundation is the recipient of a bequest of 400,000 dollars from the late Willard A. Lalor, a retired official of the Chicago, Burlington & Quincy Railway and resident of Washington, D. C. This bequest is a testimonial to his sister, Mrs. Anna Lalor Burdick, of the United States Department of Education in Washington, D. C., and to his brother, John C. Lalor, who was prominently identified with the early development of the mining and metallurgical industry in Montana.

Awards for this coming academic year will comprise five professorship and fellowship grants of 2500 dollars each. These awards are designed to give recognition to mature scholars of demonstrated ability and to afford opportunity to these men and women to conduct advanced investigations of a purely scientific character in appropriate fields of knowledge and under the freest possible conditions. Recipients of the awards for the coming year will be made public shortly.

The announcement was made by Dr. C. Lalor Burdick, Secretary of the Foundation.

FARM OIL CROP

RECENT studies made by the American Petroleum Institute have disclosed that oil taken from beneath American farms provides income of approximately 200,000,000 dollars annually for American farmers.

Adhesive Plaster Solvent

THE difficulty of removing large pieces of adhesive tape and plaster has long been known. Whereas small pieces may be ripped off by a quick jerk, larger pieces must be slowly soaked off with such irritating solvents as benzine and gasoline which frequently cause severe skin irritation and dermatitis.

A new solvent called Adhesol eliminates the danger of torn skin due to the ripping process, or the skin irritation due to the use of solvents. This liquid is dabbed on

with a piece of cotton and quickly softens the adhesive so that the tape or plaster may be removed speedily without danger to the skin or the nervous reaction often attendant upon the use of older methods.

APOTHEOSIS OF AIRPLANES

THE airplane has been deified. According to the Smithsonian Institution, this fact is indicated by five elaborately painted balsa-wood carvings of airplanes collected from the Choco Indians of eastern Panama. These same Indians, it will be recalled, still worship as a god a Scotch doctor, William Patterson, who treated them in the late 17th century and who was also founder of the Bank of England.

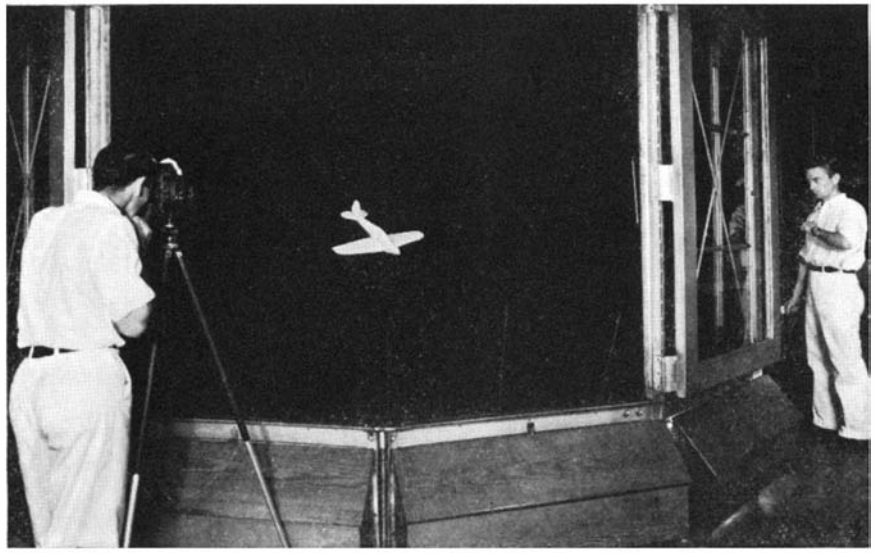
WATERPROOF MATCHES

HUNTERS, campers and fishermen may look forward to the day when their matches will not be made useless by dampness. L. E. Larson, of Jönköping, Sweden, has applied for a Netherlands patent describing the use of a water resistant resin as a binder in the heads of matches to replace the water soluble adhesives now used to hold the composition in a coherent mass.—*D. H. K.*

A VISIT TO THE LANGLEY FIELD CONFERENCE

THE National Advisory Committee for Aeronautics held its Eleventh Annual Conference at Langley Field, Virginia, recently, with the usual representative gathering of manufacturers, engineers, government officials, and university teachers in attendance. The purpose of the Conference is to allow the Committee to present the results of its researches to the industry, and to permit the manufacturers and their engineers to suggest new research problems to the Committee. There can be no argument as to the mutual benefits derived from this exchange.

The N.A.C.A. is fortunate in having perhaps the best equipment in the world at its disposal for aeronautical research and in being able to add steadily and intelligently to this equipment. Thus this year visitors were privileged to see the largest high-speed wind tunnel in the world in its final stages of construction. With a working section eight feet in diameter, the new tunnel will operate at the high speed of 500 miles per hour. The utility of such a tunnel for high-speed research is obvious. Stratosphere flying at speeds near the speed of sound may be with us in a few years, and a study of the special airfoils and other forms required under such conditions becomes imperative.



Testing a small scale-model airplane in the free spinning tunnel at Langley Field. Motion pictures of the attitudes of the model yield valuable data

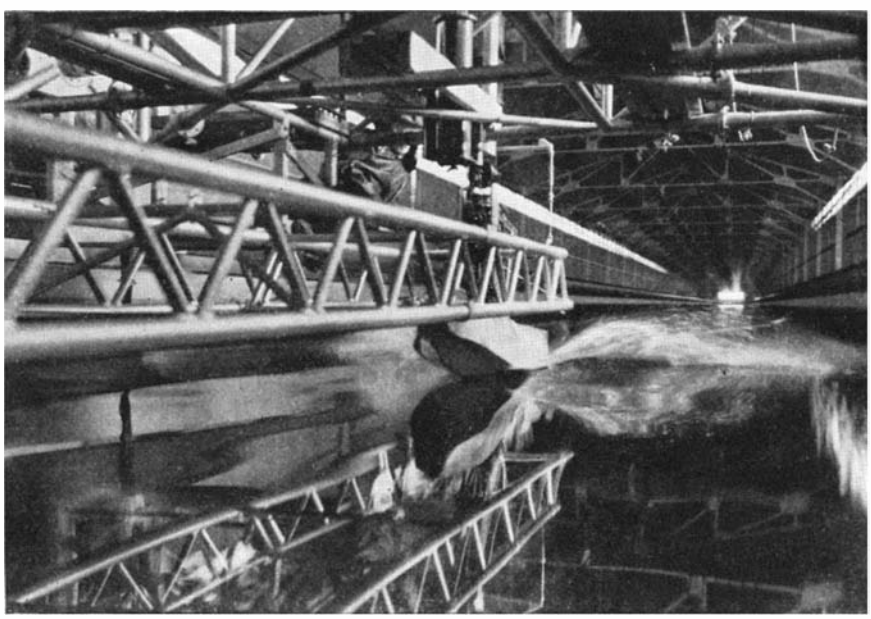
The new tunnel is built with 12-inch concrete walls with an inner reinforcement of steel plate, half an inch thick. At 500 miles per hour, the static pressure of the air in the tunnel is reduced to 800 pounds per square foot, while atmospheric pressure is 2117 pounds per square foot or 14.7 pounds per square inch. The difference is taken up by the kinetic energy of the fast moving air stream and the rugged walls are necessary to keep the tunnel from caving inwards. Incidentally, the pressure inside the tunnel is so low that it is equivalent to an altitude of 12,000 feet. The chamber in which the personnel will work and through which the tunnel proper passes is built in the form of an Eskimo igloo to resist these enormous forces, and is provided with pressure-controlled air locks.

An 8000 horsepower electric motor will be required to equip the tunnel. The motor will drive a 16-foot propeller of 18 blades. The enormous energy which is put into the airstream to overcome the friction of the walls is ultimately converted into heat. Thus a special cooling system had to be installed to keep the channel at practically outside-air temperature.

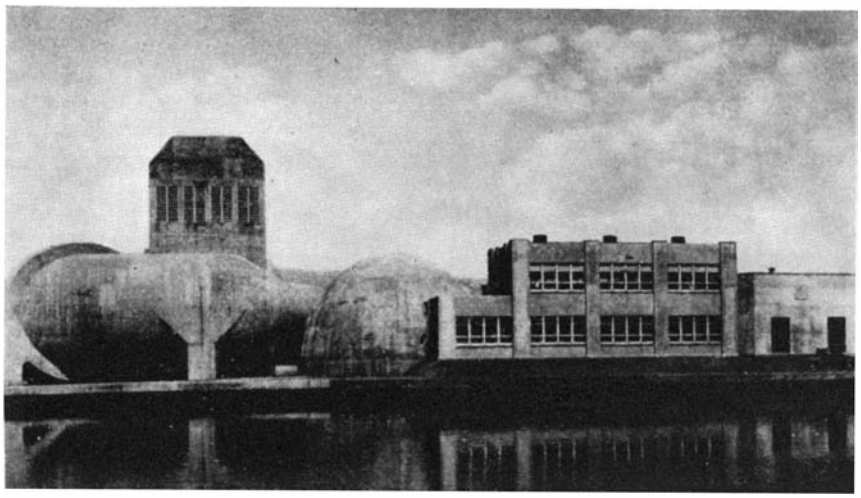
The day of miracles in aeronautical research is passing. In the future, we must expect steady improvement and refinement without such radical departures as in previous years, at least until we come to rocket flight, or flight at 50,000-feet altitude. The year's work of Langley Field brought no striking discoveries to the fore; there are, however, a large number of advances, minor in themselves but constituting invaluable knowledge as a whole for constructors and designers. The laboratories are busy all the time, and the only complaint made by visitors to the field was that they were incapable of assimilating in one day the great intellectual treat placed before them. In our story of the day's event, we can only mention the most important phases.

For high speed, propellers may have relatively small diameters; for take-off, climb, and altitude flight in thin air, the propeller diameter must be large. Accordingly, the designer must compromise. The variable-pitch propeller helps in such compromise but does not solve the entire difficulty. When stratosphere planes equipped with engines of 1500 horsepower each come into use, enormous propellers of perhaps 18 or 20 feet in diameter may become necessary—so at least was apparent from analysis of the propeller tests. The whole appearance of our airplanes may have to be changed, or else propellers will have to be built which will not only change pitch but also increase their diameters for altitude work. There is a pretty problem for our inventors and engineers.

Pilots do not like gusts and the resulting bumps, but they can stand them; passengers may find gusty flying just as uncomfortable as the rolling or pitching of a ship at



A model of a flying boat hull is shown here being towed at high speed in the towing basin at Langley Field, in order to study its operating characteristics



Part of the buildings at Langley Field. The bee-hive shaped structure in the center is the test chamber of the wind tunnel described on the opposite page

sea. Also, sufficient structural strength must be provided in planes to withstand any gust however violent. The Committee is quite rightly giving much attention to this problem and has installed accelerometers on the transport ships of all the major airlines, and thousands of records have been accumulated. Besides these accelerometer records in airline operation, Langley Field launches miniature airplanes carrying recording instruments and subjects them to artificially created gusts in the general study of the same problem.

The favorable report of the Airship Survey Committee and the successful flights of the Hindenburg are reviving public interest in the large rigid airship. It is a straw in the wind that Langley Field is almost as active as ever in aerodynamic research related to airships. One problem investigated during the past year is the forces developed during ground handling of airships. When the wind hits a ship the size of the *Macon* at an angle of 60 degrees, and at a velocity of 20 miles an hour, enormous forces are developed: the vertical or lift force is about 25,000 pounds, and the side force is about 65,000 pounds. No wonder that mechanical appliances and special tracks have to be laid down at Lakehurst for handling these monsters of the air.

Other significant researches can only be reported very briefly:

Rivet heads projecting on the underside of the hull may increase the water resistance some 25 percent, which may make a vast difference in the take-off characteristics of a heavily loaded transatlantic flying boat. This result was obtained in the large towing basin at Langley Field. Rivet heads projecting from the fore body of the hull are particularly detrimental, so the same investigation showed.

The Committee has tested hundreds of different airfoils in systematic research. Out of this vast research has come the N.A.C.A. 23012, which is recognized as the world's best airfoil, with low drag, high lift and a small movement of the center of pressure. There is scarcely a new airplane now built in the United States which does not embody this airfoil or some modification thereof.

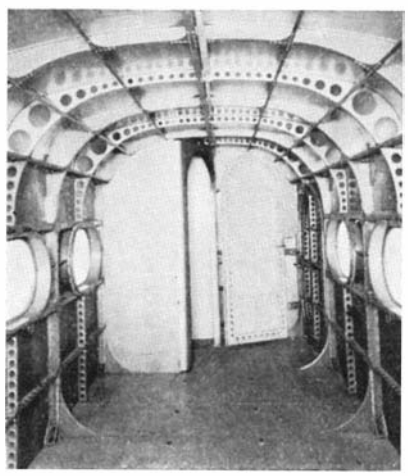
Other researches were concerned with the design of tapered wings in such fashion that the flow over the tips did not break down at large angles, thus safeguarding against the stall and spin. The effect of propeller slipstream over the leading edge of the wing was shown to increase the maximum lift 20 percent or more. In the free spin tunnel, visual demonstration was made of how machines could be improved so as to recover quickly from the spin. A mysterious engine cowl, termed the nose cowl, was shown to visitors—but a pledge of secrecy prevents the description of this entirely novel device.—*A. K.*

100,000,000 MILES

A SIGNIFICANT milepost in aviation was passed by United Air Lines on June 17, 1936, when the company completed its 100 millionth mile of flying in over ten years of operation, becoming the first airline in the world to reach that coveted goal of flying experience. The mileage record is equal to 63 solid years of flying at an average speed of 180 miles per hour.

EXPORTING THE ART OF SOUNDPROOFING

THE United States exports a great many things to Europe, and not the least of them is soundproofing. Dr. Zand of the Sperry company has just returned from a six months' stay in England, France, and Italy where he has been successful in soundproofing some of the best known European airplanes. The French Bréguet-Wibault 18 passenger, twin-engined airplane has the distinction, thanks to his efforts, of being the quietest airplane in th world with sound intensity levels, in decibels, of 76 in the bar, 72 in the pilot's compartment, and 64 in the passenger compartment. The bar is relatively noisy, but who cares?



As a Pullman running on a smooth roadbed has a noise level of over 70 decibels, this is indeed a remarkable achievement. The Martin Clippers used by Pan American have a noise level of 69 decibels, just a trifle higher than that of the French transport.

As bigger airplanes are built, the problem of soundproofing will become less difficult. The limitations on weight of materials will become less rigid and there will also be more space available. There is no magic soundproofing material; space and bulk are the all-essential factors, although there is a distinct science in selection and installation of materials. According to Dr. Zand, modern transport airplanes are now quiet enough, and it would cost 50,000 dollars in research to reduce the noise level by only two decibels.

In the specifications laid down by the French Air Ministry (which controls all transport lines in France) particular stress was placed on comfort and freedom from noise for the pilots. This is a feature which has been somewhat neglected hitherto. The low decibel level was attained in the pilot's compartment by providing a 3½ inch space between the outside and the inside walls. All parts necessary to control of the airplane were mounted on the inner walls so that this space was completely reserved for the soundproofing work.

Another important point of soundproofing is that there must be no open windows to admit the noise of engines or propellers. Ventilation must be entirely artificial with all windows closed and of thick glass, rubber mounted. The air passing into the inlets or leaving the cabin must be scrupulously guarded from noise by carefully designed acoustic filters.

***Left:* A transport plane cabin ready for the application of soundproofing. *Above:* Same cabin finished and with passenger's seats installed**

The photographs of the Bréguet-Wibault plane give an approximate idea of the steps in soundproofing the cabin. In the bare cabin structure there are longitudinal members running the whole length of the cabin,

channeled bulkheads or frames at intervals with holes punched out for lightening, the whole structure being covered by a thin metal skin.

A sound-absorbing material called "Seapack" encased between two light layers of cloth is cemented to the skin. Since the material may at times have to be removed for purposes of inspection, a flexible cement is used so that the covers may be readily peeled off from the structure without injury. The layer of Seapack is thin and the bulkheads project beyond. Layers of felt with a considerable degree of air space are then inserted. This brings the soundproofing to the outer edge of the bulkheads. Strings running the length of the cabin serve to tighten up the fabricoid which constitutes the inner covering.—*A. K.*

The Latest Hammond

OUR readers will perhaps remember the excitement aroused by the Department of Commerce competition for a private airplane of novel type, held nearly two years ago. This was part of a program for the popularization of private flying. Now after strenuous efforts by the Hammond Aircraft Corporation and the Department of Commerce, a really useful airplane, the Model Y, has received its Approved Type Certificate or ATC as it is popularly called. The photographs show the outlines of this machine.

The large dihedral of the wing, carefully designed ailerons, and large vertical tail surfaces have worked out very well. It is possible to disconnect the rudder and fly with ease under good weather conditions with only two controls. Over 100 hours' flying without the use of rudder have been achieved on the Model Y during the last few weeks.

The pusher propeller in back of the cabin gives the occupants excellent vision. When the first version of the Model Y appeared on the scene, there was considerable difficulty in cooling the engine. This difficulty has been overcome by the scoop and tunnel placed above the cabin. The scoop placed to the left of the engine receives the dynamic pressure of the air. The rear end of the tunnel is under the suction of the propeller. Therefore air is drawn efficiently around the cylinders of the air-cooled 4-cylinder Menasco motor.

It is a sign of the times that this "private owner" airplane is equipped with a complete ventilating system and some degree of soundproofing, and that it is of all-metal construction. Our readers will notice that the tail surfaces are carried on outrigger booms *without* bracing wires. The elimination of bracing wires was made possible by adopting stressed skin tapered booms of an elliptical cross-section and the use of a strong aluminum alloy.

Experiments in the free spinning tunnel indicate that recovery from the spin occurs in a very few turns in the Model Y. This is mainly due to the fact that the vertical tail surfaces project well below the stabilizer. Thus there is no blanketing of the vertical tail surfaces at the high angle of attack attitude which a machine maintains in the spin.

The most serious criticism leveled against the Hammond Y when it first appeared was its low performance. Now the figures are much better as can be seen from the following:

Wing span, 40 feet. Overall length, 26 feet 11¾ inches. Overall height, 7 feet 7 inches. Wing area, 210 square feet. Aileron area, 14.25 square feet. Flap area, 25.2 square feet. Stabilizer area, 22.45 square feet. Elevator area, 13.28 square feet. Rudder area, 10.5 square feet. Fin area, 10.5 square feet. Fuel capacity, 30 gallons. Oil capacity, 3 gallons. Baggage capacity, 99 pounds. Pilot and passenger, 340 pounds. Two parachutes, 40 pounds. Gross weight 2150 pounds. Maximum speed, 123 miles per hour. Cruising speed at 75 percent full power, 112 miles an hour. Minimum speed 39 miles per hour.

In its refined version the Model Y will be a serious contender in the private flying market.—*A. K.*

Airplane engine synchronizer

Engine Synchronizer

IN a multi-engined airplane it is quite important to keep all engines running at exactly the same speed. Otherwise it is difficult to keep the plane on its course, and a "drumming" noise may disturb the passengers. In the past, reliance was placed on the pilot's experienced sense of hearing. Now special synchronizers have been developed. A very simple and effective type has been invented by Luther Harris of Central Airlines, and is shown in our photograph.

The device consists of a rotating white disk with nine black spots equally spaced on its face. The disk is driven by a short tachometer shaft from the central engine. Between the rotating disk and the glass front of the instrument there are two Neon tubes with a partition between them. The Neon tubes are electrically excited by the ignition systems of the outboard engines. When all three engines are at the same speed Neon flashes and disk rotation combine to give the illusion that the black spots stand still. The instrument is therefore a variant of the stroboscope which has proved both practical and effective.—*A. K.*

Gliders of Rubber

SUPREMACY in the art of the glider formerly rested with Germany. Now it has probably passed to Russia. The Soviet pilots hold the record for the number of loops executed in a glider, have made experiments in towing gliders two or more miles above the towing airplane for the purpose of meteorological observations at altitude, and have carried the use of glider trains far beyond that in any other country. Thus rumor states that glider trains are to be put into experimental operation between Moscow and Vladivostok. Now we read of another glider development fostered by a Russian engineer G. I. Grohowsky. This is a craft built entirely of light cloth and rubber. It can be folded and packed in a sack only 3 feet by 3 feet by 1½ feet. The whole rubber glider weighs less than 180 pounds. The elastic properties of rubber are an advantage in hard landings, and the watertightness of the glider permits its use in water work.

The fuselage is formed like a cylindrical balloon, tapering to a conical point at the rear, and can be inflated with air or deflated very rapidly. The wing, in one piece, is formed of rubber longerons of circular form. Air inflation also provides the contour of the wing. Only control surfaces are of the classical wood and fabric construction. This is a curious development which has possibilities.—*A. K.*

Intense Cold May Not Kill Organisms

A WARNING against careless preparation of fruits for frozen storage is found in tests just completed by the United States Department of Agriculture.

Bacteriologists of the Bureau of Plant

Two views of the improved Hammond Model Y described above

Industry—in a routine examination of frozen strawberries, raspberries, and cherries held for three years at a temperature of 15 degrees, Fahrenheit—found several species of bacteria, yeasts, and molds still alive. To study the behavior of these small organisms at low temperatures, 26 were placed in culture and held in a cold storage room at 16 degrees, Fahrenheit, for one year.

Eight of the 26 were able to grow at this temperature, 13—while showing no growth at 16 degrees—produced abundant growth when removed to room temperature for 24 hours. Only five of the 26 failed to survive the year.

These tests, say Bureau bacteriologists, point to the necessity for cleaning fruits before freezing storage as well as to the need for removing any that might carry large numbers of decay organisms.

FARMING DE LUXE

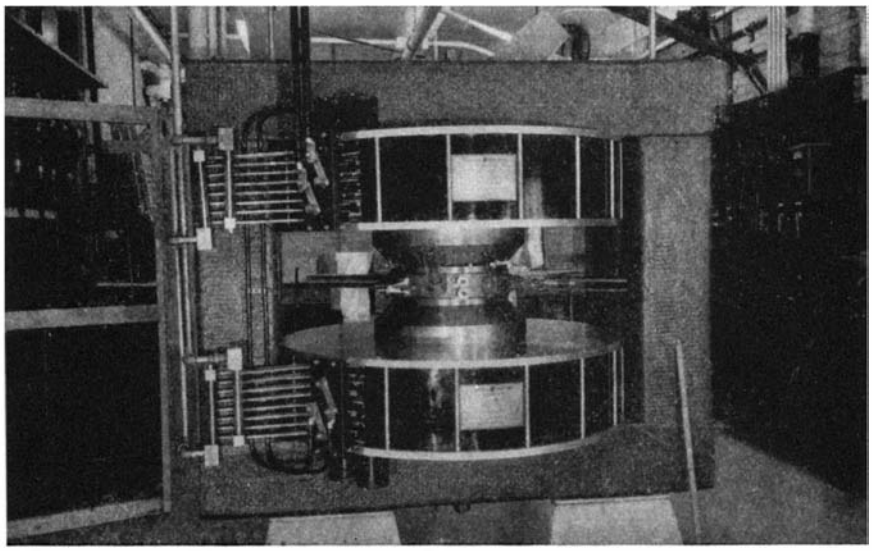
A NEW farm tractor designed to use standard motor gasoline is equipped with every convenience of a modern passenger automobile, including self starter, electric lights and radio, and at the same time gives very high economy in plowing.

Another Cyclotron

UNDER the direction of Professor L. A. DuBridge, the University of Rochester has installed cyclotron or "atom smashing" equipment for use in experiments on atomic disintegration.

As in all equipment of this type, iron and other metals have an important rôle. In the Rochester laboratories, the magnetic circuit is made up of six annealed Armco ingot iron forgings, a product of The American Rolling Mills Company. The four rectangular forgings making up the yoke are 12 by 26 inches in cross-section. Cylindrical forgings used for the pole pieces are 26 inches in diameter.

Overall height of the magnet is about six feet, overall length is eight feet, and the depth is two feet two inches. Weight of the iron is about 15 tons. The magnet is excited by two copper coils containing nearly four tons of copper taking a current of 400 amperes at 110 volts. The tips of the pole pieces are 21 inches in diameter, and the magnetic field across a three-inch gap is 21,000 gauss.



The new cyclotron for the University of Rochester

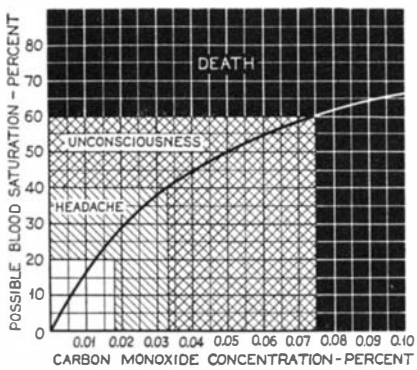
Between the pole pieces of the magnet will be placed a metal vacuum chamber weighing about 500 pounds, in which hydrogen ions can be accelerated to an energy of 5,000,000 volts.

The cyclotron can be used for the atomic disintegration of any matter. When the coils are energized, the magnetic flux causes the atom to travel in a spiral. In some cases the atom attains a speed of 20,000 miles an hour. When it reaches the outer extremity of the cyclotron, it strikes an obstruction and disintegrates.

A portable carbon-monoxide detector testing air in a motor bus

Detecting Carbon Monoxide

ACUTE danger from poisoning by carbon monoxide, the insidious poison in manufactured gas and in the exhaust from automotive engines, is based on the fact that the blood of persons and warm blooded animals absorbs dangerous amounts of the gas from concentrations so small that no simple chemical means for their detection has been found. The value of a method sensitive enough to detect low quantities of the gas is amply attested by the number of inquiries for such a method or device. Carbon monoxide detectors now on the market which have the necessary sensitivity to insure absolute safety are either too delicate or too expensive for general use.



Carbon monoxide concentrations in air, and their effects on the body

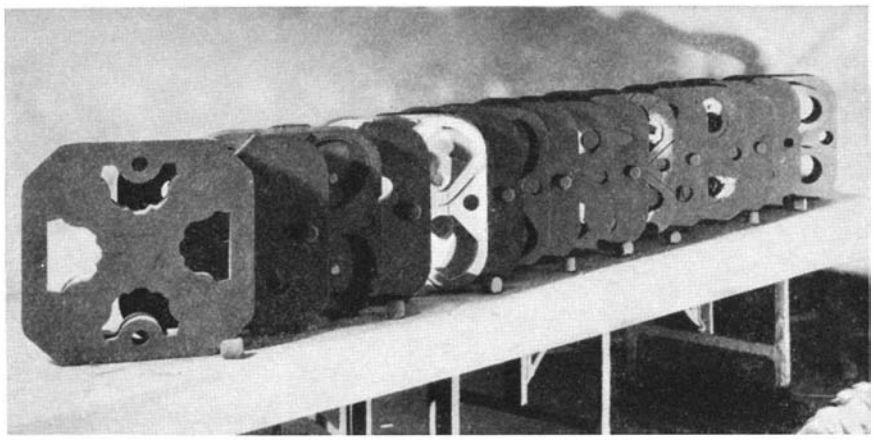
So sensitive are persons to poisoning by carbon monoxide that concentrations as small as 13 parts of the gas in 100,000 parts of air may cause headache and above 33 parts per 100,000 may cause unconsciousness. Naturally, the extent of the injury to the person exposed to carbon monoxide gas depends upon the amount actually absorbed by his blood and this depends not only on the concentration of the gas in the air he breathes but also on the amount of it he breathes. The accompanying chart shows the possible saturation of the blood on exposure to various small concentrations of the gas.

Below 17 percent blood saturation, symptoms seldom develop. Between 20 and 40 percent, the symptoms are headache and mental and physical dullness, with unconsciousness occurring between 40 and 60 percent blood saturation. Above 60 percent saturation, death occurs. Resuscitation measures are usually successful when applied during the second stage.

Obviously, the only guide to the extent of the injury to a person is to be found in the state of his blood. For this purpose, a rapid method has been devised for analysis of the blood of a suspected victim of carbon monoxide poisoning. Such a test can be made in a very few minutes and serves as a guide to the application of proper first aid measures.

The detection of extremely small concentrations of carbon monoxide can be similarly done quickly but it is necessary to observe that *any* indication whatever of the presence of the gas is a warning of danger since there are actually no "safe" concentrations. Using Hoolamite (activated iodine pentoxide) in a properly protected ampoule, carbon monoxide can be detected in concentrations as low as 50 parts per 100,000 of air by the change of color of this material from a grayish white to a shade of green, the depth of which depends on the concentration of the gas. The apparatus for making this test is easily portable and weighs but a few pounds. A similar method which is less accurate in determining actual concentrations but which indicates a concentration of 30 or more parts per 100,000 is also to be had. It depends on the reaction of palladium compounds.

The accurate measurement of very low concentrations of carbon monoxide depends upon the heat liberated by burning the gas over a Hopcalite catalyst. Instruments em-



After normalizing and heat-treating, the shafts have an ultimate strength of from 128,000 to 130,000 pounds, with an elastic limit of from 88,200 to 96,500 pounds. They can be twisted from six to nine degrees without permanent deformation and have a hardness of from 255 to 321 Brinnel. Each shaft is given an impact test to detect incipient flaws before machining and is also checked for desired hardness.

After machining, the main and connecting-rod bearing journals are ground to close limits. Every shaft is inspected for concentricity and alignment of bearings within a limit of 0.001 of an inch.

Following this and other rigid dimensional inspections, all shafts are accurately balanced, both statically and dynamically, the total permissible unbalance being 0.2 inch-ounces at one point of reference. The shafts are of the "fully counterbalanced" type, wherein not only is the weight of opposing crankthrows compensated for, but the weight of the connecting rod bearings and that part of the connecting rods which rotates is also considered. Even the weight of the oil within the hollow crankpins is included in the balancing operations.

Finally, the bearing surfaces are polished, the shafts being revolved in the same direction they rotate in the engine in order to make the "grain" of the final finish conform to actual conditions of use. Additional inspection, flushing out of oil holes and placing the finished shafts on rubber-cov-

ploying this principle to give an alarm on exposure to tiny concentrations of the gas are necessarily more complicated and delicate than the simpler ones depending on a color change. Delicate electrical instruments measure the minute change of temperature produced and an electrically driven motor pumps the gas sample through the apparatus. These devices are built to use electric current from an external supply or from a built-in storage battery.

All of these instruments are widely used in places where there is danger from carbon monoxide. Their value depends upon the fact that exposure of several hours is required to produce symptoms at even higher than minimum concentrations of the gas.—*D. H. K.*

'QUODDY

DR. Karl T. Compton estimates that the Passamaquoddy Tidal Power Project would, if ever completed, represent an investment of 1500 dollars per kilowatt as compared with an investment of 100 dollars per kilowatt for an equivalent steam power plant. Modern steam plants have been shown to be less costly even than hydro-electric plants.

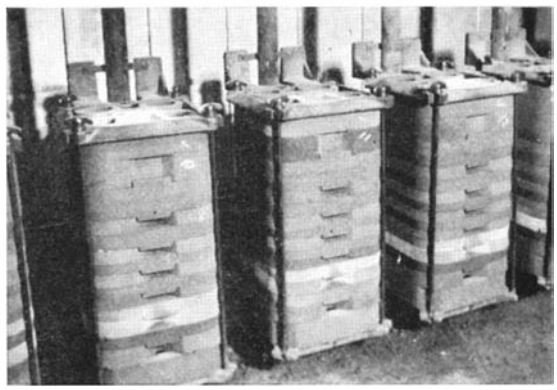
Four Tons of Periodicals

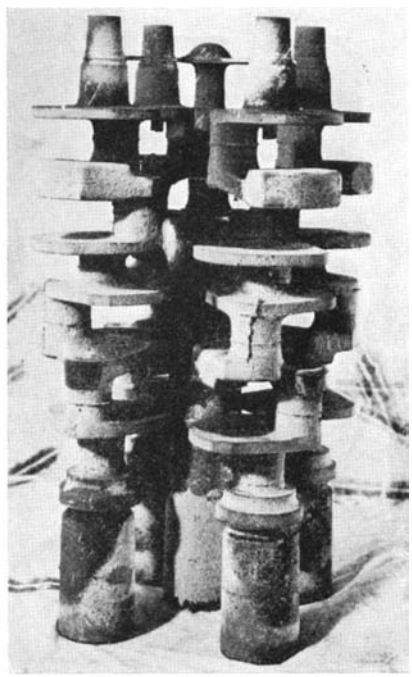
ONE of our readers, Mr. Vernon H. Springsted, of Schenectady, New York, recently wrote to us regarding a bound volume of Scientific American for the full year 1858, which was found among the effects of a man in a small village near his home. He added a note which seems to have unusual interest:

"The heirs of this man," wrote Mr. Springsted, "found that he had very carefully preserved almost every newspaper and magazine which he had purchased during his lifetime, and filed them away very carefully in the attic of his home. Out of curiosity the accumulation was weighed and found to exceed four tons."

Cast Steel Crankshafts

ALTHOUGH used for more than two years, the cast alloy-steel crankshaft of Ford V-8 car and truck engines is still unique in present day automobile manufacture. The shaft material has been defined as a "high-carbon, high-copper, chrome-silicon alloy steel." Each of the alloying metals, in addition to the carbon content, gives the metal certain desired characteristics after the shafts have been heat-treated, such as rigidity, good bearing surfaces, and resistance to shock.





***Upper left:* A group of cores which, when assembled, form a mold for casting four steel crankshafts in one operation. *Left:* A series of crankshaft molds assembled in place on a conveyor, ready for pouring. *Below:* A single casting of four crankshafts, as removed from the mold, showing the gates and risers**

Four shafts are cast vertically in each baked sand mold. Although called a "mold," it is in reality a stack of 16 "cores," the top core serving to hold the excess metal required to fill spaces caused by contraction in cooling and to cause a whirling motion in pouring, which prevents washing away or grooving the mold. The molds are stacked and carried on moving conveyors to the pouring line and remain thereon until the shafts have cooled to a dull red temperature.

The metal is prepared in four 15-ton electric furnaces, each consuming 10,000 to 12,000 kilowatt-hours of electric current per eight-hour shift. It is then transferred to pouring ladles, each containing about 1300 pounds of steel, sufficient for three molds or for 12 crankshafts. The pouring temperature range is closely controlled between 2670 and 2700 degrees, Fahrenheit. The cluster assembly of four crankshaft castings weighs approximately 430 pounds in the rough state, including gates and risers. The furnace and other foundry equipment are sufficient for a production of 6500 crankshafts daily, requiring in excess of 50 tons of metal.

Since the shafts are not straightened after casting, they must be cast straight originally, if the minimum amount of metal is to be left for removal in machining. The four crankthrows also must be spaced 90 degrees from one another in the finished shafts. This requires the introduction of purposeful errors in the shape of certain parts of the mold to counteract the effect of expansion and contraction of the steel in solidifying and cooling.

ered conveyor hooks to prevent damage to the surfaces, completes the manufacture.

Compared with the forged shafts, the excess metal removed by machining is 9.5 instead of 15 pounds, the cast shafts weighing 72 pounds, and the forged shafts 80 pounds in the rough state. The finished cast shafts weigh 62.5 pounds. The forged shafts weighed 65 pounds finished, the cast shaft being 2½ pounds lighter. The time saved in machining and grinding is 20 minutes, five minutes on machining and 15 minutes on grinding, most of this because no straightening is needed.

TWINS

TWINS are most common in Denmark and least common in Colombia, while the United States is near the average in its twin records. Twins occur once in 63 births in Denmark, once in 250 births in Colombia, and once in 87 births in this country. The world average is one set of twins in 85 births.

Piston Dispersion of Stones in Concrete Roads

IN Norway there has been developed a new method for the construction of concrete road surfaces which has proved to be advantageous with regard to saving labor and time. The method, which has been invented by Alfred Holter, Director of the Dalen Portland-Cement Factory of Brevik, Norway, briefly consists in the following:

After the road surface has been suitably prepared, a layer of sand-cement-mortar is spread thereon to a thickness of from three to five inches. On the top of this layer is placed a second layer of crushed stone of about the same thickness.

The stones from the upper stone layer are then pressed downwards into the underlying layer of mortar by means of pistons or plungers, which may be located on the surface of a cylindrical roller. The cylindrical roller usually is mounted in a truck adapted to roll on side rails, between which the layers of mortar and stones are placed on the road surface.

An accompanying diagrammatical sketch illustrates the method, one photograph shows the machine in operation, and a second photograph shows a road built by this method being completed.

The cost of these concrete road surfaces has ranged from a little over $1.00 up to $1.25 per square meter with a thickness of four inches of the finished concrete covering.

With one complete set of machinery it has been found possible to complete about 1000 square meters in seven hours with 15 men, and the road surface has been found to be ready for traffic about 24 hours after starting the operation.—*Dr. Alf B. Bryn, Oslo, Norway.*

Parasites to Fight Fruit-Fly Cross Ocean by Air

VICTORY in a battle involving millions of dollars in potential business may depend upon 19 tiny insects of two species carried to Honolulu from Africa aboard a Clipper plane by the United States Department of Agriculture.

The tiny wasp-like insects known as *Opius* and *Hedylus* are parasites of the Mediterranean fruit fly and have a reputation for being death to the flies. If *Opius* and *Hedylus* live up to their reputation, federal scientists believe it may be possible to eradicate the fly which infests several types of island-grown fruit. If the fly can be eradicated the quarantine against shipping some kinds of fruits to other parts of America may be lifted, resulting in a decided stimulus to production in Hawaii.

The insects arrived just three weeks after leaving Sierra Leone on the west coast of Africa. Two hundred left Africa by boat but only 19 arrived alive. During their journey halfway around the world they were kept in a specially constructed container and fed on lump sugar and water. Most of the casualties resulted during the trans-shipment from the boat at Philadelphia to the New Jersey station, it is reported.

Importation of the insects resulted from a trip made to Africa by R. H. Van Zwalenburg of the Hawaiian Sugar Planters Association who was sent to find fruit fly parasites. Other scientists from Hawaii are

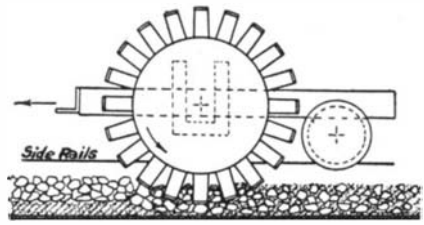


Diagram of the plungers that disperse stones in concrete. *Lower left:* The machine in use. *Lower right:* Finishing a road surface

A container of tiny insects shipped by air to battle fruit flies

in various parts of the world seeking parasites under the auspices of the AAA program in the Territory.

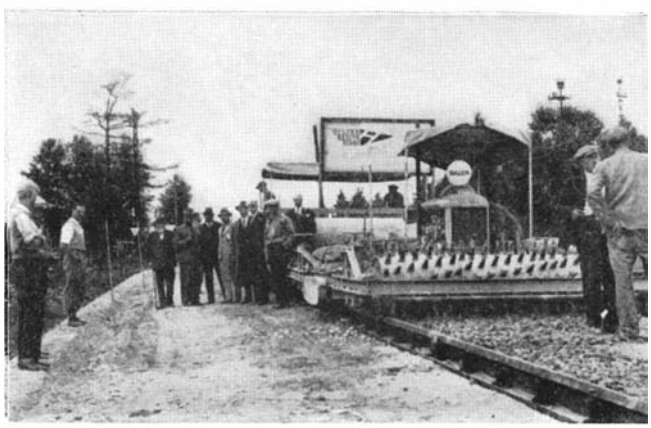
Although only 19 arrived alive, they have a few relatives in Hawaii that came by the more prosaic steamer route. At present 493 of the potentially important insects are being cared for by federal officials prior to their release on the various islands of the Territory.

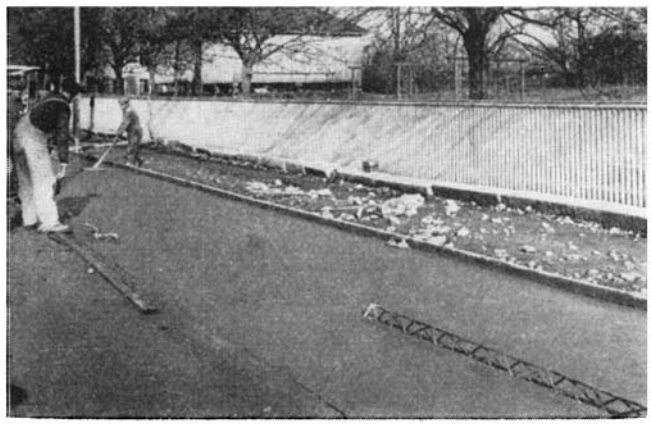
Cold Sensitiveness Causes Swimming Danger

DANGER lurks at the bathing beach for those unfortunate persons who are hypersensitive to cold. Facts about this peculiar condition were shown by Dr. Bayard T. Horton of the Mayo Foundation for Education and Research, Rochester, Minnesota, in an exhibit of the American Medical Association.

Nearly half of the persons studied collapsed after they had been in swimming, and some had to be rescued from the water. Besides the general reaction, which may cause collapse and unconsciousness, discoloration of the hands and feet and marked flushing of the face may occur. In one patient, the temperature of the cheek increased several degrees at the height of the reaction. Cold air as well as cold water brings on the condition in susceptible persons.

Experimental studies showed that the reaction is a chemical one. The effect of the cold is apparently to increase the





amount of histamine in the blood. This substance, which occurs naturally in the body, produces similar disturbances of the circulation when injected into the blood stream.

Persons susceptible to cold can be desensitized by short daily immersions of the hands in cold water.—*Science Service.*

Nature's Tiny Dams Stop Floods at Grass Roots

FLOOD control begins at the grass roots, say soil conservation men in the United States Department of Agriculture. What they mean is that run-off should be controlled for an entire watershed, from the crest of the hills right down to the mouth of the rivers.

In the uplands, at the headwaters of all streams, nature, if undisturbed, retards run-off by throwing across practically every foot of land under forest or grass cover—a maze of "slow," "stop," and "detour" signs—an interlacing system of tiny dams. A dead leaf, a blade of grass, or a root tangle stops a raindrop from running—changes its direction again and again, makes it creep away. Floods are made up of raindrops infinitely multiplied and brought together in a hurry.

Farmers are adapting nature's method of flood control when they keep their fields rough and plant soil-holding water-impeding crops. In contour farming each furrow, each tiny harrow scratch, becomes a small dam or terrace—doubly effective when reinforced by grass cover.

Department conservationists do not offer "flood control at the grass roots" as a substitute for dams and spillways farther down the valleys. They offer it as a reinforcement, because it makes water creep away and in so doing stores most of it in that greatest of all reservoirs, the soil.

Cellophane Balloon

JEAN PICCARD, stratosphere balloonist and research associate of Bartol Research Foundation of the Franklin Institute, has constructed a balloon of Cellophane to continue explorations of the stratosphere. The balloon so far built will carry only instruments aloft but it is hoped that experiments with it may yield important information both as to cosmic rays and other conditions in high altitudes and as to possibilities of better balloons. Cellophane, familiar wrapping on many commercial articles and packages, is made from wood pulp in a manner very similar to that which produces rayon, the difference being principally in the fact that the former is congealed from the syrupy liquid cellulose xanthate compound in a sheet instead of in fine filaments.—*D. H. K.*

The water in the pitcher, almost a quart, was squeezed from the six and a half inch long sponge in the foreground. The sponge, made of cellulose by Du Pont, has many uses

Brief Case Drawing Board

SENSING the need of engineers, draftsmen, contractors, designers, artists, students, and others for an efficient, compact and easily portable drawing board, H. E. Twomley has developed one that is unique. This board is only one quarter of an inch thick, requires no thumb tacks, and dispenses with a "T" square.

The illustration shows the essential features of the board. Made of pressed fiber board, Masonite, its drawing surface is recessed sufficiently to give a raised edge on each of the four sides to engage the edge of a triangle for both vertical and horizontal lines. Steel spring clamps at each of the four corners clamp the corners of the drawing paper tightly, and the corners of the raised edges beside these clamps are rounded so that the triangle will ride over them without catching.

Drawing board of novel design

This new board is made in three sizes, the smallest being the one for 8½ by 11 inch paper shown in the illustration.

Don't Force a Child To Eat

THE common maternal mistake of forcing a child to eat was attacked vigorously by Dr. Clifford Sweet of Oakland, California, at a recent meeting of the American Medical Association, reports *Science Service.* Malnutrition has been over-emphasized until it has become a menace to the peace of mind of mothers, Dr. Sweet declared. The battle waged at many a meal provides an atmosphere for the development of any and every sort of behavior problem.

One method used by Dr. Sweet to study the problem is to have parents let the child direct his own eating for three weeks while the parents keep a record of what and how he eats. The mother often finds that her child is eating more than she thought. Sometimes Dr. Sweet had trouble getting the last week's record because the problem had disappeared and the mother lost interest in keeping the record.

Definite faults in eating can usually be corrected by proper methods, Dr. Sweet indicated. The child who does not like meat usually has not learned to chew it sufficiently to swallow it. Taking away foods the child says he does not like sometimes has a magic effect; he may soon ask for them.

"I am certain," Dr. Sweet concluded, "that no normal healthy child can long resist the demands of his body for food when there is added to it the example of the other members of the family eating the food that appears on the table or omitting it without remark, in an atmosphere of comradeship and enjoyment."

Even the wheelbarrow has been improved. The one shown is made of aluminum alloy and equipped with a rubber tire. The four and a half cubic foot size weighs 36 pounds

SAPPHIRE WINDOWS

WINDOWS of synthetic white sapphire about ¾ of an inch in diameter are being used to provide openings through which scientists can look into automobile cylinders and study what is happening. This material shows the best mechanical strength, transmission of visible and invisible light rays, and resistance to chemicals of any material used for this purpose.

Direct Flame Evaporation

FLAMES burning actually below the surfaces of solutions are solving problems of evaporation in chemical manufacture otherwise impossible to solve economically. Experiments conducted at the University of Washington, Seattle, Washington, have demonstrated the effectiveness of submerged flames in evaporation of liquids commercially which under other conditions crystallize so badly that heat is wasted in large quantities in the process. By using this method of evaporating solutions, natural deposits of sodium sulfate and sodium carbonate are made commer-

cially available since the economy of the process permits recovery of these compounds at a low enough cost to be economically attractive. The same method has been previously applied to the evaporation of viscous and tarry liquids which are difficult to concentrate by other means.—*D. H. K.*

Agricultural Imports

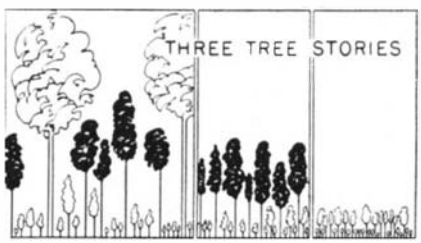
IN our December issue, we pointed out editorially that while our agricultural exports for the first nine months of 1935 had shown an astonishing decrease as compared with the same period of 1934, our imports had shown an equally alarming increase. In response to requests for data on the complete year 1935, we are therefore giving below these figures:

IMPORTS:	*YEAR 1934*	*YEAR 1935*
Wheat (60 lb. bu.)	15,848,356	38,870,398
Lard, animal oils & fats	2,001,447	18,895,241
Butter (lbs.)	1,253,392	22,674,642
Corn (56 lb. bu.)	2,959,256	43,242,296
Canned Meat (lbs.)	46,780,678	76,653,242
EXPORTS:		
Wheat (60 lb. bu.)	16,970,089	232,965
Lard, animal oils & fats	439,515,302	111,914,091
Butter (lbs.)	1,219,713	957,701
Corn (56 lb. bu.)	2,987,419	177,382
Canned Meat (lbs.)	16,361,812	12,563,973

Trees Grow More Timber When Sharing Sun

MAN can help Nature in the reproduction and growth of good timber. Finding out how to help most effectively is one of the principal jobs of the Forest Service, United States Department of Agriculture. Sunlight and water are vital to healthy tree growth.

The accompanying diagrams illustrate three conditions common on forest lands. Where the overstory trees (those trees



which overtop the rest) monopolize sunlight and soil moisture, young new growth does not come in and the understory stagnates. The first diagram shows an overstory of old growth where old, mature, and defective trees may be getting more than their share of a limited place in the sun, to the detriment of the second-growth and new-growth. The second represents an overstory of second-growth monopolizing the light with new growth again as the victim. In the third diagram, an overstory of new growth itself is overtopping smaller new trees.

For rapid growth and maximum timber production, foresters seek to maintain a desirable balance of old growth, second growth, and new growth. Several types of general forest stand improvement measures are listed by the Forest Service:

Cleaning—Cutting made in a stand not yet past the sapling stage (that is, in new growth) for the purpose of removing shrubs and herbaceous growth, vines, and trees of undesirable form or species that are injuring or are likely to injure promising trees.

(*Please turn to page* 111)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

BY special request, Russell W. Porter, Associate in Optics and Instrument Design at the California Institute of Technology, in the notes which follow, gives the amateur telescope maker a few first intimate glimpses into the operation of the grinding machine for the 200-inch Pyrex telescope disk in Pasadena, California. He writes:

"A general description of this machine

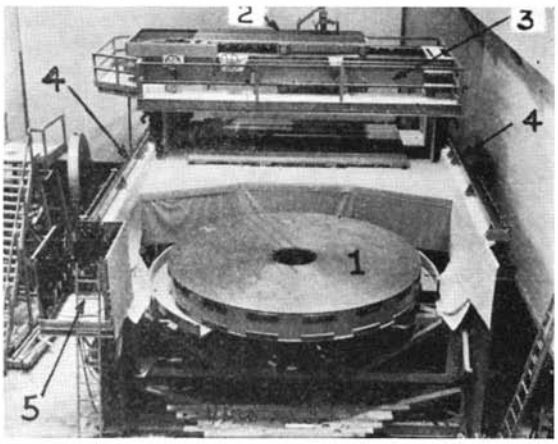


Figure 1: **The grinding table**

will interest any amateur who has made a reflecting telescope.

"In Figure 1, 1 is the table on which the disk will remain throughout the grinding, polishing, and figuring—in fact it is the cell of the telescope tube itself, and the mirror will never leave it after it is finished. The individual supporting units are not shown. The table is on trunnions that allow the mirror to be brought to vertical for testing.

"The grinding and polishing tools are controlled by a rotating spindle or driving pin, attached to the trolley 2. This trolley moves back and forth transversely on the bridge 3. This bridge in turn travels longitudinally on tracks 4, attached to the main frame of the machine.

"The driving mechanism for both the trolley and bridge motions is the scotch yoke. Figure 2 looks down on the trolley yoke, and Figure 3 is a side view showing one of the pair of yokes that move the bridge. The tracks supporting the bridge are extended at the rear of the machine so that polishing tools may be well away from the table for warming the pitch facets preparatory for hot pressing, and also for washing off the grinding tools.

"At 5, Figure 1, is the control station where the operator has complete electrical control of all the various motors and motions.

"The maximum stroke is 6 feet for the trolley, and 6 feet for the bridge. When used together, the tools may be made to move in a variety of strokes. Speeds on the track are from 8 to 25 feet per minute.

"Figure 4 shows the full size tool in process of being covered. When ready for grinding it will be covered with 1928 glass facets cemented to its convex surface. As is generally known, the 200-inch disk was cast in an open mold and hence its surface is approximately flat. Some 3¼ tons of glass will have to be removed to bring the mirror to its spherical shape. The sagitta or depression amounts to 3.8 inches. Small size cast-iron tools will be used for roughing out the curve before using the full size tool.

"The first operation on the disk will be to place it face down on the table (which is covered with 2 inches of sponge rubber) and carefully calibrate the positions of the 36 holes destined to receive the supporting units that will carry this 17 tons of glass internally at all inclinations to gravity. The holes will then be ground out, the back ground, and the edge ground. The disk will then be turned over and the rough grinding of its surface commenced.

"The 120-inch flat disk received earlier has a machine of its own, similar to the machine here shown, but

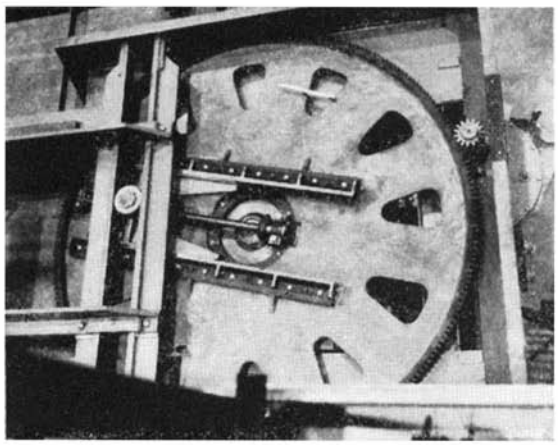


Figure 2: **Trolley yoke from above**

smaller and with a different driving mechanism. The disk at present is fine ground, and flat to 0.00012 of an inch (concave). Its flatness was controlled during grinding by testing its surface with a stretched piano wire, but sufficient reflection was obtained at grazing incidence to allow an optical check test which confirmed those of the piano wire. Polishing and figuring this ten-foot flat will not be started until the 200-inch mirror is figured spherical, the reason being obvious to mirror makers who have made flats for testing at the focus.

"The room in which the work is done is 165 feet long, 52 feet wide, and 39 feet high. The walls are covered with cork insulation. There are no windows. The room is illuminated from overhead by electric lights in the roof, and by mercury vapor lamps around the walls. The air is conditioned, washed, tempered, and given the requisite amount of humidity. The opticians like to work in a rather high humidity and a temperature of about 70 degrees.

"A visitor's gallery is provided, separated by a glass partition, so that the public may see what is going on at any time. I never go into the optical shop—and I go there quite often—without seeing several faces glued to that glass partition, evidently wondering what it is all about. And you will find them there for the next four years —the scheduled time for completion."

NUMEROUS readers have asked us why we did not, beginning several years ago, publish the data about the design of the 200″ telescope. The reason was that, while the project was announced several years ago, the design was not settled—it had only been begun. It will be understandable why those who have had the most to do with it did not wish to rush into print at each successive stage of the constantly changing evolution. Now that most of the design has been settled and actual construction begun, we hope occasionally to give our readers some of the homely details, written not as the average news reporter would describe them for a general audience but for the telescope maker.

AMONG amateur telescope makers and doers of practical things in England is F. J. Hargreaves, Director of the Photography Section of the British Astronomical Association—an amateur association which we have previously urged American amateurs to join in order to obtain the monthly *Journal*, which is a live one. Mr. Hargreaves now sends us from *Mirastelle*, Woodland Way, Kingswood, Surrey, England, the following communication:

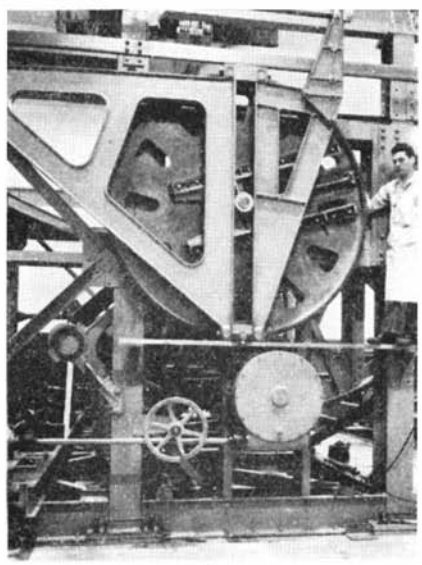


Figure 3: **Side view of machine**

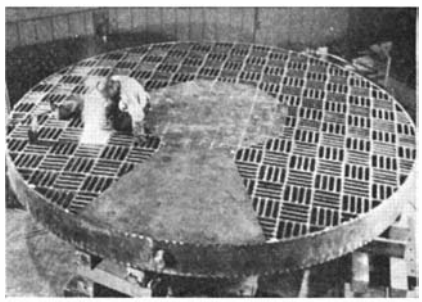


Figure 4: Making the big tool

"The purpose of this letter is to enlist your help in a matter which I and some of my friends have very much at heart. I refer to the systematic observation of the surface features of Jupiter. This subject also supplies an answer to the question in the second paragraph on page xi of 'The Book.'

"The systematic observation of Jupiter seems to be indigenous to this country. Observers elsewhere make occasional observations, sometimes of great value, but nowhere else, so far as I know, do observers watch the planet on all available occasions, for hours on end, timing the transits of markings across the central meridian.

"The trouble, however, is that England lies in high northern latitudes, and when Jupiter is below the equator the opportunities for observing it here fall off grievously. Last apparition, for example, my total of transits was only 220, as against 1500 and more in previous years. The present apparition will be worse.

"There is nobody in the southern hemisphere interested in this work, unfortunately; although we have made many efforts to rouse our brothers in South Africa and Australia to action, there has been no adequate response.

"Now the United States extends a good way south, and conditions even in the northern states are much more favorable than in England when the planet is in low southern declination, as at present. Largely owing to your efforts, there must now be hundreds of people in America who have made good telescopes and who would be glad to know of some useful astronomical work that they could undertake. Any telescope of 6 inches aperture and upwards is suitable; I have obtained as many as 60 transits in a single evening and also many detailed drawings with a 6½-inch reflector.

"Apart from latitude, there is the scarcely less important matter of longitude. Even under the most favorable conditions we can observe only for about 10 hours; for the next 14 hours the planet is below the horizon. As the rotation period is just under ten hours, you will appreciate that there are necessarily large gaps in the records of observers grouped on a small island. If we had similar observers in a widely different longitude, these gaps would be filled.

"The observations themselves require, apart from a telescope, only a clock or watch showing Greenwich Mean Time to the nearest minute, or local time if the observer will correct for his longitude. The observer must learn the names of the various belts and zones, and of course must have a good planetary eye and sound judgment. Men who see Mars covered with cobwebs (but cannot see the large markings on that planet) are not as a rule useful as Jovian

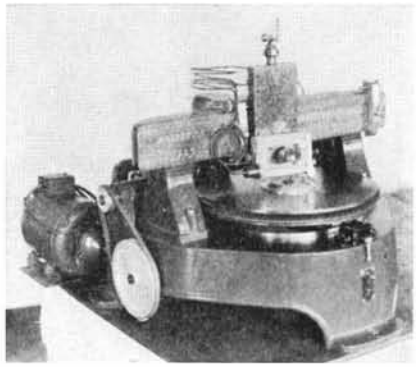


Figure 5: **Vard dividing engine**

observers. The observer notes that a dark marking of some kind on the North Temperate Belt, for example, is a little to the right of the central meridian. As it moves towards the left there will be a time when it appears to be exactly central of the belt. It is then on the central meridian, and the time is noted thus:

D spot N T B 8h 24m,

or whatever the time was.

"If it is a hump on the south edge of the North Equatorial Belt it would be described as

Hump S edge N E B

"The list of such observations can be diversified by sketches of details, or whole-disk drawings. If the separate observations are numbered serially throughout the apparition, the objects in the sketches can be identified by a reference to the serial number.

"Apart from actual observing, the observer will also be required to reduce his observations to longitude (zenographic) by the aid of tables in the 'Handbook' of the B.A.A. This is tedious, but requires nothing more of mathematics than simple addition and subtraction. Finally, observers undertaking this work would be welcomed as members of the B.A.A., although naturally this is not a requirement but only an invitation.

"Observations such as these, however simple they may seem, are of very great importance for a study of the movements of the various currents on Jupiter. They are interesting in themselves, as the observer can easily follow the various currents and their changes by plotting his own observations on squared paper, and if several observers are in touch with one another by correspondence the sporting spirit is easily aroused and they vie with one another in the matter of numbers of observations.

"The present Director of the Jupiter Section is B. M. Peek, of *Sohan*, Silhill Hall Road, Solihull, Warwickshire, England. I am writing for him, because I have already been in communication with you and am an A.T.M. He will supply all the necessary information to anyone interested."

ON page 65 of the earlier editions of "A.T.M." is a somewhat old picture of Vard B. Wallace, and now from the same Mr. Wallace, who writes on the letterhead of the "Vard Mechanical Laboratory—Scientific Instruments," 3135 Blanche St., Pasadena, Calif., we receive a description of a neat engine for dividing setting circles and making protractors, made in his laboratory.

"The table of the engine (See Figure 5) is a little more than 14" in diameter and has 360 teeth cut on the edge. The table is split through the center line of the teeth, so that the upper half may be rotated with respect to the lower half. After the teeth were hobbed (in the Astrophysics shop at 'Cal Tech') the two halves of the gear were shifted and lapped 144 times in different positions. The ultimate result was that there is no visible error in the teeth in any position when viewed through a glass.

"In Figure 6, at the left you will note a pair of cams on the same shaft as the crank. These cams actuate two pistons in small hydraulic cylinders. The liquid from these two cylinders flows through the tubes to the tracelet mechanism. One tube connects with a cylinder that moves the tracelet back and forth. The other raises the tool on the back stroke so that it is free of the table while the latter is turning. This will seem like a needlessly elaborate device till you consider that it is necessary to shift the whole tracelet mechanism laterally on the bridge to accommodate large or small protractors. It is required that the tracelet be raised and lowered to take

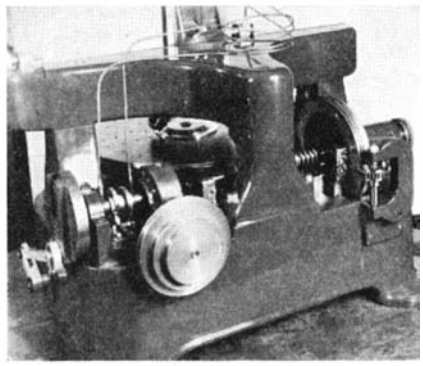


Figure 6: **Other side of Figure 5**

thick or thin work. On top of all that it is also necessary to be able to rotate the tracelet so that bevel or even cylindrical work may be done. With the hydraulic system, all this is accomplished with no difficulty other than the slight bending of the tubing. To do the same thing mechanically is quite a task.

"The machine is almost silent in operation. The engine will scratch 360 lines on a disk in about 14 minutes, putting long and short lines in their proper places, and upon completing the disk it will shut itself off and ring a buzzer for attention. You will notice that the tracelet is inclined at a slight angle in the pictures. This was for some bevel work that we do in production."

FROM time to time we receive inquiries about apparatus for making setting cir-

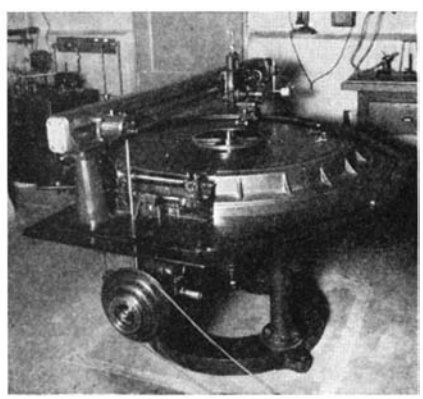


Figure 7: **Dividing engine, B. of S.**

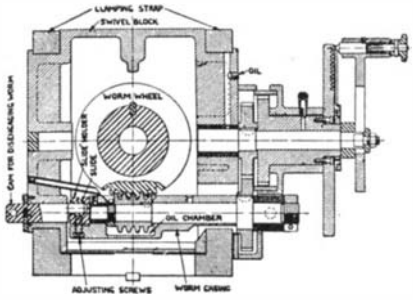


Figure 8: **Dividing head principle**

cles. The Vard apparatus, just described, is of course very far too fine an instrument to construct just to make circles for a telescope or two—in fact it is a finer instrument than most telescopes themselves, and then some. The one in Figure 7 goes still farther, being the circular dividing engine at the National Bureau of Standards and about the last word in such things. It can be used to graduate circles up to a meter in diameter. Such a machine costs about 10,000 dollars or more, and will graduate so that the errors are only about one second of arc and in some cases even less. This is better than a millionth of a circle.

In good machine shops dividing heads are used as attachments to milling machines for all sorts of fancy purposes. Figure 8, reproduced by courtesy of the Cincinnati Milling Machine Company, shows how these work. The handle at the right has a spring pin that drops into holes evenly spaced around a circular index plate. Through the gears shown in section it actuates a worm and worm wheel, the work being attached to the shaft of the latter. Such rigs cost well up into the hundreds of dollars.

Figure 9 shows a dividing head plus a divider that divides to one second of arc, and is made by Kearney and Trecker. The cost is about the same as that of a medium-priced motor car. Most amateurs are lucky even to get a look at one, like a cat and a king. Amateurs desiring to divide setting circles may, however, rig up their own dividing heads. (To be continued in "A.T.M.," Vol.II.)

MEMBERS of the Louisville Astronomical Society want a 20″ telescope and the Corning Glass Works will reduce price of Pyrex disks to about $80 each, provided five can be made at same time. Walter L. Moore of that society, who is Associate Professor of Mathematics at the University of Louisville (summer address Box 163, R.F.D. 1, Coral Ridge, Ky.), wishes to get the necessary five buyers together. Write direct to him, please, and enclose stamp.

Stellafane *get-together, Saturday, August 8. Porter coming east for it. Last call.*

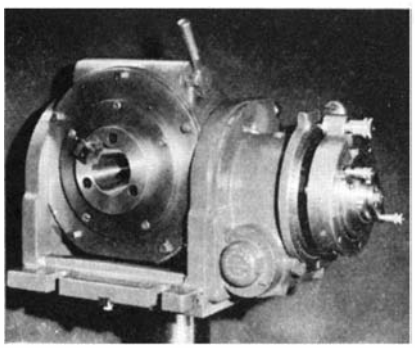
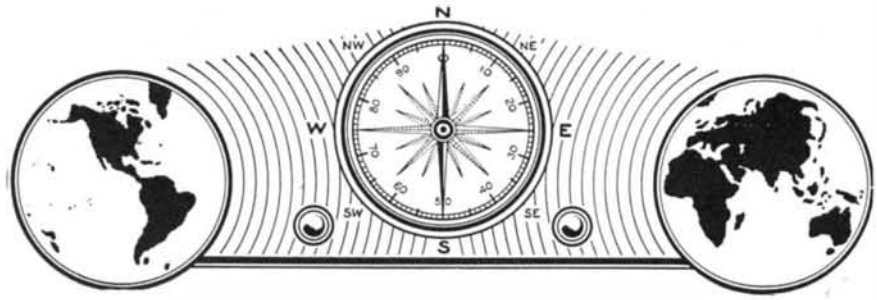


Figure 9: **Another dividing head**



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN

Editor, *All-Wave Radio*

Summer Reception

THERE are occasions during the summer months when reception in the standard broadcast band is disturbed by heavy static or the severe electrical impulses induced in the antenna by nearby thunderstorms. It is during these periods when the shorter wavebands prove of real value.

Natural static and disturbances from electrical storms are not uncommon at short wavelengths, but there are many instances when interference-free reception may be had from foreign stations or from the local short-wave outlets of our own national broadcast chains, when reception in the standard broadcast band is out of the question.

The next time natural static is particularly severe in the standard broadcast band, try switching to 25 or 31 meters for the reception of a desired program. You need not necessarily know the wavelength of the short-wave station as more than likely you will have no difficulty in recognizing the program in one or the other of these two bands. If the program cannot be found at these wavelengths, try 49 meters, where static disturbances may still be much less severe than in the standard broadcast band.

Selected Programs

MONTHLY bulletins on Selected Radio Programs, which have been distributed free to the listening public for the past year by The Radio Institute of the Audible Arts, have been considerably enhanced by the addition of data on foreign short-wave broadcasting. There are listings of selected programs as well as news broadcasts in English. In addition, there is usually a list of the foreign short-wave stations easily and most satisfactorily tuned in, including the frequencies and schedules.

Requests for these bulletins should be mailed to Pitts Sanborn, Director, The Radio Institute of the Audible Arts, 420 Lexington Ave., New York City.

Local and Distant Stations

MANY short-wave listeners are curious as to why they find it possible to receive stations thousands of miles distant yet fail in intercepting signals from stations no more than 50 or 100 miles away.

The answer lies in the behavior of radio waves of short length or high frequency. The ground waves—those which follow the curvature of the earth—die out rapidly and seldom can be picked up at a distance of more than 50 miles from the station. The sky waves—those which leave the earth—travel upwards and are reflected back to earth by an ionized layer in the upper atmosphere. The waves can be picked up only at those points where they again strike the earth, which are many miles distant from the station. Between these points no wave is present.

In other words, the radio wave skips over a portion of the earth, and if your receiver is located in this area, the station cannot be heard except under freak conditions. It is for this reason that a listener in New York City may have difficulty in picking up an eastern short-wave broadcasting station, yet find it comparatively easy to pick up signals from stations in Europe, Canada, South America, and so on.

Radio on the "Queen Mary"

RADIO listeners who wish to intercept the radiophone transmissions from the *Queen Mary* during her transatlantic voyages will be disappointed to discover that all 'phone communications other than direct broadcasting are made secret by means of speech-scrambling equipment. This system, similar in effect to the one employed

International marine radio operators in the control room on the *Queen Mary*. The transmitter, 400 feet away, is started or stopped from this room by a dialing system

by the A. T. & T., is employed to insure privacy to subscribers.

However, there is always the possibility of intercepting a broadcast or unscrambled conversation between the ship operators and the shore stations.

The call of the *Queen Mary* is GBTT. To the best of our knowledge, the transmission frequencies employed are as follows: 4100 kc, 4420 kc, 8840 kc, 12,340 kc, 13,330 kc, 16,420 kc, and 17,800 kc. The lower frequencies are employed during the hours of darkness, or during the periods when the ship is a short distance from the shore station, and the higher frequencies are employed during the daytime when the ship is a considerable distance from the shore station.

The Mystic Hand

THE possibility of mis-tuning an all-wave receiver, and the disadvantages of "frequency drift" have been eliminated in a number of the new Crosley all-wave sets by the introduction of "The Mystic Hand"

One of the new receivers employing automatic frequency control

which automatically tunes the receiver to the proper place on the dial. Instead of merely indicating the correct place on the dial, the device automatically picks it out. In addition, this feature reduces inter-station noise and compensates for frequency drift of the oscillator circuit.

This system is known technically as automatic frequency control, and is also referred to as "lock-in tuning." It cannot, of course, pick the desired station for you, but once you have at least tuned to the fringe of the desired station, it will automatically take care of any discrepancy that may exist. The listener is therefore insured that the receiver is always accurately tuned to the station being intercepted.

Short-Wave Tuning

IN tuning for short-wave stations, it is essential that the station-selector knob is turned slowly. Tuning for these stations requires the same degree of care and precision of adjustment as you would give the vernier controls on a high-power microscope. The secondary or vernier pointer on the dial scale must be made to traverse the frequency divisions at a very slow rate. If the movement of this pointer is rapid, it is difficult to perceive the presence of short-wave signals. Great care is required in tuning if any but the stronger signals are to be heard.

There are other precautions equally as important; for instance, the dial calibrations of an all-wave receiver are not accurate when the receiver is first turned on. A receiver will "drift" in frequency as much as 20 to 60 kilocycles (2 to 6 megacycles) during the warming-up period and will settle down only after temperature stability is reached, which will take from 10 to 15 minutes at least.

This explains why a station tuned in immediately after the receiver is turned on will slowly fade out, and will be lost altogether unless the receiver is re-tuned to make up for the discrepancy in frequency due to drift. This also explains why a station known to be operating on a certain frequency cannot be heard when the receiver is first turned on if the dial pointer is set to the proper position. In this instance, however, the station will slowly appear if the pointer setting is not disturbed, as the receiver will "drift into proper calibration" as it warms up.

Few all-wave receivers are so accurately calibrated that one can set the dial pointer to the exact frequency of a known station and expect the station to be properly tuned in. It is usually necessary to set the pointer at the approximate frequency of the desired station and carefully rock the station-selector knob back and forth until the station is located.

Seeking unknown stations is an art in itself. Many distant stations are there on the dial scales to be heard, but the majority of them are passed over by the inexperienced listener. The reason for this is simple; since short-wave signals are subject to fading, the listener may well tune through the station during the fade and never be aware of the presence of a station at all. This is almost sure to happen if the signal fades during a period when no program is being broadcast. Under such conditions, the only possible indication of the presence of a station carrier is a very weak hissing noise.

In roving the scales, then, it is important to listen for carrier hiss. The receiver should be carefully tuned for the loudest possible hiss, and left so until broadcasting or station anouncements commence. If the signals are still too weak, stick with them, for in another minute or two they may be so loud that it will be necessary to turn down the volume. There are few stations that cannot be intercepted moderately well when they come out of a fade and reach maximum strength.

Scientific Research Broadcasts

A NEW half-hour radio program sponsored by General Electric popularizes scientific research and makes it easily understandable to the layman. Originating in Rice Hall in the G.E. research laboratory in Schenectady every Saturday night at 7:30 o'clock, Eastern Standard Time, the program is broadcast by WGY in the standard broadcast band and on the short waves by W2XAF. It consists of a popular talk by one of the scientists of the laboratory staff, and a "Science Exchange" through which questions of a scientific nature sent in by radio listeners are answered.

CAMERA ANGLES

Conducted by JACOB DESCHIN

Lighting for Drama

NOW and then someone brings up the exploit of Edward Steichen—today almost a legend in American photographic annals, though a very active camera artist—in photographing a white cup and saucer no less than a thousand times in an effort to plumb the mysteries of photographic lighting. While it is not advocated that all our readers straightway get busy emulating America's photographic ace, the serious worker will understand the spirit that prompted him; namely, the desire to know first and to do afterwards.

A single spotlight produces a highly dramatized and unusual portrait

The subject of photographic lighting covers a vast field and deserves the careful study of every earnest camera-hobbyist. In this little discourse, which concerns itself specifically with some of the methods which can be used in lighting for dramatic effects, some inkling will be had of how a little thought and experimentation will give results which can approximate the work of some of the best of today's professionals.

Lighting for drama, as differentiated from straight lighting, involves the use of a concentrated light source to give accent and prominence to some object in order to achieve a striking effect, to give "punch" and forcefulness. A subject which under general illumination would seem lost and insignificant might, if properly lighted by a spotlight, be made to assume an air of great impressiveness. The chief characteristics of a "dramatized" photograph consist of strong, black shadows and equally strong highlights with few if any intermediate tones. Great contrast is the theme. It is the art of black and white in its purest sense.

A floodlight illuminates; a spotlight emphasizes. No attempt at dramatized lighting in photographic work can, therefore, be successful unless we use a spotlight. A combination of general lighting and "spot" lighting has been and can be used in this connection, but it will be found that the most successful results will be obtained by the use of the spotlight alone.

Some versatile workers have made their own spotlights, but if the purse will permit—and it will not be put to too great a strain, since the cost of a good spotlight is quite reasonable—it is best to purchase one and thus take advantage of a product turned out by specialists on the basis of an experienced engineer's designs. Spotlights are available which take either a Photoflood or projection bulb, the latter, for non-professional use, being usually 500 watts. The projection bulb is rated to last about 200 hours. It will give a sharper outline than the Photoflood, although for many purposes the latter may be just as useful. A good spotlight has provision for ventilation, the housing can be adjusted at various angles, the size of the light beam can be varied and the stand is so constructed that the housing can be raised quite high. When lower angles are desired than the height of the stand permits, it will, of course, be necessary either to raise the subject-matter being lighted or to remove the housing from the stand and place it on some lower makeshift support.

Deep shadows are the heart of the "dramatic" photograph, and for this reason the

With the spotlight below the subject, shooting upward at an angle

spotlight is the ideal equipment. It is preferable to use a single "spot" since the use of more than one will involve conflicting shadows; sometimes, however, two "spots" can be used very effectively. Some fine photographs of dancers have been made in this way by directing a low-placed "spot" from each side of the subject, thus casting two separate shadows on the wall.

This type of lighting is found most useful in connection with portraits and still life studies. Some idea of the possibilities

***Right:* The full beam of the spotlight was used; *below*, a rectangular cardboard mask was employed**

will be found in the accompanying illustrations. Simplicity should be the objective; the interest should center on a single point. Study the subject with the light at different angles and take plenty of time to decide when and from what point to shoot.

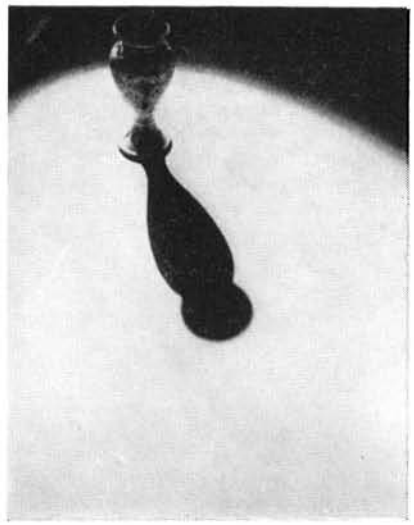
You are not limited to the shape of the beam thrown by the "spot." You can alter it to suit your particular requirements by cutting a shape out of the center of a piece of cardboard and holding or placing the latter in front of the "spot" lens. Thus, in the case of the decorated vase illustrated above, a rectangular shaped cutout was used.

New Sponges

THE popular Viscose sponges, which were first introduced in two sizes in the shape of a cake of soap, and since then have become available in a more flattened form, are now being put out with a wooden handle. This facilitates handling the sponge in passing its artificial silk, absorbent body over prints and negatives without the possibility of accidentally scratching the emulsion with the finger nails. This "brush-type, scratchless" version is available in small and large sizes.

Agitator for Development

WITH agitation of the tank during development of a roll of miniature film being generally accepted as one of the prime requisites of perfect processing, the appearance on the market of a reasonably priced power driven outfit that will do the job scientifically and steadily should be



welcomed. The "Speedway Agitator," assures uniformity of development and proper fixing, and this without the drudgery of manual agitation.

The agitator oscillates the tank at the rate of 60 times a minute and the manufacturers claim that a "reel immersed in solution advances clockwise as well as oscillates, guaranteeing a continuous flow of the fluid over the film."

Furnished for 110 volts A. C. or D. C., to plug into the ordinary light circuit, the agitator has a fully insulated, encased motor, chrome-plated acid proof tray designed with a pouring lip for over-flow of liquids, and is finished in black with chrome trim.

New Hypo Formula

WHILE retaining the time-honored ratio of 1 ounce of hypo to 4 ounces of water, a new fixing formula for films and plates has been introduced by Eastman under the name F-5. Except for the addition of one half ounce of boric acid crystals and the fact that in mixing, the hypo and the acid hardener chemicals are dissolved successively instead of in the two-formula arrangement called for in the formula F-1, formula F-5 does not differ from its forebear. F-1 is still recommended for developing papers.

ACID HARDENING FIXING BATH
Formula F-5

Water (about 125°F.)	40 ounces
Hypo	16 ounces
Sodium Sulphite, desiccated	1 ounce
Acetic Acid (20%)	3 fluid ounces
Boric Acid, crystals	½ ounce
Potassium Alum	1 ounce
Cold water to make	64 ounces

Avoiding Dust

THE motto "Put Everything Under Cover" may well be adopted by every worker in photography. No one realizes the consequences of not doing so as much as the worker with miniature films, where a tiny speck of lint or dust expands to heroic and extremely disturbing proportions when the negative is enlarged to the sizes found desirable in this field. One precaution to take is to house chemicals and other supplies in a cabinet supplied with a door which can be shut tight. If it is found inconvenient to house developer and fixing solutions in this way, periodical dusting of the bottles will be helpful. For

the enlarging camera, which is so susceptible to gathering dust, one good precaution is to make or have made a cloth bag, the opening of which is provided with a draw string. When not in use the machine will be well protected by being covered with such a bag pulled down over the top and the draw string tied at the bottom.

Buildings at Night

THE best time to take pictures of buildings in order to show the outline as well as the lights in the windows is in that brief interval between sunset and dark when there is still some light in the sky, although

". . . between sunset and dark . . ."

the sun has apparently left for the day. The accompanying picture of the Scientific American Building in New York City was photographed during such a period from the platform of the elevated railway diagonally across Bryant Park. The exposure was one second at the full opening of an F:2 lens in a 35-mm camera. No tripod was used; the camera was kept steady by holding it against a post.

Lighten up the Darkroom

CONTRARY to belief in some quarters, it is not absolutely necessary to paint the walls of a darkroom black. In fact, it will greatly cheer up the place when the room light is turned on if the walls are painted some light color such as a silver gray. Some workers even go the limit and use white paint. So far as working under the safelight goes, this illumination is made more generally effective because of reflection from the walls, which, if painted black, reflect practically nothing.

Philosophic Note

AN amateur with a developing sense of the deeper import of photographic work recently remarked to this department: "You know, the important thing is not being a photographer, but being just an ordinary human being." We who see in our work the means of translating life into pictures will understand this at once. The important thing is not gadgets and formulas,

but the subject matter—the human scene and its varied manifestations—expressed in living, sympathetic terms by means of a camera. Tones are important, composition is important, the right lighting and the correct exposure are important, but more important still is to be "just an ordinary human being." If you do not instinctively like people, if you can't "see a picture" in homely, every-day situations, if the thoughts, the moods, the problems and the way of life of the people you meet do not interest you, then you can be master of every photographic phase and yet be a miserably poor photographer.

Combined Album and Frame

THE spiral binding has been adapted to the snapshot collection in a new type of album which fits into a picture frame, the latter designed to exhibit a page of the album at a time. The album, comprising 20 black leaves with 7 by 9⅝ inches mounting space, is known as the "Snapbook" and fits into the frame, called the "Snapbook Frame." The latter measures 8¼ by 10¼ inches and takes an 8 by 10 inch enlargement; it has a Kodaloid window measuring 6 by 8 inches. The two devices, which are introduced by the Eastman Kodak Company, are sold as a unit.

New album and "Snap-Stickers"

The "Snap-Sticker," a sticker gummed on both sides, thus obviating the use of "art corners," is also announced by Eastman. They are sold in books of 800.

Contrast With D-72

IN developing bromide enlarging papers in D-72 you may find the prints falling somewhat short of the bright, snappy appearance you would like to have. Instead of using a harder paper, you may increase the contrast by diluting the stock solution in the ratio of 1 ounce of solution to 2 ounces of water, in lieu of the usual bromide ratio of 1 to 4. Still greater contrast may be obtained by a 1 to 1 dilution, although in the latter case it will be necessary to control development somewhat by adding 15 grains of potassium bromide to every 32 ounces of developer.

New Miniature

THE remark is often heard that a camera is only as good as its lens. That this is true is proved by the increasing interest

—among advanced amateur as well as professional photographers—in the type of objectives with which cameras are supplied.

The new Roland miniature has recently made its appearance in the American market, equipped with a Miniature Plasmat lens, designed by Dr. Paul Rudolph who is noted as the inventor of the Tessar and Plasmat lenses and the Kino-Plasmat for motion picture photography.

The Compur shutter of this new camera gives speeds ranging from one second to 1/400. The negative size is 1¾ by 2¼ inches. A desirable feature of the camera is the combination view- and range-finder whereby the field of view and focus are obtained in a single operation.

Mountains From Molehills

SOME time ago this department remarked on the enormous possibilities which lie in the field of re-framing the image in a negative and how a picture which at first glance might seem quite ordinary will, by careful study and experimentation, yield through the process of recomposing the picture a product that is distinctly worth while and vastly superior to the negative taken as a whole. Also, it has been pointed out that the lack of a telephoto lens does not necessarily always mean that we have to let a good subject go; we can still take the picture and, by enlarging only a part of it, get practically as good a result as could be obtained with the lens of greater focal length. The proof of the pudding is in the enlarging, and in the two examples which illustrate this discourse we have a very fine example of what can be done when the lens will not stretch as far as we want it to.

Above: Reproduction from full negative. *Below:* "Land and Sea and Sky," from the re-framed negative

One of the illustrations is made from the full negative. See how the other has been improved by selecting the real picture contained in the negative and cutting out the rest. Observe how the composition is improved and how the sky is given prominence in "Land and Sea and Sky."

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 99)

This is also sometimes called "weeding."

Thinning—Cutting made in a dense immature stand for the purpose of increasing the growth rate of the trees that are left and of improving the composition and quality of the stand.

Improvement cutting—Cutting in a forest beyond the sapling stage (second growth or old growth), the purpose of which is to bring the stand into better condition for silvicultural management, mainly through removing trees of undesirable form, condition, and species.

Liberation cutting—Improvement cutting in which desirable understory trees are freed from suppression by removal of undesirable overstory trees which may be either old growth, second growth, or new growth.

Underplanting—Setting out young trees, or sowing seed, under an existing stand.

MOTOR COILS

ELECTRIC motor design has been improved with the discovery that Cellophane used as an insulating wrapping for coils permits the insertion of the same "turns of copper" in less space. It has been proved physically efficient and makes possible a saving of 28 percent in time as compared with motor winding with coils that are insulated with cotton.

HUMAN SKIN THERMOMETER

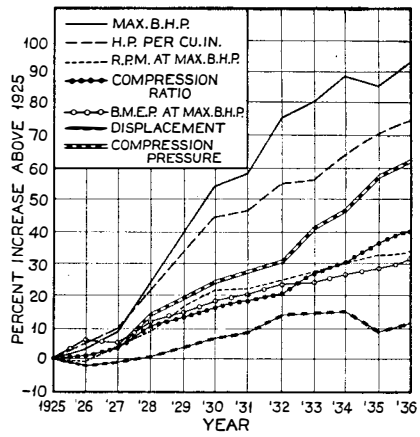
THE much-ridiculed ability of a person to go into a dark room and "feel" that another person—a burglar perhaps—is also present, even though no sound is heard or actual sight is observed, was given scientific credence at the recent meeting of the American Physical Society.

The human skin, reported Drs. J. D. Hardy and T. W. Oppel of Russell Sage Institute of Pathology, New York City, is more sensitive than the best mercury-in-glass thermometers which scientists can make. Five ten-thousandths of a degree, Centigrade, of temperature difference can be detected as a minimum by the skin.

This extremely high heat sensitivity of the skin, said the scientists, "is probably the explanation of the so-called 'sixth' sense whereby the presence of another person in the dark is made known."—Copyright 1936. *Science Service.*

AUTOMOTIVE ENGINES GAIN EFFICIENCY

BETTER fuels for automotive engines have made possible a steady improvement in the efficiency of automobiles during the past decade as shown by the accompanying chart. Since the cost of building engines is closely related to their cost, the fact that power output (Max.B.H.P.= maximum brake horsepower) has increased more than 90 percent since 1925 with an



Gains in automobile engine efficiency

increase of barely over 10 percent in displacement has given us better automobiles at little or no advance in cost. The ability to utilize gasoline of high anti-knock value efficiently through higher compression pressures and greater brake mean effective pressures (B.M.E.P.) has been the crucial point in this development. Without increasing either the size, weight, or cost of the engine, this has effected a large increase in power output. The wide distribution of gasolines of high octane rating at non-premium prices has justified this improvement in engines of all automobiles.—*D.H.K.*

BREEDS BLUE BIRDS WITH YELLOW WINGS

THE objective of thousands of bird fanciers and breeders all over the world has just been reached by E. Anderson, a 21-year-old factory hand of Geelong, Australia. He has produced a blue budgerigar with yellow wings.

Anderson has definitely established the type with three male birds. He intends to perfect the color before placing birds on the market. They may be worth 250 dollars each.

These little Australian parrakeets, known variously as budgerigars, shell parrots, grass parrakeets, and love birds, have been the subject of experiment for years. When the cinnamon winged variety was produced some years ago, its owner made more than 3500 dollars in one year. The new blue variety is a much greater achievement.—*Australian Press Bureau.*

WRONG MAN CREDITED WITH GREGORIAN CALENDAR

THOUGH several American text books on astronomy credit the Jesuit priest Christopher Clavius with having suggested the changes in the calendar which were adopted in 1582 by Pope Gregory XIII to form the Gregorian calendar that we use today, it was another man to whom the honor should go. According to a statement to *Science Service* by Prof. Pio Emanuelli, of the Royal University of Rome, the author of the reform was Luigi Lilio, generally known by the Latin form of his name, Aloysius Lilius. He was a physician of Naples, who lived from 1510 to about 1576. Clavius was a member of the commission which studied the problem, and upon whose recommendation the Pope ordered the changes. He was also a great apologist of the reform, and wrote two important books

about it. In these he speaks of Lilius in very complimentary terms. NOTE: *Readers may refer to "Our Calendar About Three Hours in Error"—in our June issue—in which erroneous credit was given to Clavius. —F. D. M.*

Breeding for Fine Short Staple Cotton

COTTON breeders are now working intently to bring to the cotton field the "blood" of an American Indian cotton that has only one important good quality—exceptionally fine fiber. This new interest in fine fiber is prompted by practical tests that have revealed the new and surprising fact that strength and wearing quality are associated with fine fiber, as much as they are with long fiber.

For generations, cotton growers and spinners have prized Sea Island cotton for its strength. Sea Island cotton fibers were exceptionally long and exceptionally fine. It seems to have been taken for granted that this cotton made strong thread because the individual fibers were long. Dr. R. W. Webb of the Department of Agriculture exploded this belief by the simple method of cutting down the long fibers of some of this cotton until they matched the staple length of ordinary upland cotton, and then spinning and testing thread from the two. Thread from the Sea Island cotton was much the stronger, indicating that strength was more a result of fineness of fiber than of length of fiber.

This discovery by specialists studying utilization of cotton in the Bureau of Agricultural Economics put the cotton production men on the trail of fine-fibered cottons. Cotton breeders in the Bureau of Plant Industry had already experimented with crosses of Sea Island and upland cottons, but Sea Island types do not fit well with boll weevil activities. Dr. T. H. Kearney recalled Hopi cotton, an almost worthless variety of very low yield, grown by the Hopi Indians in northeastern Arizona. About the only desired quality this Hopi cotton had was fineness.

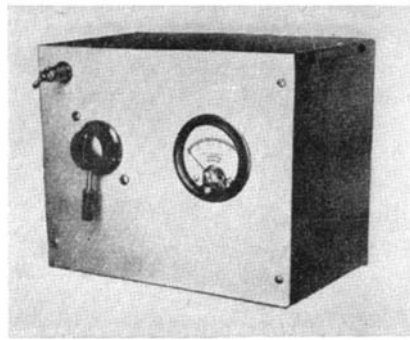
Only a small sample of Hopi was available. Webb and his staff found the fibers remarkably uniform in length, and strong —unexpectedly strong. Webb spun the fibers into thread many times finer than the thread from ordinary cultivated cotton of the same length, and as strong as that from some of the cultivated upland varieties, say around an inch and a quarter staple.

Hopi isn't a market cotton. It yields only a few pounds to the acre, drops many of its bolls, and is generally undesirable, so last year Kearney crossed Hopi with Acala cotton, a good market variety which the Department introduced years ago from southern Mexico. The limited supply of fiber from this cross showed fine qualities in Webb's spinning tests. The staple is uniform and longer than Hopi. The fiber has a silky sheen. And the yarn from the 1⅛-inch staple is estimated to be as strong as yarn from 1½-inch ordinary upland cotton.

From a manufacturing standpoint cotton of the type of this Hopi-Acala cross promises to be particularly desirable. The fiber requires less twist than other fibers of equal length, a quality that helps cut the cost of spinning. The spinner could make finer threads than with ordinary upland cotton, and the spinning costs would be lower than with the longer-stapled Sea Island fibers. The fineness of the thread and its silky sheen offer attractive possibilities for creation of new sheer fabrics of cotton.

Body-Capacity Electric Control

A DEVICE, operating on the principle of body-capacity for the control of automatic doors, alarms, signals, bells, and other apparatus, consists of a single self-contained unit in which is mounted the



No complicated wiring system is needed with this new alarm control

necessary electrical equipment and a relay, together with an antenna which may be from 5 to 50 feet of rubber-covered wire. It is only necessary that a person or car approach within three feet of the antenna to cause the device to operate. This makes it possible to mount the unit itself at almost any convenient place and the antenna run to wherever it is desired the control point to be. The antenna may be run overhead or along a wall any distance up to 50 feet and when a person or car approaches within three feet of any part of the antenna the device will operate the desired control.

This device, known as the Capacitrol, is particularly useful at points where for one reason or another it is not practical to use photo-electric apparatus or where the installation of "treads" is not possible.

Palladium

IT appears that a silvery-white companion for gold leaf has at last been found. It is palladium leaf, now produced commercially in this country and in France. Palladium metal, says the *Industrial Bulletin* of Arthur D. Little, Inc., is of extraordinary malleability, and may be beaten into sheets only 1/250,000 of an inch thick. It takes some 35,000 of these, each 3⅜ inches square, to weigh an ounce. This leaf is tarnish-proof and corrosion-proof and of beautiful color. Either alone, or as contrasting metal with gold leaf, it serves the same purposes, as for book edges, lettering, titling, and the like, and for coating leather to be made into "silver" slippers. Sculptors have used it for covering statuary.

The metal palladium is rare, but is less expensive than platinum or gold. It is found in small amounts in the nickel ore at Sudbury, Ontario, and in isolated places pretty well all over the earth. Palladium is high-melting, strong, and remarkably easily worked, a metal well liked by jewelers and dentists. It makes stronger jewelry than

does white gold. Indeed, it alloys with gold to make a markedly superior white gold, which is highly tarnish-resisting as well as very tough. It alloys well with other metals for special applications. In the chemical industry, palladium is notable for its power of occluding hydrogen, which gives it catalytic properties. A process has been devised for plating palladium to form a highly protective coating for food containers, jewelry, and reflectors, thus extending the utility of this splendid metal.

Developing Latent Finger Prints

TO the Editor: "In the summer of 1932 I had occasion to study the various means of developing latent finger prints. Two methods developed by me at that time have proved exceptionally useful and reliable throughout the past four years. I should like, therefore, to make these methods public through your journal.

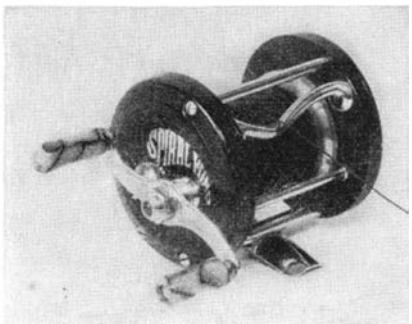
"1. One of the difficulties in developing the latent print upon manuscripts, documents, books, and so forth, is that many of the methods employed leave thereon permanent record of the print, or otherwise mar the appearance of the paper. To overcome this difficulty I have employed crystalline iodine with much success. The print may be developed by dusting crystalline iodine over the surface of the paper. This may be photographed with ease but due to the sublimation of the iodine the print disappears entirely within a day or two.

"2. Latent prints occurring upon paper surfaces, such as those mentioned above, may be developed temporarily and then brushed away or made permanent by the use of a powdered silver proteinate such as argyrol or protargol. The process consists simply of dusting the powdered silver protein over the latent print to produce a fine image of a dark brown color. This may be photographed and brushed away or it may be made indelible by the simple process of moistening it with breath blown from the mouth."—*Dudley P. Glick, Assistant Professor, Laboratory of Bacteriology, Colorado Agricultural Experiment Station.*

Level-Wind Casting Reel

A NEW, practical, fool-proof level-wind casting reel has recently been developed by the Spiral Wind Fish Reel Company. It embodies an entirely new level-wind principle and is said to make successful casting easy for the novice as well as the expert caster.

The most noticeable difference between the Spiral Wind and other reels is the spiral shaft over which the line runs, and the absence of the conventional double-thread shaft, pawl, and U-shaped guide.



The rotating spiral arm guides the fishing line smoothly on the reel

The spiral shaft has an oscillating rotary motion forward and back through two thirds of a revolution. The line follows the low point of the spiral back and forth across the spool, insuring a level wind. In casting, the line is free to "bloom" over the spiral shaft without interference. The entire reel is so constructed that all moving parts are protected from dirt and sand. The metals and alloys used have all been selected for strength and resistance to wear and corrosion. The aim has been to design a symmetrically balanced reel with all sharp edges removed so that it feels comfortable to the hand and casts freely.

A New Resin for Improved Lacquers

RESINS made by the polymerization of acrylic acid and its derivatives possess properties which make them valuable for use in lacquers to replace nitrocellulose, according to Kleiss and Pearce, writing in *Industrial and Engineering Chemistry*. Already these resins (marketed under the name "Acryloid") are being used to form the strengthening layer in safety glass with great success, in view of the fact that they do not discolor on prolonged exposure to light. The transparency of the resins, their resistance to water, petroleum solvents, and chemical attack, their strong adhesion to surfaces and their high electrical resistance are valuable in forming protective films from solutions in the customary lacquer solvents. Their use on metals, textiles, paper, and rubber provides valuable protection from destructive agencies. Unlike nitrocellulose, the Acryloid resins do not react with lead and alkaline pigments, and hence the choice of pigments is broader than with ordinary lacquers.—*D.H.K.*

St. Patrick Never Visited This Japanese Island

WHERE did the snakes go when St. Patrick, in the legend, drove them from Ireland? Maybe they came to Ireland's utter opposite, on the other side of the world off the coast of Korea. It is a small island held by Japan, which is so completely infested with poisonous snakes that human beings simply can not stay on the place. Although it would be an ideal site for a lighthouse, the Japanese have left the island to its half million venomous inhabitants, according to *Science Service*.

This island belongs to the province of Kwantung, which, after the Russo-Japanese war, was leased by Japan from China for a term of 99 years. Small-Dragon-Mountain Island, as it is called, lies at the entrance to the Gulf of Pechili, eight nautical miles from the westernmost point of the province of the same name.

In 1931, when an expedition of Japanese scientists was sent to Manchuria to study the natural resources of the country, Mr. Jumpei Sato, the biologist who led the party, was instructed to investigate Small-Dragon-Mountain Island as a possible site for a lighthouse. The investigators, although warned that the island was overrun with venomous snakes, were more than astonished

at the snakes' paradise which they discovered.

The snakes belong to a species of moccasin not found in Japan. They are not swift in attacking human beings, preferring rather to escape. They are so numerous that it is impossible for a person to walk even a few feet without encountering them, and they are easily captured by means of a forked stick. The island lies in the path of the migratory birds of Manchuria; and in migrating seasons those birds which stay their flight to rest here are devoured by the snakes, which wind their coils around the branches of bush and tree and wait for their prey. When quail or siskin or swallow are not to be had, these snakes live upon wild soybeans, maize, arrowroot, mugwort, and so on.

While one member of the party was taking moving pictures of the snakes, another suggested that the only way to rid the island of them would be by burning off the brush. But this suggestion was quickly set aside, because of the Chinese respect for the snake as the "little one" of the serpent family, the "big one" being the dragon, the Chinese national emblem. This sacred relationship makes some claim for government protection. Still another reason for protection is that the snake is—and has been for thousands of years—the source, the raw material, from which potent medicines have been made in China and throughout the Orient; and it would be an insult to Nature's bounty to destroy wantonly such a valuable supply, where the reptiles are so easily caught without danger to the catcher.

Dr. Shuji Hassegawa, M.D., director of the Bacteriological Institute of the Government Dental College in Tokyo, a member of the expedition, made a report concerning this island to the Biological Club of Nippon. He stated that the scientists who made the investigation have recommended to the government that Small-Dragon-Mountain Island be set aside as a permanent paradise for the rare snake species.

Poorly Taught Students

SCIENCE and mathematics professors in the colleges now regard the present crops of high school graduates as inferior in basic training to those students who entered college only 10 years ago. This is the unfortunate result of a recent trend in education wherein more stress is placed on the mechanics of teaching than upon knowledge of the subject matter. "Teaching I-II" and "The Psychology of Teaching" are stronger qualifications nowadays for a high school instructor's position than are, for example, "Advanced English," or graduate courses in the sciences. Because of this, many college professors could not qualify to teach in some high schools.

These facts have been brought out by a committee of the American Chemical Society who charge that the "professional teacher training" group among educators has secured a monopoly of the education machinery. In addition to the above facts the committee adds that the situation is tending toward a worse condition.

In selecting high school teachers, the committee charges, a premium has been placed on applicants who are more interested in *how to teach* chemistry, for example, than those who *know* the most chemistry. Moreover, *Science Service* reports the committee as saying that the unrestricted certification of individuals to act as high school instructors permits teachers to give instruction in fields in which they are untrained. In an understaffed high school, such broad certificates permit the biology teacher to give instruction also in chemistry, physics, mathematics, or in French or German for that matter.

"In a majority of the states," the committee finds, "the training of teachers and their recommendation for certification to the State Board of Education has been delegated by law, or other authority, to teachers' colleges and colleges of education, and in extreme instances only those persons who have been registered students in such colleges are eligible to certification.

"By this method the 'professional teacher training' group has secured a monopoly of the educational 'machinery' and in many states the fundamental subject matter departments of the universities have been legislated into a position where no member of their faculties has any voice in setting up curricula and requirements to be met by prospective teachers."

PERMANENT LICENSE PLATES

OF the several states that have adopted permanent license plates for automobiles, Connecticut is the first to use aluminum. Each owner retains his same number year after year, starting in 1937, only inserting a small year plate in a cut out section of the larger one.

10,000 Unpaid Volunteers

A COMPLETE picture of North American climate is possible only because of the great mass of fundamental facts furnished by 5000 volunteer weather observers. Each unofficial observer, says W. R. Gregg, Chief of the Weather Bureau, really runs a small field station, at no expense to the government, except for the few instruments and blank forms used.

This system of augmenting official weather records began in 1891, when the newly created Weather Bureau was charged with the duty of "taking such meteorological observations as may be necessary to establish and record climatic conditions in the United States." The cost of maintaining thousands of stations to make these observations all over the country was prohibitive.

About 300 members of the present volunteer force have served for 25 years or longer. Three have been keeping records for more than 50 years and 54 for between 40 and 50 years. There are 300 women observers, three with more than 40 years of service. To prevent breaks in the continuity of the daily records, each observer has a substitute, which means that 10,000 persons are ready to give their services at any time.

Every day at a fixed time—usually around sunset—the observer records the maximum and minimum temperature, the precipitation, and such unusual conditions as wind, dust, or thunderstorms, fog, and frost. At the end of the month the record goes to the Weather Bureau in Washington, D. C., for tabulation and filing.

From millions of these records, meteorologists work out the answers to countless questions on climatology. Recently these questions have dealt largely with land policies, for land is "conditioned by the sky under which it lies and by the climate which is proper to it."

Some Perfumes Help, Others Harm Plants

PLANTS are aided in their growth by certain odors, harmed by others, reports Dr. Madaus, of the staff of the Radebeul Biological Station, near Dresden. Seedlings of rye, lupines, and cress grew much more rapidly when exposed to the scent of ripe apples. The odor of peppermint, on the contrary, had a marked depressing effect.—*Science Service.*

FRANKFURTER ROLLS

IF the makers of a new machine have their way, visitors to resorts and amusement parks this summer will see their rolls and frankfurters baked together before their eyes. This new machine, electrically operated, actually bakes a roll around the frankfurter.

Science Lays a Ghost

GHOSTS in the spectral line photographs of elements are false lines appearing on each side of the real lines, and are caused by imperfections in the way the rulings of grooves in a diffraction grating are made. A grating consists of thousands of tiny parallel slots cut in glass or metal, which have the property of spreading out light rays into the various colors or wavelengths. Thirty thousand lines to the inch is sometimes attained in the ruling, which is done automatically with a diamond point. If the lines are not exactly parallel the ghosts arise.

With the aid of an improved technique for making diffraction gratings, Dr. R. W. Wood of Johns Hopkins University recently pointed out, the ghost effects have been reduced so that a ghost line will have only 1/1200 of the intensity of the nearby "real" line. While the ghost is not killed, perhaps, it is certainly true that it is very much weakened.

The trouble with making ruled gratings on glass or spectral metal, Dr. Wood indicated, is that the diamond point may break or at least become worn before the 180,000 lines in a six-inch grating can be finished. In his new method, Dr. Wood first coats Pyrex glass with a layer of chromium only a few molecules thick, and then puts on an additional layer of aluminum which is much softer. The chromium and aluminum are evaporated on by the methods used at California Institute of Technology by Dr. John Strong. The ruling of the grating is then performed on the soft aluminum, with improved results.

For making glass gratings, aluminum is put on the glass and scratched with the ruling diamond point. Then the surface is dipped in powerful hydrofluoric acid which eats away at the exposed glass surface and at the ridges of aluminum. Quickly, however, the grating is removed from the acid and when the aluminum is washed off it is found that little grooves have been etched in the glass. These parallel grooves are what give the grating its diffracting property.

As before, improvement comes because the actual cutting by the ruling machine is done on a layer of aluminum instead of the glass surface.—*Science Service.*

Saving 8000 Mothers

THE Maternity Center Association in New York points out that medical science could save a large proportion of the mothers who die in child-birth. These deaths are, therefore, called needless. Yet, year after year, the death rate among mothers in the United States has remained nearly stationary. People are shocked to be reminded that the United States has one of the highest death rates for mothers in child-birth of any nation.

It is sometimes argued that conditions are not so bad—that it is merely different ways of keeping statistics that make the United States deaths loom so large. But this alibi is shaken, according to *Science Service,* now that a study of the United States Children's Bureau has declared: "No matter what method of procedure is used, the United States retains an exceedingly high rate as compared with other countries."

The traffic deaths that get newspaper headlines and seem so extravagantly frequent, add up in a year to 36,400 dead. Maternal deaths total almost half that number, adding to 15,000, of which over half are pronounced preventable.

The thought that the Maternity Center Association is driving home is that prospective mothers should make every effort to get adequate care. It is a vital matter. Those who do not know where to turn for adequate care can get information from social and health agencies regarding clinics and medical centers.

The six-fold program of the Association, to prevent the preventable deaths, narrows down to these brief items:

1. A complete medical examination early in pregnancy.
2. Regular and frequent medical supervision of prospective mothers.
3. An aseptic delivery under the supervision of an obstetrician.
4. Supervision, care, and instruction until the mother is able to resume her work.
5. Examination of the mother at six weeks, three months, six months, and one year after the baby is born.
6. Arrangements for continuous medical supervision of the baby.

Captive Bats Like Cheese and Bees

BATS, which would hardly be fancied as pets by most people, have been kept as more or less docile captives for months on end by Prof. William H. Gates of Louisiana State University. At a recent meeting of the American Society of Mammalogists, Prof. Gates told of his experience in capturing and keeping bats of several species, and of his observations on their feeding and breeding habits.

Captive bats, he found, would feed willingly on a large number of things that they cannot imaginably get in their native state. American cheese, cottage cheese, yeast, bees

killed and cut into small pieces, minced insects of other kinds, bread, crackers, hard boiled eggs, any kind of vegetable, any kind of unsalted meat, milk of all kinds—sweet, sour, evaporated, buttermilk, malted milk—all these the bats fed and thrived on.

They preferred cottage cheese above other artificial foods, Prof. Gates said, and would even drop other foods they had already picked up, if they found it available. Their preference for bees rather than other insects might appear strange at first, for bats fly at night and bees by day, so that they do not normally meet. However, Prof. Gates suggested, the nectar carried by the bees may have given them an attractively sweetish taste.

All the food had to be chopped up very fine, for bats are rather helpless, with both arms and legs involved in their wide "leathern" wings, and their mouths are adapted only to the intake of very tiny morsels. Their meals must be served in very shallow dishes, as must also the necessary supply of drinking water.—Copyright 1936, by *Science Service.*

Just Like the Rest of Us

CHIMPANZEE society has both its liberal givers and its chronic beggars, to judge from a study of food-sharing behavior reported by Dr. H. W. Nissen and Dr. M. P. Crawford of the Yale University Psychology Laboratories. Some chimpanzees will never beg food of another; others will beg whether or not they have food of their own at hand. Some never respond to a plea for alms, and others, even though they are the strongest of the group, will give voluntarily.

The experiment was designed to determine whether chimpanzees ever share their food under conditions of non-compulsion, and when no direct or immediate gain for the animal who shares is involved. Eight chimpanzees were observed in different combinations of two during 90 experimental periods. Two subjects were placed in the same cage or in adjoining cages separated only by iron bars. One or both were given food. One of the most striking results when the animals were in the same cage was the discovery that the most dominant individual, that is, the most aggressive and usually the larger and stronger, did not always get the major portion of food, even though he could have had all.

Teasing behavior was common among the animals. Some enjoyed offering food through the bars to a begging companion and withdrawing it quickly just before it could be grasped. Some individuals begged food, placed it out of reach in their own cage, and immediately begged for more.

Three-Meter Facsimile Service

ON June 10th, radio communication hailed the approach of new services by which business men will send one another entire letters by radio instead of terse 10-word telegrams and in which social notes will speed through space to be received and delivered in the exact handwriting of the senders. The occasion was the first demonstration of RCA's new ultra-short wave radio circuit connecting New York and Philadelphia. The circuit is unique in that it employs ultra-short radio waves with automatic relay stations and makes possible the transmission of drawings, type matter, handwriting, and other visual material in facsimile, along with the simultaneous operation of automatic typewriter and telegraph channels. It is a completely secret system.

The automatic repeater stations, which catch the radio waves speeding in both directions and relay them to their destinations at New York and Philadelphia, are located 30 and 66 miles respectively from New York. Since the range of three-meter radio waves is virtually limited to line-of-sight, the points of reception and transmission for each of the stations were selected to provide the most distant optical horizon. In New York and Philadelphia, therefore, the antennas are located atop tall office buildings.

Each of the repeater stations employs two different transmitting wavelengths, or one for each direction. The two terminal stations each use one sending wave, making a total of six wavelengths, or frequencies, for the complete circuit. If it should be desired to extend the circuit beyond either terminal point, these six wavelengths could be used over and over again in the same sequence, without creating interference, and so a single circuit could be extended from coast to coast.—*M. L. M.*

CURRENT BULLETIN BRIEFS

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

CONSTRUCTION OF PRIVATE DRIVEWAYS is an 18-page mimeographed brochure, giving in detail the correct methods to pursue in making various types of driveways. It deals not only with materials to be employed, but also with the method of applying them. Several photographs and cross-sectional drawings illustrate the text. *United States Department of Agriculture, Washington, D. C.—Gratis.*

KNOW YOUR ROPES is a complete reference manual for users of wire rope and for engineers. It contains useful data in tables and text on how to make wire rope last longer. It also points out many of the troubles that can ensue from the improper handling of such cables. *Write for Bulletin 836B to Scientific American, 24 West 40th Street, New York City.—3 cents.*

187 BOAT BUILDERS is a large folded sheet, giving a complete boat buyer's directory of the products of leading boat manufacturers. *Write for Bulletin 836A to Scientific American, 24 West 40th Street, New York City.—3 cents.*

SELECTION OF LUMBER FOR FARM AND HOME BUILDING, by C. V. Sweet and R. P. A. Johnson, emphasizes the correct choice of wood as a money-saving factor

in building construction. The bulletin also points out the efficient construction principles, including proper roof drainage, adequate ventilation, and solid connections between superstructure and foundation. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

LOOKING FORWARD is a pamphlet dedicated to the prevention of blindness. It tells of propaganda activities directed toward this end, particularly by communities, schools, and industries. *National Society for the Prevention of Blindness, Inc., 50 West 50th Street, New York City.—Gratis.*

ASPHALT, by J. E. Pennybacker. The possible uses of asphalt are far greater than the most familiar one of paving roads. It can be used for roofs, on tennis courts and floors, in the plastic arts, for anti-corrosion purposes, and so on. This booklet, illustrated with unusual woodcuts, presents both the historical background and present day applications of the material. *The Asphalt Institute, 801 Second Avenue, New York City.—Gratis.*

AIR CONDITION YOUR ORCHARD is the title of a small pamphlet detailing methods whereby frost formation can be prevented in small and large orchards. The method is based upon the circulation of air by means of large motor driven propellers. *Towt Automatic Frost Protector Co., Ltd., 1123 North Main Street, Los Angeles, Calif.—Gratis.*

INSTRUCTIONS FOR COL. HOLGER NIELSEN'S METHOD FOR ARTIFICIAL RESPIRATION. An illustrated description, in English, of the latest method of resuscitating apparently drowned persons. Of interest to rescue squads, first-aid classes, life-guards, and so on. *Col. Holger Nielsen, Gersonsvy 75, Hellerup, Denmark.—Gratis.*

PLATERS' HANDBOOK. A practical handbook of electroplating. "Gets to the center of plating troubles." *Plater's Guide, 1 Platt St., New York.—25 cents.*

THE USE OF SULPHUR IN THE CONTROL OF TRUCK CROP AND CANE FRUIT INSECTS AND DISEASES is a complete handbook, with a comprehensive index, covering practically all types of crops grown in the United States. *Write for Bulletin 836C to Scientific American, 24 West 40th Street, New York City.—3 cents.*

THE CONSTITUTION OF THE UNITED STATES, WITH TREE PLANTING INSTRUCTIONS, is an educational pamphlet issued in the interests of the preservation of trees of all types. The first part of the booklet reproduces the Constitution of the United States of America, and the second part has to do with the work of the American Tree Association, and directions for planting ornamental trees. *American Tree Association, 1214 Sixteenth Street, N. W., Washington, D. C.—Gratis.*

PRINCIPLES OF PUBLIC ADDRESS SYSTEMS consists of a number of mimeographed sheets, with accompanying diagrams, a complete reprint of a section on "Sound and Amplifier Circuits," and a series of tables and sheets covering transformers used in this work. The booklet, 8½ by 11 inches, covers sound amplification from both theoretical and practical points of view. *Write for Bulletin 836D to Scientific American, 24 West 40th Street, New York City.—50 cents.*

WIND-RESISTANT CONSTRUCTION FOR FARM BUILDINGS is a pamphlet giving the results of studies by the Department of Agriculture engineers, showing precautions that must be taken in the construction of buildings in areas where high winds and tornadoes are to be expected. *Leaflet No. 87. United States Department of Agriculture, Washington, D. C.—Gratis.*

PRECAUTIONS FOR OIL-FIELD WORK is the A. P. I. Accident Prevention Manual No. 9, written specifically for workers in various branches of the oil industry. It covers precautions to be observed in the operation of all types of equipment, as well as the necessity for proper maintenance. *Department of Accident Prevention, American Petroleum Institute, 50 West 50 Street, New York City.—Single copies, 25c; prices for quantities on application.*

HOW TO CUT SCREW THREADS and HOW TO GRIND LATHE TOOL CUTTER BITS are two recently published bulletins completely illustrated with photographs and drawings. *South Bend Lathe Works, South Bend, Indiana.—10 cents each.*

DROUGHTS OF 1930-34. (WATER-SUPPLY PAPER 680, U. S. GEOLOGICAL SURVEY.) "This report summarizes some of the more outstanding questions related to droughts, both physical and economic." *Superintendent of Documents, Washington, D. C.—20 cents (coin).*

METALLURGY AND WHEELS tells the running story of the conversion of metallic ores into present day automobiles. Containing 48 pages, it is unusually well-illustrated and written from a non-technical point of view. *General Motors Corporation, Detroit, Michigan.—Gratis.*

THE PENNSYLVANIA RAILROAD ELECTRIFICATION describes in detail the equipment provided for this job. Numerous photographs show the various types of locomotives and also the more important locomotive parts and station equipment. *General Electric Company, Schenectady, New York.—Gratis.*

THE MODERN DRY METHOD OF FIRE EXTINGUISHMENT presents in the form of questions and answers how to go about the control of fire in homes and larger structures. It gives specific suggestions for tests which can be conducted to show the efficiency of the method described. *Write for Bulletin 836E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

FOREST TREES AND FOREST REGIONS OF THE UNITED STATES, by Wilbur R. Mattoon, lists 810 kinds of native trees, together with a notation of the region in which each tree grows, and brief descriptive notes to aid in its identification. Liberally illustrated with photographs and detailed drawings of some of the most important trees. *Superintendent of Documents, Washington, D. C.—15 cents (coin).*

Books SELECTED BY THE EDITORS

OUT OF THE TEST TUBE

By Harry N. Holmes, Professor of Chemistry, Oberlin College

A POPULAR and most readable exposition of chemistry in relation to modern life and industry, covering a wide diversity of chemical applications such as explosives, cellulose, fuels, sugar, medicines, and so on. The reader need neither be a chemist nor remember his chemistry in order to follow this book.—$3.20 postpaid.—*A. G. I.*

BRASSEY'S NAVAL ANNUAL, 1936

Edited by Commander Charles N. Robinson, R. N.

TO most of our readers this volume, published each year, requires no introduction. It contains, as usual, authoritative articles on various phases of defense needs, naval forces of the British Empire, foreign navies, naval strength, and disarmament, in the Naval Section; a Naval Air Section which covers more or less the same types of subjects; and a long Reference Section containing tables, dimensions and particulars of warships, and much miscellaneous material. Numerous large halftones illustrate ships and naval aircraft; and a large section shows silhouettes of the most important warships of the naval powers. There are also line drawings to show plan and elevation of numerous battleships, cruisers, aircraft carriers, and so on.—$12.00 postpaid.—*F. D. M.*

WHAT PLANE IS THAT?

By C. A. Weymouth, Jr.

UNUSUAL in makeup, this book devotes a single page to each of 53 airplanes. Each one is illustrated by an accurate drawing of the plane in a characteristic position, and is followed by vital statistics of its design and performances. The foreword is by Captain Eddie Rickenbacker.—$1.15 postpaid. —*A. P. P.*

THE IDENTITY THEORY

By Blamey Stevens

"THE object of this book is to build up a complete system of mathematical physics on a basis that is very different from that currently accepted. The fundamental assumptions are that inertia, time and space are each complete measurements of the same thing, and that by expressing this identity we get the laws of physics. For example, the space-time identity leads at once to the result that the observed velocity of light is independent of the motion of the observer, the fundamental postulate of relativity. Other identities lead to Maxwell's electromagnetic equations, Newton's laws of motion and a theory of relativity. The later chapters deal with radiation and the quantum theory. Whatever may be thought of the author's conclusions, he shows considerable knowledge of physics and mathematics."—As reviewed by *Nature* (London).—$2.00 postpaid.

ROCKETS THROUGH SPACE

By P. E. Cleator

LAST-CENTURY jeers at "flying machine lunatics," coupled with Kittyhawk, and, today, wings over everywhere, have taught the world a lesson, so that few but fools dare jeer at rocketry, which is now believed to be approaching its Kittyhawk stage. Within the limits of sound science, engineering, and economics there are, however, different levels of attitude toward interplanetary rocket flight and this book represents perhaps the greatest admissible level of optimism. Still, some day, we shall no doubt traverse interplanetary space in rockets. "Rockets through Space" is a highly readable, splendidly written, authoritative, popular, general, illustrated treatise on the art of rocketry, giving all the background regarding the work that is being done and the men who are doing it which it is necessary for the reader to acquire in order to bring himself up to date about that art. And a surprising amount of level-headed work is being done, in addition to some flashy things that have no doubt prejudiced some minds against rocketry and received undue notice in the flamboyant press. —$2.65 postpaid.—*A. G. I.*

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A REVISION of a book published three years ago, the present volume has been expanded in scope to include the number of "needed inventions" mentioned in its title. The author's foreword serves as an inspirational talk on the subject of inventions in general. A chapter is then devoted to a discussion of the ten most needed inventions. The book is crammed with short, pithy paragraphs describing various desirable inventions in a number of different fields. If this book does nothing more than stimulate the imagination, it will have served a definite purpose.—$2.65 postpaid.—*A. P. P.*

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By J. A. Ewing, K.C.B., Univ. of Edinburgh

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Edited by Frank H. Vizetelly

FOR reference purposes, this volume gives the complete story of the year 1935—a year of wars and rumors of wars, a year of great recovery from the depression. Prepared in encyclopedia fashion, it covers practically everything that was in the news during the year, including national affairs, industrial developments, achievements in all fields of science, explorations, necrology, and so on. Illustrated, cloth, 775 pages.—$6.50 postpaid.—*F. D. M.*

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By Harold O. Whitnall, Colgate Univ.

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THE historical background of the lumbering industry in the United States is an epic drama of pioneering. Today logging is frequently carried on under much the same conditions as it was a generation or so ago, but aided by numerous developments in methods of transportation. This book, intended as a text on the principles and methods of logging transportation in the United States and Canada, shows how tractors, skidding devices, cable hauling systems, and various types of engines, have made it possible to place logging on a more economical basis. Facts and figures are given in concise form.—$4.20 postpaid. —*A. P. P.*

HYDROSTATICS

By A. S. Ramsey, M.A.

A TEXT-BOOK for first year students in English universities, written by the president of Magdalene College at Cambridge University. Acquaintance with the calculus is assumed.—$2.50 postpaid.—*A. G. I.*

PRACTICAL FLIGHT TRAINING

By Lieutenant Commander Barrett Studley, U. S. N.

NEW chapters and new illustrations will be found in this revised edition of a well-known handbook. The author, a Flight Instructor at the Naval Air Station, Pensacola, Florida, has tested thoroughly the methods he presents in this book. It is, indeed, complete in every respect. Of it the *U. S. Naval Institute Proceedings* says: "The book is painstaking, thorough and remarkable for its clarity. . . . The author is to be congratulated on giving to the service and to the general public a truly practical flight-training manual that will prove of great assistance to anyone interested in any way in the flying of airplanes. . . ." Extremely well illustrated, cloth, 433 pages.—$2.70 postpaid.—*F. D. M.*

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By Mabel C. Williams Kemmerer, Ph.D.

A POPULAR treatise on ordinary, orthodox psychology—without the repellant earmarks of the typical textbook—intended for home study, especially among groups. What psychology is and does; colors; sounds; the world of spaces; how and why we act; fear; why we talk; use and abuse of intelligence tests—subjects similar to these caption the chapters. Good reading—bright and chatty. Sound science—no fads or freaky schools of thought. The average outside reader would derive a lot from this book.—$2.15 postpaid.—*A. G. I.*

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By A. Harvey

THE second and revised edition of a compact, 114-page book on the chemistry of oils, fats, soap, chlorine bleaching agents, blues (not the so-called musical kind), starches and so on; also on textile fibers and stain removal. It contains a chapter on elementary chemistry, to explain the chemistry used in the text. This is a practical handbook intended for laundrymen who want to learn the chemical side of their calling, but the insights it gives into the mysterious things laundrymen do with our clothes should make it of value to all except nudists.—$1.90 postpaid. —*A. G. I.*

THROUGH SCIENCE TO GOD

By Nathan A. Smyth

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AUGUST · 1936

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EWING HUTCHISON COMPANY
35 East Wacker Drive, Chicago, Ill.

BLANCHARD-NICHOLS-COLEMAN
Los Angeles, San Francisco, Seattle and Atlanta

Published by MUNN & COMPANY, INC.
24-26 West 40th Street, New York

ORSON D. MUNN, President JOHN P. DAVIS, Treasurer I. SHELDON TILNEY, Secretary

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Vol. 155, No. 2. 35 cents a copy. $4.00 a year, postpaid in United States and possessions. Canada, $4.50; other foreign countries, $5.00, postpaid.

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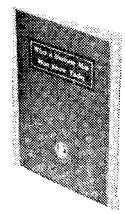

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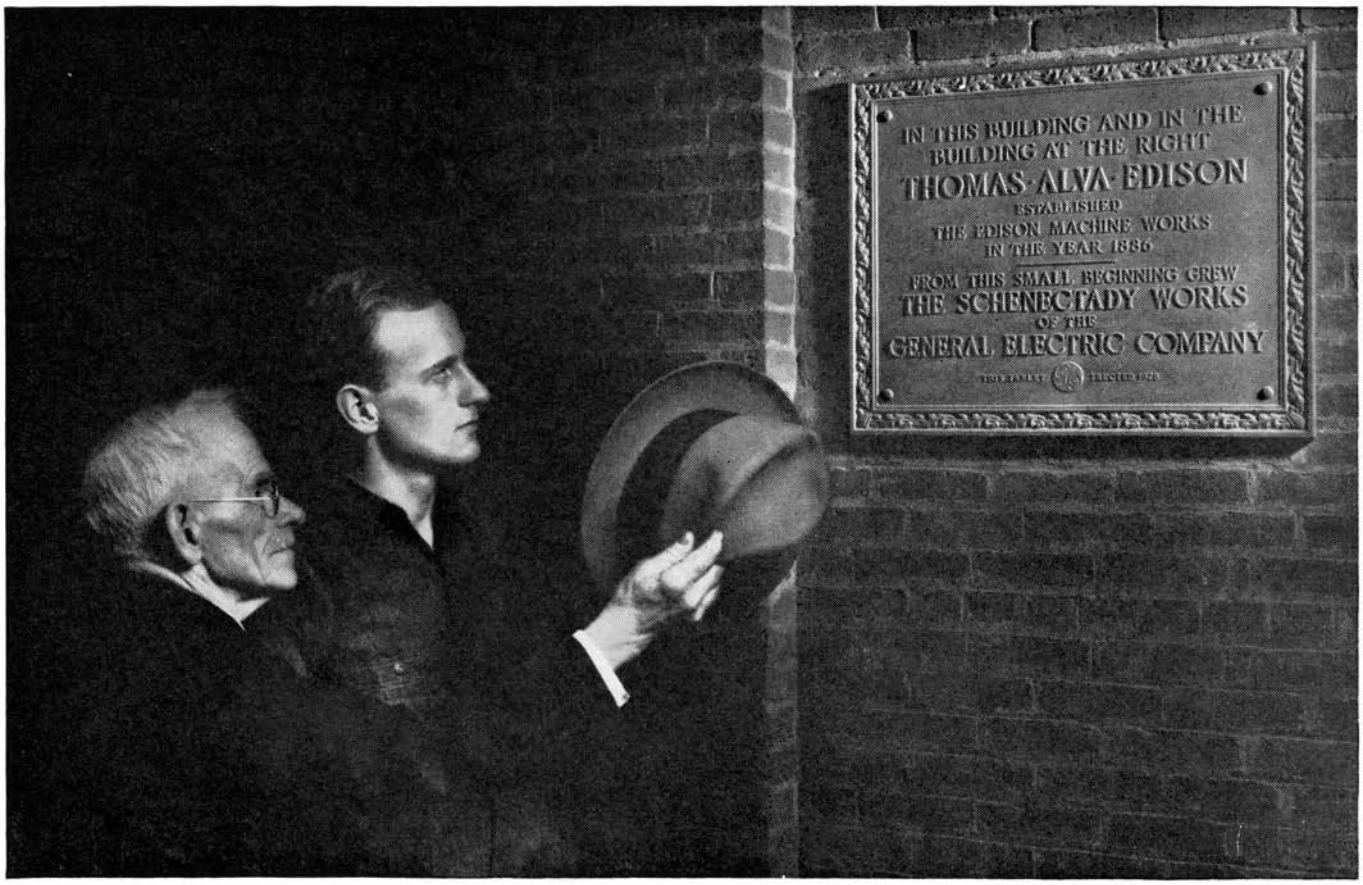

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