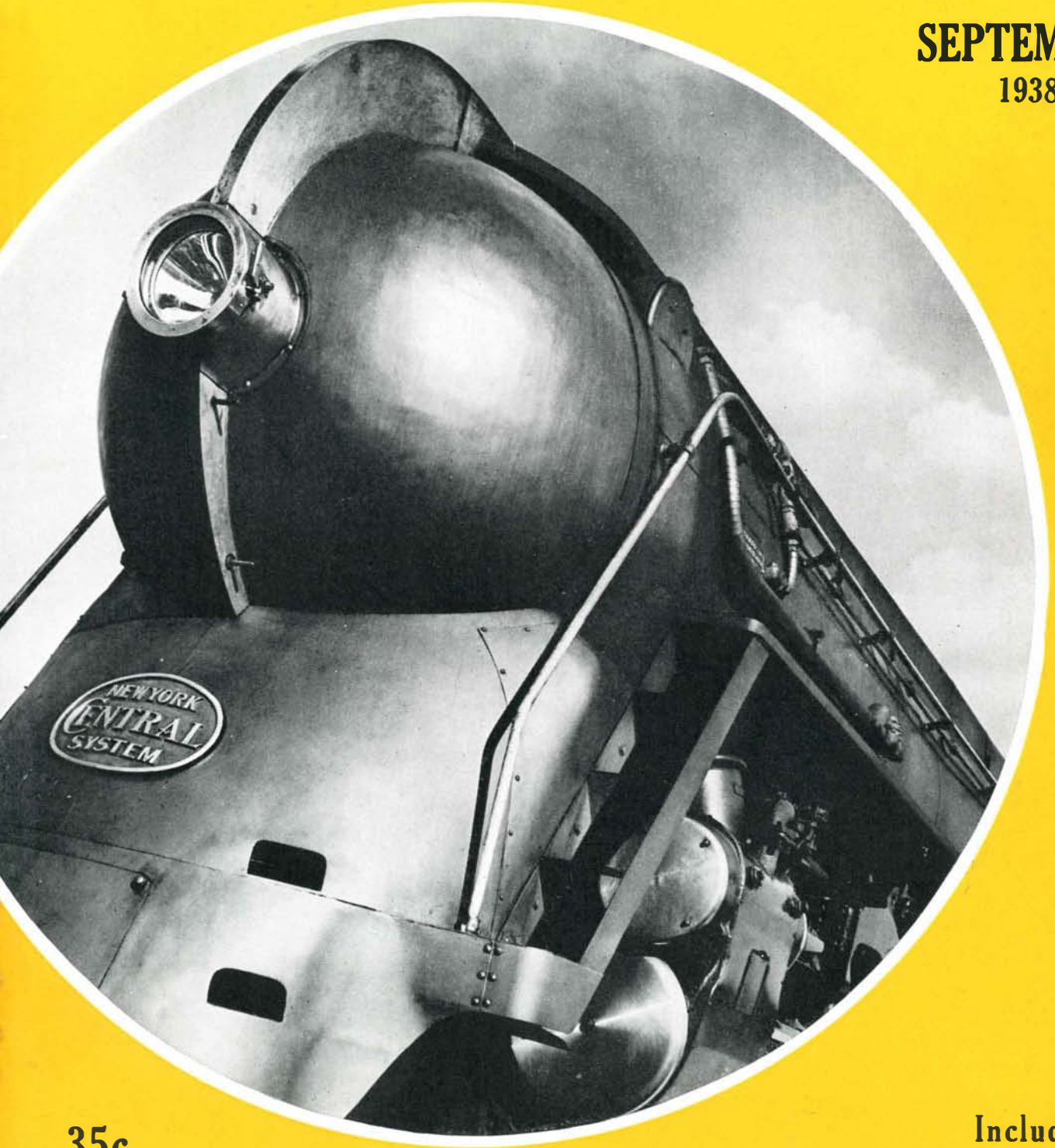
DIESELS IN THE AIR

By Paul H. Wilkinson

SCIENTIFIC AMERICAN

SEPTEMBER
1938



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ROBERT YARNALL RICHIE

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Including:
A DIGEST OF
SCIENCE & INDUSTRY

32 M. P. H. STANDING STILL

BUT IT PROVES THAT MODERN CARS HAVE 3 GRADES OF PERFORMANCE

You don't really buygasoline...you buy performance and mileage. That's why you'll be doing yourself a real favor to read the basic facts about gasoline and performance. Here's what you can expect from each grade of gasoline:—

Poor performance with "low grade" gasoline

There is no anti-knock fluid (containing tetraethyl lead) in "low grade" gasoline. Power is lost because your car dealer *must* retard the spark to prevent "knock" or "ping."

Good performance with "regular" gasoline

Most regular gasolinehas in it anti-knock fluid (containing tetraethyl lead). The spark can be considerably advanced for more power without "knock" or "ping."

Best performance with gasoline containing "ETHYL"

Gasoline "with ETHYL" is highest in all-round quality. It has *enough* anti-knock fluid (containing tetraethyl lead) so that the spark can be *fully* advanced for maximum power and economy without "knock" or "ping."

THIS DYNAMOMETER TEST at the Ethyl Motor Clinic clearly shows the three grades of performance. Illustrated above is the rear wheel of a popular make of car on the dynamometer rollers. Three grades of gasoline are used and the differences in power and speed indicated on sensitive instruments. This test leaves no doubt that every car has three grades of performance.

ETHYL GASOLINE CORPORATION, *manufacturer of anti-knock fluids used by oil companies to improve gasoline*

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SCIENTIFIC AMERICAN

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NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

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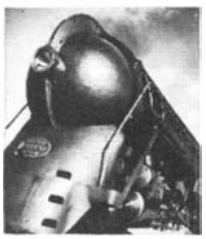

MODERN streamlining and old-fashioned exposed working parts—the joy of romantically inclined persons—combine to make unique the new Hudson type locomotive shown on our cover. Ten of these have been built by the American Locomotive Company for the New York Central to conform to the new, streamlined Twentieth Century Limited. For fast passenger service, they are of 4700 horsepower, an increase of approximately 15 percent over the previous Hudsons. Henry Dreyfuss, noted industrial designer, designed the streamlining.

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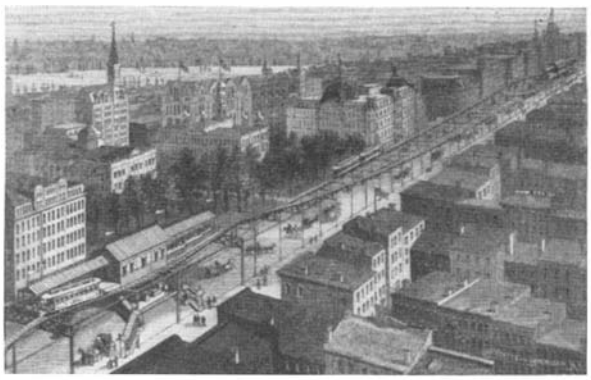
50 Years Ago in . . .

Scientific American

(Condensed From Issues of September, 1888)

YELLOW JACK—"During the month of August much alarm has existed in Florida, on account of the appearance there of yellow fever. . . . Every means was adopted to check the speed of the fever. Resin and tar fires were built and maintained, in the hopes that the bituminous fumes would kill the bacterial germs. Acting on the theory that concussion of the air would effect the same result, cannonading was extensively practiced."

GRAVITY RAILROAD—"In a new system of operating passenger railroads in towns and cities . . . the locomotive is dispensed with. Hence the railway structure may be very light and simple, offering but little obstruction to the streets. At the stations, it will be observed, there are two undulations in each track, a car approaching the station being carried up and over the slighter elevation of the first undulation, where it stops to discharge and receive passengers, after which it is carried up over the higher undulation beyond, and allowed to proceed on its way to the next station under the action of gravity alone, whereby a high velocity is imparted to the car. Attached under each car is a cable gripping mechanism designed to work automatically: as the car arrives at the end of each long incline, and without at all checking its speed, its gripping mechanism comes in contact with the moving cable, driven at the station, by which the car is kept continuously on its journey till the desired stopping place is reached, which is on a slight incline, when the cable is released. As the car stands on an incline, it starts of itself by the action of a lever."



TELEPHONE—"We can all remember when the telephone appeared and startled us. It was so novel that it was hard to understand how it could be made of practical value, especially as, at that time, with the apparatus at hand, it did not work so smoothly and reliably as now. Practical, pushing men got hold of it, and now we wonder how we could get along without it."

RAILROAD FUEL—"The Philadelphia *Record* says that the problem of obtaining a cheaper fuel than coal for locomotives, which has long bothered railroad men, seems likely to be solved soon by experiments now being made with gas."

OIL—"About 400 barrels of crude petroleum are being turned out daily by the 22 wells of the Pacific Coast Oil Company in the Pico district, near Newhall, California. The wells of the company are now sunk to a depth of from 1600 to 1800 feet. The oil is of the best quality obtained on the coast, and the demand for it is very great. Some of the new manufactories at San Francisco burn oil instead of coal."

KODAK—"One of the latest ideas based upon the dry negative process is the production of an extremely simple apparatus, so arranged that it cannot get out of order and adapted for use by the veriest 'greenhorn.' . . . When a hundred exposures have been made, all the individual has to do is to send the apparatus to the manufacturers, who do all the work of finishing up the pictures. Thus no manipulation whatever is required by the purchaser, save the making of the exposures. . . . The fact that one has a large roll of sensitive material to draw from in making the pictures inspires confidence and freedom, since the exposures may be made rapidly, without previous preparation. . . . The 'Kodak,' for such is the name given to it by the manufacturers, is essentially a portable camera, intended mainly for making instantaneous exposures, but may be used for time work also when a secure place can be found to rest it upon. Its simplicity and lightness are its chief features."

NAVAL SPEED—"The fastest armed cruiser in the world is said to be the German vessel *Greif*, which has a displacement of 2000 tons, and is fitted with engines of 5400 indicated horse power. On the voyage from Kiel to Wilhelmshafen a speed of 23 knots, or almost 27 miles an hour, was obtained. What is the reason our Navy Department does not build some fast vessels like this? Every one of the new ships so far ordered is to be a slow tub compared with the *Greif*. Why does not the Secretary of the Navy use his influence to have some fast vessels constructed?"

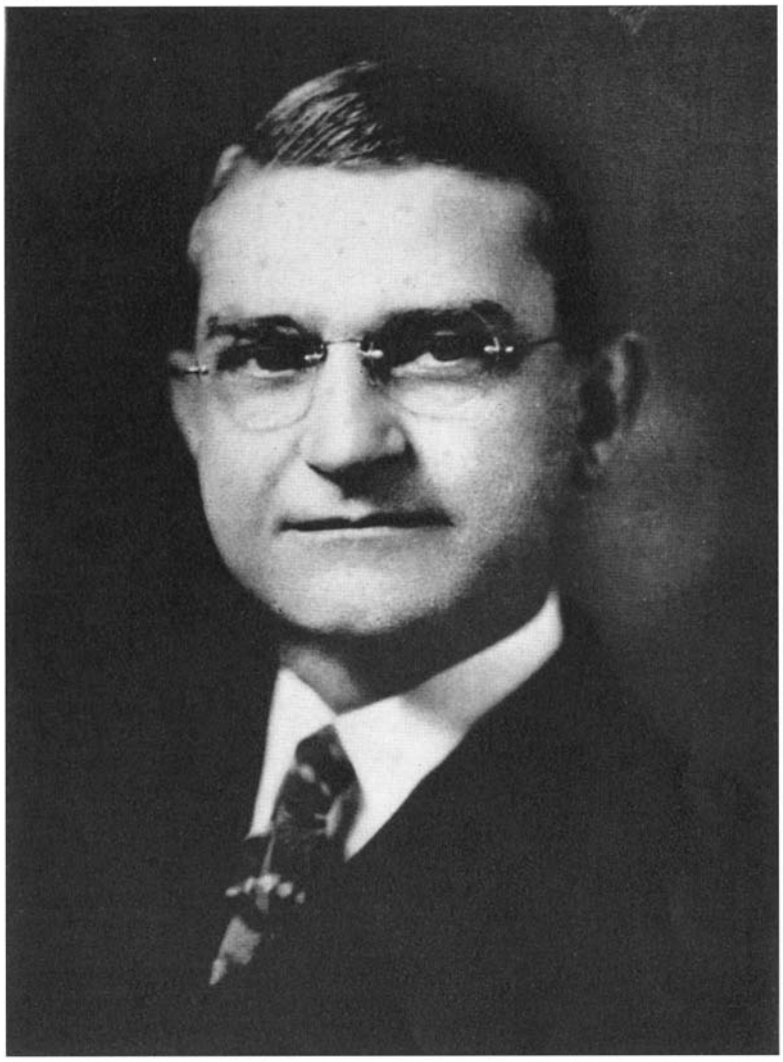
PHOTOGRAPHY—"We have received from Mr. W. H. Mowrey, photographer, Milford, Mass., a couple of instantaneous photos of railway trains stated to be moving at the velocity of 40 miles an hour. The details are excellent and the pictures very pleasing."

TRANS-SIBERIA—"According to *Engineering*, the Russian government would appear to have decided to push on the Siberian railway with energy. . . . The object the Russian government aims at in connection with the Siberian railway is not so much to provide the country with a good solid line as to link the Pacific coast with Russia proper, as rapidly as possible, with anything better than the present means of communication."

DEFENSE—"General Brialmont, Inspector-General of Belgian Fortifications, says the defenses of the Meuse are the material guarantee of Belgian neutrality and autonomy, and constitute a line of defense for France. The valley of the Meuse is continued in France by the valley of the Oise, which is not sufficiently defended. The 21 forts which are capable of offering effectual resistance are a barrier closing at the same time the gates of Belgium and those of France."

GLASS CLOTH—"Mr. Dubus Bonnet, of Lille, France, has invented a process of spinning and weaving glass into cloth. The warp is composed of silk, forming the body and groundwork, on which the pattern in glass appears, as effected by the weft. The requisite flexibility of glass thread for manufacturing purposes is to be ascribed to its extreme fineness, as not less than from 50 to 60 of the original strands are required to form one thread of the weft."

Personalities in Industry



CHARLES R. HOOK

THIRTY-FIVE years ago Charles R. Hook, who at 22 was night superintendent of The American Rolling Mill Company's original plant at Middletown, Ohio, went to the employees of the small, young concern and said:

"There are many problems in the managing of this business that you do not understand, and there are many of your problems that we of management do not understand. Why can't we get together once in a while, so you can tell us about your problems and we can explain ours to you? In that way we could learn a lot from each other and that would help us all to keep our jobs and improve our condition."

The men, who had been accustomed to the "hire and fire" attitude which was general in industry at that time, were skeptical at first. But at Mr. Hook's continued urging and repeated demonstrations of good faith, they agreed to a relationship in which the goal was "cooperation" instead of "coercion."

That was the beginning of a series of developments in "human engineering," inaugurated by Charley Hook, that brought about the remarkable spirit of mutual interest between management and men for which Armco is known throughout American industry today. A test of the employees' attitude was made recently at the company's Butler, Pennsylvania, plant, just 30 miles from Pittsburgh. In a consent election requested by the Steel Workers Organization Committee of C. I. O., and conducted by the National Labor Relations Board, employees voted 1242 to 402 to reject the outside group as a bargaining agency in their dealings with the management.

Mr. Hook, who has been president of Armco since 1930, has been successful with workmen because he has the workman's viewpoint, developed when he was a workman himself in the old Morewood Works of the American Tin Plate Company at Gas City, Indiana.

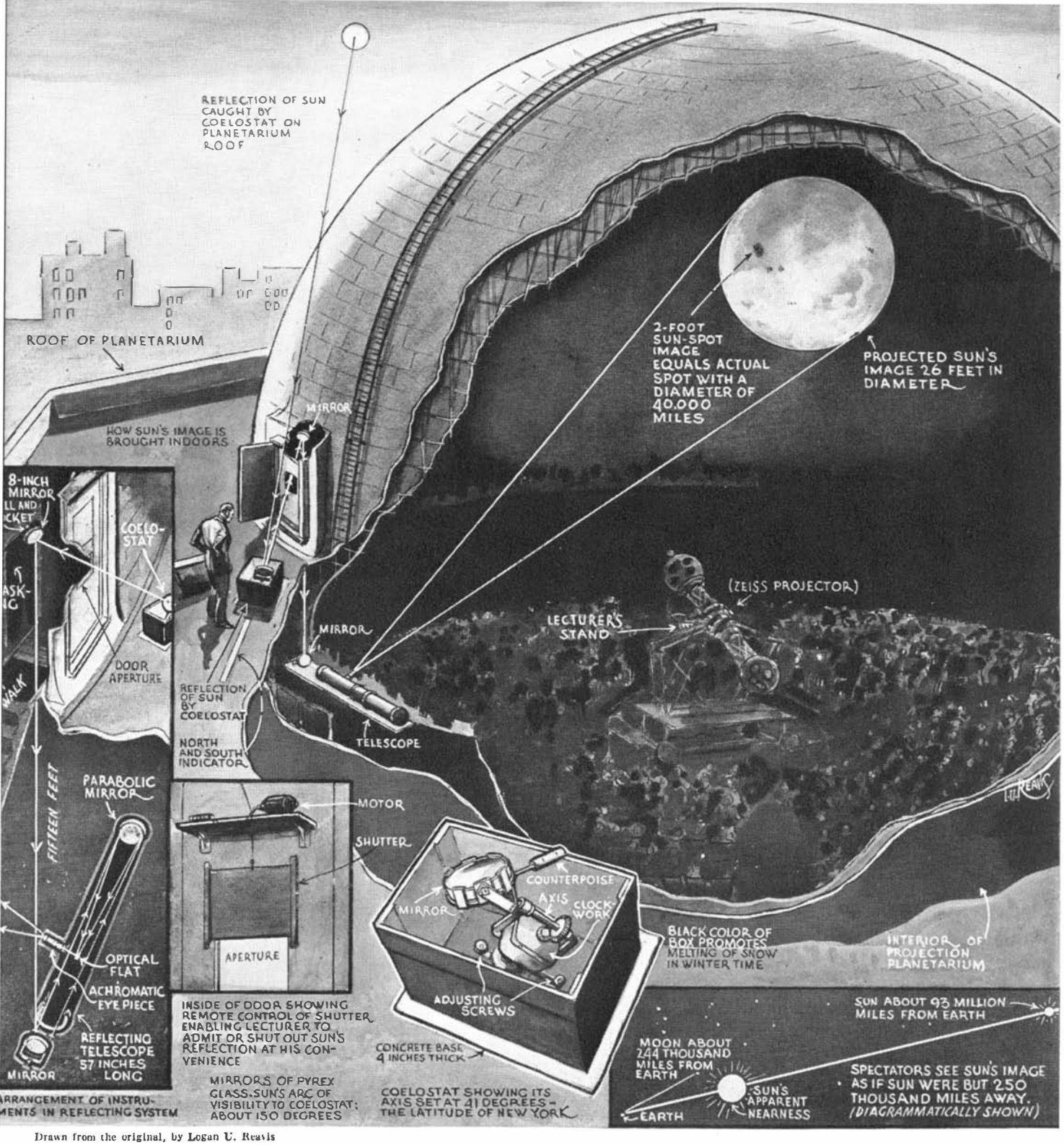
The son of a Cincinnati carriage manufacturer who "lost everything" in a financial panic in the late 'nineties, Mr. Hook, upon graduation from high school, went to work as an office boy for a tin plate concern at two dollars a week.

When the "Trust" bought out the company, he was transferred to New York, and placed in the accounting department. But he realized that if he was ever to get anywhere in the steel business he would have to know something about the practical side of making and rolling steel. So he asked his superiors for a job in one of the mills. The change was a demotion, but he gladly accepted and before going with The American Rolling Mill Company had worked up to the position of roll turner.

When Mr. Hook joined Armco as night superintendent in 1902, he was young-looking and slight of stature. When he went into the plant for the first time the workmen wanted to know, "who's the kid?" But they soon found out that he had a man's head on a boy's shoulders.

Today Mr. Hook is one of the leading men of American industry—an accepted authority on matters pertaining to personnel. He has seen his company grow from small-scale operation, with 325 employees and a monthly payroll of $25,000, to a major steel company, with 16,000 employees and a yearly payroll of $33,000,000 in 1937.

Asked once what his hobby was, he replied, "employee relations," and that pretty well covers it. As vice chairman of the Committee for Economic Recovery he made a long and careful study of housing and housing needs in the United States. He is a member of the Business Advisory Committee, appointed by Secretary of Commerce Roper, and chairman of the Committee on Personnel of the Seventh International Management Congress in Washington this fall. Last January he was elected president of the National Association of Manufacturers, and since that time Middletown, New York, and Washington have formed three points of a triangle which he covers with almost weekly regularity. He carries a young office around with him when he goes, and has the amazing ability to think of, and do, many things well at the same time.

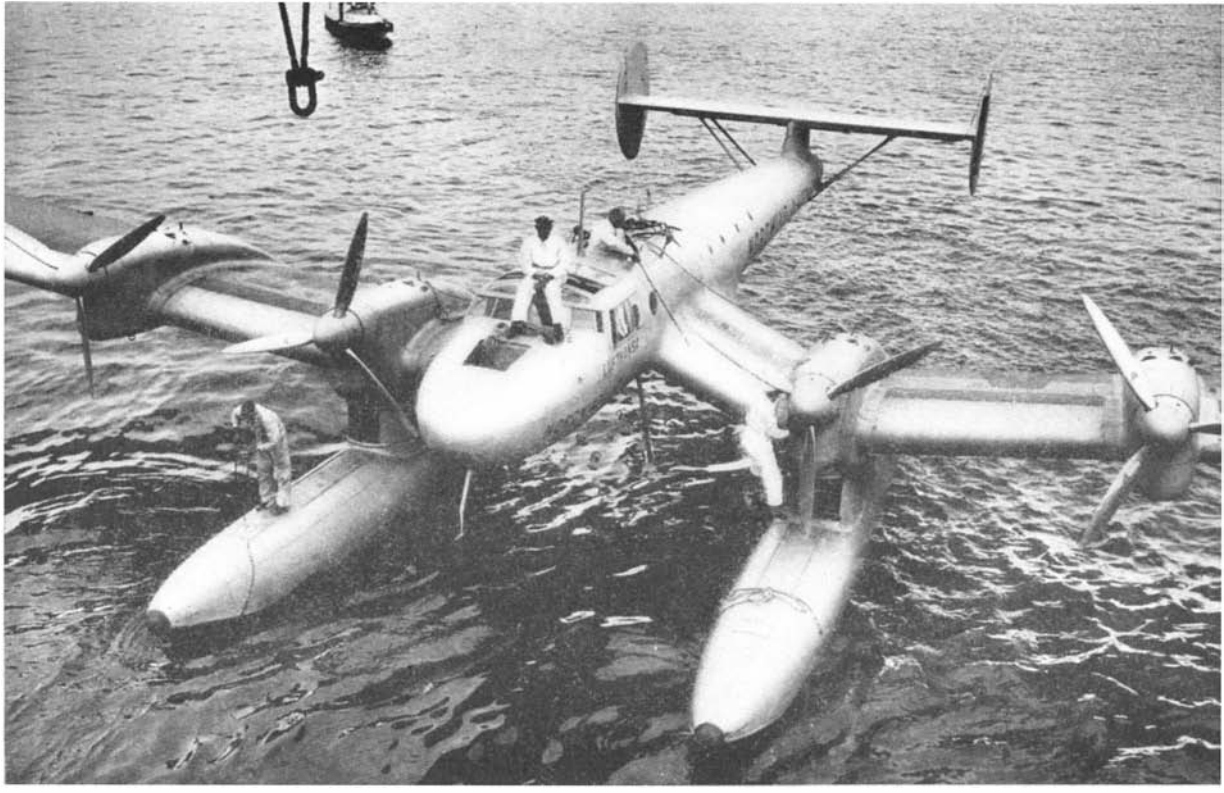


Drawn from the original, by Logan U. Reavis

Bringing the Sun Indoors

AT the Hayden Planetarium in New York a huge 26-foot image of the sun is being projected on the interior of the dome every day that the sun shines. This is accomplished by means of a first system of moving and fixed flat mirrors for bringing the sun's image indoors and a second system of mirrors and lenses for enlarging and projecting it.

The actual sun is shown at the top of the drawing. Its rays are caught by an eight-inch flat mirror mounted on an axis parallel with the earth's axis. A clock-like mechanism slowly turns this mirror as the earth's turning "moves" the sun. This image, after passing through an opening in the building, is kept constantly spotted on a second flat mirror which is permanently fixed in position. It in turn passes the image downward to the third element of the long optical train, a flat mirror fixed at a 45-degree angle which turns it horizontally. The sun's image is now where it can be used but as yet it is neither magnified nor projected. Magnification is done in an ordinary eight-inch reflecting telescope, just as it would be if that telescope were directed at the sun out of doors; and since it is possible with any telescope to view the image not alone by looking into the eyepiece but also by projecting it on a screen at some distance from the eyepiece, the same is done at the planetarium. Here the distance is long, hence the image is very large—larger, in fact, than any solar image previously projected by similar methods. All this apparatus—the coelostat, fixed flats, and telescope—is entirely separate from the regular planetarium apparatus and could be similarly used with any ordinary house or building.



One of Deutsche Lufthansa's Diesel-engined mail planes for the North Atlantic service. Four 600-horsepower "Jumo" Diesels give it a speed of 186 miles per hour

DIESELS IN THE AIR

Prove Their Value . . . For Military and Commercial Operations . . . In Active Use . . . Nearest Approach to Smooth Turbine-Like Power Flow

By PAUL H. WILKINSON
Author of "Diesel Aircraft Engines"

DRAWN up on the flying field, a squadron of Diesel-engined fighter-bombers stood ready to take off for maneuvers. As the engines were started up, the roar from 54 Diesels filled the air—high pitched and like a thousand racing cars in its intensity. At last, the order was given and flight after flight taxied to the starting line, throttles were opened wide and in a little over a minute, the squadron was in the air. As the planes climbed, their ranks closed in and the 27 fighting craft took up their battle formation. Once altitude was gained, they headed for their objective, soon to be joined by other squadrons of twin-engined bombers, Diesel-engined like themselves. With fighters above and on their flanks, and dive-bombers below, the air fleet rushed onward in impressive array. Fantastic? Not in the least. The year was 1937, and the planes were part of the regular equipment of the up-to-date German Air Corps, on their way to an air review at Nürnberg. But Diesel-engined planes? They were Junkers Ju 86 K fighter-bombers powered with Junkers "Jumo" 205 Diesels.

Following the lead of Germany, development of the airplane Diesel in other countries is now proceeding apace. In the United States, Pratt & Whitney and Wright, our two largest engine airplane builders, are understood to be busy on a confidential project for the Army and the Navy and, as their gasoline engines have now reached the 1500-horsepower stage, it is probable that a 2000-horsepower Diesel is their aim. Guiberson is working on experimental engines in the 300- to 500-horsepower class for the government, while some testing has been done with the 1200-horsepower Deschamps engine and there is the possibility that it may make its flight tests soon. Thus the United States, when the airplane Diesel "breaks" in this country, may be well to the fore with high-powered engines for military and commercial use.

In England, Imperial Airways and the Air Ministry are beginning to agitate for Diesels, and this type of power plant was made an issue in the recent debates. This should result in activity by Bristol and Napier, who already have had considerable experience in this field. On the Continent, the French government is sponsoring the 700-horsepower Clerget and the 600-horsepower Coatalen engines and, once they have proved themselves in the air, larger engines will be built. In Italy, Fiat and Piaggio are said to be much interested in the problem, while Japan has purchased a number of 600-horsepower Junkers Diesels with a view to manufacturing them in the Orient. Nor has Soviet Russia been idle, for already they have 700-horsepower Diesels in their helium-filled airships, which should result in adoption for heavier-than-air craft in due course.

DIESEL-ENGINED planes no longer are a novelty in Europe. A year ago, nearly 60,000 miles a week were being flown in regular airline service by these planes; since then, this mileage has increased enormously. Compare this with the total of 1634 miles flown in 1931, the first year of Diesel airplane operation! The most popular European plane in use is the Junkers Ju 86, the commercial version of the fighter-bomber. This is a twin-engined, ten-passenger airliner similar to the twin-engined Lockheed in the United States. Powered with two 600-horsepower Junkers "Jumo" 205-C Diesels, it has a top speed of nearly 200 miles per hour and cruises at about 175 miles per hour. The Ju 86 was the first plane to be specifically designed for Diesel operation, and is extensively used on the Deutsche Lufthansa airlines in Germany, and on connecting lines to the cities of Holland, Switzerland, Poland, and Denmark. Swissair

Swissair uses Diesel engines on its Zurich-Vienna route

uses this type of plane between Zurich and Vienna, and reports: "For your information we would like to state that for the second year we are flying a regular transport line with that type of machine. Last year it was the night mail from Basle to Frankfort, and this summer season the Junkers Ju 86 is in regular operation over the 370-mile direct route from Zurich to Vienna and back to Switzerland. The ship flies regularly 744 miles a day on that schedule. The policy of the company is to gain experience with Diesel engines as this type of powerplant is already a serious competitor for the ordinary gasoline engine."

LAST year a Ju 86 airliner, christened the *Lawrence Hargrave* after the famous Australian aviation pioneer, was flown from Germany to Australia by way of Rome, Tripoli, Cairo, Bagdad, Karachi, Calcutta, and Singapore. At the airports en route, it attracted the greatest interest, as it was the first time that a Diesel-engined plane had been seen in operation. At Rome, Signor Enrico Venturini, director of the famous Ala Littoria airline, exclaimed: "If heavy-oil engines were adopted on the Italian airlines today, instead of gasoline engines, on the mileage at present flown a saving of 10 million lira (about $525,000) could be realized." On another occasion, at the opening of the new airport at Stavangar on the west coast of Norway by His Majesty King Haakon VII, the Junkers company was invited to send over one of their Diesel-engined airliners. This they did, and the Ju 86 covered the 590 miles from the factory at a speed of 197 miles per hour. A careful check of the fuel consumed en route was made, and $14.80 was the cost! Worked out on a basis of a full complement of ten passengers in the plane, the fuel cost was $1.48 per passenger, or one fifth of a cent per passenger mile!

While the Diesel-engined Ju 86 is usually considered a passenger-carrying craft, it has also established an enviable reputation for itself in the field of private ownership. About a year ago, the *Kismet*, a privately owned plane equivalent to what we would call an "executive" plane in this country, achieved outstanding success in open competition in Egypt. It took first place in the international Oases Circuit Competition, organized as an annual sporting event by the Egyptian Aero Club of Cairo. The competition, which was a handicap affair, attracted a field of 41 entries from 11 different countries. Points were awarded for maximum speed and cruising speed, and low fuel consumption per passenger mile. The *Kismet* covered the circuit of 1300 miles, amid constantly changing climatic conditions and geographic difficulties, at an average speed of 180 miles per hour. Due to the fact that it had the lowest fuel consumption of any plane entered, it was not difficult for it to outclass its competitors.

After winning the Oases competition, Capt. von Sternburg decided to continue on to Afghanistan, along a route which some day may be used to connect Germany with the Far East. Flying by way of Bagdad and Teheran, he soon arrived at Kabul. There, a most disconcerting discovery awaited him—there was no Diesel fuel available for his plane. This did not discourage him, however, for did he not have a Diesel-engined plane with engines reputed to run on almost anything? Plenty of kerosene was to be had, so he tried it out and found that his engines ran satisfactorily. This solved his problem, so without further ado he tanked up the *Kismet* with kerosene and completed the next stage of his flight, 950 miles to Jask on the Persian Gulf, without the slightest difficulty.

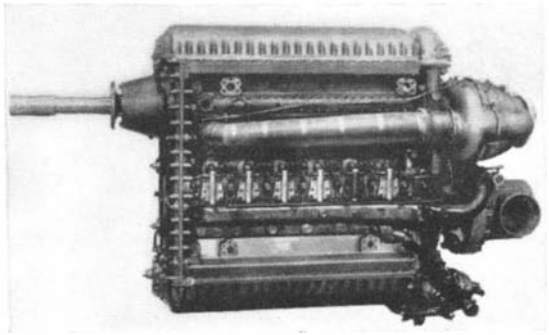
Not only is the Diesel suitable for passenger work and for the private owner, but it is adaptable to airmail service as well. This was strikingly demonstrated when the Junkers Ju 86 mailplane *Buckeburg* and its crew of three made a nonstop flight from Dessau to Bathurst, on the west coast of Africa. During this 3600-mile flight, an average speed of 180 miles per hour was maintained. More remarkable still, when the plane landed it had sufficient fuel in its tanks for another 1400 miles, thanks to the extremely low fuel consumption of its engines. This flight has been made a number of times and on another occasion a distance of over 5000 miles was covered without a stop.

Bathurst, in British Gambia, is quite a center of Diesel aviation. It is from there that Deutsche Lufthansa catapults its Diesel-engined mailplanes for their 1900 mile hop across the South Atlantic to Natal, in Brazil. Dornier Do 18 flying boats, each powered with two Junkers "Jumo" 205 Diesels, make the crossing with clock-like regularity. Two of these planes are the *Aeolus* and the *Zephir* of North Atlantic fame, while they have as their teammates, the *Zyklon* and the *Pampero*. During the North Atlantic airmail survey flights of 1936, over 19,000 miles were flown by the *Aeolus* and the *Zephir* on their eight trips between New York and the Azores. On the 2400-mile direct route between these points, it was found that even these small flying boats could carry a payload of nearly 1000 pounds, due to the 25 percent saving in fuel weight made possible by the Diesel.

SO well pleased was Deutsche Lufthansa with the performance of its Diesel-engined planes in 1936, that it ordered two four-engined planes with similar power plants for its flights the following year. These powerful Hamburg Ha 139 seaplanes soon proved that they were equally reliable and much faster than their predecessors. Payload and accommodations for the crew left nothing to be desired. Catapulting was used for these 19-ton planes, with a catapult ship stationed at New York and another at the Azores. During the trials of 1937, the *Nordmeer* and her sister ship, the *Nordwind*, completed 14 trips across the North Atlantic, proving more conclusively than before, the advantages of the Diesel for long-distance flights across the ocean. These routine flights involved more than 33,000 miles of ocean flying over the direct route to the Azores, which was no mean achievement. During these trips, it was found that the fuel consumption of the Diesel was so low that a saving of more than 79 pounds of fuel per hour was possible for each engine, compared with gasoline operation. For a 16½-hour trip between New York and the Azores, this amounted to the astonishing total of more than 5200 pounds. Most of this saving in fuel

weight is available, of course, for additional payload, apart from the nominal load of 1000 to 1500 pounds which the plane is designed to carry. Airmail service between the United States and Europe was possible in 1936, but not advisable. In 1937, the Germans could have started regular airmail service but were denied permission to do so because the United States was not ready to compete with them.

In the meantime, while waiting to see what 1938 will bring forth, the Diesel has once again made history. Its most recent accomplishment, a non-stop flight from England to South America, was made with a view to breaking the world's long-distance record—and it succeeded. The plane was a Dornier Do 18 flying boat and its engines were Junkers "Jumo" 205 Diesels. The *D-ANHR*, as the German plane was marked, was catapulted from the Deutsche Lufthansa catapult ship *Schwabenland* off the coast of Devon, and 43 hours and 10 minutes later it glided down to a safe landing in the harbor of Caravellas, in Brazil. With Flight Commander von Engel in command, a direct route over the Canary Islands and the Cape Verde Islands was followed to Pernambuco, and thence down the coast toward Rio de Janeiro.



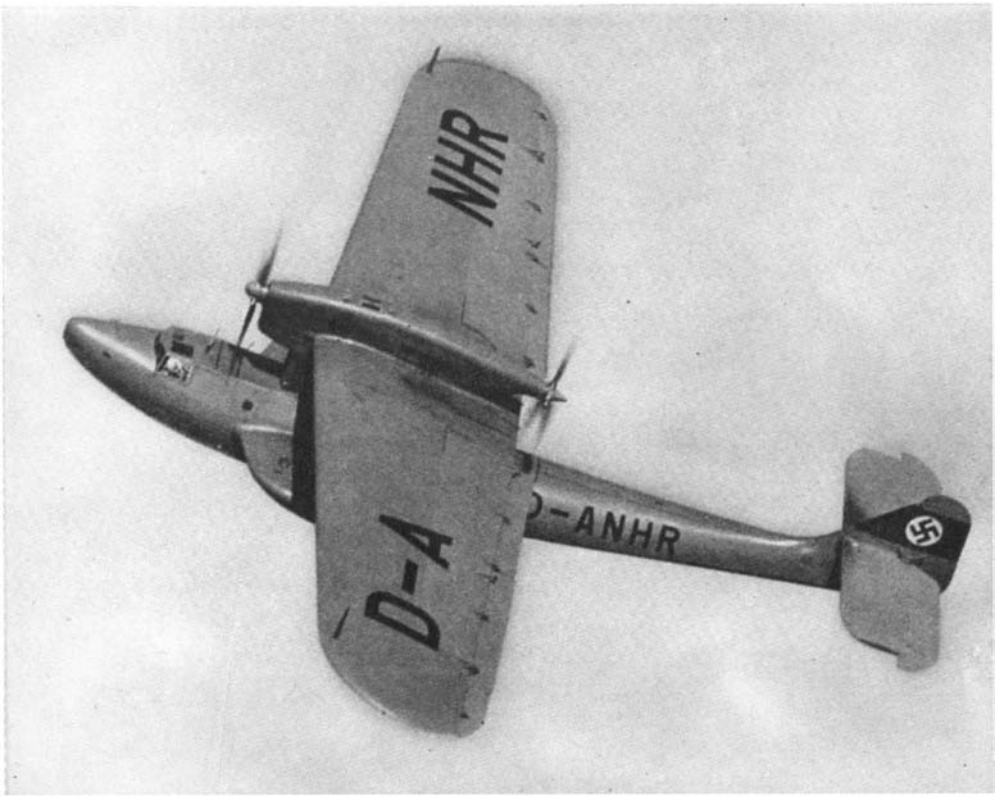
Left: A Junkers "Jumo" 205 Diesel with a new two-speed exhaust-driven supercharger

North of the Equator, the winds were favorable, but subsequently head winds and storm areas developed. Although this prevented them from reaching Rio, they covered about 5200 miles, breaking the record of 4362 miles previously held by Italy for that type of ship.

Weight will always be an important factor in aviation. Fuel weight already presents quite a problem for the relatively small transatlantic passenger planes which soon will be in service. When 100-passenger airliners with 2000-horsepower engines are built, their fuel load will be enormous if gasoline engines are used. No one appreciates this fact more than the operators of such craft, but what can they do about it? Consider, for example, the Seversky design recently submitted to Pan American Airways in response to their call for aircraft in this category. Major de Seversky visualizes a "Super Clipper" that will fulfill the requirements with a payload of 43,000 pounds, and a cruising range of 5000 miles at a speed of 250 miles per hour. For power plants, he specifies—for want of anything better—eight gasoline engines of 2000 horsepower each, with 2300 horsepower available for take-off. Assuming that the engines cruise at 70 percent power output, then 11,200 horsepower would be used continuously in flight. Assuming, again, that their fuel consumption is 0.45 pounds per horsepower per hour, then 5040 pounds of gasoline would be used each hour, or 100,800 pounds of gasoline for the flight of 5000 miles called for in the specifications.

Now let us consider the matter from the Diesel standpoint. If Diesel engines of equal power were available, their fuel consumption certainly would not exceed 0.36 pounds per horsepower per hour, and might well be 0.34 pounds under average operating conditions. Taking the higher figure to be conservative, this works out at 4032 pounds of fuel per hour, or 80,640 pounds for the entire journey. In other words, there would be a saving of 20,160 pounds, or more than 10 tons, in the weight of fuel that the plane would have to carry. But this is not all. When fuel loads of this magnitude are concerned, there is also the cost factor to be taken into account. Aviation gasoline costs 11 cents a gallon at refinery, compared with 5 cents a gallon for furnace oil suitable for aircraft Diesel use. To this must be added, in each case, approximately 5 cents for taxes and 2 cents for transportation. Thus the cost for 16,800 gallons of 87 octane gasoline would be $3024, compared with $1382 for the 11,520 gallons of Diesel fuel needed for the trip. These figures, of course, do not take into account the appreciable quantities of much more expensive 100 octane gasoline which are required for the take-off of the gasoline-engined plane. Savings such as these, of 20 percent in fuel weight and 54 percent in fuel cost, certainly are factors of importance to any airline, apart from their advantages for other users, commercial and military alike.

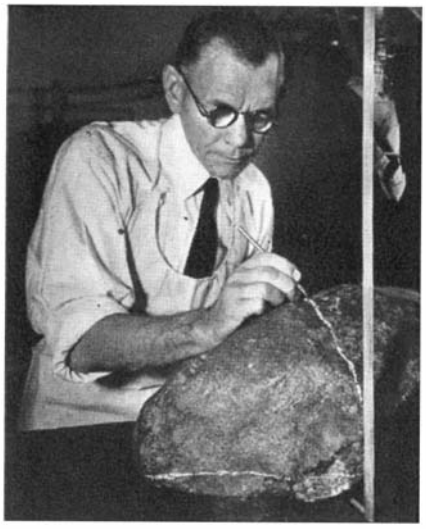
NEXT year, or the year after, may see the advent of the 2000-horsepower Diesel in huge airliners for flights across the ocean. Based on their highly successful "Jumo" 205, Junkers already has its 1200-horsepower "Jumo" 206 on test. Following this will come their 2000-horsepower engine, now under construction and to be completed by the end of 1938. So compact will this 24-cylinder "square" engine be, that its diameter will be only 39 inches. So well-designed will it be that its fuel consumption will not exceed 0.34 pounds per horsepower per hour. As for its weight, it is claimed that this will be little more than one pound per horsepower, due to the compactness of its design. Operating on the two-cycle principle like its predecessors, at 3000 revolutions per minute it will have 144,000 power impulses per minute from its 48 pistons—the nearest yet to the smooth operation of the turbine so sought after for an engine in the air.



Below: The record-breaking Dornier Do 18 flying boat, "D-ANHR," which holds the world's long-distance record for seaplanes. See the text

SLICING and POLISHING METEORITES

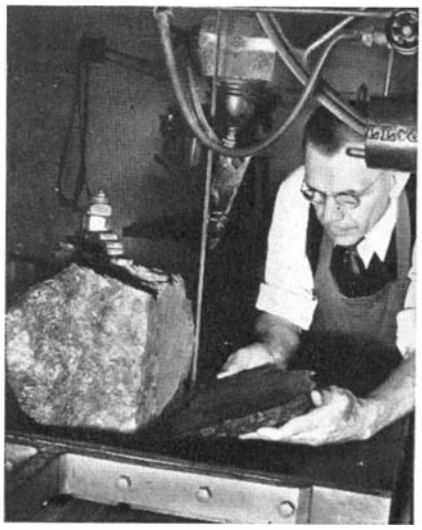
By ALBERT G. INGALLS



Marking the cut to be made

THE instant a meteor hits the ground it automatically becomes a meteorite, but the two terms are merely matters of arbitrary definition. While a majority of meteorites are mainly or almost entirely of stone, a majority of those which have been found are mainly of iron. This apparent contradiction is explainable by the fact that iron meteorites are sufficiently peculiar in appearance to be noticed, while one not well versed in mineralogy might easily pick up a stone meteorite that until the day before had been wandering alone in open space for millions of years and heave it at a too-musical back yard fence cat without knowing it wasn't a common stone.

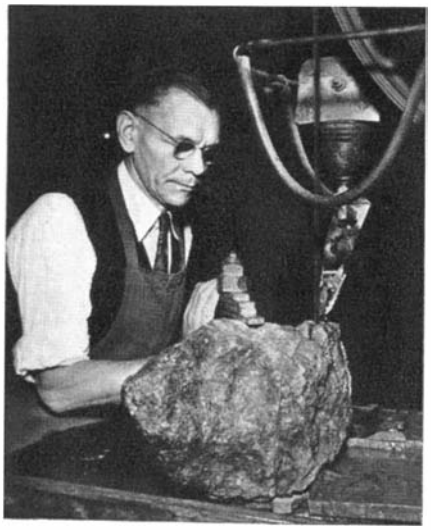
Among the larger meteorites in museum collections is one that fell at Paragould, Arkansas, in 1930. It is now displayed at the Field Museum of Natural History, Chicago, is of the stony type and weighs 750 pounds. It was actually seen to fall and was later traced down and found, and with it were some "younger brothers"—smaller meteorites that had been coasting along through space close to it, like a covey of ducks. One of these little brothers was sent to Washington, D. C., and subjected to dissection, in order that slices of it might be sent to different institutions, there to display the internal structure. The four photographs reproduced on the present page show it at four different stages in the process of preparation. The meteorite surgeon doing the work is Mr. B. O. Reberholt, an expert connected with the Department of Geology at the United States Museum.



Examining the detached slice

THE slicing is done by means of a toothless saw—a plain, smooth band of metal driven by a band saw, but there are "teeth" in this saw, after all, for these consist of loose grains of abrasive which are fed in and then pressed and rubbed against the meteorite by the metal band which is kept in continuous motion. In the first photograph (upper left) Mr. Reberholt is shown marking out the cuts to be made. In the upper right-hand picture the saw is nearly through a cut. In the third (lower left) the cut is complete and the slice is being examined, while in the lower right-hand photograph the slice lies on a flat table and is being polished.

The driven band or stone saw has a velocity of about 950 feet per minute—found to be the best speed. Carborundum grains (No. 100—about the size of grains of table salt) are fed into the cut from a small trough, by means of a trickle of water, and they drop into a kind of cup made by surrounding the top of the cut with molding clay. This directs them to the point where they will do the most good as the band moves downward through the meteorite. It all looks quite simple but anyone who has used a metal band with abrasive grains to cut stone will agree with a statement that Mr. Reberholt recently made in *Rocks and Minerals:* "There is a lot to learn about cutting minerals with a band saw." To complete a slice like that shown requires about two days' work. The meteorite cannot be hurried or crowded too rapidly into the saw, else the cut will not be straight.



Nearing the end of the cut

After a perfectly straight cut has been made the slice thus obtained is fine-ground and polished. The grinding tool, shown in the lower right-hand photograph, is a flat, horizontal piece of cast iron mounted on a vertical spindle rotating at 150 revolutions per minute and attached to the end of a movable pantograph arm. Thus the tool can be zigzagged over the specimen. Carborundum grains in sizes 100, F, and 600 are successively used, each with a fresh cast-iron tool, the last-named abrasive having the general fineness of flour. The fine-ground surface is next polished on a convex felt buffer armed with No. 600 Carborundum and the specimen is ready for public display.

Polishing the slice with power

OUR POINT OF VIEW

Steam and Wings

FOR several years, preparations have gone forward with deliberate haste looking toward the establishment of transatlantic airplane service. Expectations were that this summer would see the beginning of scheduled flights. Such a brilliant consummation of well-laid plans would have been something more than epochal, for this year is something more than normal in transportation; it is an important anniversary.

Just 100 years ago last April, two ships steamed into New York harbor a few hours apart. Mind you, they *steamed*. When the *Sirius*, from Cork, arrived in the harbor, she was not the first steam-propelled vessel to cross the Atlantic, but her arrival marked the beginning of regularly scheduled crossings. She made the trip in 19 days. When the *Great Western*, from Bristol, arrived a few hours later after a trip of 15 days, she had started a schedule of steamer travel that was later interrupted for only one short interval and had a speed record that stood unbeaten for years. The *Sirius* was scarcely larger than a modern tug and had been built for channel service, while the *Great Western* had been constructed specifically for transatlantic service; and on their first trips, neither knew that the other was on the way.

The Atlantic has been crossed by airplanes a number of times in single flights. The parallel between the beginning of steamer services and the coming airplane services stops about there. We do things differently now, have made great advances. No surprising, unheralded landing will announce the completion of the first flight of a new transatlantic air service. Radios, cables will tell of the take-off, give minute-by-minute details of the flight, flash news of the safe landing to all the world. The chances are that there will be several simultaneous flights, for it is no longer possible to get the jump on the other fellow; nations have been jockeying for top position where they can get sizable slices of the forthcoming passenger business, seeking landing privileges and entering into all sorts of reciprocal agreements. Then, too, the planes will have been built specifically for the service, and will have embodied in their design and operating features a wealth of experience gained from thousands of miles of long-distance, over-water flight.

Steamship services across the Atlantic marked the beginning of an era of speed in transportation reaching forward to the present day. The airplane has already vastly changed our mode of thinking; what will it do when it starts winging its way regularly back and forth across the north Atlantic?—*O. D. M.*

Toll

BACKED by a desire for private gain—a desirable feature in itself—come occasional proposals to build toll roads in various parts of the country. Hopefully, plans are offered that supposedly will give the motorist better and safer roads, opportunities for greater sustained speeds, freedom from congestion, and so on. The history of toll roads in the horse-and-buggy days need not be taken as the only basis upon which to predict ultimate failure of such schemes. In present-day Italy are about 300 miles of modern motor highways built originally as toll roads. Anticipated income failed to materialize; the government has taken over the roads and opened them, free of charge, to the public.

That tolls are necessary in certain cases—bridges and tunnels, for example—cannot be denied, but highways built by private companies are quite another matter. It is a foregone conclusion that a large proportion of the traffic that could use such roads would seek other and free ways of reaching destinations. Private toll roads to remote or spectacularly scenic spots are now in successful operation; these again are not to be compared with inter-city or transcontinental pay-as-you-go highways.

There is another angle to this situation: Human beings are naturally reluctant to pay a second time for something that should be theirs by right of previous payment. The motorist pays enough taxes on his vehicle, the fuel that makes it run, and the oil which keeps it running, to be provided with ample highways along which he may travel without having to pay another cent in tolls. His toll has been paid. He pays more of it every time he buys a gallon of gasoline or a quart of oil. But the pennies he contributes to the tax fund all too often do not go to the construction of new roads, the repair of old roads, or even to new signs to keep him in the right direction. Schools and sewer systems, municipal and state "improvements," eat into the funds, diverting money that was collected for specified purposes to other uses which rightfully should draw their costs from taxation levied on all citizens rather than on a segregated group.

If motorists' taxes are applied to facilities that benefit the motorist directly, and tax diversion is summarily stopped, motor-car drivers will have all the highways they can possibly use, safety will be increased, congestion will decrease, and toll-road ideas will once more be relegated to the files.—*A. P. P.*

Sedatives or Hypnotics?

"MY doctor prescribed them for me, said that they are non-habit-forming. They just calm the nerves and you go right off to sleep." So often is this statement made in this country today, that it might well have been promulgated, word for word, as an advertising slogan by the manufacturers of barbituric acid derivatives. Insomnia and this word-of-mouth advertising have so lowered the common-sense level of the American people that the sale of these synthetic "sedatives" has grown to enormous proportions. A doctor recently told us: "Their widespread use is the greatest disaster that has befallen the people in years."

The depressions, labor troubles, bewildering national policies, and the piling up of taxes have given us all cause for sleeplessness. Hence any suggestion that we must achieve an ascetic calm would be but an inanity. Yet a steadily growing dependence upon drugs which are called "sedatives" but are in reality "hypnotics," which are called "non-habit-forming" yet are cumulative poisons—a dependence upon these is bound to total up to much human misery and, in some cases, death. This is the essential argument in a long article in *Hygeia*. Some of the barbiturates "are blessings when given to the right person in the right dosage under the observation of a physician," says the article. "But there is none which is safe for Mr. Average Man to use at his own whim."

Some of the barbiturates "accumulate in the system until the organism becomes acutely poisoned"; prolonged use of most of them injures the nerve tissues irreparably; all are dangerous in some degree and have carried many people to hospitals, insane asylums, and to the grave.

The author of the *Hygeia* article makes a strong plea for a federal law to prevent promiscuous sale of these deadly drugs—a law far more stringent than that of New York City where, if the druggist knows you, the barbiturates may easily be purchased without a prescription. Before such a law is passed, however, consult your doctor or the American Medical Association before you take the advice of some well-meaning friend to "calm your nerves and sleep" with a barbiturate.—*F. D. M.*

Boards From Fiber

Composition Boards Originated as Wall Coverings . . . Now Find Wide Use . . . Field of Use Constantly Widens . . . Manufacture . . . Research for Future

By PHILIP H. SMITH

FIBER boards, which began commercial life strictly as a wall covering, now enter into the manufacture of railroad coaches and trailers, motor vehicles and toys, signs and marine partitions, and hundreds of other unrelated products.

Here is a new material rather than a substitute. Millions of square feet of it are produced annually to satisfy demands that its originators never foresaw. It has been given qualities in a wide variety of combinations to serve specific purposes. Strength, resistance to moisture and to fire, insulating and acoustical properties, have been built-in to banish forever the idea that commercial board is merely a substitute for wood.

Pioneer producers of fiber-board were concerned mainly with two objectives—to manufacture a building material having a large unit area which would reduce handling and installation costs, and to utilize waste products in the making. Use in the hands of the public soon revealed that close control over every step of the manufacturing process must be exercised to obtain a uniform product, and as that control was attained, development came rapidly.

Boards of various fibers are used in many places in homes such as this—from rough cellar partitions to fine panelling

The basic material of composition board is a fiber. The fiber may be derived from wood or other vegetable growth. Wood and paper pulps are used, while, to a lesser extent, fibers are obtained from wheat straw, cornstalks, flax, and licorice root. Some types of boards combine ground-wood with sulfite; others are made wholly from waste paper and there is a very heavy production of board made from exploded wood chips, and from bagasse, which is the cane fiber from sugar mills. Whatever the fiber used, it is the manipulation and combinations of ingredients which impart specific values to the board.

Most fiber boards are made on a modified paper-making machine; that is, the fibers are treated by a mechanical or chemical action in a pulping process and are then mixed with many times their volume of water and flowed out upon a screen so that the fibers fall into a mat as do the fibers in felt; hence this is called "felting." The bulk of the water is extracted by pressure and heat to leave a thick mat of interlaced fibers, ready for pressing to a desired thickness and density. A four-inch mat of fibers, for example, may be pressed to a half inch thickness to make a hard-finished board.

Laminated boards differ from the homogeneous board in that they are built up from several layers to impart strength. The requisite number of plies of fiber stock are fed continuously from rolls into a laminating machine. Each ply is given a coat of adhesive before all are brought together at a central point. After lamination, there comes a pressing process and then kiln drying to remove excessive moisture. Various adhesives are used, most of them secret in formula, but minerals, asphalt, mastic, and casein are known to be employed.

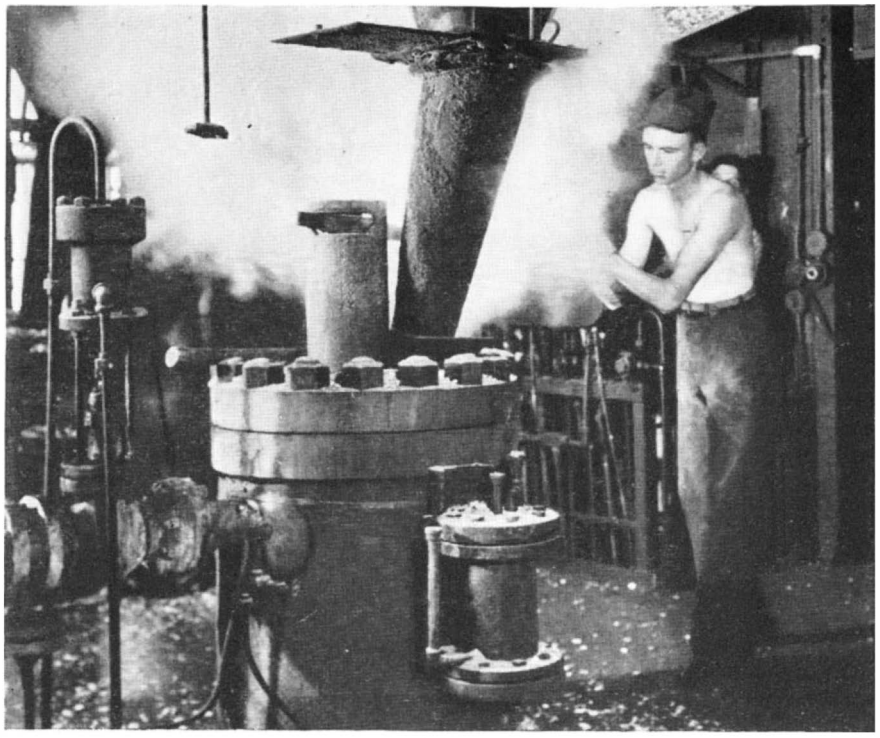
In the course of research and development it was discovered that the length of the fibers and their positioning had much to do with the ultimate strength of the board. This explains, for example, why ground-wood with its long fibers makes a product of high quality.

WHEN wall board first came into use, troubles were experienced with expansion and contraction. An excess of moisture would cause the board to buckle, while a dry atmosphere would produce cracks or cause the panels to pull away from each other. A great deal of research has been devoted to the problem of overcoming this affinity for water vapor, and a reasonable amount of success has been obtained. Practices are either to attempt to seal each fiber or to coat the entire board to exclude moisture. Some producers employ a rosin size in accordance with paper-making practice; one manufacturer uses petrolatum. Whatever the process employed, the net effect has been to reduce expansion and contraction movement to a point below that of ordinary wood.

When a board is to be used for exterior construction, more serious attention must be given to water-proofing. In certain cases, water-proofing compounds are added to the beaters while the fibers are being separated so that each fiber will be coated. Another practice calls for impregnating the board after forming, using a vacuum process. Several producers coat the board with asphaltum to make it serve for sheathing.

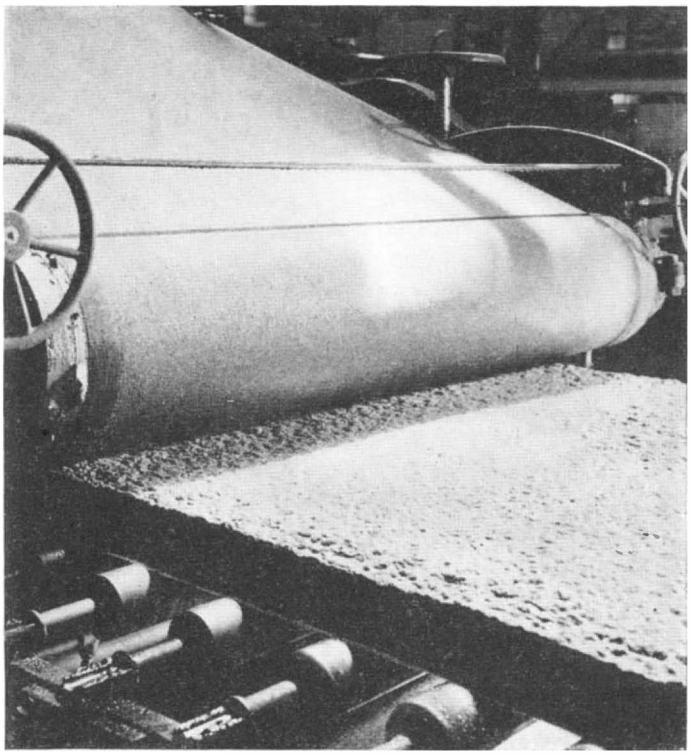
The manufacturers of board will not declare the problem of water vapor completely solved until they are able to pro-

duce an inert product. This they strive for because it would broaden the utility of the product. As it is, boards which are treated with various oils are now used for flooring and for concrete forms. Rosin and alum water-proofed boards are used for sheathing with an extra surface water-proofing coat. One product, made wholly from newspapers and water-proofed in the manufacturing process, is employed widely for chicken houses, tourist cabins, and other small structures.



AMONG the many fibers used for insulation board, bagasse (sugar cane after extraction of the juice) plays a prominent rôle. The fiber has the merits of being long, tough, springy; its serrated saw-tooth surface facilitates proper felting. Following a long and detailed preparation, the fibers are mixed with filler fiber and with rosin and alum water-proofing to exact proportions. Then, just before the mixture goes to the board machines, chemicals are added to it to coat each fiber and render them resistant to dry rot and termites.

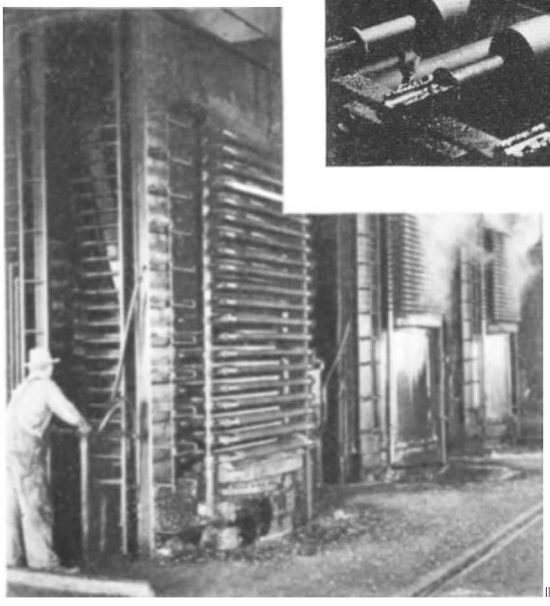
To felt the bagasse fibers into board requires the addition of great quantities of water. A mixture of one pound of fiber to 199 pounds of water enters the forming end of the board machine which produces the wet board; at the other end emerges a product consisting of water and fiber in equal parts. The form is now that of board and runs continuously into a drier which removes the remaining moisture and permits the board to shrink and set to permanent form. The final step in the process is to cut to size, bevel, groove, or drill as the need may be, and allow seasoning and humidifying to bring the moisture content up to atmospheric conditions.



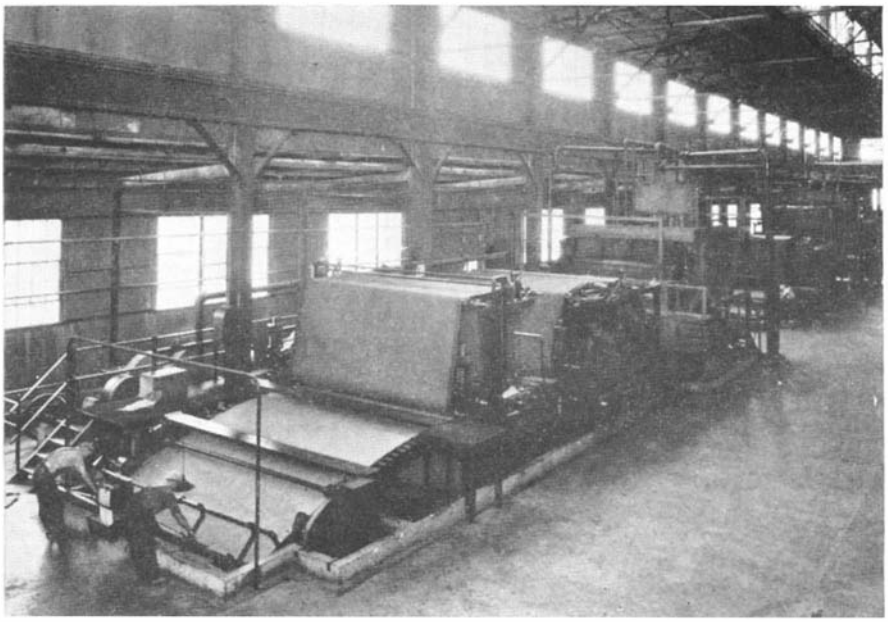
Inspection of board products on the market reveals little of the care and control in manufacture necessary to produce uniformity and specific qualities. The above-mentioned bagasse board, for example, comprises primary fibers which interlace to form the framework, and secondary, or shorter fibers, which give rigidity. Then the spaces between fibers are filled with light cellular particles or pith to increase insulating value. Finally, there are extremely fine fibers to hold the pith and other fibers in place. All these constituents must be used in exact proportions.

Quite distinct from board manufactured along paper-making lines is one made from wood fiber produced by an explosive process. Saw-mill chips and waste pieces of wood are fed into a 20-inch caliber "gun" which is then closed. Steam is introduced for about one minute until the pressure reaches 500 pounds. Then the pressure is raised quickly to 1000 pounds, held there for a few seconds, and, finally, the bottom valve of the gun is opened to release the wood and steam simultaneously. This sudden discharge causes the wood to explode into fibers.

When the fibers are thus separated, they are mixed with water in the ratio



At the top is shown the "gun" used for exploding wood chips. The resulting product is a mass of fibers which are then treated, mixed with water, and carried to a forming machine. The center picture shows a thick blanket of fibers known as the wet-lap. The presses at left squeeze out the water from the matted fibers and form the board under sustained pressure



In many respects similar to a paper-making machine, the board machine subjects a wet mat of fibers to both heat and roller pressure to make finished boards

of one to 50, pumped through refiners, and carried to a forming machine. As the fiber-water mixture is run over the machine, water is gradually withdrawn by vacuum and pressure rolls, to leave a thick blanket of interlaced fibers. This is known as "wet lap." The next step is to trim the wet lap to size and run it through presses by means of a wire screen which permits escape of the steam generated in the drying. The length of time the mat stays in the presses, and the pressure used, determine the thickness and density of the product. The binding compound in this instance is the natural lignin of the wood and, when pressures of 1000 tons are applied, it is quite adequate to produce a hard, durable board.

WHEN commercial production of this type of board was first undertaken, it was believed that adequate raw-material supplies could be had from edgings, slabs, and short lengths which were the waste of saw mills. It was an underestimate, for today thousands of cords of second-growth pines and hardwoods are required to feed the factory. The machine which forms the wet lap produces at the rate of more than 100 feet a minute and has an insatiable appetite.

The advent of the homogeneous board —that is, non-laminated—opened the way to the production of insulating board. It was realized that if fibers could be matted together and subjected to light pressure, the air cells remaining, plus the cellular form of the fibers themselves, would give insulating properties. Today, a very large percentage of all board manufactured is used for insulating purposes. It is used for interior wall covering without further treatment, or it acts as a plaster base. When used as a sheathing board where there is chance of exposure to weather, it is usually given a protective coating. One widely used board is covered with asphaltum on one side and an aluminum compound on the other.

Closely allied to the insulating boards are the acoustical products. They are too varied in nature to be described in detail here. It is enough to say that they are engineered to absorb sound and are used successfully in public auditoriums, offices, and in truck and bus manufacture where sound-deadening qualities are desired.

In recent years, board has undergone what might be called "style change" which has widened the field of use even more. Perhaps the first step in this direction came when manufacturers learned the trick of beveling panel edges to obviate the use of mouldings to conceal joints between panels. This drove home the idea that boards might be pleasing as well as practical. A subsequent development was to impart a wood grain by casting in molds and then painting in appropriate wood colors. This board is water-proofed and can be used for exteriors as well as interiors where a panelled wood effect is desired. Several manufacturers offer boards to which are bonded rare and costly woods as well as common woods in veneers. A thickness of 80-thousandths of an inch is enough to give a board veneer which is practical for most purposes.

The idea that board might be used as a base, with other materials bonded to it, opened up quite a field for development. Board is now made with a surface covering of a plastic to achieve a lower cost panel than can be had with an all-plastic product, and a more durable surface than ordinary board offers. Panels of this type are to be found in the baths on the *Queen Mary*. More recently there appeared on the market a product which is not called a fiber board, but can properly be mentioned to show this newer development. Sheets of stainless steel, either 0.008 inch or 0.015 inch thick, are bonded to a water-proof, flexible board by a heat and pressure process. They are suitable for wall coverings. When produced in tile size, they are used to line the walls of baths and kitchens, and when bonded to a thick board they are intended to serve as partitions in ocean liners where low maintenance cost and high fire resistance are desirable. The stainless steel retains its polish.

Regardless of the many qualities which have been built into boards, the original attribute of having large surface area is still predominant. It is this quality, accentuated by improvements, which made the board suitable for trailer construction. An entire side wall could be made of a single piece of board where the only opening was that for windows. Large area and good surface qualities have introduced the boards to mural work as a substitute for canvas. Millions of square feet went into such projects at the Century of Progress Exposition, the Texas Centennial, and the Great Lakes Exposition. Large surface area, light weight, and the capacity for being bent to form have made board suitable for the interior roof construction of railroad coaches. Even passenger automobiles use this board widely. Prior to 1927, many manufacturers employed it for roof construction, but it was outmoded by wire and fabric and later by steel tops. Today it serves as an insulator against heat transfer from motor to driver compartments.

THE possibilities in board development are by no means exhausted. With a firm hold on the market for interior building construction, it now moves steadily toward adoption as a material for exteriors. As fast as the means are found for imparting weather-proofing qualities, its use broadens. We can look for more durable products as the outcome of laboratory research and for many more types of boards bonded to other materials. Experiments are now being conducted with synthetic resins to serve as binders and to impart greater moisture-resistant properties.

Standing in the way of progress has been the near-dormant state of building construction. But if a building boom should get under way, manufacturers would acquire a volume of orders that would permit more experimentation. As it is, the lapse of construction has not been a total loss; it has greatly stimulated the cultivation of new uses and has provided time in which to lay a strong foundation for future conquests.

Photographs courtesy The Masonite Corporation and The Upson Company.

PLANTING FOR ECONOMY

Wider Spacing of Trees . . . Lower Costs . . . Weeds, Bushes Enrich Soil, Cause Branches to Rot and Drop Off...Pruning Unnecessary...Quality Lumber

By CLYDE MITCHELL

BETTER lumber can be grown and the speed of production can be accelerated, thanks to research, but until recently most planting methods overlooked means whereby soil fertility could be maintained for successive tree crops.

Now from Swann Forest, a state conservation enterprise in southwestern Massachusetts, comes a method of planting which assures soil upbuilding along with quality lumber, and also permits great economies in tree growing.

The new "skeleton" planting calls for setting out only as many trees as are needed for the ultimate stand. Thus, at the outset, 75 percent of tree and planting costs are eliminated, because hitherto a 1200-tree planting has been made for a 300-tree, single acre forest.

In the older method, where plantings were made six feet apart each way, the excess of trees allowed for expected losses; side crowding forced long, straight, knot-free growth, while shade checked "weed" growth. None of these advantages have been lost in the new method. Seedlings which fail to survive can be replaced, while "weed" growth, or deciduous bushes, do the crowding. But there is this added advantage; the weeds keep the air moist so that dead branches rot and fall off, thus eliminating the trouble and expense of pruning.

Skeleton planting bases on more than 17 years of experimentation with plantings and observations of the natural. One of the earliest discoveries was that old fields pass through a definite, but not clearly marked, plant succession by which soil improvement takes place. Before any natural planting occurs on impoverished soil, there must be vegetative changes or successions to restore productivity. These successions were found to be grass, then herbaceous growth, after that low-bush, high-bush and finally saplings, which formed the start of the natural forest. Sometimes the stages overlap; sometimes one appears to be skipped, but the progressions are always similar.

These plant successions were found to help reduce soil acidity and to protect the soil with moisture and shade while allowing the sun and air to reach it. When they died they gave back organic material and bettered conditions for the growth of soil bacteria and for nitrification.

OUT of the experiments leading to the development of skeleton planting came several new principles which are a part and parcel of it and these can be stated in equally direct and simple terms. Here are some of them:

Never plant land until the soil has recovered. The appearance of volunteer vegetation will herald the proper time. Any attempt to accelerate the process merely results in a waste of time and energy. Furthermore, trees planted too soon will lack vitality and be more susceptible to attack by insects and disease; soil will be unduly depleted and the quality of the ultimate stand of trees will be impaired.

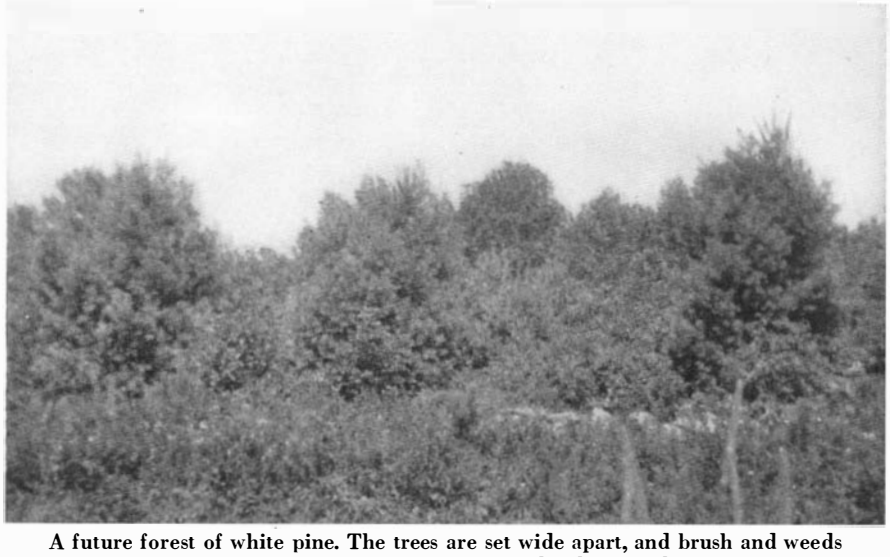
Plant trees at 12-foot intervals and permit brush to grow up around them. The only necessity for pruning arises when the brush grows too fast and closes over the stand of trees so that sun and air are shut off. Any hardwoods pruned out of a conifer stand for this reason should be scattered on the ground to decay within the forest borders. It does not make for neatness, but neatness can be had only at the expense of fertility.

It is unwise to plant more than one-quarter acre of land solid to any single species of conifer or hardwood. Extensive plantings of a single species encourage the spread of disease and pests, but, even more important, conifer plantings should always be under the influence of neighboring hardwoods. When both conifers and hardwoods grow in close association, the health of the soil is improved and we then get, in reality, a crop rotation under a continuous crown cover.

When these principles are followed in conjunction with skeleton planting the following advantages have been found to accrue:

Vegetative cycle and soil recovery can progress undisturbed. Root competition is nil at the outset, permitting maximum vigor and growth per tree. Thinning is eliminated. Pests and disease are diminished. Management operation is simplified.

While Swann Forest researches are aimed to solve the timber problems of Massachusetts, their findings are applicable to all of New England and to a very large extent to land and forest problems throughout the nation. New England is not alone in having millions of acres rendered incapable of supporting quality timber growth and the first step in doing something to arrest the spread of this disaster is to understand what to do.



A future forest of white pine. The trees are set wide apart, and brush and weeds fill the remaining spaces. The rank growth will die down and improve the soil

How Hot is the Sun?

It Has No Single Temperature but the Layer that Sends Us its Light Directly Averages About 5740 Degrees, Absolute, or 9873 Degrees, Fahrenheit

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

THIS title may suggest sweltering dog-days; but, if anything could make these seem cool by comparison, it would be the answer to the question.

It has been realized for a century or so that the sun, even on its visible surface, was hotter than anything that man's devices could produce. When the sun's rays are concentrated by a lens of short focus, or, better, by a large mirror, which does not waste heat in transmission through thick glass, the image is not merely dazzlingly bright; it will melt the most refractory metals. A more far-reaching test is found by comparing the surface brightness of the sun with terrestrial sources. A candle flame, or an old fashioned oil-lamp, is not very hot, and shines moderately—one can look straight at the flame and not feel dazzled. The tungsten filament in an ordinary electric light is far hotter; it is dazzlingly bright, and would still appear so if placed in front of a candle flame as background. But this filament, in full glow, would look black against the sun—if we set it up in broad daylight, and looked through a heavy shade-glass to protect our eyes—and if we had one of the old-style clear glass bulbs that are now out of fashion.

But this only shows that the sun is very hot, and does not tell us how hot it is. We must think a bit before we can be sure that the last question has a meaning or how its meaning is to be defined.

The sun is a sphere of gas, with no sharp boundary. Its edge looks sharp to us because it is so far off that a transition layer of gradually thinning atmosphere, a hundred miles deep, would be practically indistinguishable except with a great telescope, and air steadier than there is much hope of finding.

If the sun's atmosphere were as clear as the earth's is at its best, some diffuseness at the edge might nevertheless be observable; but it is full of electrons and other charged particles, and well-tested theory shows that such a gas would scatter light like a thin haze. The greater the pressure, deeper in the atmosphere, the hazier it will be.

This is why the details of sun-spots, and the like, look sharp in the telescope. There is nothing solid there, nothing liquid, nothing even as substantial as a thin summer cloud, with its tiny scattered drops of water—only gas which is hotter in some places than in others. But, since this gas is full of electron-haze, we cannot see deep into the sun—probably only a hundred miles or so below the level where the haze really begins. Underneath this level there are, in all probability, tremendous tornadoes in the solar gases, where in some places expansion cools them. But we cannot see down into these. The haze shuts off our view. But it does not, and cannot, prevent a greater amount of radiation from escaping upward where the deeper layers are hot than where they are cooler—and so we have the visible spots.

IN such an atmosphere, through which a great flood of energy is escaping upward into space from the deep interior, there must be a temperature-gradient. The lower layers must be hotter than the upper to keep the heat flowing. The light that we see does not come from any one layer. Part of it comes from deep, hot layers, but has been much enfeebled in getting through the haze above them. Part of it comes from upper, cooler layers, which we see almost unobstructed, but which are almost transparent, and so send out little light. When this is realized we can understand why that great solar physicist of an earlier day, C. A. Young, said: "It is only by courtesy that the sun can be said to have a temperature." However we make our observations, we have to deal with a complex mixture of influences from different layers, of different temperatures.

Obviously the best we can hope is to get some sort of average, but even this is hard, for we cannot find, directly, the temperatures of the hotter and cooler layers, which we have to average. We are therefore led to the invention of an "effective temperature." This is the temperature which a body of standard radiating properties must have, if its radiation is to be like the sun's when compared in some specified manner.

There are many different ways of making our specifications and, naturally enough, they lead to different results. The simplest is to specify that our standard radiator shall be as big as the sun, and send out the same total amount of energy—or, alternatively, that it shall send out the same total amount of energy per square centimeter of surface.

For a perfect radiator, or "black body,"[1] this amount is proportional to the fourth power of the absolute temperature (measured from absolute zero). The radiation at a temperature of 1000 or 2000 degrees can be measured in the laboratory. The radiation which we get from the sun can also be measured, and a simple computation makes the sun's effective temperature 5740 degrees K (on the centigrade scale, from absolute zero). The uncertainty of this figure is perhaps 1 percent—arising mainly from the difficulty of allowing precisely for the absorption of the sun's radiation in the earth's atmosphere before we can measure it.

This is far hotter than any terrestrial furnace—naturally, because it is far above the boiling-point of any known substance. The incandescent gases in some electric arc discharges are about as hot, but too thin to send out very much light. Higher temperatures have been reached by "exploding" thin metallic wires by the passage of a very heavy condenser-discharge; but, within a few millionths of a second, the gases expand and cool.

This value of 5740 degrees (absolute, or K) is doubtless the best one to remember, if we wish to speak of the sun's temperature. It is practically certain that this temperature is reached somewhere in the middle of the layers from which light reaches us directly; the deeper layers, almost obscured by haze, are hotter, and the outer ones cooler.

But we may set up our specifications in other ways. For example, we may seek the temperature of a black body which would give out, per square centimeter,

[1] It has this strange name because a perfect radiator would also be a perfect absorber of radiation, and, if cold, would reflect no light at all, and be perfectly black.

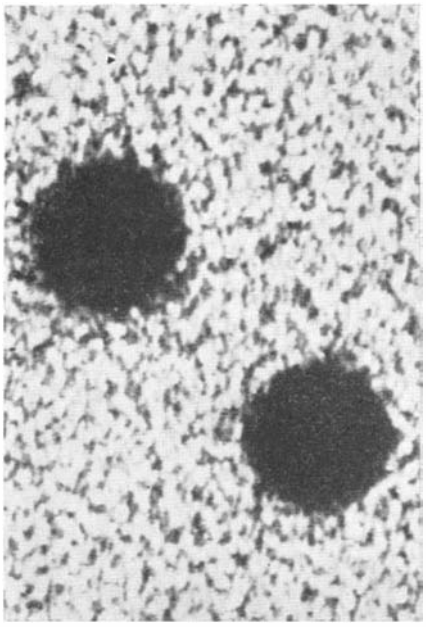
the same amount of light of one given color (or wavelength) as the sun does. Calculations on this basis are easy enough to make, and the sun's radiation in different wavelengths has been pretty well measured; but the results range from 6300 to 5600 degrees, according to the wavelength taken for study.

This is not surprising. The opacity of the sun's atmosphere need not be the same for light of all kinds. With a wavelength to which it was more transparent than the average, we would see deeper, and get light from hotter layers, and more of it, and the reverse is obviously true. The differences are not alarmingly great; indeed, the theorists have rather a hard job explaining why they are not greater.

If we take our sample area of the sun to represent, not the average for the whole as we see it, but the measured values for a small portion of the center of the visible disk, we find higher temperatures—for example, about 6300 degrees from the total radiation, while, if we measure an equal apparent area close to the sun's limb, we get only 5000 degrees. This is again easily intelligible. When we observe the center of the disk, we are looking straight down into the haze and so see as deep as possible. Toward the limb, our line of sight strikes the sun's surface at an increasing slant, and the same number of miles of path in the haze take us to a smaller depth, and so to cooler gases. Both 6300 and 5000 are good and reliable average values, under the circumstances of the special observations, for the layers from which the light actually comes. The value 5740 degrees is a sort of general mean for all angles of observation—or of emission of the sun's light.

BUT, we may ask instead: How hot must our standard body be if it is to give out light of the same color as the sun? This is too vaguely stated; to be precise, we should demand that the relative intensity of the radiation of two specified wavelengths—say in the yellow and the violet—should match the observations of the sun.

"Color-temperatures" of this sort have the great practical advantage that they can be made just as well on a distant star as on the sun, for, in empty space, the color of the light is not altered as it travels. (In some cases there is evidence that the space between us and the star is not perfectly clear; but we need not bother with this now.) But they have two disadvantages. First, their evaluation demands high accuracy of measurement. This is not very bad, as good measures of the kind required can fairly easily be made. Second, and much more serious, are the difficulties which arise if the atmosphere of the star (or of the sun) is not equally opaque for all wavelengths. Suppose, for example, that we are comparing yellow and violet light. If the haziness and opacity of the gases affect the two to the same extent, we will "see down" to the same depth with both, and the light we observe will come from substantially the same layers. Under these circumstances, it is found that the color is nearly—though not exactly—the same as would come from a black body giving out the same total radiation, so that the "color-temperature" and the other effective temperature are nearly the same. But, if the atmosphere is considerably more transparent in the yellow than in the violet, the yellow light will



Sunspots photographed with a 12-inch reflector, by L. and H. Cox, Mitcham, County Surrey, England

come from deeper and hotter layers, and be stronger in proportion than the violet light. More yellow light corresponds to a lower temperature; so the color-temperature will be low. Conversely, if the atmosphere is more transparent for violet light, the color-temperature will come out high.

This actually happens for the A-stars (of which Vega is a type). Careful measures at Greenwich have shown that the average color of these stars corresponds to a temperature of about 16,000 degrees—while the degree of ionization of the metals, revealed by the spectrum, shows that it cannot be higher than 12,000 degrees and is probably lower. There is good reason to believe that the opacity of the atmospheres of these stars is mainly due to hydrogen, and is much greater in the red than in the violet. We should therefore expect the color-temperature to come out too high.

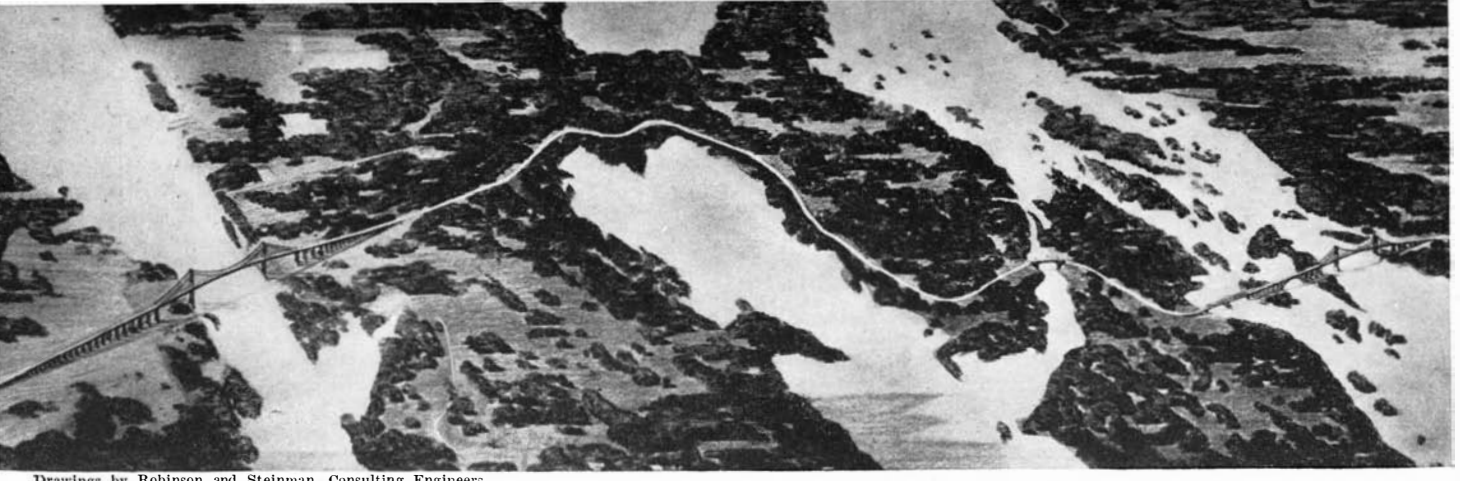
Finally, there is still another way in which we may define the effective temperature—the "excitation temperature." The lines of a rich spectrum, such as that of iron or titanium, are not all absorbed by atoms in the same state. Some are produced by atoms in the normal state—to which they automatically revert if left alone long enough—and others by atoms in "excited" states, loaded up with considerable amounts of energy. Most of the atoms are always in the normal state. The proportion which are in the excited states should increase rapidly with the temperature.

By measuring the strength of lines in the solar spectrum, and comparing the results with the strength observed in the laboratory under known conditions, it is possible to find the relative numbers of atoms—say of iron—which are in the ground state and various excited states, and hence to calculate the temperature which would be required to produce these results.

Two independent investigators have lately applied this method to the sun—R. B. King, working on lines of titanium, and Menzel, Baker, and Goldberg with iron and titanium. They agree in finding a very much lower temperature than any of these already mentioned—King obtaining 4400 degrees, and Menzel and his associates 4350 degrees from titanium and 4150 degrees from iron. The last named result depends on intensities calculated from a theory which is admittedly too simple for the complicated spectrum of iron, but the general agreement of all the results is impressive.

AT first, it looks as if something was very wrong indeed; but, when one looks into the theory one finds that, under such conditions as prevail in the sun's atmosphere, the atoms are got into, and kept into, the excited states mainly by the absorption of light in their own spectral lines. The degree of excitation should therefore depend mainly on the amount of light available for the atom to absorb. Now the region in which the observed lines are produced is pretty well up in the sun's atmosphere. Could we strip it off entirely, there would still be iron and titanium in the layers then exposed, and the spectrum would still show their dark lines. The atoms with which we have to deal, then, are excited, not by radiation corresponding to the intensity of the spectrum in the bright parts outside the lines, but by something little stronger than the central parts of these dark lines themselves. This relatively feeble radiation corresponds to a lower temperature, and the main part of the difficulty is explained—though there is room for plenty of work still on details.

Before theoretical investigators get through with a complete discussion of what happens in the solar spectrum, it is likely that they will have to invent still more kinds of effective temperature—each with its own definition, and its own numerical value; but for the present we may have had enough.—*Ragusa, Jugoslavia, June 28, 1938.*



Drawings by Robinson and Steinman, Consulting Engineers

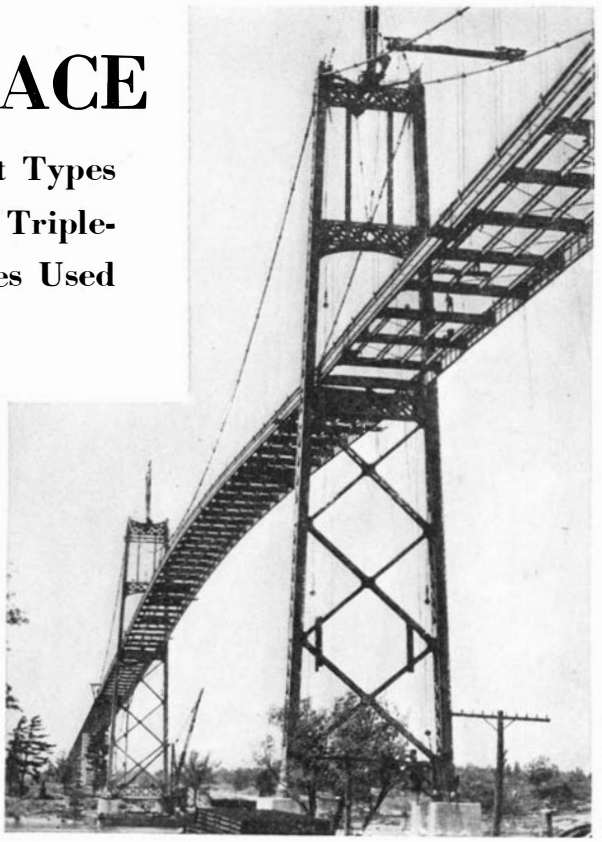
General view of the International Bridge system. *Left to right:* American channel crossing from Collins Landing, 800-foot main span; reinforced concrete bridge, 90-foot span, crossing International Rift and boundary; two 300-foot continuous truss spans; 348-foot span steel arch; Canadian channel crossing with a main span of 750 feet, terminating on the Canadian mainland near Ivy Lea, Ontario

A Bridge of Peace

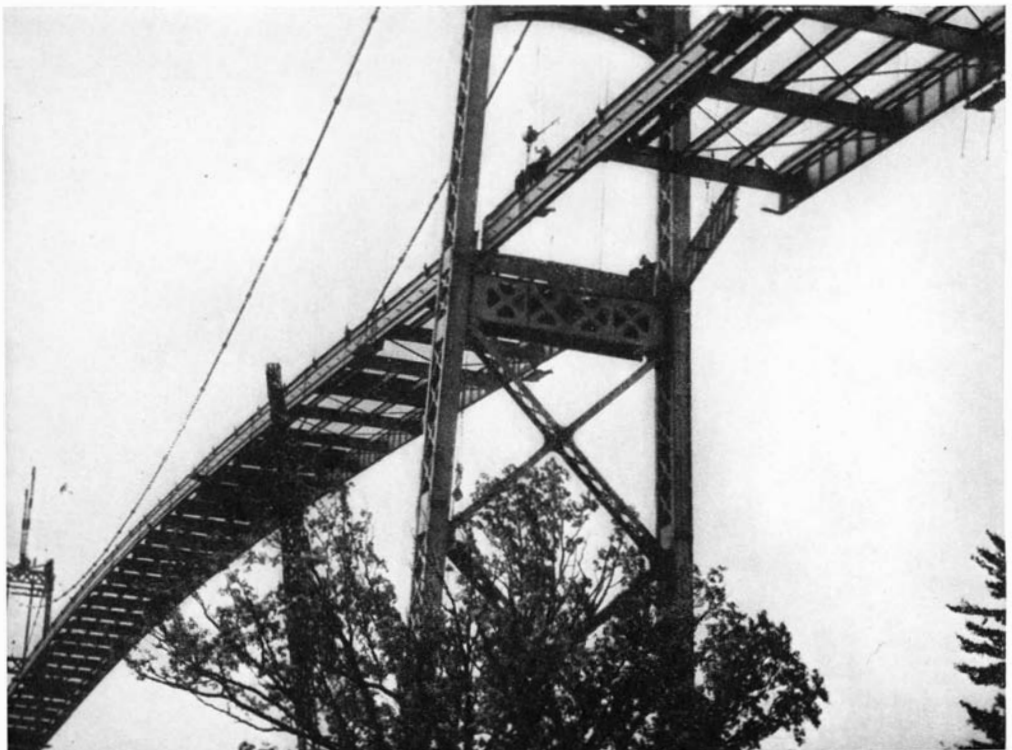
United States to Canada . . . Four Different Types of Spans . . . The Biggest Little Bridge . . . Triple-Function Pier . . . New Cable Anchorages Used

By D. B. STEINMAN

THE new Thousand Islands International Bridge, opened in August during a joint U. S.-Canadian celebration of 100 years of international peace, affords the student of engineering an opportunity to study an interesting and comprehensive project. Comprising five separate spans crossing the St. Lawrence River and Thousand Islands, the complete unit involves four different types of bridge construction. These are the two suspension spans linking the Islands with the Canadian and United States mainland; a double Ferris truss, a rigid formed arch, and a stone arch. The three last, with roadways, link the Islands with the two main spans.



Right: The suspension-bridge crossing of the American channel nears completion; the steel deck ready for the road

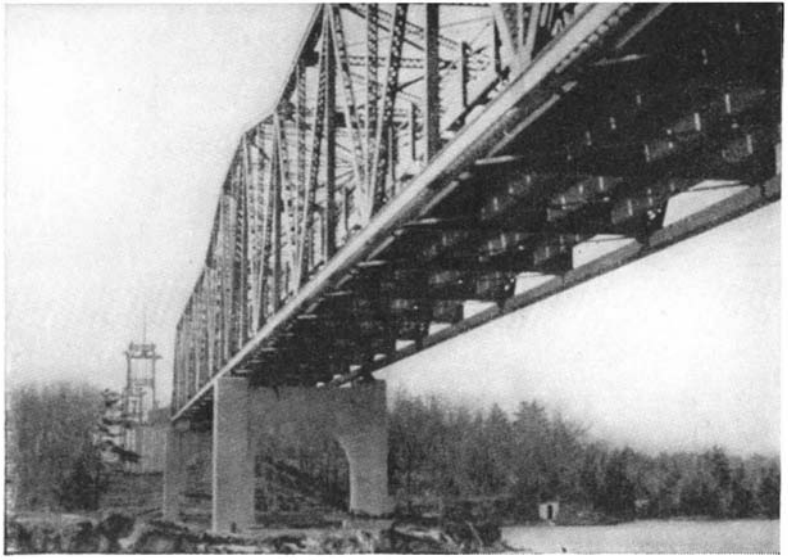


Below: Workers high above the St. Lawrence River close the last gap in the roadway deck of the American channel span of the International bridge

The official opening of this bridge was almost exactly a century after the last border trouble when William Johnston, colorful buccaneer of the last century, ended his "one man" Patriot's War against the British government.

The designing engineers have joined economy with beauty and practicality in utilizing natural topography and natural rock foundations to reduce total construction costs for the five spans and 8½ miles of roadway to $2,200,000. Engineers who planned the new steel and concrete path learned later that they had echoed an older judgement. Two centuries ago, Indians of the Mohawk Nation trekked across the frozen river over an almost identical course—the old Mohawk Trail immortalized by James Fenimore Cooper.

Favorable topographical conditions influenced the selection of bridge types,



served to reduce costs of substructure to a minimum, and made possible several unique anchorage treatments. The cost ratio of substructure to superstructure is only 1 to 5 instead of being equal, as in the case of what is considered to be a normal economical plan.

Massive natural rock abutments on Constance and Georgina Islands were factors in the choice of the steel arch type of span. A sharply rising rock formation on Georgina's south shore, found ideal for both horizontal arch thrust and horizontal cable pull, is the scene of the project's outstanding engineering feat—a triple-function pier serving as the south anchorage of the suspension bridge, as the north abutment of the steel arch, and as the pylon forming the north end of the arch to support the connecting viaduct span and the arch floor panel.

Above: **Continuous truss spans cross the historic Lost Channel from Hill to Constance Islands**

Right: **Fabricating the steel of the graceful arch that will support the span from Constance Island to Georgina Island, Ontario**

Below: **"The Biggest Little Bridge in the World," a 90-foot span, crosses the border of the United States and Canada**

A new anchorage for multiple rope-strand cables, considered the simplest and most economical form yet devised, and invented by Dr. Holton D. Robinson, of Robinson & Steinman, designing engineers, has its original application on the project's two suspension bridges. In this new anchorage form, each of the 37 1¼-inch strands composing the suspension span cables, which are of prestressed rope-strand construction, is separately and adjustably connected to a projecting end of one of 37 round steel bars, 2⅜ inches in diameter and independently imbedded in the anchorage concrete. Each strand terminates in a steel socket which is externally threaded, opposite hand, and the upper end of each bar is upset and threaded. An internally threaded sleeve, turned by a wrench, serves for connection and adjustment between the anchor bar and strand socket. Following adjustment for length variations to assure uniform strand tension, the ends of the connecting sleeves are spot-welded to preclude subsequent rotation.

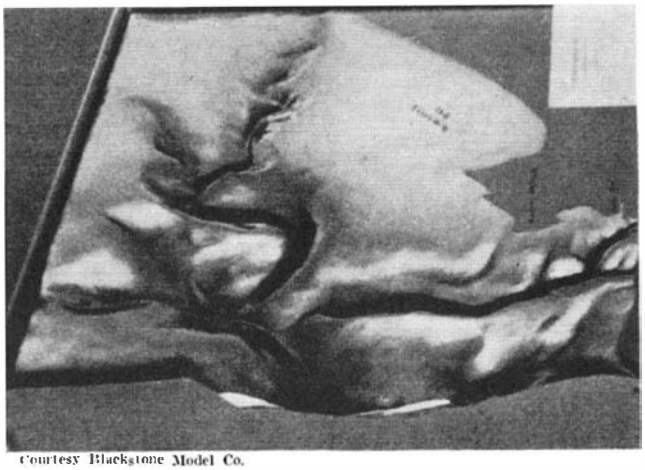
Right: **From Canada to the United States. Compare with the drawing reproduced at the top of opposite page**

THE ENIGMA OF THE

What Radical Happening Produced Vast Submarine Canyons Comparable with the Grand Canyon? ... In Lively Fashion the Geologists Debate this Mystery

IF you examine a geology textbook of the late 19th Century you may find mention of the existence of valleys on the sea floor. Today's textbooks also give the same casual reference to these valleys. In recent years, however, largely as a result of the work of the United States Coast and Geodetic Survey, information has become available which indicates that these neglected submarine valleys include some of the deepest gashes in the face of the earth. In fact, the term "valley" is no longer appropriate. These depressions are so steep sided and so enormously deep that they should be dignified by the name "submarine canyon."

Withdrawal of the waters from the ocean would show these canyons as scenic features that would be almost without parallel. Even the Grand Canyon might be eclipsed by the most striking of these oceanic depressions. It is literally true that most coasts of the world have nothing above water that will compare from a scenic point of view with the canyons on the adjacent ocean floor. Thus there are canyons off the New England and mid-Atlantic states that have walls rising as much as 4000 feet above their bottoms. None of the New England nor even the Appalachian mountains have valleys that will hold a candle to these giant submarine features. Even off a low coast like west equatorial Africa there is a gigantic gash at the mouth of the Congo River which has been cut 4000 feet into the ocean bottom. Another off the broad delta of the Indus River cuts at least 3000 feet below the surrounding sea floor.



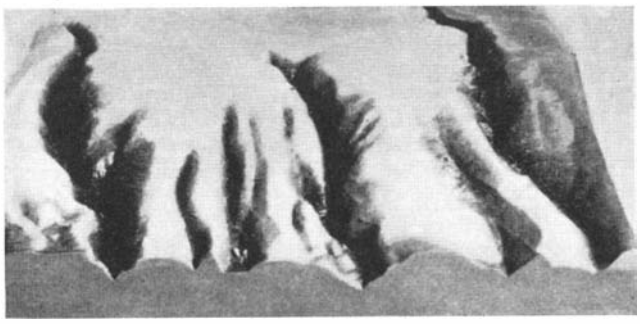
Courtesy Blackstone Model Co.

A scale model of the big Monterey submarine canyon, off the California coast. It extends to 10,000 feet depth

A few of us have been investigating these submarine canyons. Where we have made detailed examinations, we have found that they are in every way comparable with the river-cut canyons of the land. They have the same V-shaped cross-sections. They have winding courses like river valleys on land and they even have the same types of tributaries extending into the main canyons from either side. Also, they slope outward along their channels as continuously as do river valleys. In some cases, as at Carmel Bay, California, river canyons on land can be traced directly out into submarine canyons of exactly the same character. They are found off many of the large rivers of the lands, such as the Hudson, the Mississippi, the Francisco of Brazil, the Salinas of California, the Columbia of Oregon, the Ganges and Indus of India, the Congo and Niger of Africa, and the Adour of southwestern France. All these points lead to the conclusion that the canyons were cut by rivers at a time when the water did not cover the present oceanic slopes and that subsequent submergence has brought them to their present position.

Against the river origin various geologists are raising a storm of protest. Nor is the solution of the problem as simple as might be supposed. Here are some of the difficulties which confront the river erosion hypothesis:

If you partially submerge a model of a mountain slope cut by canyons the water will extend up the canyons, forming bays and leaving the ridges standing out as peninsulas and capes; but the coasts adjacent to the submarine canyons are commonly straight or almost straight, as for example the coast of California or the southern coast of western France.



A model of a group of deep submarine canyons found off the coast of New England. Their origin is unknown

Because sea-bottoms are supposedly not dissected by stream erosion, coasts with indications of considerable uplift might be expected to be free of adjacent submarine canyons, and yet it is off such coasts that many of the deepest canyons are found.

Geological work on the land areas has shown that some coasts have been elevated and that others have sunk, but that most coasts have been extremely stable for long periods. Accordingly, it is surprising to find that deep submarine canyons with their indications of enormous sinking exist along practically every coast of the world.

IT might be supposed that if the continental margins have all been greatly depressed, the downward movements would have taken place at a variety of times during the past. However, we are discovering more and more evidence in the form of fossil-bearing rocks dredged from the canyon walls to show that the canyons were made in relatively recent times and, therefore, must have been submerged even more recently.

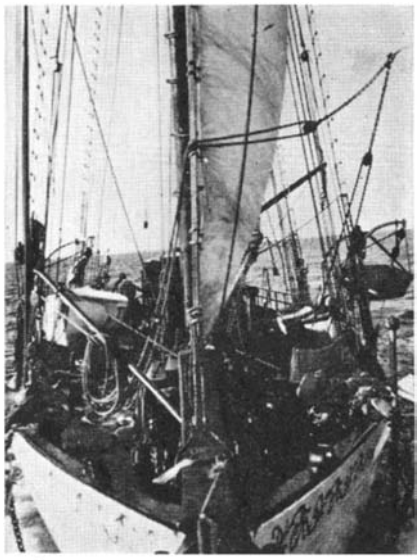
Is it any wonder that a recent geological metaphor is "as puzzling as a submarine canyon"? Picture the dilemma of the poor geologist with his past experience and his logic telling him that submerged river canyons simply should not exist off such a coast as California which has been uplifted, and certainly not off that remarkably stable New England coast, and yet finding off these places features which are the twin sisters of the land canyons which he knows to have been cut by rivers.

As a result of this quandary, proposals have been coming out to the effect that the submarine canyons are the result of processes which could operate on the ocean bottom. The authors of these

SUBMARINE CANYONS

By FRANCES P. SHEPARD

Associate Professor of Geology, University of Illinois
Research Associate, Scripps Institution of Oceanography



The *E. W. Scripps*, 104-foot auxiliary schooner belonging to the Scripps Institution and being used under a co-operative arrangement with the Geological Society of America for investigations of the ocean floor, including the canyons

ideas seem to have been rather poorly informed of the characteristics of the canyons and have in general failed to answer objections to their hypotheses. For example, the idea that downward movements of the earth's crust produced the canyons is disproved by the pattern and shape of the canyons: they are entirely different from those of land valleys produced by movements of the crust.

AN idea which has more support than that of earth movements is that there are or have been currents moving down the submarine slopes and cutting canyons into them. It has been suggested that waves beating against the coast and stirring up mud might make the water so heavy that it would slide down the slopes and produce this cutting. However, such an explanation fails to account for the typical river pattern of the canyons and for their relation to many of the largest rivers of which they are extensions. Nor does it explain the existence of many canyons directly off sandy or rocky coasts where mud would not be accessible to produce the currents. Furthermore, it is highly improbable that muddy water would set up currents of sufficient force to excavate enormous canyons out of solid rock formations.

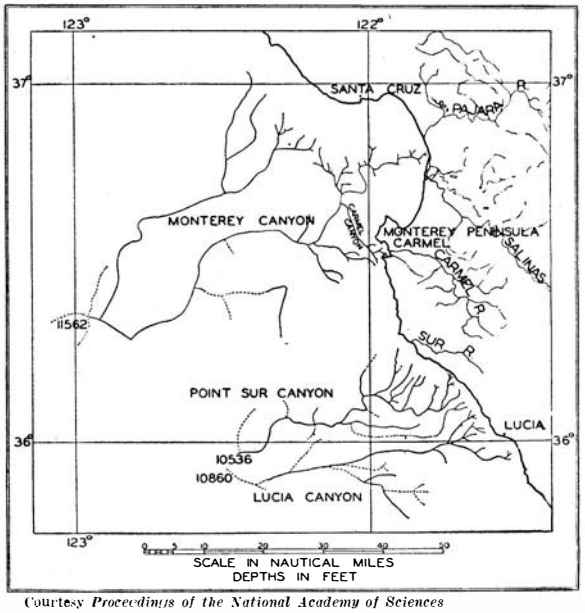
Other geologists, accepting the implication that the canyons were cut by rivers and realizing the improbability that all the continental margins had been recently depressed, have resorted to the alternative of sea level change. Thus it has been suggested that the whole Pacific Ocean basin sank, drawing off the waters from the coasts of the world. This would have allowed the canyons to be cut and a return of the ocean floor to its former position would have drowned the canyons. Sank!—but into what could the basins sink, since the earth's interior is known to be solid? Furthermore, the islands in the Pacific have submarine canyons, hence they were involved in the same changes as the continental margins. Probably we have little help from this source. A still more fantastic notion is that the earth's rate of rotation was suddenly decreased by a collision with a heavenly body and that, as a result, the oceanic waters were thrown toward the pole, permitting canyons to be cut into the exposed slopes of the equatorial regions. Subsequently, drowning of these canyons would have occurred when the earth's surface had bulged sufficiently at the poles to be adjusted to its new rate of rotation. Unfortunately, even if such a thing could have happened, it would not explain the canyons since they should all be found near the equator and should completely disappear at 35 degrees of latitude, but it is north of that latitude that all the deepest well-surveyed canyons of the world have been found.

One thing is perfectly evident, namely, that we will never solve the enigma of the submarine canyons by devising hypotheses which do not take into consideration the facts of the case. The present writer has been gathering these facts from all over the world for the past 15 years. There is still much to be desired and it is only during the past year that it has become possible to begin extensive and systematic observations with all the expensive equipment necessary for such studies. However, there are already some indications of a solution of the canyon mystery.

The difficulties confronted by the submerged river canyon hypothesis would fade if the following contentions could be demonstrated:

1. That the canyons have been submerged long enough to allow the adjacent coasts to be straightened by waves and currents. 2. That the sea level was greatly lowered by the extraction of water from the ocean and piling of this water on land in the form of continental glaciers. This would have allowed the cutting of canyons by the extended streams off all the coasts of the world and off the oceanic islands. Then the melting of the glaciers would have drowned the canyons. 3. That the outer portions of the submarine canyons were formed independently of the lowered sea level by a variety of processes.

It has been shown that enormous quantities of sediment are being carried toward the submarine canyons either by rivers entering at their head, as in the case of the Congo where a submarine canyon extends well in toward the shore line, or by currents as in the case of southern California where enormous movements of sand along the coast are shown by the fills behind breakwaters and next to piers. Despite this fact some canyons come up almost to the beach. If these canyons have not been submerged recently, why are they not filled? The answer to this can be given with some confidence. The valleys are being kept open. As mud and sand accumulate on the floor of these steep sloping troughs the force of gravity causes them to creep or slide outward into deeper



Courtesy *Proceedings of the National Academy of Sciences*

Part of California (to the right) and canyons on adjacent sea-bottom, exhibiting stream patterns

water. These movements, which are probably of the nature of mud flows, have been known to occur after earthquakes. For example, the canyon off Yokohama was found to be hundreds of feet deeper after the great Japanese earthquake of 1923 and this deepening must have been due to sliding of the bottom material since it is far too great to be accounted for by sudden crustal movements. More recently, checking of the depths at the head of a canyon off the coast at La Jolla, California, has led to the discovery of landslides in operation. The slow progress of one slide was charted and a large crack was found to open on the side of the canyon. Later the block on the seaward side of this crevice was detached and slid out to sea, leaving the canyon considerably wider than it had been previously.

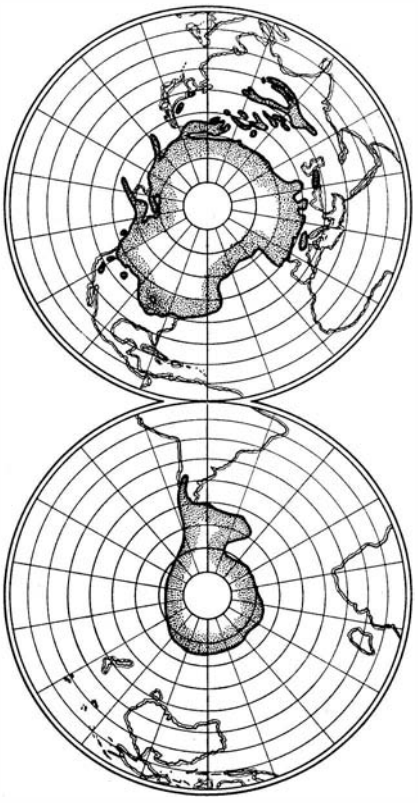
THE significance of these mud flows and landslides is that they make it possible for the canyons to have been submerged for indefinitely long periods without filling and certainly for long enough time so that the rivers and waves could have straightened the adjacent coast, by filling in the heads of the bays which resulted from the canyon submergence.

With regard to the lowering of sea level due to the forming of great continental glaciers, there is no question but that the glaciers during the ice age received their water from the ocean due to evaporation and later precipitation of the water vapor in the form of snow. As this snow accumulated on the land the ocean level was reduced by an amount corresponding closely in volume to the growing ice sheets. The question is whether the ice caps could have been large enough to have produced the lowering of thousands of feet which are essential in order to make this idea of any consequence. It has been estimated that the sea surface was lowered only 300 feet from this cause, but such an estimate is very conservative and it doesn't look as though we were going to solve the mystery of the submarine canyons by conservative speculation. Something pretty radical must have happened.

The Soviet geologists have been mapping the evidence of glacial action in northern Russia and Siberia and their latest report shows that all over this territory the ice caps moved onto the lands from the north where the Arctic Ocean now exists. These findings may be interpreted as meaning that there was a great ice cap centering in some place in the Arctic, perhaps northern Greenland. From this the ice spread on the one hand into North America and the other into northern Europe and Siberia. What, after all, could be more natural than to have an ice cap in the northern hemisphere with a center near the pole, similar to the Antarctic ice cap in the southern hemisphere?

Furthermore, a great enlargement of the Antarctic ice cap may have occurred. These huge masses of ice in both hemispheres may have grown till they became several miles thick; certainly an average of four miles is a reasonable estimate. The result of such caps would have been the lowering of the sea level to an extent which would at least have been a great help in explaining the submarine canyons.

On the other hand, if the ice had lowered the sea level as much as 10,000 feet, which may be necessary to explain the deep outer portions of some of the canyons, there would have been so little water left in the basins that practically all the marine life would have been killed by the great increase in salinity due to such concentration. There is no evidence of great extinction of life, nor is it likely that the ice could have grown till it produced a 10,000-foot lowering. These outer portions of the canyons are for the most part only poorly surveyed, so that we do not know whether they represent the same river canyon types as the inner portions. It is not unlikely that they were formed in some other way. There are plenty of irregularities on the deep sea-bottom, due to crustal movements and to sub-oceanic volcanic activity. It is quite conceivable that, when the waters were lowered by the glacial period, rivers flowed into pre-existing depressions on the former ocean bottom and cut their canyons in continuity with these features. Also, it is very likely that some canyons have been depressed over a long period of time by earth movements till they reached great depths.



The possible distribution of ice during the maximum of glaciation

It is, of course, impossible to tell whether new information will finally demonstrate the correctness of the hypothesis which has been outlined. On the other hand it is safe to predict that the ultimate explanation of the canyons will be equally revolutionary so far as the science of geology is concerned, and will probably have an important bearing on the other natural sciences of the earth.

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In recent geological and other professional journals there is a growing literature on the submarine canyons. The American Philosophical Society, Independence Square, Philadelphia, Pa., has recently published a book containing a number of papers delivered at a symposium on this subject, with the discussion that followed the symposium.

Small boats used near the Scripps Institution, of La Jolla, California, for research such as charting minor changes in the heads of the submarine canyons

VEGETARIAN CHINA

For Centuries China Has Unconsciously Been Working Out a Vast Food Experiment From Which the Western World Can Learn Practical Lessons

By WILLIAM H. ADOLPH
Professor of Biochemistry, Yenching University, Peiping, China

RURAL China has furnished what is probably the best large-scale, long-term experiment with a vegetarian diet which the modern world has witnessed. Vegetarian fads in our Occident have come and gone and, while enthusiasts still stage occasional revivals, it is probable that as an accepted nutritional regimen, pure vegetarianism is on the wane. By vegetarianism is meant eating food which is solely of vegetable origin. The ration therefore does not include milk, milk products, meat, eggs, or other food-materials derived from animal sources.

The experiment which the rural populace of China has been carrying on is in many respects unconscious, but one source of its importance lies in the fact that it is unconscious. Another reason for its importance is the fact that it has involved not merely a few selected white rats, or even a few human subjects sheltered in the artificial comforts of the nutrition laboratory, but several millions of people as experimental subjects. Furthermore, it has extended not over a few weeks but over a score or more of centuries. It is estimated that not more than 10 percent of China's population live in the cities, and the food habits of the remaining rural 90 percent have remained largely unaltered, even as the agricultural economy has remained largely unchanged, over a period of thousands of years. The solution to its foremost problem which China has reached—that is, the problem of maintaining a large population on an agricultural basis—is therefore worthy of study. In fact, such a state of nutritional equilibrium as has been attained with human subjects in this area of eastern Asia is unique in the realm of nutritional investigation. Moreover, with the economic factors of the modern world rapidly changing, the opportunity which this experiment offers for study will quite probably never exist again.

Figure 1 is based on a number of preliminary surveys of what Chinese natives eat. It provides a comparison of the average dietary of China with that of America. Also, it indicates the almost complete extent to which the Chinese diet is vegetarian. In the Chinese diet, meat, fish, and eggs furnish only a very small amount of the total food supply. Even then many observers feel the figure indicated for meat—3 percent—is too high and does not properly represent the facts, while the milk and milk products consumed in China are so small in amount that they do not appear in the diagram at all. The amount of milk consumed averages less than 0.1 percent. It is of no small moment to realize that this large rural community of several hundred million people has lived and survived for, say, 40 centuries without milk as food and without the use of any kind of dairy industry. Nor can it be asserted that the net result of this national experiment is qualitatively inferior, for example, to that of the Mongols to the north of the Chinese who do consume milk. Nor is this result in any sense culturally inferior to that of non-vegetarian countries.

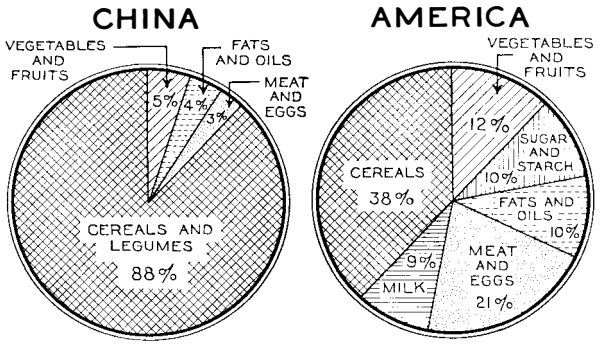


Figure 1: Even an avowed vegetarian in the Occident might find himself hungry for foods of animal origin —butter, eggs, milk—if he ate a rural Chinese diet

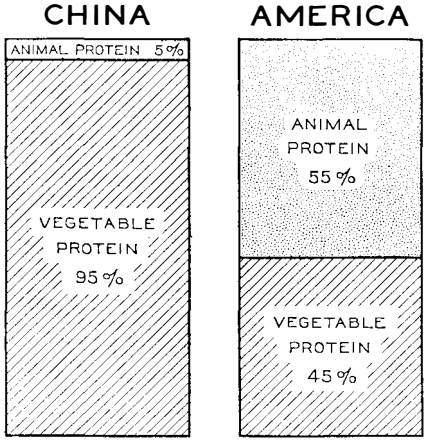


Figure 2: Like it or not, China's peasant must get his protein—all but 5 percent—from vegetable foods

The same diagram shows that the American dietary is a true omnivorous diet and, while it is not a perfect diet in many respects, it does provide what the nutritionist terms a well-balanced intake.

The vegetarian diet of China is, strictly speaking, a cereal diet. Legumes—and this includes the soybean—are here included in this cereal group. The cereals consumed in North China (generally eaten as bread) are mainly wheat, millet, corn, and kaoliang; the southern Chinese replace these by the single cereal, rice (steamed rice). The customary reference to China as a rice-consuming nation applies, it should be observed, only to the southern two thirds of the country.

A MORE careful analysis of the data from dietary figures for China shows an apparent shortage of two items—calcium and protein. The first of these, calcium, is closely related to skeletal growth and stature. The amount of calcium consumed per capita throughout China appears to be not only dangerously near the minimum amount consistent with health and vigor but, according to western standards, it is far below that amount. An abundant supply of calcium is related to the use of milk. American nutritionists, in fact, are accustomed to look to milk to supply practically the entire calcium need of the human organism, and the one quart of milk per capita per day recommended by the Occidental nutritionist for the growing adolescent is largely dictated by this need for calcium.

The protein factor, on the other hand, involves a question of quality rather than one of absolute quantity. Figure 2 indicates the extent to which the protein consumed is derived from animal sources (meat, milk, eggs) and vege-

table sources (principally cereals). Protein studies show that vegetable proteins have many shortcomings; they are less completely digested in the alimentary tract, and the portions digested are intrinsically of lower nutritive value. This means that, from a purely quantitative angle, more vegetable proteins must be eaten to meet the requirement. If 60 grams (two ounces) of protein per day are recommended for the mixed meat-milk-vegetable diet, probably 80 grams per day should be the intake on a more strictly vegetarian diet.

One of the interesting results of the Chinese experiment is the unconscious but independent discovery by the farmer-consumer that bread made from a mixture of cereals is usually to be preferred to that made from a single cereal. Various types of mixed flour are found native to different areas in North China. Crop conditions in each district dictate different mixtures, but in almost every district the farmers report a conviction that the mixed flour is superior to any one of the constituent simple cereals. Exact laboratory measurements have only in recent years demonstrated that this concerns the protein factor, for mixed cereal protein has an enhanced nutritive value. It is no longer regarded as surprising when laboratory experiments confirm the findings of the ages! Figure 3 shows the growth curves obtained when mixed cereals from representative rural districts in North China were fed to laboratory test animals, in such a manner that the protein constituted 10 percent of the food.

FIGURES 4 and 5 illustrate the results obtained with laboratory white rats, using littermates of the same age and initial weight, when fed typical omnivorous and vegetarian diets—in both cases the rat that received milk grew far larger and heavier than the other. It must be kept in mind that an experiment with laboratory animals, under controlled conditions, accentuates one particular factor and purposely overlooks the many other physiological factors to which man in daily life is subject and which in human practice would also affect the results. The results pictured here, from the Yenching University laboratory, are, however, typical of many growth experiments carried out with vegetarian diets. In the Peiping Union Medical College, under the direction of Dr. Hsien Wu, attempts were made over a period of years to find a combination of vegetable materials which would produce growth in white rats comparable with that produced by an omnivor-

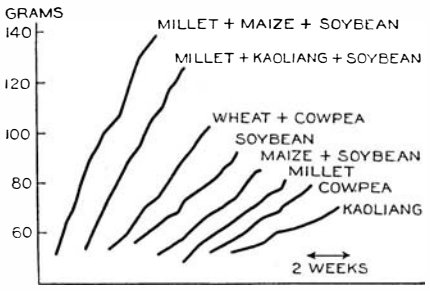


Figure 3: **Modern science proves that the whole exceeds the sum of the parts. However, China learned this fact empirically, centuries ago**

ous diet, but the search did not lead to success. As a result, nutrition laboratories in the Orient which maintain rat colonies and raise white rats for experimental purposes, have found it advisable to feed these animals with a stock diet containing an appreciable amount of animal protein. This may be meat protein, casein (from milk), or even milk itself in some form. Results obtained with white rats may not be directly applicable to man, but the experience of nutritionists indicates that these qualitative differences between vegetable and animal protein cannot be overlooked.

Many of the food habits of the Chinese people, however, involve questions of food economics. Milk has never become a substantial item in the dietary. The reason is related to economic factors. The agricultural economist explains that calling upon a cow to eat cereal and convert this into milk, which in turn is then consumed by man, involves a greater energy loss than allowing man to consume the cereal in the first place. If man can actually convert cereal food directly into human brawn and human energy, then a cow becomes only an expensive intermediary. Such economic facts, particularly when the tremendous loss involved in a "cow converter" is weighed, become part of the inarticulate nutritional experience of a people. The same line of experience applies to meat, which is an expensive food in the Orient. When meat as a food is measured in a similar way it is found that the process of changing the agricultural crop into beef before it becomes human food involves a similar conversion loss. Animal husbandry furthermore has demonstrated with regard to meat production that the crop yield of a given unit of land area, if used to feed farm animals, will produce twice as much pork as beef—a fact that may be connected with the well-known prevalence of pork over beef in China. It has also been similarly suggested that *steamed* bread, because it is prepared with the expenditure of much less fuel than baked bread, has become the bread of North China, due to an economic factor.

THE laws of supply and demand are related, of course, to the province-wide task of feeding large populations. Food consumption is readily estimated directly from the crops grown, for in China no significant amount of food is transported from one province to another. The close relationship between crop-production and population is suggested in Figure 6. The calculation shown in this table takes Shantung province for an example and merely converts the food yield of a given area into food calories available per capita of population. The figures indicate that, for a typical agricultural community (an area without extensive industrialization) this province can provide just barely enough agricultural product to support its present population. There is certainly no margin! Shantung is typical of the region of the Yellow River delta. The population is dense and the area averages hardly more than one crop per year. Other formulas for estimating population pressure yield similar results. Significant population facts for Hopei, another of the north China provinces, are illustrated in Figure 7.

Nutritionists during the past decade

Figure 4: **Rat at left ate a wheat-milk diet and outweighs its undersized rice-and-vegetable-fed littermate 252 percent**

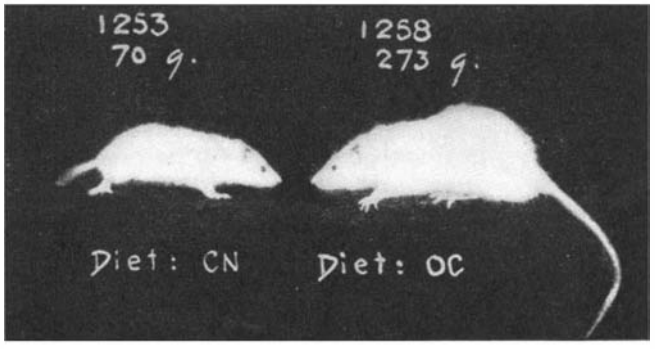


Figure 5: **Rat at right grew up on a milk-meat-egg-vegetable diet. It outweighs its vegetable-fed littermate 390 percent**

have turned from a discussion of what is the *minimum* diet to a consideration of what is the *optimum*, or best, diet. Superior effects measured in terms of growth in weight have been many times reported for laboratory animals when the amounts of certain chemical essentials in the diet have been augmented. Especially favorable results have been obtained by increasing the calcium and the milk protein, as well as the vitamins. Measurements in the United States indicate that during the last half century there has been a marked increase in stature and physique in the younger generation of Americans. This may be attributed to improved living conditions, but among these conditions the improvement of the diet is certainly a leading factor. This observation is paralleled by results obtained at the Connecticut Agricultural Experiment Station where one of the oldest and largest of the white rat colonies used for nutrition experiments is housed and has been kept under careful observation. These animals have been fed the best diet available. A recent report shows, however, that in this colony over a period of 25 years there has been a gradual improvement in growth as new discoveries in nutrition made possible successive improvements in the stock diet fed. This growth performance is represented by the curves shown in Figure 8; these curves indicate averages, of course, for a large number of rats. In the same way in man the norm of growth may be rising. No one has yet accurately defined the upper limit of increased stature and physique which may be reached with improvement in the diet. It is evident that many of these factors are subtle, and that such experimental results often become apparent only when the experiment is extended over many generations. We can merely ask: How far can such an increase be continued? Is there an optimum physique for the animal and for man which we have not yet attained?

The bare fact remains that the Chinese peasant has maintained himself for 4000 years or more on a diet which is not only vegetarian but which does not contain milk, the *sine qua non* of the western dietitian. Milk is the one item without which our nicely balanced calculations become sadly deranged. Nevertheless, not only do simple calculations demonstrate that in China a nation-wide dairy industry is at present impossible, but history would seem to indicate that the Chinese people have never used milk.

The low calcium intake mentioned above causes the eastern dietitian some concern, for instead of milk, which in other countries is the chief source of calcium, the Oriental must seek vegetable sources of calcium to bolster up this supply. The amount of calcium consumed per capita per day is startlingly low by western standards. The importance of this element lies in the fact that calcium is the chief constituent of the bones and skeleton, and it seems likely that the low calcium intake is one of the limiting factors to which the Chinese physique has had to adjust. It has been naively suggested that the lower stature of the Oriental races is the result of this adjustment! This is only a conjecture, but it reflects some of the basic facts which the nutritionist may be called upon to explain! What is a nutrition standard? It may be wrong to refer to the diet of the Chinese peasant as a deficient diet. May it not be true that observations on long-term experiments, such as the Chinese experiment, will assist the world to establish truer norms? If so, we can look to the Orient for a more satisfactory definition of many of these dietary values.

It is impossible to discuss here other important aspects of China's vegetarian experiment. The problem of vitamins in the vegetarian diet forms a distinct chapter; the effect of high carbohydrate diet with its abundance of roughage is another; the soybean in China's dietetic repertoire is still another episode whose importance America has just discovered; there are other unique contributions. It may be concluded that, in the realm of rural nutrition, China has attained a solution to her food problem which economically is creditable and intensely practical, but qualitatively, the verdict declares, there is ground for much improvement. Improvements which health officers and nutritionists are proposing will involve decreasing the percentage of cereals in the diet and increasing the amount of green leaf vegetables and tubers such as sweet potatoes, and also the greater use of eggs as food; these changes possibly can be brought about without serious jolts to the agricultural economy. In addition to these, most programs propose rapid industrialization which, by raising the economic level, will enable the individual to expand the food budget and will make possible the beginnings of a dairy industry. Industrialization may thus be defined as a device to relieve the pressure on the land! Health education is receiving special attention. All the nations of the world are absorbed in the task of developing national vigor and physique. Nutritional science in the Orient has only begun to apply itself to the problems at hand.

MAN has for many years been aware that there was some relationship between food and physique, but the realm of nutrition is being expanded to include other qualities than mere growth. The president of the American Medical Association recently proclaimed that the newer knowledge of nutrition promises "greater vigor, increased longevity, and a higher level of cultural development."

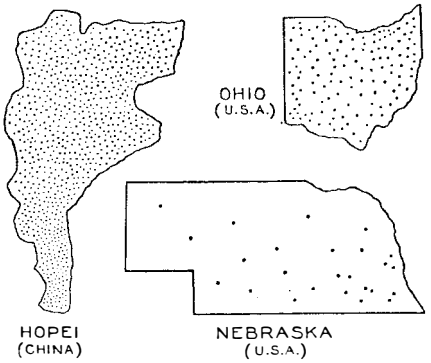


Figure 7: **Each dot represents 50,000 population. Let the Nebraskan, or even the Ohioan, imagine what his state would be like under the population pressure of Hopei Province**

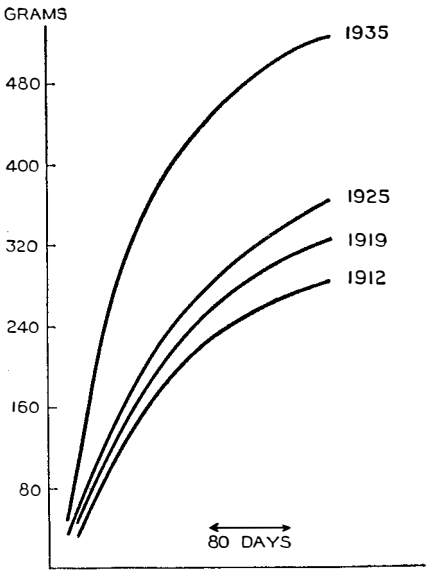


Figure 8: **Generations of improved diet work changes on rat growth**

CALCULATION OF FOOD SUPPLY

PROVINCE OF SHANTUNG

Average Crop Production (wheat as an example; 1 kilo of wheat equivalent to 3500 calories)	
Yield, 1 crop per year, per hectare (2.5 acres) = 1000 kilos, equivalent to:	3,500,000 calories
Area of province	14,000,000 hectares
Tillable area (estimated)	10,000,000 hectares
Population	37,000,000
Tillable area per capita	.27 hectares
Producing food energy (1 crop per year) per capita	950,000 calories
Per capita equivalent in food energy per day	2600 calories
Energy standard for man doing light work	2400 calories

Figure 6

Turning 'Em Around

Cargo Ships Unloaded, Reloaded Speedily, Efficiently . . . Method is Exacting . . . Stevedores Supervise, Arrange Cargo . . . Difficult Details

By DAULTON MANN
Executive Vice President, Grace Line

ALONG the South Street of 19th Century New York, bowsprits protruded over the sea wall almost to ship chandlers' doors. Out of the holds of sleek clippers came silks, teas, rare woods, and bric-à-brac, all the lush wealth of China and India, to be hauled away over the cobble-stoned waterfront street by four-horse teams. Today, huge motor-trucks laden with machinery, tires, airplane propellers, copper, steel rails, auto chassis—the products of a highly industrialized society—crowd the docks of New York City.

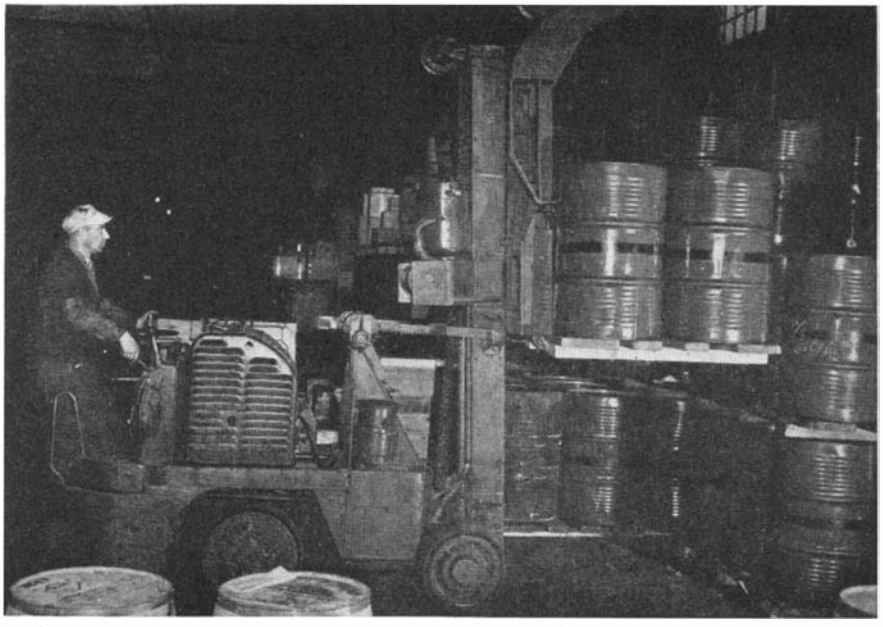
Instead of the uncertain cargo movements of sailing days, these goods move between ports today on schedules which are clock-like in their regularity. A hundred years ago perishable cargo was nearly unheard of, but now fast freighters, equipped with modern refrigeration, carry fruits from California, bananas from Central America, meat from the Argentine, to the ports of the world.

Few nations are as self-sufficient as the United States, yet this country must import many of the materials for one-time luxuries—present necessities which mass-production technique has transformed into household articles. For the tremendous electrical industry, 17 nations ship materials to the United States. The radio's countless parts travel about 250,000 miles before assembly at the factory.

But countries like the United States and Great Britain, which have built up huge industrial centers, export great quantities of manufactures. During 1937 alone, the United States exported goods valued at about $2,453,056,000. And 80 percent of all American exports are transported by water.

During the year ending December 31, 1936, about 8591 vessels entered the port of New York and about as many left. In the holds of incoming ships were 34,000,000 tons of merchandise; and ships, leaving for foreign ports, carried 11,500,000 tons of freight. Valued at over $2,000,000,000, this import and export cargo was entrusted to the care of stevedores who unload and load the freighters, tramps, and combination passenger and cargo vessels which dock at New York's North and East River piers. To facilitate the movement of this freight, about $1,000,000,000 has been spent on piers, warehouses, drydock, and other necessary equipment.

Definite problems — technical, geographic, and labor—face the shipowner in the movement of water-borne cargo. From the point of view of variety of cargo and ports of call, Grace Line is an example of modern cargo handling at maximum efficiency. From the North River pier, in New York City, south to Valparaiso, Chile, the ships of this line stop at more than a dozen ports which bridge the gap of temperature from winter to summer and present varying problems of unloading and loading from lighter to ship, or from dock to ship. Because of these natural difficulties the handling gear is of special design—hatches are unusually large and the old donkey engine has been replaced by the electric winch. The Grace Line's schedule of operation is based on a quick turn-around, necessitating the utmost ingenuity in handling cargo with the greatest possible speed. The man who makes this possible is the stevedore.



From piles on the pier, most cargo is loaded by trailers or by derricks. This electric hoister lifts a skid-load of barrels and will carry them to the proper pile

ALL repairs, painting, and renovating are done in port by shore gangs employed by the shipowner. Once the ship is unloaded, a gang of men cleans out the hold before the job of loading the ship with new cargo is begun. The unloading and loading are done by the stevedore; he is no unskilled laborer doing his job by rule of thumb, but an important cog in the business of ocean shipping. Upon his skill depends, to a certain extent, the safety of the ship at sea. Yet his work begins and ends at the pier; he never goes to sea. The quick, sure movement of freight is largely due to the efficiency with which he performs his task. The stevedore is a skilled member of an essential craft; he is a supervisor and directs the loading and unloading of the ship and has charge of what cargo goes where. On the other hand, longshoremen are laborers who work in the ship's holds, on the pier, or on lighters, and who stow away the cargo.

There are certain general factors which ease the task of loading ships. As a rule, a ship line will consistently transport one type of cargo out, while another general type of cargo will be imported. For example, Grace Line ships going south always stop at the same ports, and carry cargoes of finished goods, manufactured products. Returning north,

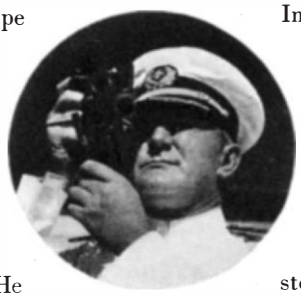
For hoisting aboard liquid-filled barrels, perhaps those shown in the opposite photograph, spreader bridles and skids, upon which the barrels rest, are used as in the illustration above

these ships mainly carry raw materials such as beans, wool, copper, coffee, and tobacco. Therefore, for all ships carrying cargo on definite schedules, the cargo stowage plan is uniform.

When cargo reaches the pier, or is brought alongside the ship by lighter, a cargo checker notes the bill of lading (size, weight, and quantity of cargo), checks the measurements, and makes out a dock receipt. A carbon copy is attached to the shipment. On this carbon copy receipt is a description of the cargo and the weight of the shipment.

As cargo accumulates, the pier superintendent begins to check his loading lists, noting the weight-ton and stowage-ton. Stowage-ton is calculated at one ton to 40 cubic feet of space, and shipowners have the choice of charging per weight-ton or stowage-ton. If the shipment is copper, which weighs so much more per cubic foot than wool, the freight charge would be by weight-ton.

After sorting out the varied shipments, the pier superintendent must next solve his labor problems. Perhaps the ship has docked at New York on Tuesday at 9:00 A.M.; then, at 5:00 P.M. on Friday, she will leave for Chile. During the short interval, cargo must be unloaded and shipments out of New York, as well as the ship's stores, must be put aboard. The stores are routine work, but the cargo is a weekly headache. Whether it is a job of loading or unloading, the pier superintendent knows, from the manifest lists, the amount and type of cargo which must be handled. Also, he knows how many tons the ship can load and unload per hour. Thus, from the manifest lists and the ship's capacity for working holds, he can tell how many longshoremen he will need to load the ship. He hires these laborers to work in eight-hour shifts, for loading a vessel is a 24-hour job; work goes on day and night, often up to within an hour, or even less, of sailing time.



His labor problem settled, the superintendent studies the nightmare task of loading the ship. It must be done most economically, and in such a manner as will provide for the most efficient discharge. There is a stated amount of cargo to be shipped. But there is the inexorable fact that the ship can carry only so much freight. Will there be an over-load—an excess amount of cargo which can be loaded on the deck? Or had the shipments of rails for Cristobal better wait for the next ship south? Would it be more economical to ship the crated automobiles this trip and unload and reload them five times before reaching their port at Salaverry, Peru, or delay shipment until the next ship leaves for South America? Within 24 hours after completion of the superintendent's loading lists, other freight may have been booked; where will this cargo go? He has to find a place for it. With such problems vexing him, the pier superintendent struggles with the puzzle of allotting cargo. It's a magician's hat trick in reverse and on a gargantuan scale. The problem is not *what* things come *out*, but *how* to get the known objects *in*.

In charge of all loading is the Chief Mate. In the ship's chart room is a plan of the ship's holds; as the freight is placed aboard the vessel, the cargo is plotted on this plan. In each hold is an officer and a checker; the officer notes the port and stowage in a "cargo book," while the checker jots down each shipment as it is stowed away.

The actual work of loading, however, is in the hands of the stevedore. The stevedore divides the cargo according to ports (away from the home port this is done by the Chief Mate). From the pier superintendent, the stevedore receives the distribution list, which describes the cargo, tells the amount of each shipment, and where each allotment is to be stowed.

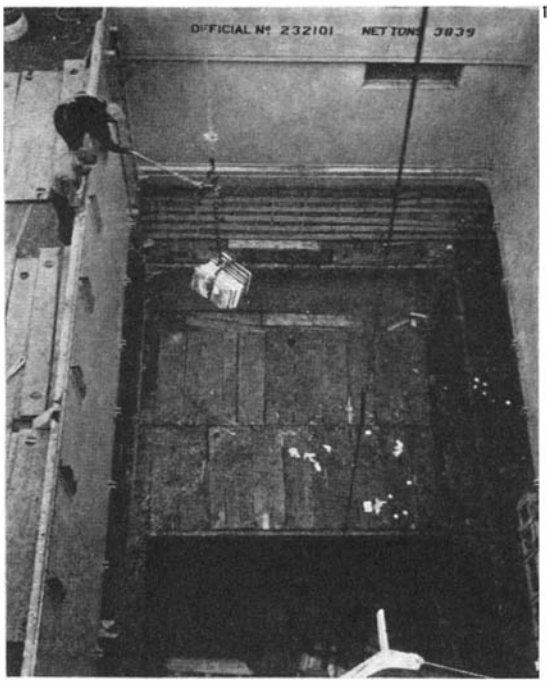
When the ship arrives at the pier, the stevedore's work begins. On the pier he must separate valuable cargo and perishable shipments from the rest of the freight. The cargo is further divided up into heavy and light cargo, into character cargo (such as "reefer" cargo—freight kept under refrigeration), and according to port. Then the cargo is ready for loading.

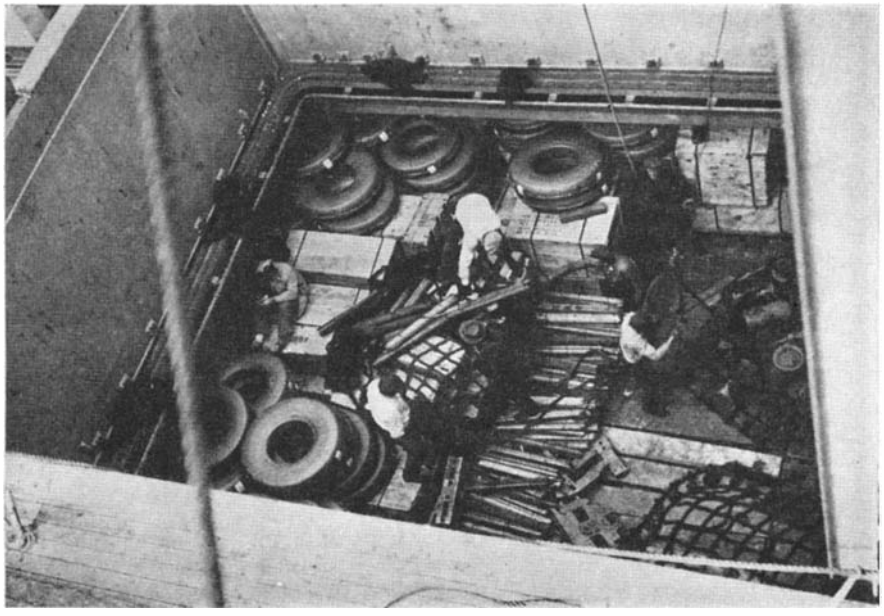
Looking down into the hold of a ship is almost a dizzying stunt. As though in a deep well, men are working far below, swinging bulky machinery, copper ingots, or boxed automobile parts into position while the derrick booms swing high overhead. Each hold aboard Grace Line ships is divided into three sections: lower hold; next, 'tween deck; and last, next to the hatch, the cover of the hold or the shelter deck. (This is the general American below-deck plan. The English is: lower hold, orlop deck, 'tween deck, shelter deck.)

DEFINITE rules for loading ships have evolved from experience and common sense. Cargo is loaded with two requirements in mind—safety and accessibility. Cargo is a ballast, and improper loading will affect, dangerously, the balance of a ship. Poor loading will make the ship sluggish in rough weather, cause the ship to list dangerously in choppy seas because of shifting cargo, make the ship too heavy forward so that she buries herself in high seas, or too light and thus put an undue strain on the ship's hull. Heavy cargo goes into the lower hold, but some heavy cargo is also distributed between 'tween deck and shelter deck so that the ship will be neither too tender nor too stiff in rough weather.

For certain light cargo, rope or wire net slings are used for lowering; box and crate slings for heavier cargo; wire cables and chain for machinery and steel rails; canvas slings for bags and flour; barrel hooks for kegs, and so on. In some cases, automobiles are driven right into the ship's hold through side ports; in other instances they are hoisted aboard by the ship's derricks.

In a ship loaded in New York for Valparaiso, cargo for the last port is loaded first, and that for the first port last. But not all shipments for one port are loaded





Number 3 hold of the *Santa Lucia* (left) showing the lower hold, far down; next, the 'tween deck; and last, the shelter deck. Often loading and unloading go on at the same time, as is the case here. Copper bars are being hoisted out of the hold; the longshoreman has just hooked on the "Burton hook" coupling the "Pennant" to the "cargo fall" to swing the load over the ship's side. *Below:* A seated ship's officer checks off shipments as longshoremen level off cargo being lowered into the hold in slings

into one hold, for this would slow up loading and discharging. Instead, shipments for Callao, Peru, will be distributed among as many holds as possible so that the maximum number of holds can be worked at one time, thus facilitating the unloading of the ship and reducing the number of man-hours of work. Economy is, in the shipping business, a shrew of a taskmaster.

But regardless of the orderly loading of cargo according to ports of call, there are other trials and tribulations to vex the stevedore. Certain types of cargo cannot be placed together, and certain other cargoes must be isolated. The stevedore may tear his thinning hair, but these rules are inflexible.

All moist freight—or liquid—must be separated from dry goods, since moist freight tends to cause injury to cargo which must be shipped dry. Oil and turpentines are never stowed in the same compartment with wool, flour, or sugar. However, cotton, a dry cargo, must be segregated from all other shipments and is usually protected with 'tween deck hatches, thoroughly secured. When damp, cotton is subject to spontaneous combustion. All freight with cotton's similar combustible nature is placed far from passenger and crew quarters, boilers and bulk-heads.

Other freight also must be given special compartments. Certain moist cargo doesn't exude the pleasantest of odors, and some types of material were never intended for perfume: these cargoes must be stowed far away from green fruits, foods, and similar freight.

Aside from proper distribution to protect cargo from spoiling, mechanical precautions are taken. Certain freight, including foods, must be kept at definite temperatures to prevent spoilage. Modern cargo ships today are equipped with the finest of mechanical refrigeration. Cargoes which must be kept at certain temperatures will be placed in refrigerated holds and kept at the required temperatures throughout the voyage. In the Chief Engineer's log room are gages which keep a record at all times of the temperatures in the ship's massive refrigerators and these data are regularly checked by assistant engineers in charge of the cooling apparatus. Temperature levels are pre-determined by the requirements of each kind of perishable cargo.

As cargo is swung into place and stowed by longshoremen, the strictest precautions must be taken against shifting during rough weather. Listing, dangerous to ship and passengers, can result from two causes directly laid to loading—improper distribution of cargo; shifting of cargo during rough weather. The first cause is eliminated by proper loading at the pier, and the second is counteracted by correct stowage.

Simple devices are used to keep cargo in place. Carpenters make bulky cargoes solid. On top of the lower tiers of freight, "dunnage" (wood planking) is laid down as a flooring upon which the next tier of freight is stowed. Between the empty spaces of articles are placed blocks of wood ("chocking") so that empty places are completely filled and each tier of freight becomes one solid mass. Freight such as barrel goods, rolls of paper, newsprint, and roofing are stowed in "head-up" position, which prevents sliding and acts as "dunnage" for other material.

Safeguarding ship and cargo by proper stowage does not end the precautions against accident. There is ever present the fire hazard, and against this most dangerous of threats to safety the modern cargo ship has arrayed a formidable variety of equipment.

The most effective method of fighting such a fire today is by use of carbon dioxide. After closing all hold ventilators, the gas valves are opened from the engine room or the bridge and the carbon dioxide pours into the hold, smothering the fire.

THIS efficient 20th Century transportation of cargo by water is essential to the general good living of a highly industrialized society. Many luxuries of the past have become household articles today because of the ingenuity of modern transportation.

Celluloid for Hollywood film, iron for gas ranges, brass for faucets, porcelain for electric insulation, wire filaments for the radio tube, and constant supplies of fresh foods from the far corners of the earth—all these are the rewards of invention, modern water transportation, and the ingenuity displayed in handling mass freight shipments.

SCIENCE AND INDUSTRY

A MONTHLY DIGEST

Conducted by F. D. McHUGH

Contributing Editors

ALEXANDER KLEMIN
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Chemical Engineer

Making Money Out of Roads

IF a road carries 700 vehicles per day, how much revenue will it yield in gasoline taxes alone? The sum is surprising. If the drivers get 15 miles to the gallon (which most of them do not) and the gasoline tax averages 5 cents per gallon (which it does —at least), then the 700 cars a day will burn a little less than 17,000 gallons per mile of road per year, and the income from gasoline taxes will amount to about 850 dollars per mile.—*Highway Research Abstracts.*

Pipe-Line Tracer

AN unskilled person can operate a new radio pipe-line detector which has been designed by Engineering Laboratories, Inc. With this instrument an underground line can be traced throughout its length. The receiving unit, which is shown in accompanying illustrations, comes complete with ear phones and weighs but seven pounds. A transmitter complete with batteries, two spears, and the necessary wiring, weighs but 10 pounds.

An alternating current is caused to flow in the pipe line by attaching the transmitter, which is in effect an alternating current generator, to the pipe line at some point where it is known or where some connections

Following a buried pipe line

Checking location of a pipe line

are visible and to a ground connection placed at some distance from the pipe line at right angles thereto. Current will, therefore, flow between the pipe line and the ground connection.

The receiver is a loop which picks up by induction the alternating current pulses when the loop is held in the proper relation to the pipe line. The maximum signal is received by the loop when its plane is perpendicular to the surface of the pipe. Therefore, it is possible to walk holding the loop in such a manner that it hangs down at right angles to the ground and thus to follow the pipe line indefinitely. When the loop is removed from the vicinity of the pipe line the signal naturally diminishes in strength. An amplifier is enclosed within the housing of the receiver to increase sensitivity.

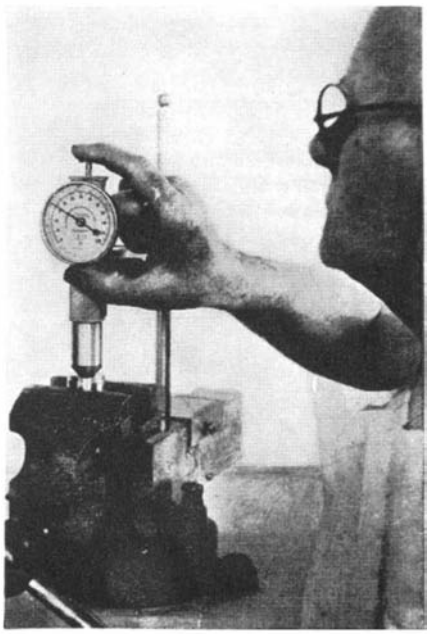
Explosives from Manna

THE manna which miraculously fed the children of Israel in the wilderness contains mannitol, an alcohol which is being synthesized in large quantities from corn sugar. Quite different from its original use is the modern application of nitrated mannitol as a safer explosive for use in blasting caps. Detonators containing hexanitromannitol are less sensitive to impact and friction than those containing other explosives.—*D. H. K.*

Portable Hardness Tester

A POCKET-SIZE, indicating, hardness tester, which has a direct reading dial and therefore requires no microscopes or calculations, has been developed by The Shore Instrument and Manufacturing Company, Inc. It is just six inches long and weighs one pound. The test point is a diamond-pointed hammer and the instrument has a new and improved clutch mechanism.

In making hardness tests, the instrument, shown in an accompanying illustration, is placed on the work in an upright position. The small button on top is pressed down and released. This completes the test, for the operation is entirely automatic, the indicating pointer finally coming to rest at the proper hardness number. Suitable attachments are supplied for using this tester on small objects which should be held in vises



Hardness tester in use

and also when it is desirable to make several tests on the face of a single piece of metal. The instrument comes in a small carrying case together with one hard and one soft master block for checking purposes.

Rayon Spinnerets

THE tiny orifices through which viscose is squirted to form rayon are ordinarily minute holes in platinum fittings. The reasons for the selection of this precious metal have been the ease with which holes of the proper size and shape could be made in it and its extraordinary resistance to corrosive materials used in the process. Recently the Japanese have succeeded in making spinnerets of glass which are much cheaper than those of platinum. The method consists of casting glass, in an atmosphere free from oxygen, around minute filaments of an alloy of iron and nickel which has the same coefficient of expansion as that of the glass, and subsequently dissolving out the metal with acid.—*D. H. K.*

Unique Electrically Recording Foucault Pendulum

IN an unoccupied elevator shaft at Mundelein College for Women, Chicago, a Foucault pendulum is being installed, by which rotation of the earth on its axis may be demonstrated and measured. Swinging nine stories, the pendulum is 120 feet long, the longest of its kind in existence and the only one of its kind, so far as is known, to have its movements recorded by an electric spark.

The suspension consists of two cylinders at right angles, rolling on flat surfaces. It is a device credited to Alaeine Cummings Longdon, of Knox College. The pendulum ball, which swings in the pit 120 feet below the suspension, is supported by wires from the upper cylinder. The contact surfaces are hardened and polished, resulting in very low friction.

Recording of the azimuth of the swing is by means of a spark discharge which punctures a coated paper disk, eight inches in diameter, on a suitable table below the pendulum. The table holding the paper disk is made of hard rubber, 12 inches in diameter, supported by a tripod casting. A brass ring about 8.5 inches in diameter is inlaid in the top surface and is connected to a terminal below.

A high voltage transformer is connected between this terminal and the ground. Thus as the pendulum swings across the ring, a spark jumps between the ring and a platinum point on the ball. The coated paper on the ring is thus marked by the spark flashing through it. The brass ring is graduated in degrees to read the angular position of the points on the coated paper.

The recording Foucault pendulum

NOT OPINION

"IT is research, it is science, that has put success on a foundation of fact, not opinion."—E. R. Weidlein, Director, Mellon Institute.

New Hampshire Aerial Tramway

RECENTLY completed in the mountains of New Hampshire was the first project of its kind in North America, when the American Steel & Wire Company, subsidiary of United States Steel Corporation, put the finishing touches on an aerial passenger tramway constructed for the New Hampshire Aerial Tramway Commission. The project provides a safe, thrilling ride up the side of Cannon Mountain, near Franconia, New Hampshire, for the thousands of tourists, sightseers, and winter sports enthusiasts who visit New Hampshire annually.

One of the two new tramway cars that carry passengers to the top of Cannon Mountain in New Hampshire

The cableway consists of two cars suspended from cables supported by steel towers. The cars are pulled 40 feet above the tree tops by means of a traction rope, controlled by machinery located at the Valley Station of the carrier, and pass each other at the half-way mark, one tram being at the Valley Station while the other is at the summit.

One of the outstanding advantages to be derived from the new project is the opportunity which will be afforded for an unsurpassed view of the surrounding countryside from the top of Cannon Mountain. The peak is over 4000 feet above sea level and other mountains and valleys for many miles in all directions are visible. The tramway makes the ascent in approximately 5½ minutes, whereas formerly a two-hour climb up a tortuous trail was necessary to attain the summit.

Included in the construction are five distinct safety features, including a patented braking device which prevents slippage in case the traction rope breaks; a special swing dampener, which operates on the principle of an automobile shock absorber and neutralizes swing of the cars; automatic stopping of the cars in case of accident to the operator; speed control; and an auxiliary traction rope for raising or lowering the trams to either the Valley or Mountain Station in case of failure of the regular rope. In addition, an auxiliary power plant is provided in the event of interruption of the regular power supply, besides many other features which are designed to eliminate accidents and discomfort to the passengers.

Arrow points to one of tramway supporting towers. Note that scenic beauty of the spot is not marred

The cars are dodecagonal, or twelve-sided, with windows in each side made of a non-brittle substance similar to that used in airplanes. Twenty-seven passengers and one attendant can be accommodated each trip and a total of 225 persons can be transported each way in an hour's time.

The cars travel at a normal speed of 1000 feet per minute, or at approximately the same rate as modern, high-speed passenger elevators in our skyscrapers. The length of cables between landing points is 5410 feet, or slightly over a mile, and the difference in elevation between the Mountain and Valley Stations is 2007 feet.

Marine Studio Design

IN our article on the new aquarium at Marineland, Florida, published in our June issue, lack of space caused us to omit mention of some of those concerned with the design of Marine Studios.

The design for the shape of the tanks was recommended by Fred Waller, president of Courier Productions, Inc., and other technical motion picture experts, following conferences by them with executives of Marine Studios. Mr. M. F. Hasbrouck, president of the Hasbrouck Company, Inc., New York City, developed the structural design of the tanks, using the shape recommended to him, after consultations with Gilbert Fish, consulting engineer who specializes in welding. The architectural design of the cor-

ridors around the aquarium hull was developed by two architects, John Walter Wood of New York and Frederick A. Henderich of St. Augustine.

Radiator Paint

THE time for painting household radiators usually being in the autumn, it is well to point out once more that the color of paints used on these radiators has no bearing whatsoever on the amount of fuel required to heat a given room or building. It is true that a black or dark radiator will emit more heat per square foot of surface than will a radiator painted a lighter color. But to produce a given amount of heat for any given interior space, the same amount of coal must be burned regardless of the color of the radiator.

It may be well to point out another fact emphasized years ago by the U. S. Bureau of Standards. This is that the flow of heat from radiators is better with an ordinary pigment paint than when one with a metallic pigment is used. Here again the amount of fuel will not be affected by the type of paint when a given amount of heat is desired.

Atom "Chips"

WHEN a housewife burns her finger, how much "nerve current" does the digit need to tell her brain how much it hurts? Westinghouse research engineers have developed a vacuum tube so supersensitive that it can measure the tiny current associated with nerve impulses, count the "chips" knocked off atoms by cosmic rays, and determine the acidity or alkalinity of blood. Known only as "RH-507," the tube may help reckon the earth's age by detecting radioactivity in rock.

High Nicotine Tobacco

NICOTINE, a valuable insecticide, is produced in the United States principally from the waste of factories where tobacco is prepared for smoking. Since nicotine is thus a by-product, American plant breeders have directed their attention toward producing leaves of superior smoking quality. Recently word came from Germany to the effect that tobacco plants containing an average of 8 to 10 percent nicotine are being bred for the purpose of supplying the alkaloid and that occasional plants contain as much as 16 percent of it. These percentages are several times as high as those in ordinary smoking tobaccos and compare with 2 to 3 percent nicotine in American cigarette tobacco. Obviously one might not find this tobacco pleasant to smoke.—*D. H. K.*

FREIGHT

FOR each pound of coal consumed, the railroads in 1937 hauled 8⅗ tons of freight and equipment one mile, the best record in fuel efficiency ever attained by them.

96 Messages Over One Pair of Wires

A NEW development in communication, making possible the sending of 96 telegraphic messages in one direction over a single circuit simultaneously has been demonstrated by Western Union Telegraph Company engineers. The system is now in commercial operation over Western Union circuits between New York and the following cities: Chicago, Washington, Atlanta, and Buffalo. It will eventually be extended throughout the country.

The new system utilizes a tone generator from the recently invented Hammond electric organ. This instrument, introduced about two years ago, reduced the pipe organ to a space no larger than that occupied by a grand piano by eliminating all pipes and reeds in favor of electrical impulses. Depressing a key on the Hammond console generates a minute electrical current of a given frequency which, carried into a tone cabinet, becomes the musical note corresponding to that frequency. Thus the key which sets up a frequency of 440 cycles is A above middle C on the piano keyboard and produces that note from the tone cabinet.

Communication engineers, hearing the Hammond in its legitimate rôle of organ, began thinking of it in terms of their business. They knew that multiple messages could be sent over a single circuit on different tone pitches. And the Hammond, operating on synchronous motors, offered a ready means of furnishing numerous pitches.

They experimented, found that by separating these pitches by 300 cycles they could put 22 on a single circuit. But each of these pitches can carry a number of messages by methods previously used by Western Union, with the result that a total of 96 messages in one direction is made possible. Twelve of the 22 frequencies are now in use, and the others are ready to take care of future business growth.

Tone generator of Hammond organ, *left,* and of telegraph equipment, *right*

In a demonstration of the new telegraph system described, an electric organ, *background,* supplied tones

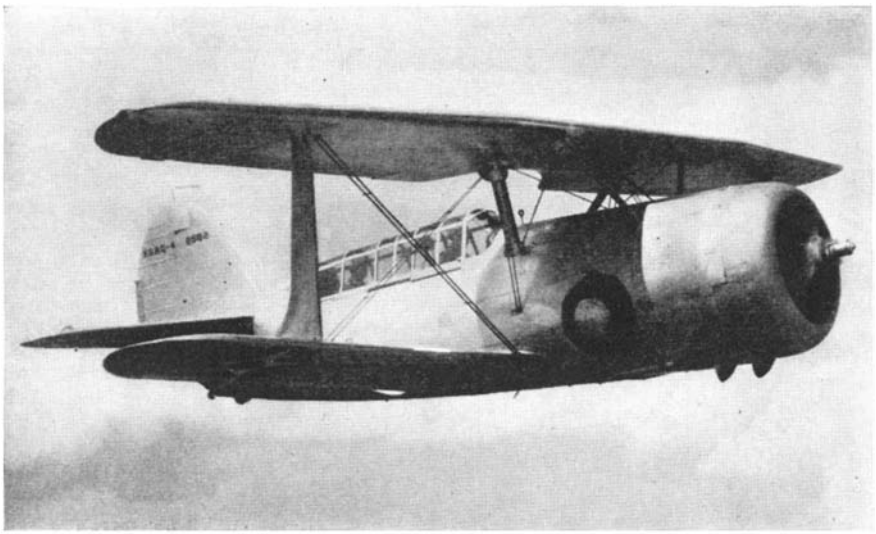
Stamp-Pad Ink

A STAMP-PAD ink, recently developed by C. E. Waters, of the National Bureau of Standards' Chemistry Division, penetrates most kinds of paper so quickly that there is little or no blurring of the impressions when they are rubbed with the fingertips immediately after they are made.

Duration of Life in Prehistoric Man

THE life of fossil man was short. Of 187 skeletons of determinable age recently examined by Dr. Henry V. Vallois, 55 percent Neanderthal, 34.3 percent upper paleolithic and 37 percent mesolithic subjects died before reaching the age of 20 years; while of the remainder, the majority, 40 percent Neanderthal, 53 percent upper paleolithic and 58.5 mesolithic, died between 20 and 40 years. Of the remaining sixteen, 5, 10.8, and 1.5 percent respectively died between 40 and 50 years, while only three survived the age of 50 years. Yet even these three had not attained true old age, as important sutures of the cranium were still not closed.

Notwithstanding defective evidence, there would appear to be a marked increase in the duration of life in the Bronze Age and among the Egyptians of the Roman period. In the fossil groups, man appears to have lived longer than woman. Especially below the age of 40 is feminine mortality



The Curtiss scout bomber, SBC-4

higher. As regards the cause of the early mortality, so far from civilization having shortened the natural span of life by "dysharmonics" as Metchnikoff thought, it appears to have lengthened it.—*Nature* (London).

Two Engines or Four?

THE Douglas DC-4 has gone through its tests with flying colors, but no orders have been placed for it as yet. The Boeing Stratoliner, nearing completion, is likely to be an excellent ship. Both are four-engined aircraft.

Now Curtiss-Wright challenges the theory that it is necessary to build four-engined transports like the DC-4 and the Boeing Stratoliner, and is building a slightly smaller craft, with only two engines. But each of these two engines will be of 1500 horsepower and the ceiling *on one engine only* will be 14,000 feet. The ship will have a cruising speed of over 200 miles an hour; the cabin will be supercharged to an equivalent altitude of some 12,000 feet so that flight at 20,000 feet will cause passengers not the slightest inconvenience.

For the twin-engined ship, the following advantages are claimed: lesser initial expense; lesser operating expense; lesser complexity. The designers of the twin-engined plane say that they will come very near to the pay-load capacity of the larger four-engined craft, with the possibility of much more economical operation.

Nothing will settle the argument except actual operation, but it is gratifying to see real competition between the various builders. At one time it looked as though Douglas, receiving a co-operative order from the five major airlines, would dominate the field of transport equipment. Competition is far more likely to aid progress than would a monopolization of the field by any one builder, however experienced and however skilled in the construction of these commercial giants of the air.—*A. K.*

Scout Bomber

WE have heard so much of the flying fortresses, bomber-battleships of the air, that we are prone to think of all bombers as being huge multi-engined affairs. But the Navy has to think of smaller craft which can be flown off the decks of the aircraft carriers—ships which can act as scouts as well as bombers. Therefore, Curtiss-Wright is building a whole series of relatively small single-engined scout bombers for the Navy. They are termed SBC-4, signifying scout bomber, Curtiss type 400.

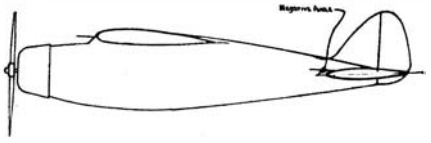
The new ships are powered with 1000-horsepower single-row Wright nine-cylinder Cyclones. They are biplanes, so that the wing area may be concentrated in the relatively small dimensions required for aircraft carrier duty, and to give high maneuverability. Even though the SBC-4 is a biplane, it is exceedingly clean. The photograph indicates how snugly the landing gear rests within the fuselage, the small number of wires, the beautifully streamlined end struts, the enclosed transparent cockpit, and the smooth lines of the engine cowling.—*A. K.*

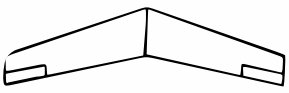
A Unique Tailless Design

SEVERAL readers have asked for information on the "Bumblebee" which James B. Taylor, Jr. has been testing recently. The Bumblebee is unique because it is not only tailless but is also without sweepback; many aerodynamic questions arise therefrom.

First of all: How is static longitudinal stability attained? In the entirely conventional machine static longitudinal stability is attained by the use of horizontal tail surfaces disposed at some distance from the center of gravity, and forming a negative dihedral with the main wing. In the tailless airplane the wing tips are turned up at the trailing edge so that the equivalent of the horizontal tail surfaces is provided. How, then, is static longitudinal stability provided in the Bumblebee? The conjecture is that such stability is secured by the special design of the wing itself. A wing with a pronounced turn-up of the trailing edge gives stability in itself although at the expense of reduction in maximum lift and in efficiency of the airfoil. Of course the Bumblebee has the compensating aerodynamic features of no horizontal tail surfaces and no long fuselage. Only refined wind-tunnel testing and careful calculations can determine whether there is over-all aerodynamic loss or gain in this novel design.

Besides the static longitudinal stability, a good airplane should have dynamic stability. In the conventional machine this is obtained by the "damping" of the horizontal tail surfaces, and such damping depends largely on the distance of the tail surfaces from the center of gravity. In the Bumblebee, "damping" can come only from the wing itself, and may not be quite large enough. Without sufficient "damping" a machine may be stable, but once disturbed may oscillate or pitch up and down for quite a long time. The mechanical analogy is that of a strong spring carrying a suspended weight. Without being immersed in oil, let us say, the spring is undamped and when the weight is pulled down it may subsequently oscillate up and down for a long time before coming to rest.





In a conventional plane, *above*, the tail surfaces form a negative angle. In the tailless plane the same stabilizing effect is obtained by the turned up wing tips as shown below

The tailless "Bumblebee," described in the text and drawings

Again, in the conventional machine directional stability is secured by the use of vertical tail surfaces (fin and rudder) disposed a long way from the center of gravity. In the Bumblebee, the vertical surfaces are naturally quite close to the center of gravity, but there are (as our photograph shows) four vertical surfaces, and the propeller itself acts as a vertical fin. Thus adequate directional stability is probably attained in spite of the small leverage of the vertical tail surfaces.

Steering is no doubt achieved by using the vertical surfaces at the tips of the wing as drag elements. If the pilot wishes to turn to the right, he displaces the right rudder *only*, introducing more drag at the right wing tip. If he wishes to turn to the left he displaces the left wing tip.

Long flaps run along the whole length of the wing, with auxiliary or trimmer surfaces behind them. Simultaneous depressing or raising of the flaps on either side gives elevator action; raising the flap on one side and depressing the flap on the other side should give aileron or lateral control.

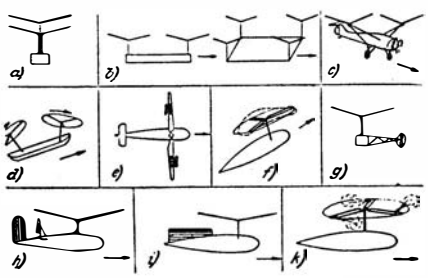
The craft is a pusher type with the 95-horsepower engine and propeller in the rear. Mr. Taylor points out that if two engines were fitted at the rear with a wide interval between the propellers a machine gunner would be able to shoot directly back, unhampered by the tail—a distinct military advantage. The machine illustrated on the opposite page is a two place cabin model and the top speed is estimated at 120 miles an hour.—*A. K.*

HELICOPTERS

THERE is real promise of a revival of interest in rotary-airfoil craft. The Army Air Corps, artillery experts, and other military authorities have become convinced that the Autogiro has a unique rôle to play in military operations, and a number of Autogiros are under construction by the Kellett Autogiro Company, *not* as experimental machines but as additions to the specialized equipment of the Army. From Long Island City, New York, there come reports of a small helicopter, being built to the designs of Dr. De Bothezat, which is to give us a small, high-speed machine of particular utility for warfare. In Germany the Focke Helicopter has broken all previous helicopter records.

In an article in *Luftwissen*, Professor Focke describes his remarkable craft and in so doing presents a very fine picture of the general principles and difficulties of the helicopter. A study of Professor Focke's article will be of value to all those interested in that final mastery of the air which calls for vertical ascent, vertical descent, and the ability to hover at will.

Professor Focke spent five years in theoretical research, in experiments in the wind tunnel, and in flights with a "captive" helicopter before securing his final excellent results.



Proposed helicopter ideas

The lifting airscrew, in order to provide sufficient lift per horsepower, must have a large diameter and rotate rather slowly. The necessity for a large, slow airscrew has long been recognized, but such an airscrew introduces a very large torque or unbalanced moment which must be eliminated if the fuselage and the pilot are not to turn dizzily in space. Several plans have been proposed to this end and are illustrated in an accompanying drawing. These ideas may be classified as follows;

a. Two propellers mounted on a common vertical shaft, and rotating in opposite directions. Professor Focke rejected this arrangement because interference between the screws reduces the lift, and also makes the vertical descent without power less effective.

b. Two screws placed one behind the other, or four screws arranged at the corners of a square. Here the criticism is that the rear propeller is powerfully influenced by the wash of the front propeller, with adverse effects on stability.

c. Two airscrews placed on opposite sides of the fuselage. This has been tried by Berliner, and has been adopted by Professor Focke.

d. Screws rotating in the *same* direction; skilful inclination of the axes eliminates all unbalanced moments.

e. A single large screw on whose blades are located small propellers. Since the small propellers provide the drive, there is no reaction torque. Experimental work has shown that this type, instead of achieving simplicity, produces enormous complication.

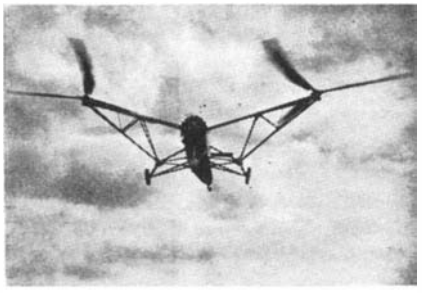
f. A screw with flapping blades so that rolling and pitching moments cannot be transmitted to the fuselage. Flapping blades may be very useful in the helicopter art but they do not eliminate the rotation torque.

g. A single airscrew for lift and another smaller propeller mounted on outriggers far at the rear, providing a lateral thrust to counteract the turning moment of the main airscrew. A long transmission to the rear is necessary and power is wasted in the production of side thrust.

h. A variation of *g*.

i. A vane is mounted in the slipstream of the main airscrew but assumes formidable proportions.

k. Jets acting by reaction at the ends of the lifting blades may be dismissed as in the realm of the fantastic.



The Focke helicopter in flight

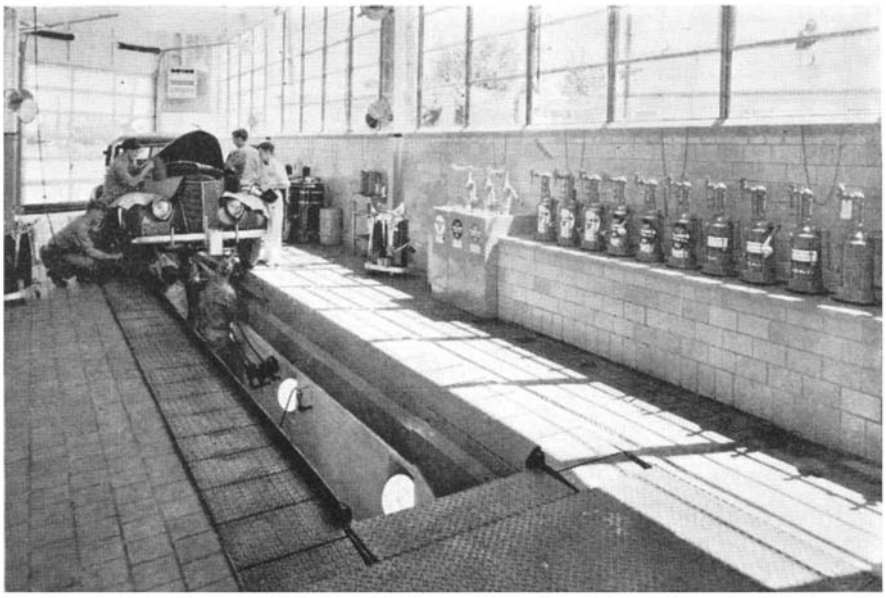
After passing all these schemes in review, Focke decided on the two screws placed on opposite sides of the fuselage, the rotating blades of which can be varied in pitch when they pass certain points. This we presume is analogous to the control introduced by E. Burke Wilford in his Gyroplane, and is a promising method. To secure safety in the event of power-plant failure the pitch of the blades can be rapidly reversed so that the aircraft descends as a windmill without power. Three blades on each screw of moderate diameter were developed by intensive wind-tunnel research.

Front view of the Focke helicopter with lifting screws in rotation

The diameter was rather smaller than one expects in a helicopter. No doubt some degree of climb was sacrificed so as to secure reasonable forward speed. There is a very delicate problem here for the aeronautical designer. The temptation to increase the diameter and thus secure more lift is apt to lead to an inadequate forward speed.

The mechanical difficulties in the bevel-gear drive from the engine mounted at the forward end of the fuselage were surmounted by careful design and test. A friction coupling was included in the transmission system. A small airscrew mounted at the nose of the fuselage serves to cool the motor when vertical ascent, descent, or hovering fails to give sufficient cooling air-stream. In all other respects Focke followed conventional airplane practice.

The actual figures of performance have been checked by representatives of the International Federation of Aeronautics. With a machine carrying a single occupant, and a small amount of fuel (this is perfectly legitimate, particularly as in a small helicopter the weight of the transmission is much more of a handicap than it would be in a much larger machine), with a gross weight of 950 kilograms or about 2190 pounds, the figures are: Climb at the rate



Ten minutes on this conveyor and an automobile is completely serviced

of about 12 feet a second; altitude attained 7500 feet; endurance 1 hour 20 minutes; distance 67 miles; speed 74 miles an hour.

There is not the slightest doubt that all previous helicopter records have been far surpassed.—*A. K.*

Civil Aeronautics Authority

ESTABLISHMENT of a Civil Aviation Commission was recommended by the Federal Aviation Commission two or three years ago but was opposed by the President and by several government departments. Now the passage of the McCarran Bill in the Senate and the Lea Bill in the House has resulted in a conference report and the final passage of an Act which will establish an independent Civil Aeronautics Authority.

The Civil Aeronautics Authority will include five members at $12,000 per annum each; an Administrator at the same salary; and a Safety Board of three well-paid members, besides several secretaries and other officials. It will be expensive, but provided the Authority is on the whole non-partisan, and provided it includes men well versed in various branches of aviation, such as air transport, miscellaneous flying, airports and airways, and so on, the expense will be well worth while. At least that is the opinion of well-informed aviation men, based on the following facts:

It will concentrate the authority of three bodies—the I.C.C., the Post Office Department, and the Bureau of Air Commerce—in one body of a semi-judicial, semi-administrative character, and it is always better to be regulated by one Board than by three.

It will remove the fixing of mail rates from the Post Office Department, which was both the customer and the arbiter.

It will make recording of aircraft ownership a matter of one record, thus permitting mortgages to be made on aircraft and the airlines to borrow money on aircraft trust certificates analogous to railroad equipment certificates.

It will further aviation safety and make reporting of accidents more of a public matter.

It will permit the Federal Government to take over the regulation of flying in all phases of inter-state commerce, and by enlargement of this sphere will avoid the duplication of licensing effort by Federal and State authorities.

The aircraft industry has suffered so much and so long at the hands of the Government that it is almost afraid to voice these hopes; on the whole, however, confidence outweighs fear of the new Authority.—*A. K.*

Conveyor Lubrication for Motor Cars

FIFTY minutes' work in ten minutes' time on automobiles riding the new lubrication conveyor at the service center and store just completed by The Austin Company for an auto supply company in Detroit, is proving the answer to many an impatient motorist's prayer.

Five to seven men are on the job as cars travel on a continuous conveyor above the spacious 53-foot pit where recessed spotlights and hose carrying special lubricants for every motor maintenance need have been installed. If an oil change is necessary, the old oil is drawn out of the crankcase under a powerful vacuum, which takes with it all the sludge, sediment, or other foreign matter and leaves the crankcase vacuum cleaned. Old grease is drawn out by a similar vacuum suction method, after preheating when cold weather makes this necessary. Transmission and differential grease is metered into the car under pressure direct from sealed drums, to assure accurate measure and proper grade.

Before the ten-minute conveyor ride is up, tires have been checked and inflated to the desired air pressure; battery tested and filled to the proper level; floor mats brushed or vacuum cleaned; all glass polished; and door locks and hinges treated with dry oil, which provides easy operation without danger of motorists soiling gloves or clothes.

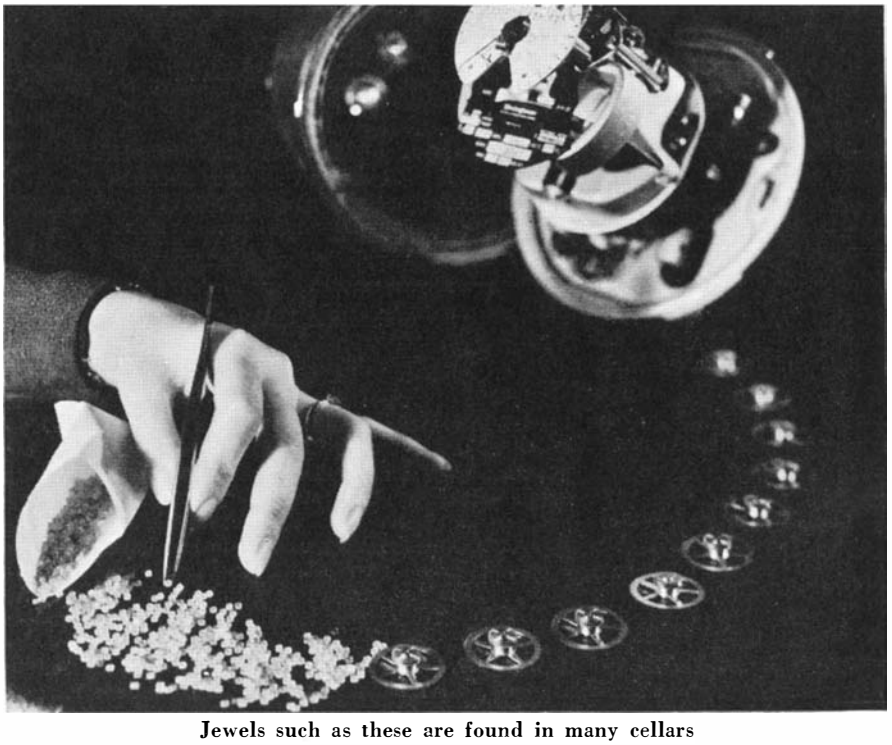
ROLLING POWER

A STANDARD Pullman car generates for its own use enough electricity to supply four ordinary homes.

Jewels in the Cellar

JUST 50 years ago in May the electric meter was invented by O. B. Shallenberger of the Westinghouse Company. Today, with an annual national power production of 110,000,000,000 kilowatts, 237 different types of meters, relays, instruments, and electronic devices chiefly used in measuring and controlling electricity are made by that company.

The house meter of the familiar round type usually placed in the cellar, and which was developed by Dr. Frank Conrad, is built with the precision of a fine watch. For the



Jewels such as these are found in many cellars

bearings alone, the Meter Division of the above-named company uses about 2,000,000 sapphire jewels annually. Our accompanying illustration shows a quantity of these jewels cut in tiny disk shape and drilled ready for use.

Printing Type from Resins

SYNTHETIC resins are being used in Germany for the molding of type to save metals. The resin used is a polystyrol which can be cast and re-melted after use. Among the advantages claimed are lightness, and hence low transportation cost, and avoidance of possible lead poisoning of printers.

—*D. H. K.*

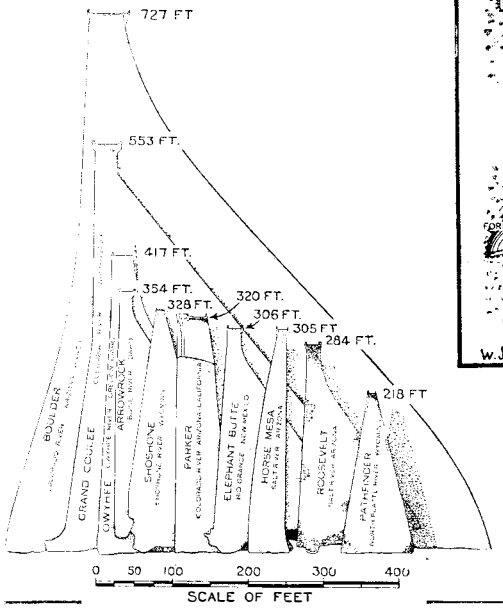
Mental Disease Not Increasing

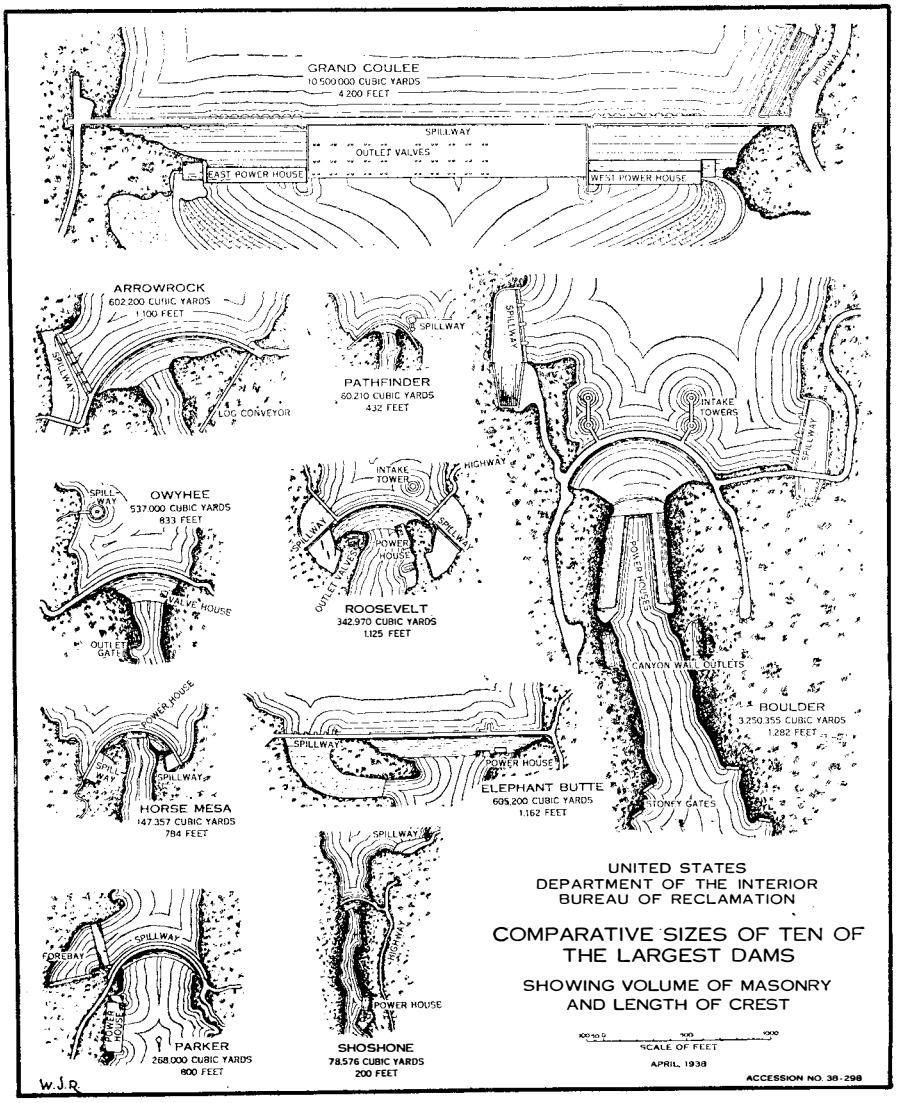
MENTAL disease is not increasing and the outlook for recovery of the mentally ill is hopeful. This is the opinion of Dr. Richard H. Hutchings of Utica, New York, State Hospital, who will be president of the American Psychiatric Association for the coming year.

The undoubtedly great increase in recent years of the number of patients in mental hospitals is not a sign, in Dr. Hutchings' opinion, that mental disease is increasing. It means that mental disease is being discovered in its milder forms and that patients are going into hospitals, many of them voluntarily, for treatment of these mild forms of mental ill health.

The present popularity of the mental hospital, Dr. Hutchings said, is a phenomenon of modern times. About one fifth of the patients at Utica State Hospital have committed themselves, a thing which would have been unknown 40 years ago when Dr. Hutchings first entered psychiatric practice. At that time, patients usually had to be brought to the hospital by the sheriff.

Progress in methods of treating mental disease, and in preventing it through mental hygiene in schools and colleges, makes the outlook on the whole problem today very hopeful. In the case of paresis or general paralysis of the insane, the question of curing a patient never was considered 40 years ago. The only question then was how long the patient would live. Now, with the use of fever treatment and arsenicals, about one third of such patients recover and another third are able to leave the hospital and find gainful occupation.—*Science Service.*





A comprehensive idea of the sizes and forms of the ten largest dams in the United States may be obtained from a study of the drawings at *left* and *above*, published through courtesy of the Bureau of Reclamation, Department of the Interior. Sections at left are through the center lines

Sally's Balloons for the Navy

SALLY RAND, who occasionally lectures to advertising clubs on the subject entitled, "The Value of White Space," decided to change her fan dance into something else. She chose a bubble dance, and wanted to use huge balloons in this act. These balloons were to be inflated up to 60 inches, which is her height, and they were to be of the proper density.

There was no rubber manufacturer in the country who made toy balloons of such a size and no one cared to invest in the equipment for making balloons just for Sally. She was so sold on the idea, however, that she decided to pay for the necessary equipment herself. She accordingly had some forms made from aluminum, the accepted material for making molds in the rubber industry.

At the time of her investigation into the balloon situation, she found that the United States Weather Bureau would be glad to use large balloons in order to take barometric measurements, but did not have available the funds which would cover the cost of making such large balloons.

The Navy also would like to use large balloons for airplane targets on the water. Sally now sells her balloons to both the Weather Bureau and the Navy, but refuses to sell the balloons to anyone else.

Horses and Mules Down

THE number of horses, including colts, on farms January 1, 1938, is estimated by the Bureau of Agricultural Economics at 11,163,000 head, a reduction of 282,000 head, or approximately 2.5 percent, from a year earlier. The reduction during 1937 was larger than during 1936.

Although the number of colts raised in 1937 was larger than in 1936, death losses of horses were unusually large in a number of states. The average value per head, January 1, 1938, was $90.83 compared with

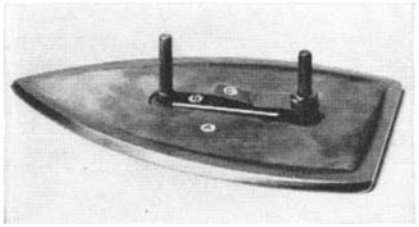
$99.16 a year earlier and the total value of $1,013,960,000 was $121,000,000 smaller.

The number of mules on farms, January 1, 1938, was 4,477,000 head, a reduction of 94,000 head, or 2.1 percent, from a year earlier. The value per head of $122.43 was $7.50 lower than a year earlier and the total value of $593,898,000 was about $46,000,000 smaller.

Flatiron Thermostat Without Lag

THE efficiency of an electric flatiron with automatic heat control depends on the design of the heat controlling mechanism, usually called a "thermostat."

Should the heat transfer from soleplate to the thermostat be delayed, the action of the thermostat will lag behind the temperature changes which take place during ironing, and wide temperature fluctuations at the ironing surface are the result. This defect is especially dangerous when the iron is operated at the lower temperatures where delicate fabrics such as silks and rayons are



For better ironing

ironed. These fabrics require even, moderate heat to save them from becoming brittle.

In order to correct the defects of the conventional thermostat, which depends on a secondary unit (a strip or plate of two metals of different expansion coefficients welded together) for its actions, the bimetal strip or plate has been abandoned by an inventor and the soleplate itself made the heat controlling member. In other words, the heat controlling member was put *directly* in contact with the goods to be ironed, without any detours.

The simple construction of the heat control is shown by the photograph. The minute expansion and contraction of soleplate "A" is multiplied by toggle lever "C" and member "B" which is made of metal of very much lower expansion coefficient than soleplate "A". The up and down movement of lever "C" actuates a make and break switch that is not shown in the photograph.

Saw Cuts With Electric Arc

AN electric arc saw that will cut iron, steel, any alloy metal, ferrous or non-ferrous, tungsten carbide as readily as low carbon steel, and yet leave the surface of the cut clean and smooth, is announced by Miller Electric Mfg. Company, under the trade name "Miller-Strobel" Electric Arc Saw. It is easy and safe to operate, due to the low voltage applied across the arc, and can be operated by anyone without special training. It cuts with equal efficiency, economy, and speed regardless of the hardness or analysis of the metal, and without changing the temper or destroying the structure of the metal. It is said to be more economical and

High-speed metal cutter

faster than any other type of metal cutting.

While the illustration here shows a saw for cross cutting, it can be furnished in special models for slotting, turning, arc threading, arc milling, and arc turning. Mechanically, the sawing unit itself consists of a soft alloy steel blade provided with a multitude of small straight teeth on its circumference. This blade is V-belt driven at a high speed by an industrial type electric motor.

Cuts are made by means of a controlled electric arc that "leaps" ahead of the saw and brings the metal along kerf lines to a molten or plastic condition. The saw blade functions only to sweep the molten metal from between the kerf lines and as an electrode from which the heat generating arc "jumps" to the work. The blade itself does no cutting, as it is of soft alloy metal. Its real function is to give impulse to an oscillation of the current through a lengthening and shortening of the arc which stabilizes and directs the path of the arc to such an extent that side arcing is eliminated. The arc thus controlled travels in a path a few thousandths of an inch wider than the width of the blade. When cuts are completed the saw will be found to be cool.

To generate the arc between the saw and the work, a specially built welding transformer is used to provide a current of suitable voltage and amperage to melt the metal to be cut. This current is controlled so that it will cut metal of various thicknesses. Stacked metal is cut as easily as a solid piece of metal. The "Miller-Strobel" Electric Arc Saw is made in a range of models to handle different types of production.

DESTROYERS

WOOD is destroyed on land by six kinds of insects and one plant species. The plant is the shelf, or bracket, fungus; the insects are the dry-wood and damp-wood termites, the death-watch, the false death-watch, and the powder-post beetle, and, finally, the carpenter ant.

Train Speeds on Schedule

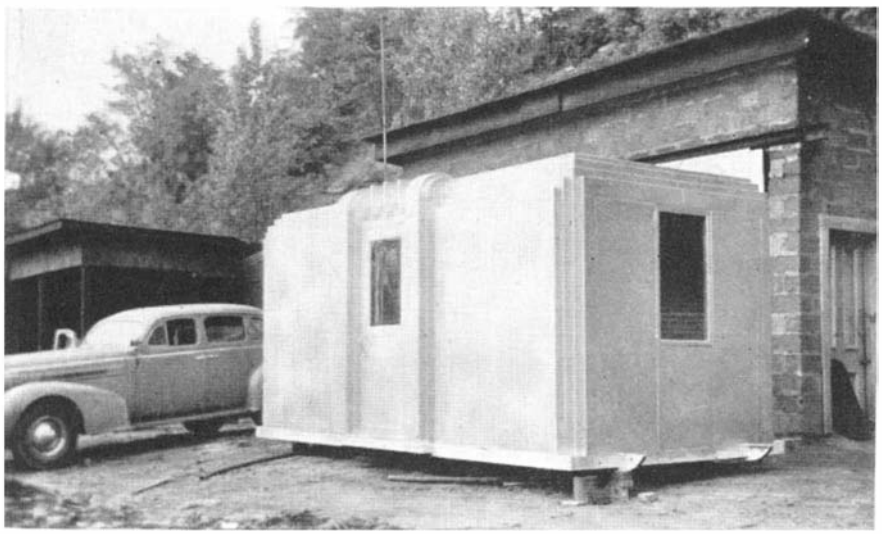
THERE are nearly 800 passenger train runs in the United States at speeds of 60 miles or more an hour. The fastest train run in the United States, start to stop, is 81.3 miles an hour, although some trains attain speeds over certain stretches of their runs of 90 to more than 100 miles an hour. Including all stops en route, the average speed of passenger trains operated in the United States in 1937 was 34.5 miles an hour. This average compares with 34 miles an hour in 1936.

The fastest long-distance freight train in the United States covers a run of 527 miles in 12 hours and 50 minutes, including stops. This is at the rate of 41.1 miles an hour. The average speed of freight trains, including all stops en route, was 16.1 miles an hour in 1937, compared with 11.1 miles an hour in 1922.

Welded Trailer-Office

"SORRY, but we do not have a single room left," a familiar statement by hotel clerks in Kansas, Oklahoma, or Texas during an oil boom, doesn't bother Mr. U. H. Hunt of Kansas City, in the least. For Mr. Hunt, welding contractor, literally takes his house and office with him. It can readily be moved about on a trailer.

The modernistic, all-steel building serves as office during the day and hotel at night. It is 16 feet long, 8 feet wide, and 8 feet 4



All-steel welded body of the trailer-office

inches high. The frame, walls, doors and window frames are all electrically welded with shielded arc equipment of The Lincoln Electric Company. In walls and ceiling, to insulate the structure, is two inches of cork. Inside, the finish is in plywood. Power for electrical appliances, when not otherwise available, is supplied by a 200-ampere gasoline-engine-driven Lincoln welder fitted with an oversize exciter.

The cost of building this portable arc-welded steel hotel and office, including material and labor, was no more than that of a house trailer.

140,000 YEARS

ONCE every second for over four years, a silent mercury-type switch—a test sample of the type recently placed on the market by General Electric—noiselessly turned a lamp off and on. Early in June this switch had operated as much as it would have in ordinary household use during a period of 140,000 years.

SIGHTLY SCREWS WITH PLASTIC HEADS

ABOUT a year ago Mr. Granville Bradshaw, the well-known research engineer, invented the thief-proof screw in response to an appeal from railway and omnibus companies and hotel proprietors, who suffer considerable loss through the theft of various small fittings. These losses are estimated to amount to many thousands of pounds per annum.

In principle, the thief-proof screw, like most successful inventions, is a very simple one and consists of a cup-shaped head which

Decorative thief-proof screws

requires a special screw driver to insert the screw and a special one to remove it. Thus, the petty pilferer carrying a small screw driver or other useful implement could not remove the screws or the fittings.

It then became essential to find something to fill the hollow head in order to provide a more finished appearance, and Mr. Bradshaw tried literally hundreds of different materials, including metals, wood compositions, casein and, at last, cellulose acetate. With this he found that if it were made up into small domed cap pieces to fit the threaded hole in the screw head, a solution to the problem was at hand. Further experimenting with acetate showed that his original idea was correct and now it is possible to drive one of the plastic heads lightly into the screw after it is screwed home in the wood. The natural resiliency of cellulose acetate obviates any possible risk of fracture and it is soft enough to sink into the thread and so ensure a tight grip.

The new plastic-headed screw is infinitely preferable to a metal cap since it is obvious that the metal cap when driven home ruins the thread in the screw and makes it almost impossible to remove the screw without dam-

age to the surrounding parts. This trouble is, however, completely overcome by the use of the new plastic caps, which, although costing no more per gross than the metal caps cost per dozen, can be removed without much difficulty. Caps can be obtained to match any scheme of decoration. Thus there is no longer any need for work to be marred by rows of unsightly screw heads.—*Plastics*, London.

Electric Metal Etcher

An electric etcher for permanently marking on metal surfaces has been announced by the Ideal Commutator Dresser Company. Used in the same manner as an ordinary lead pencil, the etcher writes, prints, or marks on tools, gages, dies, and hard metal parts by burning the surface

Etching electrically

electrically. The permanent lettering stands out clearly and positively, eliminating mistakes and losses, confusion and improper assembly. The device operates rapidly, economically, and accurately. Two points are provided with the unit, one copper that may be sharpened for fine marking, the other a special alloy for ordinary marking. The depth of the mark is controlled by the speed at which the point is moved over the metal, and also by changing the Hi-Lo switch on the transformer.

Molasses Roads

Resins made from molasses may soon be used to bind road surfaces if experiments now in progress in India are successful. The method consists of resinifying molasses with coal tar and asphalt in the presence of acids. A combination occurs between the sugars of the molasses and the phenols contained in the asphalt and tar to yield a product insoluble in water which can be applied to the road as a liquid and which later solidifies. It is expected that the new compound will be cheaper than asphalt products now used.

The molasses is heated to free it from water and is then treated with 1 percent of dilute sulfuric acid. A mixture of asphalt and coal tar is similarly treated and the two mixed and heated together until the resin is formed.—*D. H. K.*

A Job For Lignin

Millions of Americans make daily use of shirts, sheets, paper, rayon fabrics, artificial leather, Cellophane, and Celluloid—all products of cellulose, the substance which forms the cell walls and fibers throughout the plant kingdom. But of cellu-

lose's almost inseparable botanical brother, lignin, most people are not even aware.

In fact, so elusive has lignin been that in almost 100 years of study, scientists have not been able to determine its chemical nature. What they have known is that lignin is a powerful cement which binds plant cells together. Aside from that function, lignin has been not only useless, but something of a nuisance in that it must be removed before white paper, rayon, and many of the other cellulose products can be produced; and a million tons a year of it (constituting part of the waste from pulping mills), have been polluting streams into which it is dumped, killing fish. Moreover, 15 million tons more, contained in four times that tonnage of waste wood, have been worthless.

Only now, after years of research, has the U. S. Forest Products laboratory at Madison, Wisconsin, discovered a means of end-

HYDROPONICS

DURING the first ten days of May on Wake Island's famous soilless farm, 33 pounds of tomatoes, 20 pounds of lettuce, 20 pounds of string beans, 15 pounds of squash, and 44 pounds of corn were harvested from the shallow water-filled trays in which the crops are grown.

ing this vast economic waste by qualifying lignin for inexpensive moldable, machinable plastics with possibilities which appear limitless.

The striking advantage of the lignin plastic, which the laboratory has named Xylite, over its established competitor-plastics lies in its being a product of wood wastes that until now have had no economic value. It is, therefore, possible to produce it at a very low cost which Carlile P. Winslow, chief of the laboratory, estimates to be two to three cents a pound in bulk. Other types of plastics, which are already serving as substitutes for still more costly wood, metal, glass, and leather, cost very much more than Xylite. Thus, new spheres of usefulness, which cost prohibits present plastics from entering, are almost certain to be opened up. Adaptability of the new product to radio cabinets and table tops, floor tiling and wall paneling, bathroom scales, electrical insulators, auto instrument boards, and even bath tubs is foreseen by laboratory experts as the basis of a profitable industry.

The abundance of the raw materials for making such products is emphasized by Mr. Winslow when he says: "Lignin makes up 20 to 30 percent of the weight of the average plant stem. Billions of tons of it are present in the world at all times, and the supply renews itself indefinitely by natural growth."

Whereas the process of lignin wood-waste molding is patented, under the terms of the grant, any manufacturer has the right to use the process in making sawdust-base products. Although no manufacturer has availed himself of the rights as yet, it is expected that Xylite products will appear on the commercial market within the year.

Relative simplicity characterizes the new process. Into a heavy iron kettle, known as the digester, sawdust is shoveled, dilute acid is added, the digester closed, and the mix-

ture heated or "hydrolized." Change in the chemical nature of the sawdust converts part of the wood into sugar, so that when the digester is opened, what has been sawdust is found to be a mixture of dark syrup and powder. By draining off the syrup, placing the powder in molds of desired form and subjecting it to powerful hydraulic presses, it is possible to turn out disks, trays, knobs, handles, bowls, or sheets which may be machined by turning, sawing, or boring, much as hard rubber is handled. The products have a high glossy polish which needs no burnishing.

Although Xylite is an opaque ebony-colored product, which cannot be prepared in the transparent and light-colored types of some established plastics, it responds readily and attractively to surface finishes in any shade of enamel, paint, or lacquer. If a metallic tone is preferred, powdered metal sprinkled into the mold before it is filled with the plastic powder makes the metal a part of the completed product. If the effect of wood is desired, beautiful hard panels may be produced by similar use of figured veneers such as walnut, woven veneers, or appliquéd veneers, none of which will peel off. Similarly, decorative materials such as paper or cloth may be used.

Among the desirable qualities of Xylite are its high electrical resistivity, its waterproof qualities, its resistance to acid, and its warmth to the touch.

Simulated Neon Signs

SIGN manufacturers have found an interesting new use for fluorescent paints. When a so-called neon sign is proposed, the manufacturer paints a miniature model of the sign with various colors of fluorescent paints serving in the place of the gas tubes that will be in the completed sign. This model, exhibited to the purchaser in a dark cabinet under the rays from ultra-violet lamps, gives a perfect imitation of the glowing sign as it will appear complete with its tubes.

Fly Spray

INSECT sprays use huge quantities of pyrethrum flowers, a Japanese variety of chrysanthemum, as the source of the insecticide, pyrethrin. This insecticide has the advantage of being harmless to human beings but deadly to insects. Present disturbed conditions in Japan have seriously curtailed the world's supply of these unique flowers and a world-wide search has been made in an effort to find a climate and soil where they can be grown. Present indications are that the British colony of Kenya in southeast Africa provides ideal conditions for this plant and its culture is being undertaken there on a large scale.

Shortage of pyrethrin has also encouraged the search for synthetic materials of equal potency and safety. One of those recently announced as meeting the requirements is isobutyl undecylene amide. Investigations so far made suggest that this compound can replace pyrethrin from flowers in household insecticides.

These two attacks on the natural monopoly which Japan has held seem both to be successful.—*D. H. K.*

Conducted by JACOB DESCHIN

Action Picture Time

IF you're aiming to get some action pictures, we hope you have done something about the matter by this time; if not, prepare to do so now before vacation time comes to an end. It is during these vacation months, when all the world is eager to be on the move, just for the pure animal fun of it, that you will have more rich opportunities for real action shots than at any other time of the year.

A lot of camera-toting people seem unaccountably timid about this whole business of action photography. Those who own cameras with top shutter speeds of 1/100th or 1/200th second are particularly dubious about getting any results, feeling that these top speeds limit their chances of stopping action. Haven't they tried now and then and haven't the results been distressingly fuzzy? So what? Leave the ultra dizzy subjects alone and aim for the possible.

One thing should be kept constantly in mind when taking action pictures: make your picture give the impression that your subject is really in action and is not stuck in space. Obviously, we know that the subject was moving when the shot was made, particularly when the subject is caught in mid-air. However, fact and impression do not always go hand in hand, and though we know the action to be a fact, yet somehow the "frozen" action in which every detail is dead sharp often fails to evoke in us the emotional truth necessary to make us feel that the subject was in action.

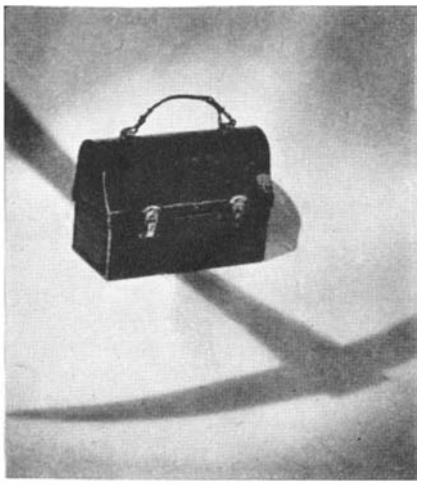
What it all comes down to, then, is this: reasonable show of movement or "fuzziness" is more often a help than a hindrance in achieving the all-important impression of movement. There is a limit beyond which, of course, it is ludicrous to go, and it is not advocated that a subject requiring 1/500th second to "freeze" may, for the purpose of conveying the feeling of action, be shot at 1/50th. Off-hand, we should say that in many cases a shutter speed of 1/200th or 1/300th may be sufficient. The picture will not be dead sharp but the subject will look alive and kicking (or flying).

Workers lacking the very high shutter speeds may also take comfort in the fact that the point of view with relation to the moving subject will alter considerably the shutter speed required. By taking the subject as it is moving toward or away from the camera, on a straight line with the lens, the required shutter speed may be as slow, relatively, as three times that required for the same subject moving parallel to the camera lens, while the diagonal point of view, which is the most pleasing, will call for a shutter speed twice as long. Another point to consider is the fact that the greater the relative distance from camera to subject the slower the shutter speed required.

The principal thing to consider is that stopping "dead" is more to be avoided than

1ST The hand of a carpenter working on his new home furnished R. B. Stewart, Yellow Springs, Ohio, with the inspiration for this First Prize "Work" picture. Graflex camera, Defender XF Pan

Prize Winners in Our "Work" Competition



2ND Symbolism by Louis A. Paige, of Utica, New York. Pick shadow was cast by a cardboard cutout placed three feet over the lunch box. Taken with a Feca camera on Super Plenachrome film

desired, however thrilling the prospect may sound, and that an impression of movement is preferable to a sharp image. Sharpness is not to be despised altogether, of course, but somewhere in the image let there be some slight fuzziness to satisfy the emotional sense that action has taken place. Those who see the picture afterward should not be required to take this fact for granted but must be made to feel that it is so.

Photography at New York's World's Fair

WITH the New York World's Fair only a few months away, there is considerable discussion in photographic circles as to the possibility of an international photographic exhibit at the Fair. That such an exhibit is bound to be included seems to be taken for granted, the general opinion being that even if photography had not attained the remarkable popularity that it enjoys today, it has a rightful place in such a project as a World's Fair by reason alone of its century of achievement and service to humanity both in the arts and in the sciences.

To many it seems obvious that the responsibility for assembling an international exhibition of photography that will befit such a grand-scale venture as the World's Fair should fall upon the shoulders of an organization with experience in such exhibitions and enjoying contacts enabling it to gather the best the world has to offer. Frequent references are made to the Oval Table Society, Inc., until recently headed by Pirie MacDonald, Hon. F.R.P.S., and now presided over by Dr. Orrin Sage Wightman, A.R.P.S., as the organization best fitted for the undertaking. This is the society, it will be recalled, which recently brought together from many corners of the world the International Exhibition of Photography that attracted so much attention when shown at the American Fine Arts Society in New York.

But whether this organization or some other will be called to the task, the general opinion seems to be that an exhibition of international proportions is bound to be held and that the Fair would be incomplete without one.

Flash Contest

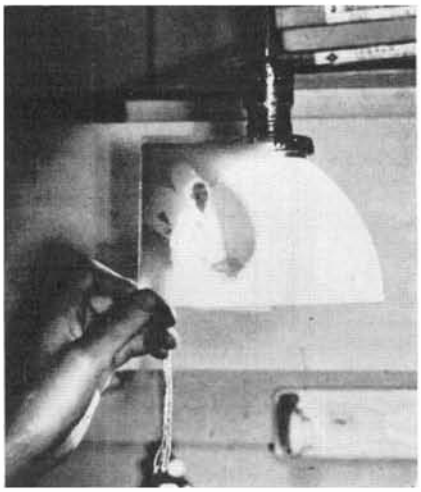
THE Second Annual Kalart Synchro Sunlight Contest has been extended to Nov. 1, 1938, according to an announcement by the sponsors. The prizes total $250, with first prize of $100, second, $50, and third, $25. In addition there will be 15 other prizes amounting to $5 each. An entry form may be obtained by writing to the sponsors. Judges will include Willard Morgan, publisher of books on photography; Herbert C. McKay, F.R.P.S., well-known photographic technician and writer; and Kip Ross, Supervising Photographer, Associated Press.

Inspiration Box

THE darkroom is a fine place for thinking up the swellest ideas, but if you don't put them down somewhere at once, nothing is easier than to forget them after you emerge into the open again. So set aside a box or other receptacle in the printing table drawer or elsewhere, and use it as a sort of "inspiration box" in which to drop your hastily penciled ideas as they occur in the course of meeting unusual darkroom problems. You will be surprised how the mere writing down of the idea, even though you may later have the misfortune to misplace the piece of scratch paper, will help you to retain it in your memory to spring into service when needed.

Light Reflector as Viewer

WE had been using the light reflector over our darkroom sink as a negative viewer for a long time before we realized what a valuable darkroom accessory our light reflector had become. You have probably seen the type, available for a quarter or so. With a frosted finish, the reflector not only controls light in the normal way, but also acts as a sort of translucent light surface against which translucent objects may be held and viewed. Now we habitually employ this "viewer" for examining negatives after washing and occasionally when selecting negatives in the darkroom for enlarging or printing.



For viewing negatives

For the Slippery Easel

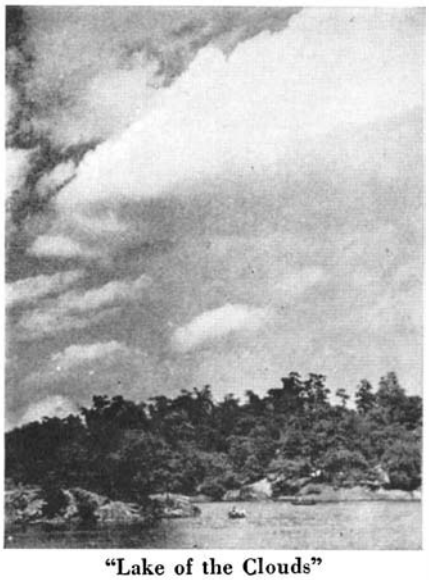
HAS it ever happened to you that, after having prepared everything for the final exposure under the enlarger, your easel suddenly slipped and threw off all your neat calculation and arrangement? Why ask! Well, we have found one perfect cure for this

and to date have had uniform success with the scheme. Obtain in the five-and-ten-cent store a supply of rubber stripping having an adhesive on one side; cut off two short lengths, each one a little shorter than the length of the easel. Attach one of the lengths to each of the long sides—underneath, of course!—and your troubles are over.

For the Clouds' Sake

CLOUDS are the making of many a scene that is otherwise of little worth pictorially. There is a glorious beauty to clouds that is probably unmatched by anything in

"Silver Lining"



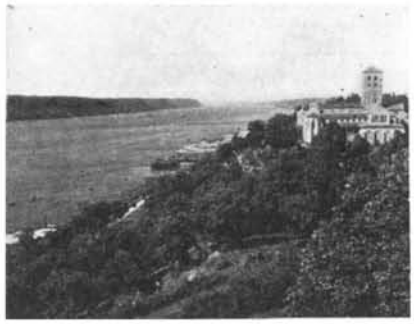
"Lake of the Clouds"

nature and many a photographer has spent his film substance in the wonderfully exhilarating endeavor of attempting to transfer to film and later to record on paper the majestic and often awe-inspiring beauty of those moving white masses. The two examples illustrated here indicate how, by subordinating the foreground, either by keeping it low in the picture space or by leaving it in shadow, the cloud-filled sky gains the emphasis and importance that is its due. A medium yellow filter was used in each case because areas of blue sky were included in the view. A red filter gives interesting dark skies but this would be inadvisable in both instances. In "The Silver Lining" we already

have a dark contrasting mass and in the other little could be gained by a darker sky than we already have. As a matter of fact, it must be remembered that the use of any filter is not required in the very late part of the afternoon when the light becomes yellowish and the sky is no longer the pure blue that it was during the day. The use of a yellow filter, under such circumstances, will usually give you a black sky or at least a very dark one.

Watch Your Foreground

IN picturing such a large expanse of area as that included in the accompanying illustrations of a view from Fort Tryon Park, New York City, it is important that the picture be given some balance such as that



Right

Wrong

afforded by the Cloisters building in the first illustration. It provides a sense of perspective, a high point of interest and serves to remove the monotony from an almost completely blank sky. In the second picture the photographer ignored the building, thinking only of the general scene, with the unpleasant result that you see. The building is partly included but seems to be in the picture merely by sufferance because it could not be kept out.

Camera and Gun Exchange Shots

SOUNDS like a good plot for an adventure-thriller type of magazine, but the picture boys say it's so and have the pictures to back up their story. It seems that recently in Knoxville, Tennessee, a man, charged with traffic violation, was standing outside the courthouse when a news photographer started to "shoot" him with flash bulb exposures. The picture "victim" liked the idea so little that he pulled out his gun and started firing bullets at the photographer. The latter stood his ground, however, and got his pictures anyway. A photograph published in

connection with the story shows where two bullets had struck the wall near where the photographer stood, one of the bullets evidently having come dangerously close.

When Bottle Caps Stick

UNFORTUNATELY certain bottles sold for photographic use are equipped with screw-type metal caps that begin to show rust signs very soon after the first few pourings from the bottle. This rusting is aggravated with continued usage until a time comes when the rust has cut almost completely through the entire inner surface of the cap and difficulty is experienced each time it is necessary to unscrew the cap. The best cure is to purchase or otherwise obtain bottles with plastic screw caps. (There are certain photographic liquid chemicals and solutions that are sold in bottles having this type of cap.)

WHAT'S NEW
In Photographic Equipment

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

One-Shot Color Camera

MAKING three color-separation negatives in a single exposure, with each negative sharp and perfectly balanced, the Lerochrom Direct Color Separation Camera ($168 without lens) is offered for general amateur as well as professional use. The camera is of the single reflector type and makes negatives 2¼ by 3¼ inches, from which it is claimed that the average amateur may make his own full-color prints in enlargements up to 11 by 14 inches.

The camera, the invention of Adrian LeRoy, known for many years for his inventions in the engraving field, is furnished with a densitometer for properly balancing the black-and-white color-separated copies as to contrast and density. The camera employs two special film holders, one of which supplies two of the three color-separation negatives.

Panflex for Contax

PERMITTING the use of a variety of lenses interchangeably, the Panflex is introduced on the market as an accessory for converting the Contax camera into a reflex camera for short-range work. In addition, as previously announced, the Flektoscope is available in three models with long-focus lenses, the Sonnar *f*/2.8, 18-cm, the Tele-Tessar *f*/8, 30-cm, and the Tele-Objective *f*/8, 50-cm. These devices incorporate a mirror coupled with the cable release that operates the camera shutter, so that the mirror is automatically lifted away just before the exposure and returns of itself immediately

400-mm Telyt Lens

PROVIDING a focal length of 16 inches—16 times greater than the short side of the 1 by 1½ inch Leica negative—the 400-mm Telyt lens ($450.), with lens speed of *f*/5 and focusing by means of a mirror reflex housing, giving ground glass focusing up until the moment of exposure, is now made available for the professional, newsman, and advanced amateur. The weight of the 400-mm Telyt is 7 pounds.

Photrix Electronic Timer

ADAPTING a timing method hitherto employed for industrial purposes, the Model B Photrix Electronic Timer ($37.50) is introduced as a device for automatically turning off the enlarging or contact printing light after a predetermined interval. In use, the Timer is plugged into a light socket, the enlarger or contact printer is plugged into the Timer, and the selector switch of the Timer is set at the desired time of exposure. Then a button on the Timer is pressed, which turns on the light of the enlarger or printer, the light being turned off automatically at the end of the indicated exposure interval. Features of the Photrix include: resetting of the Timer required only if the time of exposure is to be changed; being electronic in nature, there is neither motor nor clockwork and no moving parts; a switch is provided for operating printing light by hand and to allow for continuous light for focusing, shading and spot printing.

Camera Automatically Sets Diaphragm

COUPLING of a photo-electric cell with the lens diaphragm in the new Super Kodak Six-20 2¼ by 3¼ camera ($225.) makes possible automatic adjustment of the diaphragm to whatever the lighting conditions happen to be for a particular subject. With snapshot shutter speeds from 1/25th to 1/200th second, all one has to do is to select the desired shutter speed and the lens automatically stops down to the exact aperture required for perfect exposure.

A range finder of radically new design is incorporated in the camera; it is mechanically coupled to the focusing mount of the lens and combined with the direct eye-level view finder in a single eyepiece. Double exposures are automatically prevented by a device which precludes re-tripping of the shutter until the film-winding lever is after the exposure. The image is viewed under approximately 5x magnification on a fine-grain ground glass, the center of the field being marked by a small engraved cross.

operated. For special effects the lens diaphragm may be adjusted by hand.

When the camera is held for a vertical picture, the range finder is at the top. Just below it is a multiple collective lens, with the sensitive photo-cell behind it. This multiple lens is so calculated that it covers the exact field of the camera lens, causing the photo-cell to react only to the light conditions in the picture scene. At the moment the shutter is released, the photo-cell actuates the galvanometer in the lens housing, and the diaphragm adjusts to the correct aperture at the chosen shutter speed to produce a technically correct negative.

Tilt-O-Rama, Jr.

THE Tilt-O-Rama, Jr. ($4.50) tripod swivel head, made of polished aluminum, has recently been made available. The long goose-neck support allows the camera to be tilted to any position; and a large ball-and-socket joint holds it there firmly.

Enlarging-Paper Box

AN ingenious enlarging-paper box, equipped with a spring actuated lid which snaps shut and protects the contents of the box against light as soon as you remove your hand, is now available for those who are tired of fumbling with paper packages and boxes while working in the darkroom. The box ($10.80) holds several sizes of papers and provides a convenient method of storing paper as well as selecting papers of different contrasts, surfaces, and sizes, when doing varied work under the enlarger.

Leica Self-Timer

A SELF-TIMING device for the Leica camera incorporates visible-action design and a spring mechanism that trips the shutter after a delay of 12 to 15 seconds. By observing the relative position of a white dot on the face of the slowly rotating winding disc of the self-timer ($5.40), the operator is always aware of the time remaining before the shutter is to be released.

Portable Darkroom

DESIGNED for developing film and making contact prints wherever one happens to be, and in broad daylight, if necessary, the Midget Marvel ($10) has been placed on the market as a portable darkroom completely equipped for the purposes intended. In addition, the device may also be used for loading cut-film holders or developing tanks. The complete outfit contains 14 items, including trays for developing and fixing, negative and paper holder, and so on. In use, the operator inserts his hands into flexible light-proof sleeves snapped over the open ends of the box. A safety glass is placed in the front and another in the top window; an operating hood provides a shelter for the top window through which the worker observes what is happening in the box. For loading and unloading film, darkening boards are provided to fit into the glass holders.

CAMERA ANGLES ROUND TABLE

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

Q. What is the weakest light by which a photograph may be taken?—D. L.

A. A match flame or candle flame is often employed to show the great sensitivity of certain films, but these, as you will notice, are generally quite close to the subjects. Any illumination, no matter how dim, that makes a subject visible, will enable that subject to be photographed. We are not, of course, concerned here with the matter of the exposure time required and in the case of a portrait an extremely dim light may not be useful at all because of the long exposure that would be required.

Q. Can you give me a formula for sensitizing fabrics or paper? I want something fairly fast, so it can be exposed by projection.—E. W. D.

A. While we cannot vouch for the "speed" in printing that is possible with the following sensitizing formulas, here they are for what they are worth to you. The essential, with all sensitizing processes of this type, is that a snappy, fairly contrasty negative be used for printing. The first solution, which is applied with a wad of cotton in very weak light, a precaution that holds for the other formula as well, is made up as follows:

Potassium ferricyanide	700 grains
Ferric ammonium citrate (green)	1600 grains
Water, to make	20 ounces

Print out and wash in water.

The other formula:

Water	10 ounces
Common salt	100 grains
Gelatine	20 grains

Dissolve in warm water. Stretch the fabric on a frame and uniformly moisten the fabric by floating the latter, or paper, as the case may be, on the surface of the warm bath for three minutes. When it is dry, sensitize it in a solution of silver nitrate, 40 grains to the ounce. Fix in a bath consisting of one part sodium hyposulphite to six parts water.

Q. What is meant by the term "circle of confusion"?—P. P. A.

A. Light reflected from a photographed subject is registered on the film as a group of circles or disks of light. The smaller the diameter of this circle or disk of confusion (the degree of unsharpness permissible in an image because not perceived by the eye), as it is termed, the sharper the definition in the resulting negative and, as a consequence, in the print or enlargement made from it. A negative intended for enlargement will call for a relatively smaller circle of confusion than one from which only contact prints are to be made. In the case of a 2-inch lens exposing 35-mm negatives, therefore, which often are enlarged to 8 by 10, 11 by 14 and larger, the disk is calculated as small as 1/750th inch, although 1/250th will be found sufficiently small for a lens of about 6 inches focal length, exposing negatives 3¼ by 4¼ inches. For the purpose of devising a depth of field table, discussed in our reply to Rev. R. T. in the July Round Table, a larger disk has the advantage of offering relatively a greater range of sharpness.

Q. I am anxious to know how the coupled range finder is made—the principle on which it works.—E. A. L.

A. The principle of the coupled range finder is similar to that employed for big-gun setting, namely, the use of two prisms, one fixed, the other moveable to cause coincidence of a "split" or "double" image seen in the viewing prism. Drawings and fuller explanations may be found by consulting the Leica Manual and Clerc's "Photography: Theory and Practice."

Q. Would you advise me to use the lens from my camera as an enlarging lens? What is the highest temperature the lens could be subjected to without damage? The lens in question is an Exaktar F:3.5, 5 cm from my Kine Exakta.

Looking through some negatives developed about two years ago by a commercial shop I find one roll is turning purple. What causes this?—I. M.

A. It is a common practice to employ one lens interchangeably on both camera and enlarger. In fact, as you probably know, an enlarger is available specifically designed to take the lens of your Kine Exakta camera. Other camera makes, such as the Leica and Contax, also offer this facility. As to the maximum temperature that the lens will stand, we can say from experience that with a well ventilated housing, even so powerful a light source as the Photoflood bulb may be employed, provided the light is burned

for only very short periods. Such a light, incidentally, might be found desirable only with very dense negatives in order to cut down the time of exposure which might be excessive with a normal light source. As a matter of fact, with a condenser type enlarger such as the one you have, the concentration of the light rays afforded by the condenser lens will provide a strong enough light with a normal light source to take care of practically all negative densities within reasonable exposure limits. However, if a Photoflood is employed, it is advisable to employ a rheostat device in order to cut down the light intensity, and hence the heat generated, during focusing.

The staining of your negatives is probably due to improper processing, the finisher doubtless having used old developer or an old fixing bath or both. If the purple stain is uniform over the entire negative, however, there is nothing to worry about as the stain will merely increase the required printing exposure time.

***Q.* Is there any accepted way of preventing a movie film from drying out and cracking from continued use? Would an application of glycerine help?—B. R.**

A. A number of so-called hardening solutions are available on the market dedicated to the preservation of miniature and motion picture negatives and positives. Any one of these should give complete satisfaction. Storage in a cool place is a good general precaution to observe. As to the glycerine treatment, we learn that this is not to be recommended because films so treated remain permanently damp, thus leaving them subject to the possibility of slow image deterioration through atmospheric action on the silver.

***Q.* I intend to buy a miniature camera. Of two prospects I am undecided as to whether I should buy one with an *f*/3.5 lens and shutter speeds to 1/500, making album size prints, or a 35-mm camera with an *f*/2.9 lens and shutter speeds to 1/300. The latter is $20 less but has a cheaper hand strap and winding knobs, and so on. Should I buy the higher priced one because of the greater shutter speed or can I get the same or better results with the cheap one?—R. M. W.**

A. Let us line up the pros and cons. In the first case, you have a camera with a lens of *f*/3.5 speed, a shutter giving exposures up to 1/500th second and a picture size which we presume to be 2¼ by 2¼ inches. In the other case, the lens is a faster one, but the top shutter speed is slower and the film size is 35 mm or 1 by 1½ inches. Without an inspection of the cameras involved in the choice, it is not possible to make any recommendations, but we gather from your question that what you are concerned with most is the speed of the shutter. On this score, we can say that many amateurs get along very well with a top shutter speed not even as high as 1/300. If you have a special and frequent need for a shutter speed of 1/500, this is something to think about. If not, then the difference in top shutter speeds can be discounted. You cite a cheaper hand strap and winding knob on the lesser priced camera. On the face of it, these are not serious enough to be worth consideration, but you are right in intimating that because of the cheapness of the fittings the conclusion must follow that the general construction of the camera also is cheap. This does not always hold true, but generally speaking the fittings provide some hints as to the worth of a camera. Your decision must rest, however, on the size of negative that you prefer, the quality of the lens, and, if both are approximately equal in value, whether the difference in the speeds of the two lenses means anything to you. Offhand, we should say that the speed of the lens in this particular case is of no great importance. We would place the question of the difference in price at the bottom of the list. In any event, our suggestion is that you have a good heart-to-heart talk with the dealer, state your case frankly and persuade him to do the same.

***Q.* I wish to make my own camera for taking instant pictures (stamp size) on "direct positive paper," pictures to be taken indoors. Will you please tell me what lens to use and if I could purchase it second hand? What special basic knowledge would be needed?—J. M.**

A. The lens you will need will have to be of 2-inch focal length or a little less if you want to include a view of about 50 degrees, which is the "normal" photographic angle of view. If you want to get less on your picture (that is, obtain a larger image), your lens would have to have a longer focal length, perhaps 3 inches or more. Lenses may be purchased second hand from any of the large dealers; you can find some of the addresses in the advertisements in this department. The basic knowledge required is that needed for the construction of any camera and this may be learned by consulting some elementary books on photography that include such descriptions.

***Q.* In loading with 120 or B-11 roll film for a heavy day of picture-taking, I find that carrying a half dozen rolls adds up to quite a bulk when carried in the coat pocket. I have, therefore, adopted the habit of taking the rolls out of the boxes, thus cutting down the bulk considerably. Is this an unwise habit?—L. H.**

A. The method you cite should be perfectly safe provided the rolls are allowed to remain in their foil wrappers and are kept in a bag that can be closed up to protect the rolls from dirt. The exposed rolls can be returned to the same bag; there can be no confusion as to which rolls have been exposed and which are still unexposed because the latter will remain in their foil wrappers until ready to be loaded into the camera.

***Q.* In using the brilliant finder of a camera I have just purchased, I find that the subject in my prints appears on the extreme left of the prints, although in taking the picture the subject is perfectly centered. Is this natural with a view finder of this type?—P. F. P.**

A. A view finder is designed, as the name indicates, to reveal the view or picture subject being photographed. There is, therefore, no excuse for the discrepancy in image framing that you mention and our best advice is that you return the camera to the dealer from whom you purchased it. He will have the camera adjusted so that the view encompassed by the lens is practically that which you see in the view finder.

Books

SELECTED BY THE EDITORS

SOILLESS GROWTH OF PLANTS

By Carleton Ellis and Miller W. Swaney

AT last! So great has been the up-surge of interest in this new science of chemical gardening and so many have been the requests to us for complete information regarding this method, that we can say "at last" with almost a sigh of relief. Popularly written, this volume brings to the layman complete information regarding the problems and difficulties of tank farming and gives the solution in each case, together with formulas for the chemicals to be used and instructions for preparing tanks and other containers. While this volume may be limited in certain respects, it is to be recommended to all those who are interested in experimenting with the method, either indoors as a hobby or out-of-doors as a commercial venture. (155 pages, 6¼ by 9¼, illustrated.)—$2.90 postpaid.—*F. D. M.*

TRIUMPH OVER PAIN

By René Fülöp-Miller

AROUND the discovery of anesthesia 94 years ago and the end of horrible pain in surgical operations, the author of several notable books (such as "Rasputin, The Holy Devil") has woven a spell of charm backed by accurate science and exhaustive historical research. Two Americans claimed credit for this discovery. To one the credit was given, while the other became a raving maniac. Even today this bitter battle rages. How theologians, and scientists too, fought the use of anesthesia and how it supremely won—these things and numerous others are told in this fascinating volume.—$3.70 postpaid.

PORTRAIT PHOTOGRAPHY

By H. Williams

STEP by step the author takes the reader through the principles of lighting and portraiture, making the way plain for those approaching for the first time this phase of photography. For those who have attempted portraiture in the past, with more or less satisfactory results, the suggestions given will prove helpful in attaining more perfect workmanship. Fundamental principles of lighting and composition, clearly explained and illustrated, serve as a basis for the development of a satisfactory technic. A chapter is included on retouching, giving details that often are left to the imagination of the reader. (68 pages, 6½ by 9½ inches, numerous photographs and drawings.)—$4.45 postpaid.—*A. P. P.*

ASTRONOMY

By Robert H. Baker, Professor of Astronomy, University of Illinois

OF the six or more extant texts of astronomy some are long, some medium, some shorter. Some are kept up to date while some have lost their edge. The Russell, Dugan and Stewart Astronomy is the most detailed, the Moulton text the most readable, the Fath text probably the most lucid and compact, the Duncan text the most attractively produced. This new and third edition of Baker's text, now published, may be characterized as the most detailed text that is closely up to date. It is dated May, 1938, while the closest runner-up is dated 1935. Its star maps—four one-page simple maps of the seasonal constellations, plus two circumpolar maps—are greatly improved. Some new photographic illustrations have been substituted for old. Some chapters have been rearranged. The account of the galactic system has been largely rewritten to follow the developments in the active field. New readers who are unfamiliar with textbooks of astronomy often harbor the belief that they are mainly mathematical. On the contrary, the science, for all except the case-hardened professional, is adequately covered in elementary college texts having less than 1 percent of mathematics, and even this may be skipped. Thus this fascinating science, with its frequent revelations of undreamed-of vastness, is easily absorbable from books like this by the average intelligent reader. (527 pages, 5 by 9 inches, many illustrations.)—$3.95 postpaid.—*A. G. I.*

PSYCHOLOGY OF SEX

By Havelock Ellis

A NEW edition of a book published in 1933 and written by the greatest and foremost contributor to the subject of scientific sexology, who offers in it much excellent advice. It covers the usual scope and is written in a very lucid, easily read style. (377 pages, 5½ by 8½ inches.)—$3.20 postpaid.—*A. G. I.*

BREATHE FREELY!

By James Kendall, Professor of Chemistry, University of Edinburgh

THE oft-denied tale of super-war gases is here denied again in words that cannot easily be contradicted even by the sensation mongers, exhorters, and arm-flailers. In this volume the author develops his theme logically from a study of the gases used in the past War and of little-known facts concerning present work in chemistry, to the end that civilian populations may be reassured. He does not believe the ghastly predictions of wholesale slaughter behind the lines in the next war with poisonous gases or by air bombing, and the reasons he offers bear out his argument. We welcome this eminent chemist's contribution to a steadily growing literature which tends to prevent the sleepless nights that some people have had in recent years after reading in the sensational press of the horrors that are to come. (179 pages, 5 by 7½.)—$1.60 postpaid.—*F. D. M.*

We can supply our readers with any of the books reviewed in this department. Prices quoted include domestic postage. Foreign prices are necessarily higher due to increased shipping charges.

SCIENTIFIC AMERICAN
24 West 40th Street New York, N. Y.

WETTING AND DETERGENCY

Foreword by W. Clayton

FIRST in the English language dealing with wetting and detergency, this work is important for the chemist, physicist, and engineer, whether industrial or academic. It presents in a concise form the most modern theoretical considerations of the subject and their bearing on industrial problems. And these problems do abound in such industries as those concerned with textiles, hides, skins, leather, paints, varnishes, insecticides, fungicides, flotation, solders, metal coatings, and many others. The data in this book are the most complete on these subjects seen by this reviewer. Eminent scientists have prepared this work, which is up-to-date in every respect.—$6.20 postpaid.—*F. D. M.*

EAT AND KEEP FIT

By Jacob Buckstein, M. D.

A POPULAR treatise on foods, vitamins and cognate subjects, with instructions for dieting. (128 pages, 5 by 8 inches.)—$1.10 postpaid.—*A. G. I.*

COLLEGE PHYSICS

By Henry A. Perkins, Professor of Physics, Trinity College

A TEXTBOOK covering both the classical and newer physics, without the too-common over-emphasis on the latter at the expense of the former. The treatment is detailed but conventional, for this is not an attempt to humanize physics. The language of mathematics (high school) is freely used. An excellent reference book and source of study or review for serious readers. (820 pages, 6 by 9 inches; many illustrations.)—$4.00 postpaid.—*A. G. I.*

JEWELRY, GEM CUTTING AND METALCRAFT

By William T. Baxter

THE author is a high-school teacher of the subjects treated and his handbook is chiefly practical. While it is about 75 percent explicit, it is not wholly so. Even so, it would be an invaluable aid to workers in any of the hobbies treated in it—many of whom, in fact, prefer not to be instructed too minutely but to explore or adventure a little and find out the lesser details for themselves. The numerous illustrations tell much of a practical nature; the names and addresses of dealer sources of materials are given in full. (224 pages, 5½ by 8 inches, 128 figures.)—$2.65 postpaid.—*A. G. I.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

FURTHER to emphasize the merits of a type of refractor previously described in these columns (Oct., '37, p. 232) we present a follow-up on the same instrument, reproducing Figure 1 again from the earlier publication. Capt. Maurice A. Ainslie, R.N., the owner, who stands next to the telescope in the picture and who is well known in British amateur circles because of his work in practical astronomy ("Astronomy in Navigation," a chapter in "The Splendour of the Heavens," by Instructor Capt. M. A. Ainslie, Royal Navy), writes from Grenville, Talbot Drive, Wallisdown, Bournemouth, England, concerning this "reflex" type of telescope:

"It has occurred to me that some further remarks concerning the instrument—which has now been in regular use for two years—might be of some interest to your readers. As shown in your photo, the triangle which forms the base of the mounting stands up clear of the ground; this was soon found to cause some inconvenience, as well as to make the eyepiece rather inaccessible in some positions; so the triangle has been sunk 6″ in the ground with great advantage. At the greatest northern declination (about 43° north) which permits of the telescope passing the meridian without reversal, the lower end of the tube just swings clear of the ground, while the eyepiece is always readily accessible. In respect of convenience of working, the instrument equals, if it does not surpass, a reflector with rotating tube; and the optical parts, once adjusted, are so stable that finding objects by the circles is an easy matter. This is just as well, since it has not, as yet, been found easy to mount the finder so as to be easily accessible in all positions; the arrangement shown in the photo is probably about the best, but is not very satisfactory; however, since the finder is hardly ever used, this does not matter very much. The 'swiveling' arrangement for the eyetube, giving a side-to-side range of some 225°, has been found very advantageous—especially for work on variable stars—as the orientation of the field of view is always under control.

"Of course, with two reflections between the object glass and the eyepiece, some loss of light is bound to occur; assuming 87 percent for the reflectivity of the aluminized 6″ flat, and the same figure for the prism, the effective aperture of the object glass is about 8.4″ x 0.87, or about 7.3″; this gives ample light for such powers as can usefully be employed on Jupiter; while I find that my not very sensitive eye can just see steadily a star of magnitude 13.7 on a good night, so that there is sufficient light for observation of pretty faint variables.

"The circles, which are divided only to half degrees and read by simple pointers, bring any desired object into the field of a low power eyepiece giving x 60 and a field of 43′; and the remarkable stability of the whole stand goes a long way toward making 'setting' easy and certain; repeated tests on the Pole Star have failed to show any appreciable movement in the polar axis.

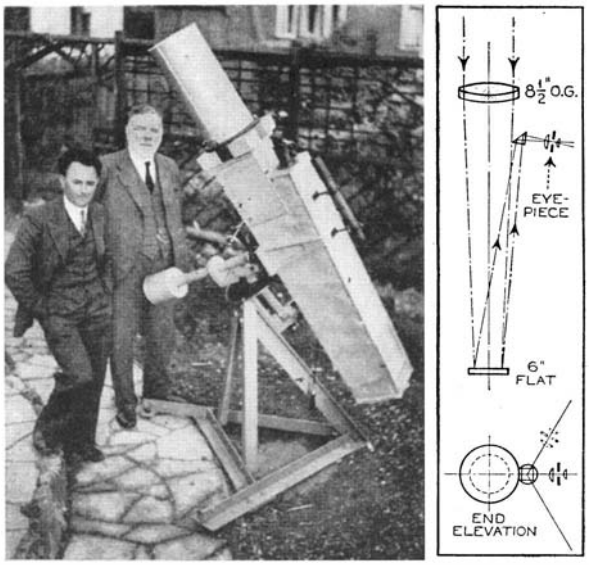


Figure 1: **The reflex euphonium refractor**

"I venture to think that anyone possessing an object glass of similar, or even greater, aperture, might do worse than consider the possibilities of this form of mounting, especially for prolonged observation of such an object as a planet."

The photograph reveals less distinctly than the drawing the position of the eyepiece, the latter being foreshortened in the photograph. Commenting on this, Horace E. Dall, of Luton, Beds., England, who made the optics (the mounting was made by Perry, also shown in the photograph) states:

"The whole point of that extra reflection is accessibility of eyepiece and orientation of image. The Captain is keen on planetary work, in estimating position angles of Jovian spots, and so on. He prefers to set the belts horizontal, which is easily done by swinging the short, projecting eyepiece tube 'round."

So far as is known, no American amateur has yet made a reflex—or "euphonium."

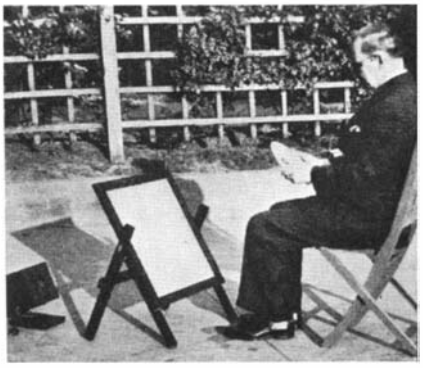


Figure 2: **The strained glass tester**

BECAUSE glass, such as that from which mirror blanks for reflecting telescopes are made, is cooled rapidly on the outside after it is poured, stresses due to unequal contraction are set up in it. Annealing in a lehr is supposed to ease off these internal stresses but does not always do so. Later, when the telescoptician removes glass from parts of the disk, these stresses (for some unknown reason called "strain" by the optical industry) are able to warp the disk out of shape, and then there is grating and gnashing of teeth, for the disk is probably a candidate for the discard.

Last April, H. E. Dall, of England, told in these columns how he had designed and built an inexpensive tester for strain in glass, making use of the new polarizing material, Polaroid. This tester, he stated, consisted of (1) a lamp in a blackened box having an opening covered with Polaroid; (2) a ground glass screen; (3) Polaroid goggles worn by the viewer. He added that this simple equipment "showed up strains so brilliantly that there was no need even to test in a darkened room, subdued light sufficing to permit the indications to reveal themselves."

F. M. Garland, 1006 Davis Ave., Pittsburgh, Pa., read this note, obtained a few more details from England and built a Dall tester. He now writes: "Scanlon and I tested all the glass within reach at the Valley View Observatory with it and the set-up really works." Therefore we have obtained from Garland some of the details.

Starting at the lower, left-hand corner of the photograph (Figure 2) the following elements of the set-up are seen: (1) A wooden box, hinged beneath for adjustment in altitude and containing an ordinary 25-watt lamp. Fastened over the hole in its front, this hole being made as large as the polarizing material will permit, is one half of a pair of Polaroid goggles of the kind now obtainable at many filling stations, with their normally horizontal dimension vertical. (2) An easel with a pane of common window glass frosted on one side, to provide a fairly uniformly illuminated area of polarized light large enough to permit the examination of a moderate sized disk against it. (3) The glass under test, held in the hands. If the glass is not strained, the expansion due to the heat of the hands will give it a strain, hence it should be insulated with a cloth or felt; but if the desire is to study the effect of heat in causing temporary strains, no insulator should be used. (4) A pair of Polaroid goggles worn in the normal manner, which will cause the horizontal dimen-

sion of the lenses to cross that of the Polaroid in the lamp box and thus be at right angles to one another. (5) The eyes of the tester—in Figure 2 these are the property of F. M. Garland. The photograph was taken at our request.

"When the glass is badly strained," Garland points out, "dark and light streaks are seen strongly contrasted against the fairly dark screen. Faint shadings are inconsequential; but if there are strong bands it is best not to work such a disk. If no bands can be seen it is interesting to make some, simply by warming the mirror with the hands."

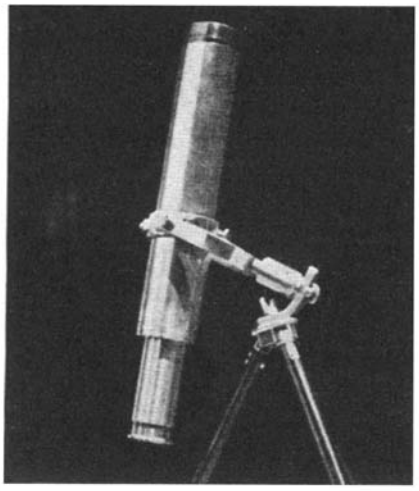


Figure 3: Garland's spotter

The above paragraphs may supersede the description of apparatus in ATM, page 461. When that description was prepared, only a few years ago, no such low-cost, large-area polarizing material as Polaroid was anywhere available.

PORTABILITY is a quality many seek in telescopes which they wish to carry about in a car. Figure 3 shows a little 1⅞" refractor with ½" eyepiece, giving about 30 diameters magnification, owned by the F. M. Garland mentioned above. The mounting is a bar with a bend equalling the latitude, and the fork is attached to it by means of a quarter-inch removable pin, as shown. By giving the bar a curve instead of an angle, such a telescope would be adjustable for any latitude and be suitable for the wandering type of telescope user.

THAT the Republica de Argentina is very much on the telescoptical map is evidenced by a letter from a member of the "Amigos de la Astronomia," in Buenos Aires, Carlos Luis M. Segers, Calle José Bonifacio 1488—the address of the library of the Association. Segers, who writes better English than some of us Yanks, says many amateurs have made and are now making telescopes in the Argentine Republic and that ATM and ATMA are thoroughly known in those latitudes. They have published in Spanish an excellent booklet on telescope making and they regularly publish the *Revista Astronomica.* This is an amateur journal but is quite professional in appearance, judging by the samples sent to your scribe.

IN a chapter in ATMA, Hindle of England tells how to make a diagonal for a Newtonian and states that, while the use of a totally reflecting prism is permissible, we must use an optical plane of elliptical con-

tour if we desire the very best results. Commenting on this in the present department some time ago, Wates of Canada showed the very small losses of light caused by other types of diagonal.

Replying to Wates, Hindle now adds the further fact that "the use of an elliptical flat insures that the black spot [the spot at the center of the diffraction pattern, which is the shadow of the diagonal.—*Ed.*] is perfectly circular, and one can easily judge the perfection of the instrument by the out-of-focus images of a star. Not only the permanent characteristics of the telescope but the varying characteristics due to temperature changes can be immediately determined." He quotes from a letter by W. H. Steavenson, prominent English amateur astronomer:

"Other things being equal, I think there is no doubt that the ellipse is the shape of choice, since it combines circularity of projected outline with a minimum of obstruction. The objection to any other shape (necessarily presenting a larger area by projection) is not, to my mind, concerned chiefly with reduction of light-grasp; because, as Wates has shown, the loss in ordinary cases is negligible from a practical point of view. The drawback consists rather in the production of increased or unsymmetrical diffraction effects or both. *Any* central obstruction tends to throw a certain amount of the light from a star into the diffraction system surrounding it, which is objectionable from certain points of view, though inevitable in all practical forms of the reflector. The most we can do is to keep the obstruction down to a minimum, as is done by adopting the beveled ellipse. Any increase in size of obstructed area increases the amount of diffraction, as may be seen by taking the extreme case of a flat so large as to leave only a narrow annulus of main mirror exposed. In this case you get a slightly *reduced* central image, but an enormously enhanced ring system, which would blot out any close faint comparisons and also destroy contrast in planetary detail.

"In any case," Steavenson continues, "I should always, even at the expense of slight extra loss of light, fit a circular disk as a mask over the flat mount, since any other shape, square or elliptical in projected outline, will produce unsymmetrical effects. The square gives four rays, and the ellipse two, though these may be so oriented as to coincide with those produced by the supports.

"But actually, as I said at first, none of these effects is *very* important in its bearing on practical performance, and, to quote Bell, they 'affect the observer's feelings more than his images.' The matter only becomes important with small f ratios, when the flat is necessarily already on the large side in comparison with the main mirror. Thus for $f/4$ the change from the elliptical type with circular projection to the circular flat of same minimum projection, or to a type with projection filled out round by a mask, might be really serious, though fortunately the work done by such mirrors is generally photographic, where definition under high powers does not enter into the question. For the ordinary amateur's visual work, at say $f/6$ to $f/8$, I don't think much harm would result from a projection of *any* reasonable size or shape."

Thus the beginner needn't worry *very* much about the shape of his diagonal. Figure 4, drawn by Wates, provides an organized picture of the ins and outs of it. Wates comment on the statements by Hindle and others is as follows: "I should imagine it would be just as easy to get used to an elliptical extra-focal spot as to a circular one; that is, as a standard of performance. My whole object was to point out that, while the beveled ellipse is undoubtedly the ideal shape, there is no serious objection to an unbeveled, circular disk which does not apply equally to a prism. The advantage of the circular disk is the ease with which flats of this shape can be made. All this is for the 12-incher, not for the 6-incher who, of course, uses a prism, or the lordly 20-

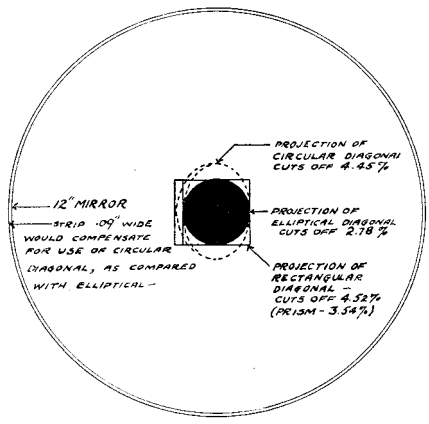


Figure 4: Wates' diagonalology

incher who doesn't give a whoop for trouble or expense."

A good many letters received from amateurs are passed round by your scribe among other amateurs, much like family letters passed to relatives, and when Everest saw the collection reproduced above he added the following on a cognate subject:

"I agree that the elliptical diagonal at 45° is the best. Another thing is that, for uniform diffraction effects, the projected circle must be concentric with the mirror's axis, which will make it appear off-axis when viewed from the focal point at the side of the tube. Most tyros don't understand this and try to correct for the apparent displacement, but a simple geometrical diagram will show why it can't be done. Also, theoretically, this means adding slightly to the size of the diagonal as usually calculated for complete coverage of the field lens of the eyepiece, but it's not important."

Everest then proceeds with the following train of logic:

"1. The whole plea for the elliptical diagonal is to project a *circular* shadow on the mirror, so that its figure can be interpreted from the extra-focal image of a star, also to produce uniform diffraction around the image at focus. The light gain over the rectangular diagonal is insignificant.

"2. To produce concentric rings in the extra-focal image, as shown at *A*, Figure 5, or uniform diffraction effects around the in-focus image, this circular shadow must be concentric with the axis and rim of the mirror. If this condition does not exist, the extra-focal image will be as at *B*, with rings not concentric, while the in-focus image will be cockeyed to the critical observer.

"3. For freedom from astigmatism, the axis of the cone of light reflected from the mirror must coincide with the axis of the mirror.

"4. For the same reason, the axis of the cone of light reflected from the diagonal

must coincide with the axis of the ocular.

"5. For 3 and 4 to be possible the intersection of the axes of mirror and ocular must lie in the plane of the diagonal.

"6. If you agree with 1, 2, 3, 4 and 5, you must also agree to the construction shown in Figure 5.

"7. If you agree to 1, 2, 3, 4, 5, and 6, you must also agree that, when viewed from the focal point, you will see something like *C*.

"8. If you have followed thus far, you will see that the *area* of the diagonal actually used in reflection will be as shown in D.

"9. If you cut down the diagonal to the area actually used in reflection, the projected circle will not be concentric with the mirror's axis.

"10. If you push the diagonal toward the mirror (dotted line), as most tyros attempt to do, the cone of light between diagonal and ocular will be off the ocular axis, resulting in astigmatism.

"And there you are.

"The extra size of diagonal needed to accommodate the field lens of the lowest power ocular used has not been considered in the diagram, as this would complicate the explanation.

"The amateur who is interested only in seeing the splendors of the heavens through his telescope needn't worry much about all this theory—as it is not important from a practical standpoint. This is directed at the armchair telescope makers with the hope that it will cause them no end of worry."

TOO convenient is a common belief that a poor flat will do for a diagonal "because it is used close to the focus." Due to frequent repetition without examination, this error has acquired sanctity. But F. J.

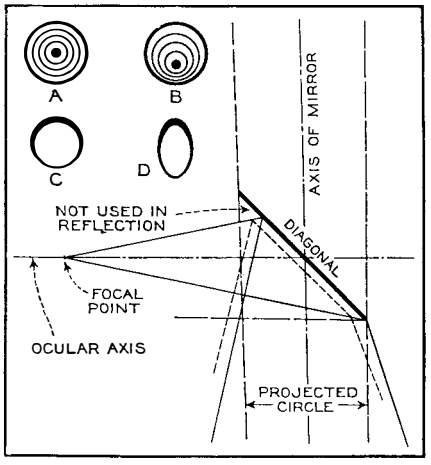


Figure 5: Everest's diagonalology

Hargreaves has analyzed the question, in the *Journal B.A.A.* If a large surface having uniform departure from flatness were used, so that the reflected beam filled the whole surface, the error would equal that of this surface. If less of the same surface were used, the error would be reduced (the linear error being reduced in the ratio of the squares of the diameters taken), and perhaps that part of the uniformly curved surface might be near enough to flat to be harmless—not, however, directly because of its nearness to focus. Distance, as such, has no effect. In other words, as Hargreaves puts it, "A small part of a large bad mirror may be good, but it does not follow that a small bad mirror is a good one."

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

REDUCE THE WASTE LINE IN HEATING YOUR HOME is a brief, illustrated description of a gas-fired home heating and air-conditioning unit of novel design. *C. A. Dunham Company, 450 East Ohio Street, Chicago, Illinois.—Gratis.*

CANADA YOUR FRIENDLY NEIGHBOR INVITES YOU presents an attractive series of photographs and colored plates, and an intriguing story, all designed to lure the tourist to the wide variety of recreational facilities offered by our northern neighbor. This booklet will be of value to anyone who is considering visiting Canada for either business or pleasure. *Canadian Travel Bureau, Ottawa, Canada.—Gratis.*

TECHNICAL CHARACTERISTICS OF ALCOHOL-GASOLINE BLENDS is a 16-page pamphlet that presents a carefully considered and authoritative discussion of the various technical characteristics of such blends. Data have been obtained under carefully controlled test conditions; the conclusions drawn may therefore be considered highly authoritative. *Committee on Motor Fuels, American Petroleum Institute, 50 West 50 Street, New York City.—Gratis.*

BARGAIN BOOK OF CAMERAS AND SUPPLIES is a 32-page catalogue which lists and describes hundreds of cameras, both still and movie, together with a wide variety of lenses, tripods, and other photographic accessories and supplies. *Central Camera Company, 230 South Wabash Avenue, Chicago, Illinois.—Gratis.*

THE FACT MANUAL OF STANDARD ELECTRICAL PORCELAIN presents in a large folded sheet pertinent data regarding the use of porcelain in domestic and industrial wiring. Installation suggestions are given, together with tabulations and drawings that will interest the electrician, the home owner, and those in shop management who are concerned with the subject. *Standard Electrical Porcelain Mfrs., 201 North Wells Street, Chicago, Illinois.—Gratis.*

STATISTICAL ABSTRACT OF THE UNITED STATES, 1937 assembles in one compact volume of 839 pages data on practically every phase of the social, economic, and industrial life of the nation. Included are 857 tables presenting statistics from the earliest available date up to the present day. Subjects covered include area, population, vital statistics, national wealth and income, wages and employment, manufactures, construction, and so on. *Superintendent of Documents, Government Printing Office, Washington, D. C.—$1.50 (check or money order).*

THE ABC OF NAVIGATION, by George A. Boyce, is a popularized presentation of navigation for marine and air travel. Illustrated with photographs and diagrams, it gives the essentials of the use of charts, the sextant, the compass, and so on. A chapter is included on dead reckoning. Low-priced but accurate navigating instruments are listed and described. They are satisfactory for use by the amateur navigator who has neglected to provide himself with equipment because of the high costs that formerly prevailed. *Boyce-Meier Equipment Company, Bronxville, New York.—25 cents.*

WORTHINGTON-CARBONDALE REFRIGERATION COMPRESSORS describes a vertical duplex double-acting unit with enclosed crankcase suitable for the requirements of large-tonnage installations. *Worthington Pump and Machinery Corporation, Harrison, New Jersey.—Gratis.*

RAILROADS AND RAILROAD WAGES 1938 condenses into a 16-page booklet pertinent facts regarding the present railroad situation and the wage scales of railroad workers. *Bureau of Information, Eastern Railways, Room 5710, Grand Central Terminal, New York City.—Gratis.*

FIRE-PROTECTIVE CONSTRUCTION ON THE FARM shows the fire hazards that exist in various types of building construction and how they may be overcome. It is estimated that the annual loss by fire on farms is approximately $100,000,000 worth of property and 3500 lives. Farmers' Bulletin No. 1590. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

SCENARIOS is a 44-page pocket-size booklet designed to give instruction in the art of writing scripts for commercial motion pictures. The booklet will be of interest to anyone who has ever considered motion pictures as an advertising medium. *Alexander Film Company, Colorado Springs, Colorado.—Gratis.*

LOOK YOUR BEST IN GLASSES drives home the fact that glasses need not detract from a person's appearance. When this fact is realized, many people who need glasses and have avoided them will gain the benefits which come from the proper care of their eyes. *Bausch & Lomb Optical Company, Rochester, New York.—Gratis.*

THE NEW ATLAS SHAPER is a small but interesting catalogue which presents close-up views of the most frequent shaping operations, together with complete construction details and technical specifications. *Atlas Press Company, 1830 North Pitcher Street, Kalamazoo, Michigan.—Gratis.*

SOIL EROSION BY WIND is an 86-page book which tells the factual story of the severe dust storms of the central United States, pointing out in both photographs and text the steps that can be taken to prevent further erosion. *Kansas State Board of Agriculture, Topeka, Kansas.—Gratis.*

RAYONS AT RETAIL is a 16-page pamphlet prepared by the producers of rayon yarns to give the facts about the textiles as simply as possible. The information will be of assistance to both buyers and sellers of rayon at retail. *Rayon Yarn Producers Group, 51 Madison Avenue, New York City.—Gratis.*

LEGAL HIGH-LIGHTS

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

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

Illegal Brokerage

THE intricate provisions of the Robinson-Patman Act are slowly being clarified by the federal courts. It will be recalled that the Robinson-Patman Act is an amendment to the Clayton Anti-Trust Law and is intended to eliminate price discrimination in transactions affecting interstate commerce.

The latest section of the Act to be judicially construed is the very important Section 2-C which prohibits the payment of commissions or brokerage fees by sellers of merchandise to purchasers or to the agents or representatives of purchasers.

The Circuit Court of Appeals for the Second Circuit recently confirmed an order of the Federal Trade Commission prohibiting certain practices which were construed to be violations of Section 2-C of the Robinson-Patman Act. In the case in question a corporation engaged in the business of selling market information to its subscribers for a fee of $25 to $50 a month also represented its subscribers in making certain purchases of merchandise. The corporation entered into written contracts with its subscribers whereby the subscribers employed the corporation to make the purchases. When purchases were made by the corporation it received a brokerage fee or commission which was remitted to the subscriber for whom the purchase was made. In most instances the commissions remitted to the subscribers in this manner did not exceed the subscription fee for the information service. However, in approximately 14 percent of the cases the commissions did exceed the subscription fees.

The Commission instituted proceedings against the corporation and several of the subscribers and sellers doing business with the corporation, charging that the practices as outlined above constituted a payment of brokerage fees or commissions to the agent or representative of the purchaser, in violation of the Robinson-Patman Act. After a hearing and taking of testimony, the Commission ordered the corporation and the purchasers and subscribers to cease and desist from these practices and a petition was filed with the Circuit Court of Appeals to review and set aside the order. The Circuit Court of Appeals affirmed the order of the Commission, holding that the disputed section of the Robinson-Patman Act did not violate the Fifth Amendment to the Constitution and that it was a valid regulation of interstate commerce.

The difficulties encountered in construing and interpreting an intricate statute such as the Robinson-Patman Act is indicated by the fact that one of the three judges of the Circuit Court of Appeals dissented from the decision of the majority and held that the practice of remitting commissions and brokerage fees to the subscribers, not in excess of the subscription fee paid for the information service, did not constitute a violation of the Act. The dissenting judge agreed, however, that the payments made in excess of the subscription fee did constitute a violation of the Act.

This case is of great importance to companies engaged in interstate commerce or in competition with firms engaged in interstate commerce, and it is believed that because of the importance of the issues involved an attempt will be made to have the decision reviewed by the Supreme Court.

Where There's Smoke

A PERSON who copies only a small portion of a copyrighted book may be guilty of copyright infringement even though he gives credit to the copyright owner, according to a recent decision of a federal court.

A manufacturer of cigarettes published an advertising pamphlet in which it paraphrased three sentences from a book on the human voice written by a prominent physician. The paraphrased portion of the pamphlet read as follows:

"Statistics have it that 80 percent of physicians are smokers * * * It appears unanimous that smoking is not nearly so injurious as over-eating * * * From my experience with ear, nose and throat cases, I firmly believe that tobacco, when properly used, has no ill effect upon the auditory passages."

The copyright proprietor brought suit for copyright infringement, alleging that the publication of the pamphlet had cast reflections upon the professional ethics of the physician and had retarded the sale of the book. The cigarette manufacturer contended among other things that only an insignificant part of the copyrighted book, that is, three sentences, had been copied, and that in any event the pamphlet contained suitable acknowledgment of the source from which the material had been taken. Because of this it was argued by the cigarette manufacturer that the pamphlet could not be construed as infringing upon the copyright. The court rejected both of the defendant's contentions, pointing out that even though the three sentences in question only formed a small part of the copyrighted book, they formed an important and material part thereof. In this connection the court stated:

"In order to constitute an infringement of the copyright of a book it is not necessary that the whole or even a large portion of the book shall have been copied. It is sufficient if a material and substantial part shall have been copied, even though it be but a small part of the whole."

With regard to the acknowledgment the court stated:

"While the acknowledgment indicates that it did not intend unfair competition it does not relieve the defendant from legal liability for the infringement."

Unloading

WE have pointed out before that where an inventor discloses his invention in confidence prior to the granting of a patent he can recover damages from the confidant if the confidence thus reposed has been abused. This principle has been reaffirmed in a recent rather important case.

In the case in question a railroad corporation requested bids for the construction of car-dumping apparatus used for loading coal on cargo vessels from railroad cars. One of the bidders, the plaintiff in the case under consideration, submitted in connection with his bid a drawing and description of car-dumping apparatus which bore the following notice: "This drawing is the property of R. W. Kaltenbach Corporation. It shall not be copied or duplicated in any manner, and shall not be submitted to outside parties for examination without our consent. It shall be used for reference to work under contract or proposals submitted by this corporation only."

Thereafter the railroad company awarded the contract for the construction of the car-dumping apparatus to another bidder. It was contended by the plaintiff that the drawings submitted to the railroad company showed certain important new features; that the drawings were submitted in confidence as shown by the notice; and that the railroad company violated the confidence and arranged for the manufacture of apparatus embodying the plaintiffs' new features. At the time that the apparatus was constructed for the railroad company the plaintiff did not have any patents covering it. However, thereafter he obtained two patents covering the apparatus and brought suit against the railroad company charging patent infringement and breach of confidential relationship. The Court found that the apparatus constructed for the railroad company did embody the new features developed by the plaintiff and which were submitted to the railroad company in confidence and held that the railroad company had infringed plaintiffs' patents and also had breached the confidential relationship existing between the bodies prior to the granting of the patents. The plaintiff accordingly was awarded damages on the theory of patent infringement subsequent to the granting of patents and on the theory of breach of confidence prior to the granting of patents.

In support of its decision the Court quoted an opinion in a prior case as follows:

"Under such circumstances, we think that defendant should account to plaintiff for the profits realized from its sale of the infringing device prior to the grant of plaintiff's patent, not under the patent statutes, but under the long-recognized principle of equity that no man ought to be allowed to enrich himself unjustly at the expense of another."

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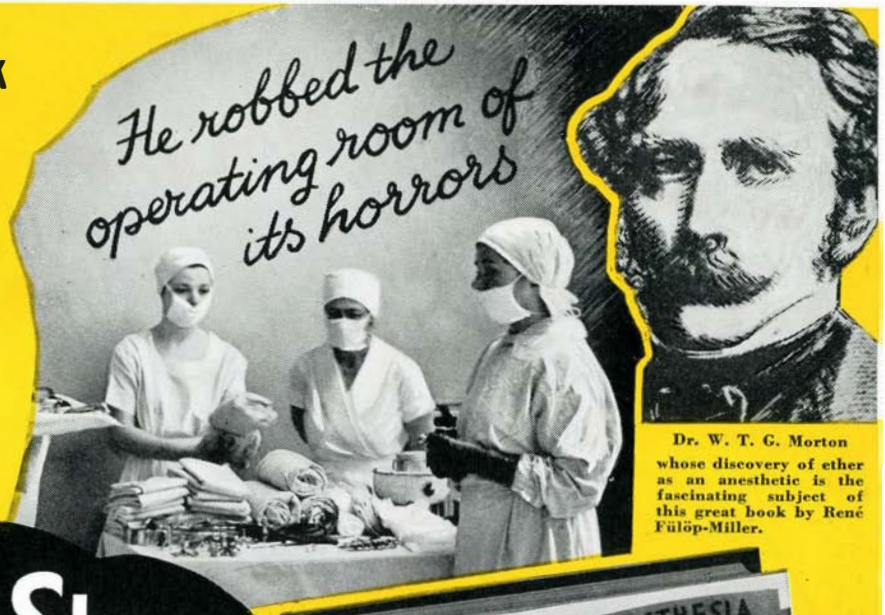
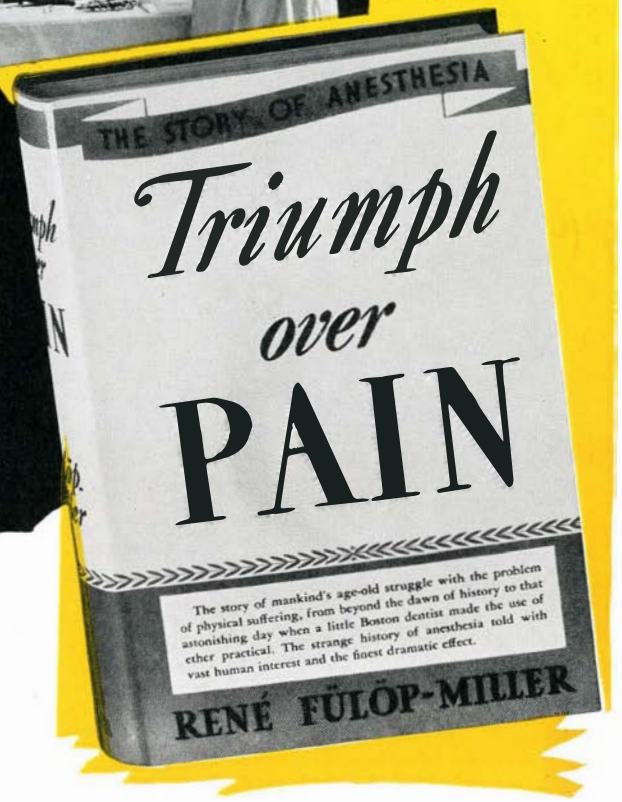


Dr. W. T. G. Morton whose discovery of ether as an anesthetic is the fascinating subject of this great book by René Fülöp-Miller.

The Amazing Story of ANESTHETICS

--and of the Boston Dentist who discovered how to conquer surgical agony



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