EPIDEMIC CONTROL: By G. H. Estabrooks

SCIENTIFIC AMERICAN

December · 1937

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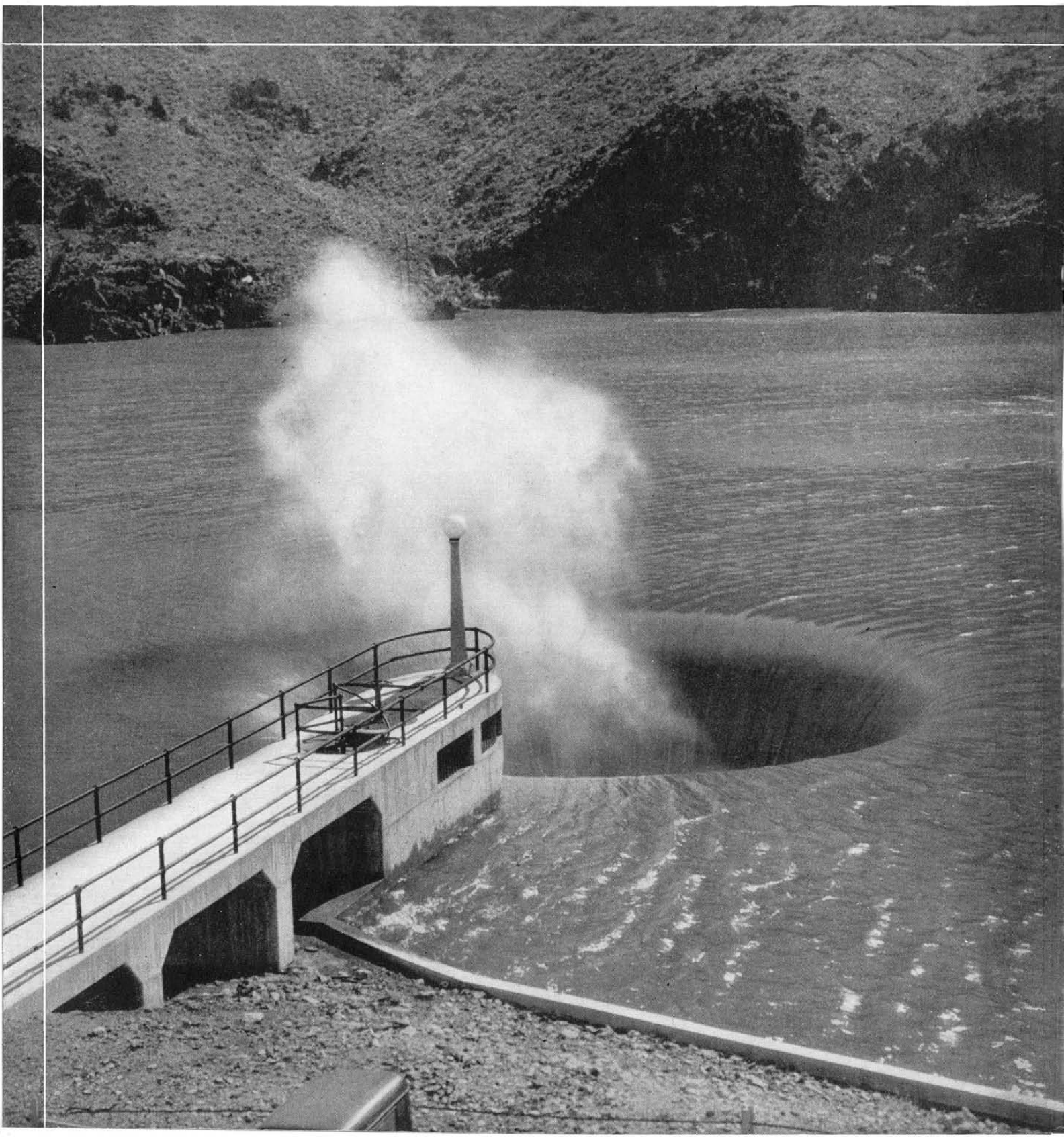

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SCIENTIFIC AMERICAN

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NINETY-THIRD YEAR • ORSON D. MUNN, Editor

CONTENTS • DECEMBER • 1937

THIS month's front cover, reproduced by courtesy of the Bureau of Reclamation, United States Department of the Interior, shows water pouring into the Owyhee Dam spillway at the Owyhee project, Oregon-Idaho. The rising spray is caused by the updraft of air from the huge spillway opening.

INDEX TO VOLUME 157

A COMPREHENSIVE index, carefully cross-referenced, for issues of Scientific American from July to December 1937 inclusive, is available in the form of a four-page pamphlet identical in size with the magazine. Copies of this index, suitable for filing or binding, may be obtained by addressing the Editor and enclosing a three-cent stamp.

The SCIENTIFIC AMERICAN DIGEST

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50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of December, 1887)

CANAL—"The proposal made by M. De Lesseps in his letter to Premier Rouvier will not fail to interest those who have followed the progress of his scheme for an interocean canal at Panama. After an expenditure of nearly three times the sum originally estimated by him as sufficient to build a surface level canal, he now asks the French government to authorize him to raise $113,000,000 additional by a public lottery, to enable him to construct a lifting lock canal. It would seem from this that unless the French people subscribe a sum which, with what has been expended, will raise the cost of the canal to the extraordinary total of nearly $500,000,000, the project of a canal at Panama must be abandoned."

FOR CELLAR FIRES—"The Paulin cellar-fire apparatus (used by the Paris fire department) consists of a suit like that used by divers, which allows a fireman to enter a cellar in which the air has been rendered irrespirable by a conflagration. . . . The fireproof suit consists of a leather blouse, fastened at the waist and wrists with ligatures, and provided with a hood and iron mask. The air necessary for respiration is introduced through an aperture in the back of the suit, by means of a rubber tube of great length. The blouse is very roomy, and allows great liberty of motion."

FROGS—"Almost all the frogs used for experiments in vivisection in the European universities are supplied by an old fisherman of Kopenich, who, for forty-five years past, has devoted himself to this pursuit. Sometimes he has succeeded in catching as many as a thousand in one night." (*Sic.*)

SALT—"In the Colorado desert, near Idaho, there is a large bed of rock salt, and the Southern Pacific Railroad, in laying the track to the salt bed, has been obliged to grade the road for 1,200 feet with blocks of these crystals. This is the only instance where a roadbed is laid and ballasted on salt."

NITRO-GLYCERINE SHELLS—"At Sandy Hook, recently, Serge D. Smolianinoff made experiments in firing nitro-glycerine from a 100 pound Parrot rifled gun, using eighteen pounds of service powder for a shot. The shells used were of about ninety-two pounds weight, and were charged with five pounds of nitro-glycerine each, and provided with the inventor's igniter. . . . Only three shots were made, further experiments being prevented by darkness. . . . With these three shots Mr. Smolianinoff has to his credit 327 shots, all of which are said to have been successful."

POWER—"Four-fifths of the engines now working in the world have been constructed during the last 25 years. . . . The steam engines of the world represent approximately the work of 1,000,000,000 men, or more than double the working population of the earth, whose total population amounts to 1,455,923,000 inhabitants."

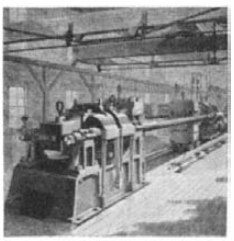
WIND—"Mr. Max Nicolaus, editor of the *Avalanche*, Sauk Center, Minn., has two job presses run by a windmill. . . . Wind is an important agent in the running of political newspapers, especially about election time, but its employment in such prosaic service as doing useful commercial printing is, we believe, quite exceptional."

WELL—"The deepest well drilled in the United States is that of George Westinghouse, at Homewood, near the city of Pittsburgh, which had reached a depth of 4,618 feet, when the tools were lost and drilling ceased."

INTROVERT—"In any line of business, the man who uses reasonable economy and has the ability to give fair management and the perseverance to hold on will, in a great majority of cases, make a success; while, on the other hand, the one who rushes into whatever he has undertaken with a spasmodic endeavor to win all at once, as a general rule wastes his energies and often fails for sheer want of perseverance."

CATAMARAN—"A steam catamaran, intended for whale and walrus hunting in the Arctic regions, is being built at Montreal, Canada. It has two steel cigar-shaped hulls, each sixty-five feet long, and built in two compartments, one for water ballast, and the other to carry petroleum for fuel. The catamaran is constructed so that it may be taken apart for transportation on the deck of a whaler."

TESTING—"The great testing machine at the United States Arsenal at Watertown, Mass., in the environs of Boston, is properly considered one of the engineering triumphs of its day. A machine which will break by tension a five inch bar requiring 350 tons stress, and immediately after the strain and shock of recoil due to this performance will break a horse hair, and indicate perfectly the required rupturing tension of one pound, must be mechanically perfect. . . . The machine works by hydraulic pressure for heavy strains, while for light ones, and especially for such as require a very large range for stretching or contracting, screw power can be effectively applied. . . . Elaborate sets of calipers and all necessary accessories are supplied for testing elongation under stress, and other factors and data."



PHONOGRAPH—"A very interesting and popular use of the phonograph will be the distribution of the songs of great singers, sermons, and speeches, the words of great men and women, music of many parts, the voices of animals, etc., so that the owner of a phonograph may enjoy these things with little expense."

KEELY—"Mr. Keely, the man whose motor was to revolutionize the machinery of the world, is hardly off with the old force before he is on with the new. At a meeting of the stockholders of his company in Philadelphia, Mr. Keely explained that, while experimenting with his etheric or vapor force, he has run against another form of energy, the properties of which are so captivating as to cast into shade those of his first enchantress." [The Keely motor was a famous fraud.—*Ed.*]

AND NOW FOR THE FUTURE

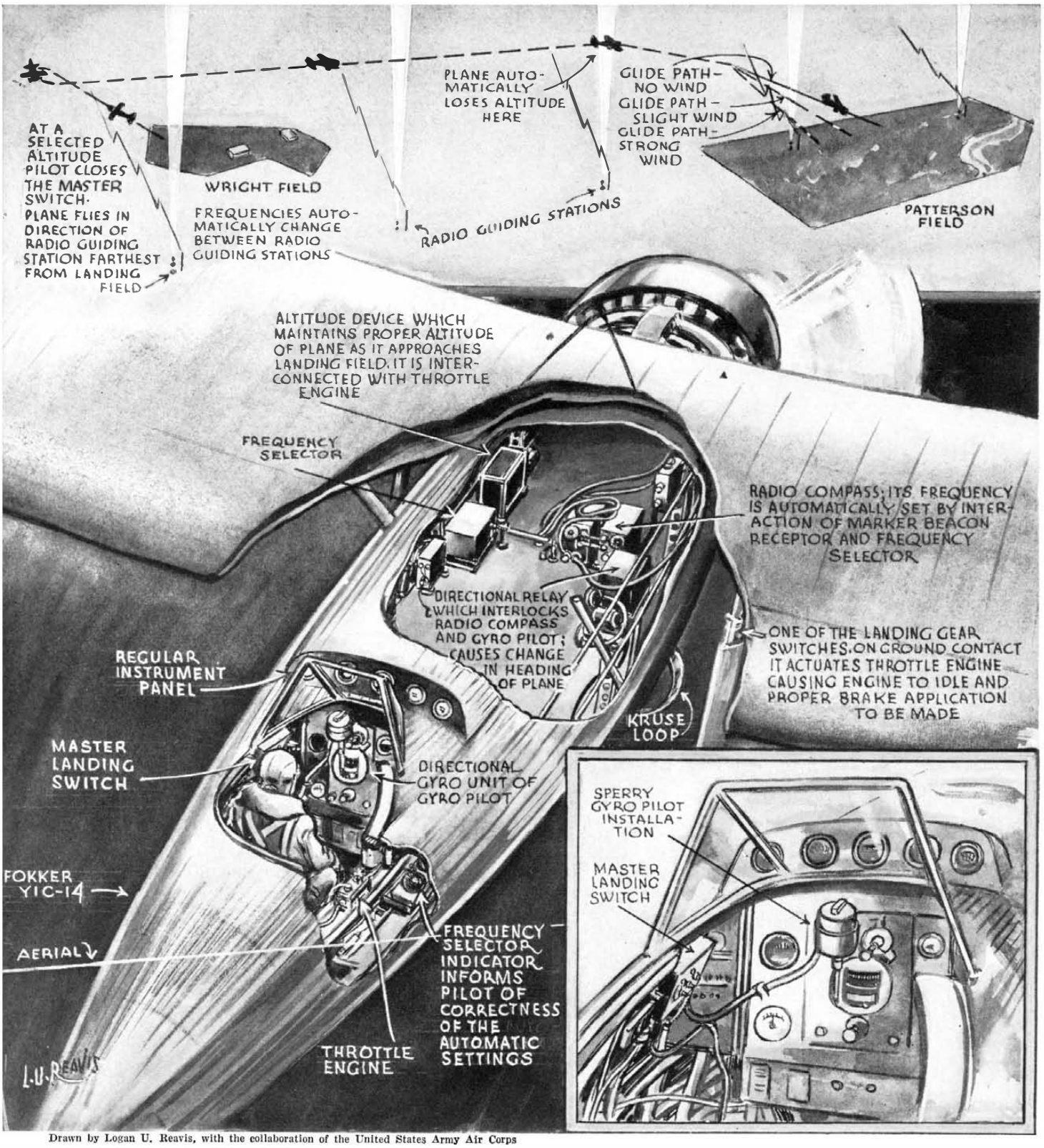
¶What can be done about the rare and vanishing species of American wildlife? By Ira N. Gabrielson, Chief, Bureau of Biological Survey.

¶Abrasives make precision products, by Philip H. Smith.

¶Birth of a plastic—told in photographs.

¶Clean air to aid many industries, by John F. McMahon.

¶The concluding installment of the life and death of Ra-mose and Hat-nufer.



Drawn by Logan U. Reavis, with the collaboration of the United States Army Air Corps

AUTOMATIC LANDING FOR AIRPLANES

AN automatic landing system for airplanes, wherein the plane, without human contact with its instruments, literally finds its own way to the landing field and makes a safe landing, has been designed and reduced to practice by a group of engineers co-operating with the Army Air Corps. Making use of radio guiding stations that control the heading and altitude of the plane through a Gyro-pilot and the speed of the engine through a small throttle engine, the system has been put through a rigorous series of tests, many of which were conducted under moderately rough air conditions. The operation (see illustration) is briefly as follows: The pilot brings the plane within range of the landing field's radio facilities and to a certain altitude as indicated by a sensitive altimeter. He then closes the master landing switch and automatic control is established. Responsive to the successive frequencies of the guiding stations, the various units take over their own particular functions and bring the plane to a landing at an angle that depends upon the resistance of the wind. The drawing gives additional operating details of this promising system.

One of the sleeper *Mainliners* used in the overnight coast-to-coast service

AIR TRANSPORTATION

1927 1937 The Future

Transcontinental Flying Time Cut by More Than 50 Percent . . . Research and Experience Have Vastly Increased Safety and Comfort . . . Things to Come

By BOB JOHNSON

ALTHOUGH the beginning of scheduled flying in the United States can be traced back to pre-War days, when optimistic airplane operators launched the nation's first airlines on a small scale, and although the maintenance of regular air schedules invaded the coast-to-coast field as early as 1920, when the Post Office Department completed its pioneer mail route across the country, the inauguration of regular air travel between the Atlantic and Pacific came in September, 1927. It was then that commercial companies took over the operation of scheduled airmail and simultaneously provided facilities for passenger service across the New York-Chicago-California airway.

At the beginning of air transportation's first decade, pioneer air travelers rode across the continent in single-engined mail-passenger planes which required 33 hours to complete the 2700-mile journey. Today the same route is flown with giant twin-engined airliners in 15 hours. Thousands of persons now make the cross-continent flight in a routine manner during a single month, as against the adventurous baker's dozen who essayed that trip ten years ago.

As air transportation enters upon its second decade, one has only to contrast today's operations to the pioneering service of 1927 to foresee the progress which airlines may reasonably be expected to achieve during the coming ten years.

In reviewing air transportation in this country it is evident that technical development must receive a major share of the credit for the growth in air travel which has resulted in the carrying of a million and a quarter passengers on regular airline schedules during 1937. In 1927 flying was still in its "helmet and goggle" days, and the operation of an airline depended principally upon the pilot and his airplane, with the emphasis upon the pilot. The immediate problems which confronted the airline operator included lack of communication between planes and the ground, absence of organized weather observing and reporting systems, lack of adequate instruments for accurate air navigation, limitations of airplanes in cruising range, and limitations of aircraft powerplants in maintaining sustained operation and in functioning efficiently at high cruising altitudes free from weather disturbances.

In ten short years technical research and development has contributed satisfactory answers to all these problems.

By developing two-way voice radio communication between planes and the

ground and by evolving the directive radio-range system of marking airways, radio engineers of airlines and manufacturers made two of the greatest contributions to the dependable operation of airliners.

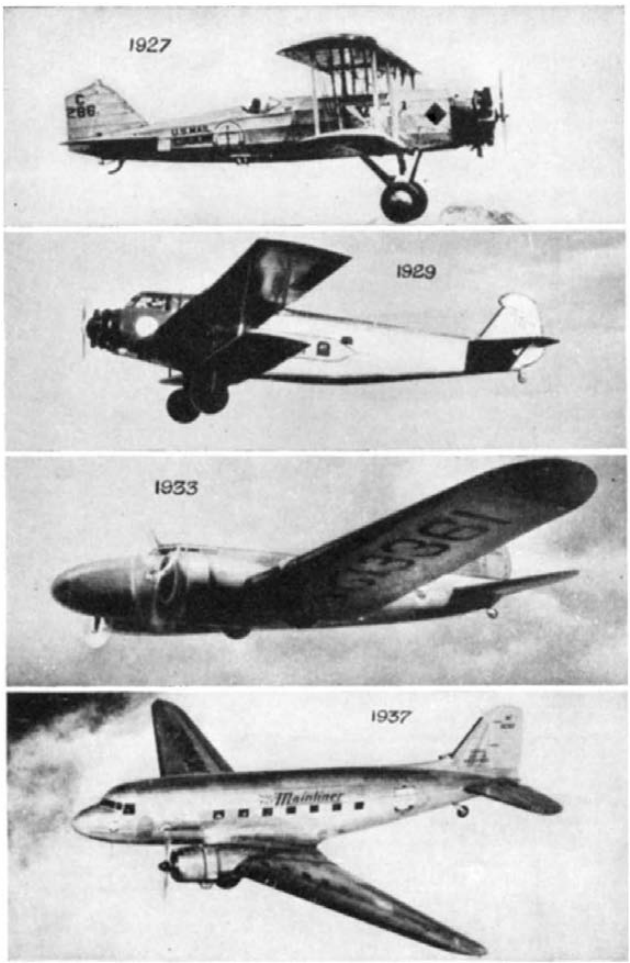
The combined forces of the Department of Agriculture, Department of Commerce, and the airlines themselves established a systematic organization for observing, reporting, and analysing weather that not only has placed the handling of airway weather conditions on a scientific basis, but likewise has made important contributions to the knowledge of weather in general.

In addition to the aid to air navigation of the radio marking of airways, instruments have been developed to the point where the "art" of flying has been changed to the "science" of flying.

THE airplane of 1927 was required to make 14 stops during a trip from coast to coast, while today's transports are required to make only three stops and can actually cross the continent with only two stops, because of their great reserve cruising range.

While mechanical forced landings on account of engine trouble were relatively frequent during the pioneering days, they are now almost non-existent; for, in addition to mechanical excellence of modern engines and systematic methods of routine overhaul, today's airliner can sustain flight with only one of its two engines in operation. Supercharging of these engines makes it possible to operate schedules at cruising altitudes approximating 10,000 feet, clearing the low overcast conditions which hampered early-day operation and avoiding the turbulent air conditions that prevail at low elevations and which were responsible for considerable discomfort to passengers during the first years of cross-continent flying.

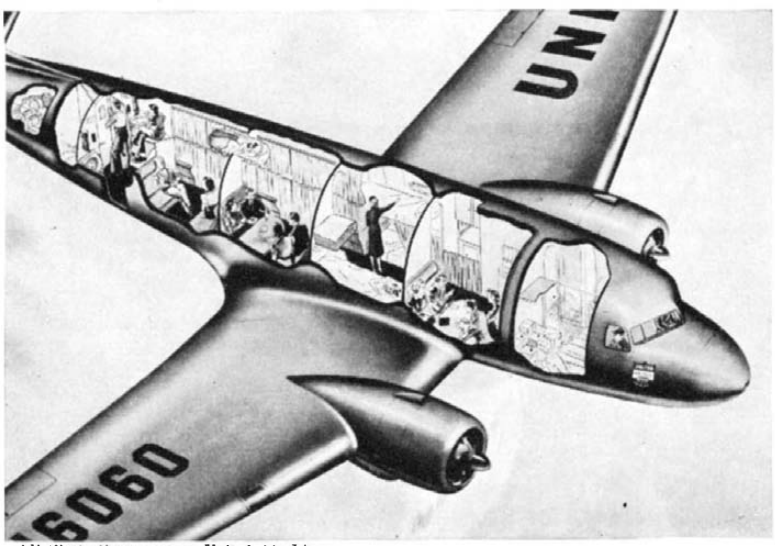
While the task of technical advancement in scheduled air transportation has been complex, the efficient operating records established by airlines of today represent a tribute to the engineers of the lines and companies allied with the industry, in bringing under control the natural and mechanical elements which presented obstacles to the efficient maintenance of schedules. As the airlines enter upon the second decade of coast-to-coast air transportation there is no tendency to relax the efforts to advance the science of air transportation; this is going forward steadily in the directions both of refining present facilities and of solving those technical problems which remain. As a matter of fact, the year 1937 is noteworthy for several outstanding contributions to the technical progress of the industry. From the airport and flying laboratories of the airlines have come two major projects during the year, with others well under way.



Ten years of progress in coast-to-coast airliners: a two-passenger plane with which the service was inaugurated 10 years ago; a tri-motored transport; a low-wing twin-engined monoplane; and one of the latest *Mainliners*

ONE significant problem which confronted air transportation at the beginning of 1937 was the so-called "snow and rain" static which stood in the way of positive use of such radio facilities as the short-wave equipment for voice communication between planes and the ground, the long-wave radio range and radio marker systems, and the airport approach facilities. This problem was not so acute during the earlier years of flying but, with the advent of the current three-mile-a-minute all-metal transports, it became so serious that efforts were concentrated on its solution. The accepted theory was that the impinging of electrically charged particles of moisture and dust on the surfaces of airliners created the natural static which interfered with clear reception of radio signals and at times even blocked them out, and it was believed that with the substitution of metal skin as the covering for airplanes, in place of the fabric used on earlier planes, this situation had been aggravated. Efforts to shield antennas against the static proved only partially successful. Then United Air Lines assigned its flying laboratory—a conventional Boeing *247-D* twin-engined passenger airliner with its cabin converted to a regular laboratory—to the project of developing a more positive method of eliminating the trouble.

For three months during the late spring of 1937 this plane hunted static. Under the direction of a communications engineer a party of airline technicians, radio equipment man-



All illustrations courtesy United Air Lines

An artist's conception of a modern sleeper plane in flight, showing the comfortable arrangement of compartments and berths in the fuselage

ufacturing representatives, and professors of physics studied the static problem on the very scene itself. They deliberately sought out the worst weather conditions, in order that when they completed their work, the steps they had taken to eliminate static would be effective under maximum conditions instead of the more moderate situations prevailing during 99 percent of scheduled airline operation.

The results of these experiments were revolutionary for they developed an entirely new fact—that static interference resulted from the discharge of snow and rain static from the airplane on which it had accumulated, instead of from the impinging of the electrically charged particles on the surfaces of the ship.

With the real cause of this trouble ascertained, the way was paved for the proper solution. This has come in the form of a static-discharge system comprised of trailing wires, by means of which the discharge of the static of the airplane is so controlled as to reduce its effect to a negligible point and thus insure constant and true reception of radio signals. This system is being supplemented with shielded antennas as well as the use of radio transmitters of greater power in order to permit a consequent lower volume regulation of receivers.

THE importance of this development lies in its insurance that the transport plane can fly from destination to destination over the established airway with its pilots able to use to the fullest extent the positive radio markings.

This leads to another obstacle remaining in the path of positive all-weather air-transport operation—accomplishing landings at airports under conditions of poor visibility. In the past, as today, airline operation has recognized ceiling and visibility limitations to safe landings at airports, and schedules are not operated when weather conditions do not conform with the safe minimums of ceiling and visibility. In fact, through the exacting weather reporting and dispatching procedures of the established lines, when conditions at a terminal destination are changeable and indications are that they might develop unfavorably beyond the limitations, no trips are dispatched unless alternate terminals with definitely favorable conditions are available. When conditions at the destination are such that limitations are definitely exceeded, trips are cancelled. The number of cases where such conditions are encountered is extremely small but, nevertheless, such conditions do exist and, therefore, airlines have not been able to achieve 100 percent all-weather operation.

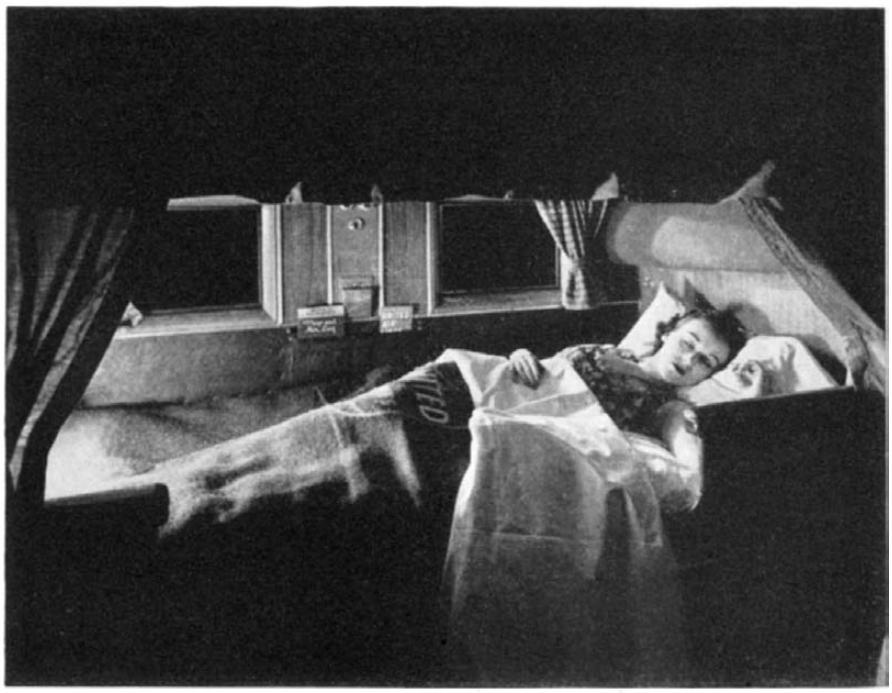
The answer to this problem was furnished during 1937 with the successful completion of years of experimentation of instrument landings. Since as early as 1919, research on this project has been under way and by 1929 concrete results were being obtained. During the following year several systems of instrument and radio landings were effected but none of them was completely satisfactory, with two difficulties generally being encountered. One was the failure to obtain a precise, constant, radio landing beam and the other was to overcome a certain amount of variation of landing procedure, chargeable to the human element.

The major airlines, working with an equipment manufacturer, took the best features of the systems then in existence and overcame the difficulties by using an ultra-high-frequency transmitter for the transmission of the landing beam signals and by applying the automatic pilot to obtain uniform landing procedure. Thus, in the late summer of 1937, members of the Radio Technical Committee for Aeronautics, engineers representing airlines, manufacturers, the Army, Navy, Bureau of Air Commerce, and other interested agencies assembled at the Oakland Municipal Airport to observe a system on which several thousand automatic landings of conventional type transport planes had been effected.

This system fundamentally involves these factors: An ultra-high-frequency runway localizer and glide path, ultra-high-frequency radio markers identifying points at regular intervals on the approach to the airport itself, and satisfactory visual and aural indicating facilities.

In actual operation the pilot of a transport plane equipped with an instrument landing system approaches the field and bisects the glide path and the signals of the runway localizer at a point approximately five miles from the boundary of the field and 1500 feet above the terrain. Maneuvering his plane

A United States Weather Bureau airway station. Efficient weather reporting and analysis are important in dependable airline operation



Solid comfort aloft. The comfortable berth in one of the modern sleeper planes of United Air Lines is six and a half feet long, and as wide as a standard twin bed

Introducing the extra-fare note in air travel, the *Skylounge Mainliner* offers the luxury of 14 swivel chairs in a cabin that is large enough for 21 standard seats

so that the indicators show it is exactly on the glide path and aligned with the airport runways, the pilot throttles back to a speed of in the neighborhood of 90 miles per hour and either engages the automatic pilot to hold the plane in its exact position on this course, or controls the plane himself in a similar manner, and then literally follows the radio signals to a complete landing.

THE application of the landing system to regular scheduled air transport is still a matter of many months or even two years in the future. Its installation on the airways will, in all probability, be undertaken by the Bureau of Air Commerce in order to obtain a uniform system at all fields on the Federal airways network. Following the installation there will be a period of pilot training to familiarize all flying personnel with the operation of this system. Until these preliminaries are satisfactorily accomplished, the landing system will not be applied to scheduled flying. However, the obstacle of so-called blind landings has been successfully overcome and it is only a matter of time until the benefits of this development will be reflected in an even higher record of safely completed flights on the established airlines of this country.

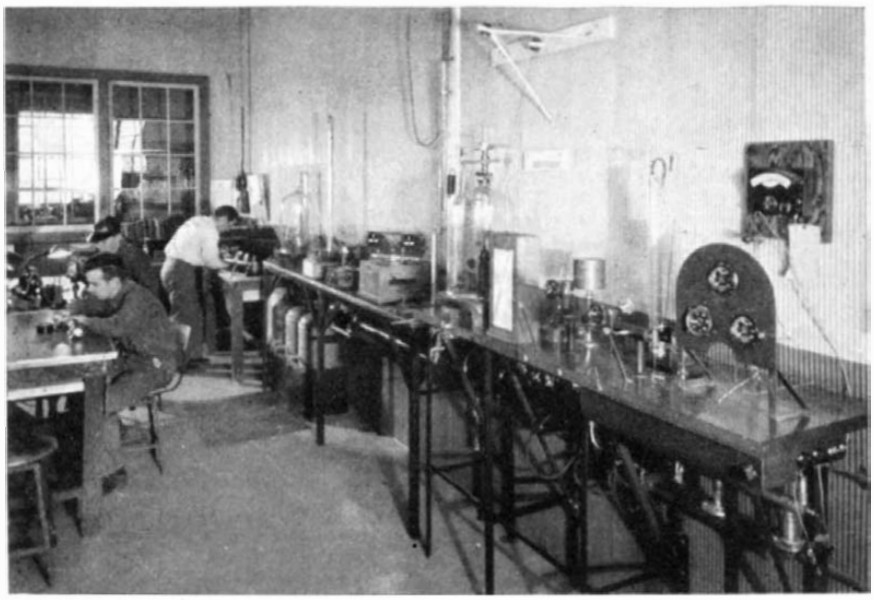
These developments clearly mark the path which airlines are taking to achieve automatic flight. As a matter of actual record, the use of automatic pilots, which are standard on the major airlines, has progressed to the point where the Gyro-pilots actually control the physical flight of the plane on as high as 85 percent of scheduled flights across the airways. The human pilots control the planes during take-offs and landings, but during the flight at cruising elevations, the automatic pilots relieve them and allow more time for the actual navigation of the course, the regulation of the power-plants, and other details incident to flight.

With the adoption of instrument landings it is apparent that the mechanical end of the operation of airplanes can become virtually automatic, and this step will bring to a completion the evolution of airline operation from a matter of flying to one of navigating.

Still another development which is now in progress and which will contribute much to the positive navigation of planes across the nation's airways is that of ground direction-finding systems. Until recently the work on direction-finding equipment for land planes has been confined largely to experimentation with aircraft direction-finding equipment, the installation of such equipment being on the airplanes themselves and the burden of their use on the pilots. In order to achieve a more positive system, engineers are now at work on ground direction-finding equipment, and while this engineering is still in its early stages, indications point to a successful completion of this project early in 1938, which should result in a method of locating the positions of planes in flight over the airways that will be both instantaneous and automatic.

HERE, then, is another achievement of airline engineers to control air navigation scientifically and further to reduce the human element. Meanwhile, the results of years of planning on the part of airline and factory engineers are being manifested in the imposing 4-motored *DC-4* project now well into actual construction at the Douglas Aircraft factory at Santa Monica, California. This 40-passenger 65,000-pound giant of the airways will be test flown in 1938. It represents the engineering experience and specifications of five major airlines—United, American, TWA, Pan American, and Eastern—as well as the engineers of the factory.

When one appreciates the swift progress which was achieved in air transportation during the first decade, from the small, poorly equipped single-engined plane of 1927 to the scientifically operated 12-ton airliners of today, one realizes the futility of attempting to forecast the status of air transportation in 1947. But the *DC-4* is tangible evidence of where air transportation is going. This giant plane should be in service in 1939, and with the requirement that it be able to fly on any two of its four motors and with its great cruising range, coupled with the many engineering requirements which have been built into its specifications, this project points the way to even greater dependability of operation.



The inspection department at an airline base, where servicing and maintenance methods are tested and checked to insure efficient performance on schedule

As the Camera Sees it

STRIKINGLY illustrative of the difference between photographs taken on ordinary negatives and those made on special negative material that is sensitive to infra-red rays, the pictures above and below were taken within a few minutes of each other, under identical conditions of lighting. Both exposures were made with the same camera and lens; the view is from the slope of Mt. Hood, Oregon, looking south, with Mt. Jefferson on the skyline 48 miles away. The photograph above was made on a type 1-R infra-red plate with a Wratten "A" filter, exposure four seconds at F:16. The one below was taken on Commercial Ortho cut film with a Wratten K-2 filter, exposure 1/5 second at F:16.—*B. W. Leroy.*

RA-MOSE AND HAT-NUFER*

(*In Three Parts—Part Two*)

Woman's Rights in Ancient Egypt . . . Hat-Nufer's Mummy Glittered with Rings and Scarabs but Her Husband, at Time of Burial, Was Out of Funds

By AMBROSE LANSING
Associate Curator of the Department of Egyptian Art of the Metropolitan Museum of Art; In Charge, Metropolitan Museum Excavations in Egypt

and WILLIAM C. HAYES
Assistant Curator of the Department of Egyptian Art of the Metropolitan Museum of Art

THE tomb entirely cleared, we set ourselves to the long and interesting task of opening the coffins, boxes, and baskets, noting their material, construction, and so on, and thoroughly investigating their contents—a series of operations carried out in the workroom, under the watchful and infallible eye of Burton's camera.

Ra-mose's coffin was the first opened—not without misgivings as to its contents, for the coffin itself is of mediocre quality, enriched only by the thin gold foil with which the face, throat, and ears are covered. Four wooden pegs fastened the lid in place, but they were provided with rounded heads and were easily withdrawn, allowing the lid to be removed without difficulty. Our pessimism was more than justified, for, with the exception of Ra-mose's disjointed skeleton, packed in a mass of mud and gravel and wrapped in layers of linen sheets (including an old shirt) and bandages, the coffin contained not a single object, funerary or otherwise. Two of the bandages were marked in ink with the cartouche of the Princess Nefru-Rē, daughter of Hat-shepsut and Thut-mose II, a fact which indicates that, as in most of the other burials in the tomb, some of Ra-mose's linen was drawn from the royal store. An examination of the skeleton showed that Ra-mose, short and lightly built, was an elderly man. His head, crowned by long, wavy hair, still dark brown in color at the time of death, is of intellectual type, with high, vertical forehead and great breadth across the back of the skull.

The poverty of the burial of Sen-Mut's father, whom we should have expected to surpass all the other occupants of the chamber in the quality and the extent of his funerary equipment and personal possessions, is perhaps the most striking feature of the contents of the tomb. Clearly, the style with which an ancient Egyptian was buried depended on his own state of prosperity at the time of his death rather than upon the filial piety of his children, which, however elaborately protested it may have been, did not, in this case at least, include the outlay of benefits of a material nature. Ra-mose was evidently not only an insignificant man but also an exceptionally poor man.

Hat-nufer's burial was another story. Sen-Mut's mother was clearly a lady of means and the fact that she was able to maintain her right of possession independent of her husband is an interesting commentary on the position and privileges of women in ancient Egypt.

Figure 9: **The coffin of Hat-nufer**

Her large and well-built coffin (Figure 9), "pitched within and without," is elaborately modeled to represent a mummiform human figure with the arms crossed over the breast and each hand holding a papyrus flower. The eyes are inlaid in ebony, alabaster, and obsidian, and the face and throat are covered with gold foil, which is also used to overlay the inscribed bands, the broad collar, and so on. Among the elements of the decoration added in paint are polychrome figures of the goddesses Nephthys and Isis on the ends of the coffin. Although lacking in fineness of detail, the coffin is a handsome monument, and its black and gold color scheme is most effective.

THE removal of its lid required considerable ingenuity, for an intricate locking device, which left no clue as to its nature or mechanics on the exterior of the coffin, held the cover and the coffin firmly clamped together. Four stout tenons shaped like inverted wedges, descending from the underside of the rim of the lid, could be removed from specially shaped mortises in the rim of the coffin only by first sliding the whole lid horizontally in the direction of the head end. To prevent this there was a wooden tumbler in the head end of the lid which, when the cover was originally lowered onto the coffin and subsequently slid into place, swung of its own weight down into a transverse mortise in the rim of the box and effectively checked any longitudinal movement of the lid. A good, heavy ax, much favored by our ancient predecessors in the art of opening coffins, would have solved our problem very simply. Actually, after a series of gentle soundings had revealed the secret of the system, a thin blade was used to push the troublesome tumbler at the head end up into its slot, and by means of this expedient the lid was removed without the slightest

*Courtesy the *Bulletin* of the Metropolitan Museum of Art.

damage either to itself or to the coffin.

Covering and surrounding the body in the coffin were 18 shawls and sheets of linen, some spread out over the top, some rolled, twisted, or folded into wads and packed tightly around the sides of the copiously wrapped mummy. Most of these were stuck in places to the pitch on the interior surfaces of the coffin, evidently still fresh and sticky when the contents were inserted.

WHEN the outer coverings had been removed, the mummy, fully wrapped, the head and shoulders incased in a gilt mask, was revealed, not sharply but through a filmy shroud of fine linen inscribed with funerary texts in black and red ink (Figure 10). Like those of the outer sheets, the edges of the shroud were stuck fast to the pitch on the walls of the coffin, which had to be softened before the inscribed cloth could be freed. This was accomplished with the aid of a chemical bearing the impressive name of orthodichlorbenzene and the shroud was salvaged in one piece, complete except for a few small portions which had become moldy and fallen to powder. It is inscribed with 51 vertical columns of cursive hieroglyphic, comprising two of the most ancient and most important spells, or "chapters," from the Book of the Dead: Chapters 72 and 17 (Figure 11). Both spells are recited here by "the honored one, Hat-nufer, the deceased," who, we now learned, was called "Tju-tju" for short—a nickname by which she was probably known among her friends.

The funerary mask (in Figure 10, right) is a hollow, cartonnage shell, composed of 11 layers of coarse linen cloth, coated inside and out with fine white stucco. The eyes are inlaid and the whole of the exterior is covered with gold foil. Unfortunately the linen body of the fabric was everywhere badly rotted, the whole mask slightly shrunken, and the foil very loose. In addition, the sides and bottom of the mask were stuck fast, not only to the unguent-drenched mummy wrappings, but also to the heavy coating of pitch on the floor and walls of the coffin. It was removed, only with the greatest difficulty, in two sections and has had to be extensively reinforced and restored for future preservation.

Figure 10: **The mummy of Hat-nufer before and after the removal of the shroud**

On the breast of the mummy, outside all the wrappings proper, lay a bundle, tied with a linen tape and consisting of two rolls of papyrus and a roll of leather. Owing to the extreme dryness of the climate of Upper Egypt it seemed wise not to attempt to unroll the papyri on the spot; but the larger roll is identified by a hieratic title on its exterior as a Book of the Dead, and the smaller was tentatively conjectured to be a Book of Emy Det ("He-Who-is-in-the-Underworld"). When found, both were complete and in good condition, as was also the leather roll. The latter was subsequently opened for inspection by the officials of the Cairo Museum, and its nature and contents are therefore known to us. The text is Chapter 100 of the Book of the Dead. It is accompanied as usual by a vignette depicting the deceased, in this case Hat-nufer, in the bark of the sun-god together with a group of four divinities who are described in the text as the

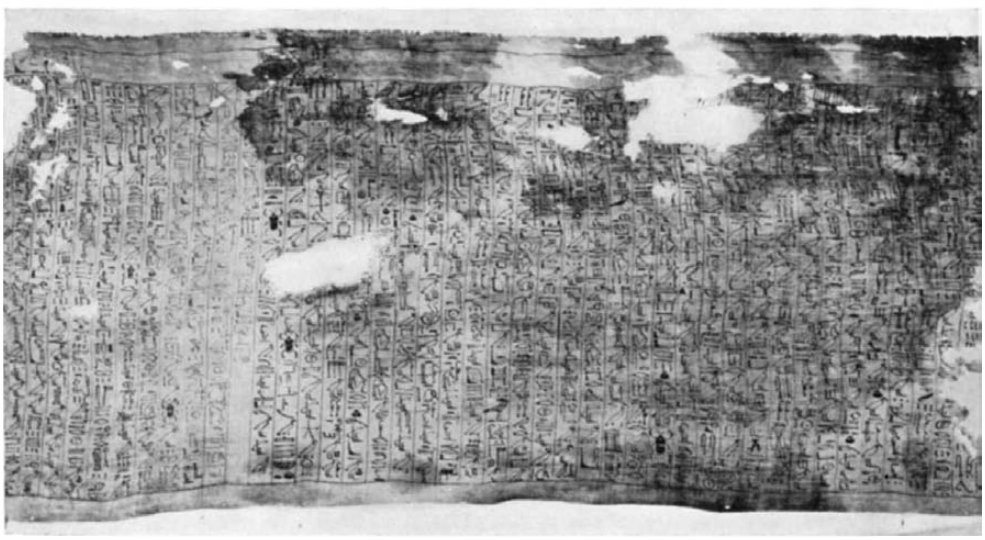


Figure 11: **A portion of the inscribed shroud of linen on Hat-nufer's coffin**

Figure 12: **Hat-nufer's heart scarab, which was worn like a locket, around the neck. At left is the back and at right the inscribed base worn next the chest**

"followers of Rē"—that is, of the Sun-god.

Lying over the throat and upper breast of the mummy, outside the wrappings but hidden under the front of the mask, was a heart scarab of hard green stone, set in a heavy gold mounting (Figure 12) and equipped with a suspension cord composed of innumerable, interlacing links of fine gold wire—a marvel of the Egyptian jeweler's art. Near this, over the right shoulder of the mummy, lay a small silver "pocket" mirror with carved wooden handle, less than 12 centimeters long over all.

THE well-preserved mummy of Hat-nufer was almost lost in a colossal bale of carefully applied linen wrappings. Four full days were taken up in recording and removing, one by one, the 14 sheets, 80 bandages, 12 pads, and four sets of trussing tapes which composed these wrappings. The body itself was clad in a loincloth composed of two linen shirts, their tops tied around the waist, the tails brought up between the legs and tucked into the waist loop. The

Portrait sketch of Sen-Mut. Others that were found showed the same pronounced lines about the mouth

Figure 13: **Hat-nufer's head**

head of the mummy (Figure 13) was adorned by two long, heavy rolls, or "switches," of false hair, each made up of an enormous number of fine, tapering braids of black, human hair, their upper ends braided into Hat-nufer's own sparse, gray locks on either side of the crown of the head, the mass of the rolls falling down over the ears and ending in flat, spiraled disks on the upper breast.

Hat-nufer's left hand and wrist glittered with signet rings and scarabs (Figure 14). The rings, three in number, were worn on the second, third, and fourth fingers. Their bezels—two scaraboids and a button seal—are of blue-glazed steatite, the rings themselves and the swivel mountings being of gold and silver. One of the scaraboids has the figure of a scorpion engraved on its underside. The designs on the other two bezels are purely decorative patterns. A fine blue scarab, tied by a loop of string to the thumb of the same hand, bears the personal name of Hat-shepsut accompanied by the title "God's Wife," a title which she bore as crown princess or as queen of Thut-mose II. Another scarab, with dark blue glaze and displaying on its underside a complicated linear design, had been tied to the wrist with a length of linen cord.

Hat-nufer was an old woman at the time of her death. Short and, though delicately boned, distinctly fat, she was pathetically unlike the slender and graceful young woman depicted in the tomb of her son.

It is safe to assume that, with the obvious exception of the two rectangular coffins, all the remaining objects from the tomb, including the Canopic chest, were the property of Hat-nufer. None bears the name of its owner, but a number of pertinent considerations make the foregoing assumption reasonably certain of accuracy. That the objects formed one group and belonged to one person is indicated by the fact that there are no real duplicates among them. True, there are seven baskets, three boxes, three alabaster jars, seven pottery jars, and six pottery dishes, but these had no individual use except as containers, and one person could have possessed 50 of each, if the commodities supplied to him (or her) required as many containers. The whole group of objects, on the other hand, includes only one Canopic chest, one razor, one pair of sandals, one kohl jar and stick, one

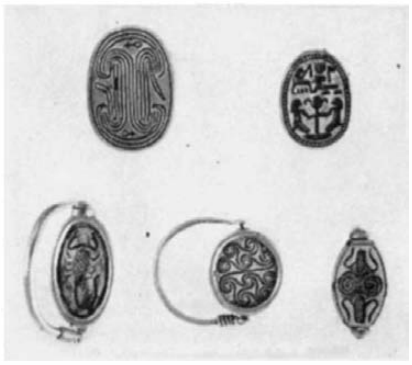


Figure 14: **Gold and silver scarabs from the left hand of Hat-nufer**

pillow, one set of silver vessels, and one bead necklace. All are appropriate to a woman, and, of all the burials in the tomb, Hat-nufer's is the only one rich enough to be consistent with the ownership of this large group of fine articles. What few objects the occupants of the rectangular coffins possessed were found on their bodies; and, since Ra-mose was evidently too poor to own even the essential items of funerary equipment and personal adornment usually found in the coffin or on the body, it is unlikely that he had a share in such extraneous luxuries as boxes of spare linen, store jars of precious oils, fine toilet articles, and the like.

(*To be concluded*)

OUR POINT OF VIEW

"Thar She Blows!"

THANKS to the common sense and co-operativeness of 11 governments representing both the economic interests of the whaling industry and the broad interest of science in the preservation of our remaining fauna, that valuable and ever-fascinating aquatic mammal the whale, by far the hugest bulk of animate flesh this old earth has known at any period, is now probably saved. The world will know the definite answer within a few years.

Last summer, after protracted meetings, the delegates of the whaling nations—Norway, those of the British nations which do whaling, the Irish Free State, the United States, and Germany—came to an agreement which is to be tried out for at least one year. Game laws are now to be applied to whales. Since the participants have known that with present methods an early extinction of their source of living was in clear sight, the chances are that the agreement will be made to work and that it will be extended from year to year. These game laws of the international whaling industry are to go into effect in the most important area of that industry, the Antarctic regions, on December 8, and whaling will continue only until March 7 when a closed season will begin.

Some species of whales are to be protected completely: right whales, gray whales, cow whales with calves, and immature whales. To cramp the style of the greediest individuals and save the whales to propagate more, the pay of the gunners who perch on the foredecks of the modern steam whalers and shoot the Svend-Foyn gun with its 100-pound harpoon that carries an explosive bullet, is no longer to depend merely on the number of whales they kill. Moreover, whaling vessels must now keep full records of all whales killed.

In general, there are two kinds of whales—those that have teeth and can use them fiercely, and the great toothless hulks which feed wholly by sifting vast volumes of water through whalebone sieves in order to obtain its content of those tiny forms of life collectively called plankton and found in special abundance in the waters of the Arctic and Antarctic because these cold waters are the richest in nutrient salts. That huge chunk of frenzied fight, the sperm whale or cachelot, the familiar fellow with the high forehead and a head that runs a whole third the length of his body—the ugly one with huge jaws that crush boats in the illustrations of sea stories, and which could easily have swallowed Jonah—may not be killed if less than 35 feet in length, and the female of this species may not be killed at all. The famous blue whale, known as the sulfur-bottom when its body is covered with diatoms—a regular *whale* of a whale, and, in fact, the largest whale of all, with a mean size of about 75 feet—must first reach a length of 70 feet before it is now eligible for the kill. This is one of the sieve feeders, with a bulk sometimes of 85 tons and with room inside to stuff three jumbo elephants plus the largest dinosaur that ever lived. Yet it is supported wholly on near-microscopic mincemeat and its throat is so small that it would have choked to death on Jonah's head alone. Other restrictions prohibit, over vast areas of ocean, including the whole Atlantic north of Patagonia, the use of those too efficient, mechanized "floating factories"—steamships that skid killed whales up inclines into their opened maws and treat them on the broad seas.

Drastic restrictions, these. Yet they are the doctor's orders for the good of a very sick patient (has the modern gunner not killed 100 whales to the old harpooner's one?) and nobody knows it better than the whaling industry of the nations, except apparently Japan, which is the one important non-signatory.

Before these restrictions could be applied intelligently it was necessary to learn about the lives of whales. Here one might think the old whalers could tell us the whole story, but this is an illusion, for whalers have been interested in making their living, not in natural history. So two English vessels, the *Discovery* and the *William Scoresby*, have been patiently plodding up and down the seas for the past dozen years snooping everywhere into the ways of whales—their movements and migrations, their food, and their everything. They have marked 4000 whales with darts: another version of bird-banding, and with a similar purpose. More than 90 of these 4000 darts have been returned by whalers.

To strike a sane middle-of-the-road course between the dreams of the sentimentalists who would see none of our forests cut, and the hogs who would see none left, conservationists now regard trees in the light of a crop and aim to provide for the future—*enough.* So with the whaling conservationists—whales are to be run exactly as a crop, for there is little sentiment in the question. The purpose is simply to see that the whaling industry is provided with "enough" whales—the meaning of enough being expressed in permanent terms and not in those of a short-sighted decade or two. However, notwithstanding the lack of sentiment expressed by those practical men who have made the agreement, the world will applaud it also on sentimental grounds; for how could future generations of boys find whaling stories good meat if there were no more real whales plowing the wide reaches of the chill Antarctic seas? This, therefore, is game protection on a grand and romantic scale. May it save the whale from going the tragic way of the buffalo.

Are We Wholly Intelligent?

NOW that this past summer has brought a fine rainfall and a good crop in our Dust Bowl, everybody will forget all about the bitter experiences of the two recent droughts. The past is past and never can harm anyone, the present is not harming us, while the future isn't here yet, so why worry? Besides, maybe luck will run better next time. Maybe the scientists will find (?), before the next drought, some easy, artificial way to make it rain by pressing a button. Maybe none of us will be alive by then anyway. Maybe this or maybe that or something else; for haven't we present and real troubles enough of another kind? Shoo—go 'way—don't be a gloom. Forget it.

Human nature!

Man has occupied the Dust Bowl and observed its climate for about half a century, a long time in terms of one human being's span, but Nature moves on a vaster scale and generally in cycles. Often the cycles have smaller, shorter cycles within them, and the whole would form a kind of pattern or rhythm of climate, if only it really would form a rhythm and thus make itself predictable. Seeking to check on past performances, William Van Royen of the University of Nebraska has been digging up strata of earth which contain evidences of climatic changes long past and he finds proof of droughts that lasted whole half centuries. Such droughts doubtless will recur—why wait helplessly?

Now that we have been on this continent long enough to feel sure we like the place and will stay here, we really ought to study it closely and follow this with a few rational plans. One might be to confine our crops to the parts that are best for raising crops, and use the rest for other purposes. What we need is a permanent policy for these regions, to forestall repetition of sad experiences like the recent ones.

THE ROTATION OF

New Research Based on Planetary Nebulae Provides the Most Striking Evidence and the Best Picture of Galactic Rotation Thus Far Made Available

UNTIL about 30 years ago, it was generally believed that the sun, with its attendant planets, lay near the center of the Milky Way. This opinion was not based on any *a priori* assumption of the importance of our own position, but on what looked like good evidence. The stars, down to the limit visible in a two-inch telescope, had been counted and catalogued—almost a million of them in all. There were far more of them per square degree in the Milky Way than near its poles—showing that the stars were more thinly scattered in space in the latter direction. But around the circuit of the galaxy, the "star-density" with which they appear to be scattered over the heavens was substantially the same. Barring obviously local irregularities, there were as many in Cassiopeia as in the Southern Cross—in Gemini as in Sagittarius. It seemed reasonable then to conclude that the stars, in space, were distributed uniformly around us in the galactic plane.

But this conclusion was wrong—not because it did not make sense, but because there was an equally reasonable alternative. It was obviously true that the stars were about equally numerous in all directions (in this plane) *out to the distance to which we can see with a small telescope;* but, beyond this distance, our observations told us nothing.

When, early in the present century, studies and counts came to be extended to objects of great real brightness—such as globular star-clusters and novæ—which could be seen at great distances, it became very plain that these were not distributed uniformly along the Milky Way, but showed a marked concentration on one side of it, centering in the constellation Sagittarius, near the great clouds of very faint stars which are so conspicuous in our summer skies. Evidently, after all, the sun was far off center. Our earlier soundings of space had given the same results in all directions because none of them had reached bottom! They had not gone far enough, for example, to include any of the faint stars which form the great clouds. Had they done so, we would have realized that we were not at the center of things.

AT about the same time Barnard discovered the dark nebulæ—vast obscuring clouds which conceal the Milky Way behind—and it gradually became clear that these clouds were thick and black in the very direction of the galactic center, so that the star-clouds which we see were only at the edge of a great obscured region—which, if seen unobstructed, might far outshine them.

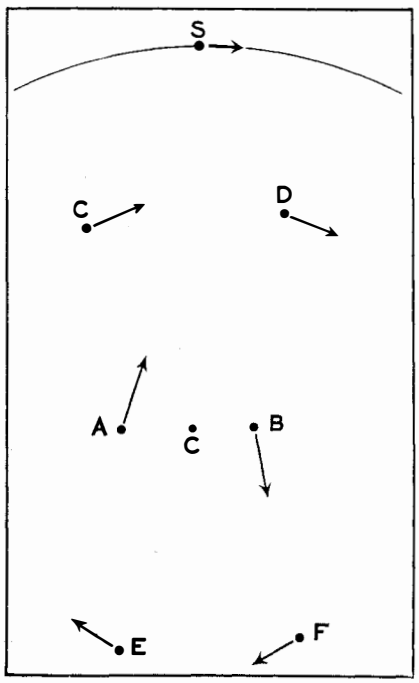


Figure 1: **Arrows represent the motions of bodies at different distances from center *C* of galaxy. Sun (with the earth, our viewpoint) is at *S***

Now a flattened, disk-like swarm of stars—or of any other things which are subject to their mutual gravitation—will not be permanent if the stars are at rest; the swarm will slump in toward the center. To keep it flattened, it must be in rotation around its own center. So it was morally certain that the galaxy must be rotating.

For a swarm of uniform density, the rotational velocity (in miles per second, not in years per revolution) would increase outward, so that the whole swarm would revolve almost like a solid block. Such a motion would be very hard to detect by observation. The distances of the stars from one another would not change—barring their random individual motions, which, for the sake of simplicity, we have so far ignored, and which the calculator has not much trouble in allowing for. Moreover, the rotation of the whole mass would be slow—not faster than one turn in 100,000,000 years—and (like that of the earth) it could be detected only by looking at something outside it. The remote spiral nebulæ would do for this purpose, but their exact positions have not been accurately enough observed in the past to detect such small apparent motions.

If, however, the galaxy had a strong central condensation, the chances of detecting its rotation are much better. In this case, the orbital speed of rotation grows faster near the center (as is true for the planets around the sun). Could we detect objects, as far off as the center, and measure their radial velocities, we should find them receding rapidly on one side of it, and approaching on the other, as at *A* and *B* in Figure 1. Those farther from the center would move slower and the effects, for points like *C* and *D*, would be smaller, especially as they would be partly "washed out" by the sun's own motion. For bodies near the sun there would be little difference from our own motion left over to measure. Finally, for bodies more distant than the center, like *E* and *F*, the effects would again be small—provided, indeed, that we could see them at all at such great distances.

NUMEROUS investigations within the last ten years have shown that (when averages are taken to clear out the random motions) the stars which lie on one side of the center in Sagittarius are actually approaching us, and those on the other side receding. For the nearer stars (out to 1000 light-years), the effect is small—showing that the region in which they lie extends to but a small fraction of the distance of the center. When the search is extended to 5000 light-years the effects are more pronounced, but even out to twice this distance there is little sign of that pronounced heaping up of high speeds on each side of the center which we should find if our study had extended to points like *A* and *B* in Figure 1.

This long-desired goal has at last been attained, by an investigation of bodies of a different type—the "planetary" nebulæ.

There is probably no more unfortunate name in astronomical literature

Our Galaxy

By HENRY NORRIS RUSSELL, Ph.D.

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

than this—though it was given by Herschel, one of the greatest of observers. Here and there in the heavens are roundish patches of greenish light, which look at first glance somewhat like the planet Uranus, whence the name. They are in reality utterly unlike planets in every way. They do not revolve about the sun, but are far off in space: they are not dense opaque bodies, but tenuous envelopes of faintly glowing gas: and, when carefully observed, they are not even round, but of more or less irregular outline. Their bright-line spectra (which closely resemble those of other gaseous nebulosities, like that in Orion), make them among the easiest of all objects to detect, and it is probable that our present list is very nearly complete (down to about the 14th magnitude). It includes not quite 150 of them, so that they are among the most unusual types known to astronomy, and not one of them is bright enough to be seen with the unaided eye. Some of them, such as the well-known ring nebula in Lyra (Figure 2), are bright and big enough to be easily seen in small telescopes; the rest are less conspicuous. A few appear almost like stars, and are identified by their peculiar spectra—though small disks can be seen with high magnifying power.

THE velocities of these nebulæ, down to the faintest, can be observed without much difficulty, since their light is concentrated into a few spectral lines. They are considerably greater, on the average, than those of ordinary stars. A few show very high speeds, exceeding 100 kilometers per second. All these are small, and presumably distant.

The physical nature of these remarkable bodies appears to be well understood. They are huge envelopes of exceedingly rarefied gas, surrounding very hot central stars. Ultra-violet light from the star, absorbed by the gas, sets it shining with visible light—by rather complicated processes, already described in these columns. In most cases, the star looks to us much fainter than the nebula—which indicates that its surface is so exceedingly hot that almost all its radiation is in the ultra-violet and visible to us only because the nebula traps a part of it and transforms it into light which we can see. From this it has been calculated that, when the nucleus and the nebula give out equal amounts of light, the temperature of the former is about 30,000 degrees. In some cases, where the visible light of the nebula is a hundred times that of the nucleus, the latter must be as hot as 80,000 degrees.

A thorough study of the motions of these nebulæ has recently been published by Dr. Berman, a former worker at the Lick Observatory, who is now at the San Francisco Junior College. Comparing the observed radial velocities of planetary nebulæ with the proper motions, observed by van Maanen, and utilizing also the observed brightness, he obtains, by an ingenious series of approximations, estimates of distance ranging from 2500 light-years to almost 60,000.

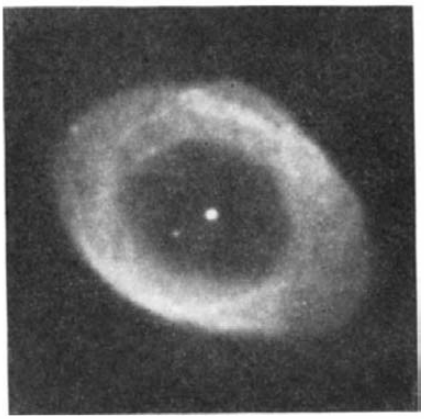


Figure 2: **The ring nebula in Lyra. The doughnut shape of the ring is misleading: it is only that part of a spherical nebular envelope that surrounds the central star which will show in photographs, because at this part of a sphere there is enough thickness to preponderate. Photo, 60 inch reflector, Mt. Wilson**

Though pretty rough, as far as individual nebulæ are concerned, these make it possible to sort them into nearer and more distant groups. When this is done, the remoter, almost star-like, nebulæ show just the distribution of velocity which Figure 1 would lead us to expect. Those to the south of Sagittarius—on the side of the Southern Cross, are rapidly approaching, some with a speed of nearly 150 kilometers a second; while those on the side toward Ophiuchus or Cygnus are receding with equally high speed.

This is the most striking evidence of the galactic rotation that is so far known. It is no longer the small, though distinct, difference between the motions of bodies revolving on the same side of the center and with a good deal the same speed, but the rapid motion of bodies very much nearer the center than ourselves, like Mercury seen from the earth.

For the nearer groups of nebulæ—and for the distant ones in other parts of the heavens, the motions are also in good agreement with the predictions of theory, the effects diminishing, as, with proximity to the sun, they are washed out by the sun's own motion.

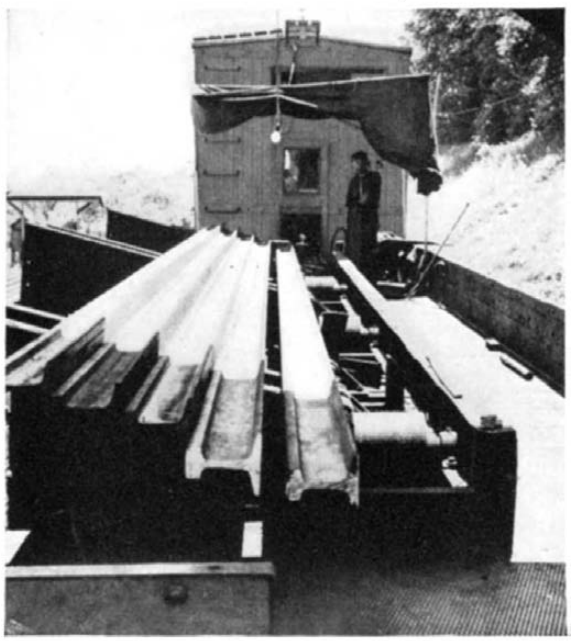
Seven small and doubtless distant nebulæ, on each side of the center, show much smaller motions than the rest, and are interpreted as bodies like *E* and *F* in Figure 1, so distant that they lie beyond the regions of rapid motion.

The whole set of results is admirably consistent, and affords the best picture of motion within the galaxy which is now available.

DR. BERMAN—who has discussed thoroughly many matters which must be passed over here—concludes finally that the distance from the sun to the center of the galaxy is 9400 parsecs (30,000 light-years). One revolution of the sun (and the neighboring stars in general) about this center takes 210,000,000 years. The total mass of the galaxy comes out 230,000,000,000 times the sun's. Half this is concentrated in a region extending 3000 light-years from the center. If this is true, and the obscuring clouds could be removed, we would see a central nucleus in the Milky Way, far more conspicuous than any observable star-clouds, and no one would ever have thought that we were near the center. Dr. Berman places us two-thirds of the way out to the edge. The planetary nebulæ themselves are large affairs, with an average diameter of some 30,000 times the earth's distance from the sun, or half a light-year. The total light of a typical specimen is about 300 times that of the sun. By an unhappy chance (for us) not one of the nebulæ appears to be nearer to us than 2400 light-years. If a sample one was as near us as Arcturus or Vega, it would look nearly twice as big as the moon, and its total light would outshine either of these stars.—*Princeton University Observatory, October 4, 1937.*

Railroad Rails by the Mile

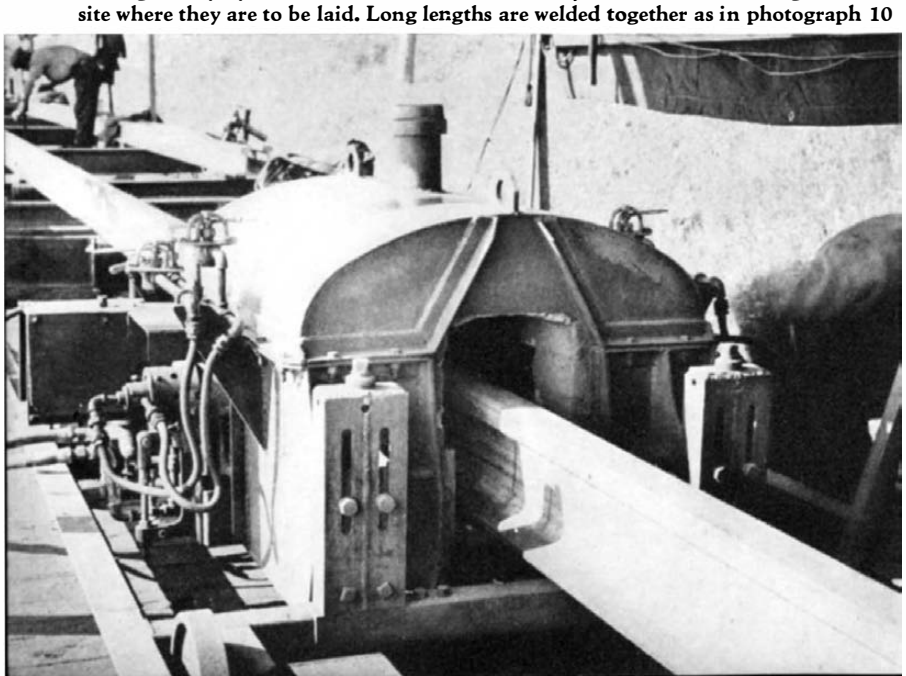
1 Years of experiment have proved the practicability and marked advantages of welded railroad rails in long lengths. Several miles of welded track are being laid on the Delaware & Hudson with the Sperry welding, annealing, and grinding mobile train unit shown above



2 Standard 39-foot, 131-pound rails in the rack car, ready to be delivered to the welding equipment in the next car of the train, by means of power driven rollers

3 The ends of two rails are carefully aligned and then flash welded in the welding car of the special train. The welding machine has automatic control. Power for the Sperry Products, Inc., welding equipment is supplied by two General Electric turbine-driven generators operated by steam from the locomotive. Each weld cycle takes six minutes to complete; succeeding operations are so timed that the production of welded rails in long lengths is almost continuous

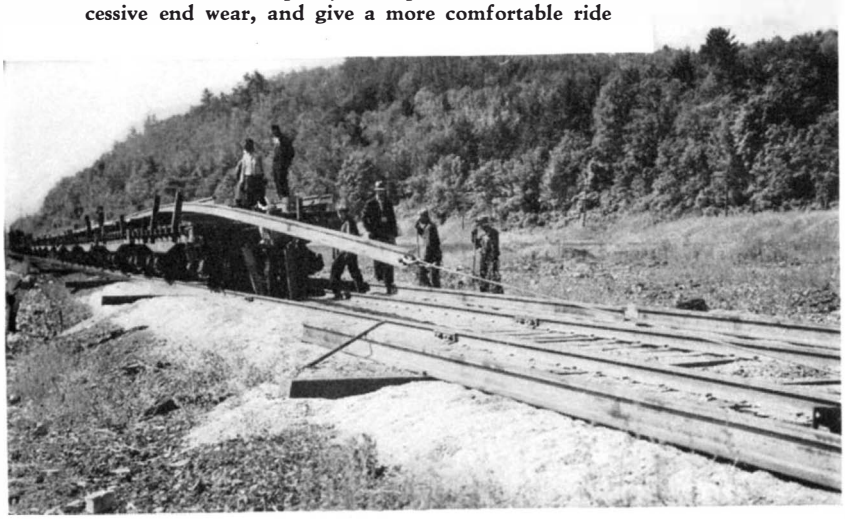
4 Mounted on the next car following the welding car is the stress-relieving furnace shown below. Making the weld, stress relieving, and the following grinding operations may be considered as forming a complete cycle. Upon completion of each group of operations, the rail is hauled one rail's length along a string of flat cars that are attached to the rear of the train. Thus it is possible to weld rails limited in length only by the number of flat cars available, and to haul these lengths to the site where they are to be laid. Long lengths are welded together as in photograph 10



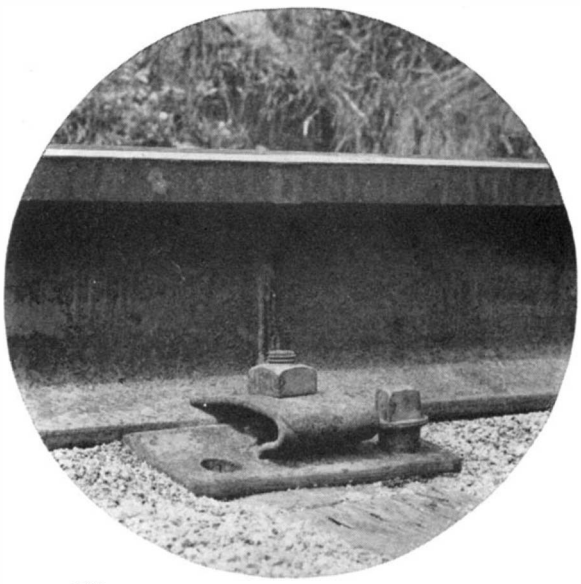
5 After the welded rails have been checked for alignment and a gage grinder has removed upset metal at the joint from the sides of the rail-head, a second grinder in the production line removes excess metal from the fillet, as shown above. A third or intermediate grinder then removes still more of the upset metal from the rail-head

6 The fourth and final grinding. An accurately controlled abrasive block smooths and contours the rail. Welded joints eliminate the "click" of wheels passing over open joints, flattening of the rail ends which necessitates repairs, rail replacement due to excessive end wear, and give a more comfortable ride

7 Welded rails in transit. When the required number of rails of a given length have been loaded on flat cars, they are dispatched to the point where they will be laid. Long lengths of rails give no difficulty when rounding curves; they bend and straighten as necessary without even being fastened to the bottoms of the cars



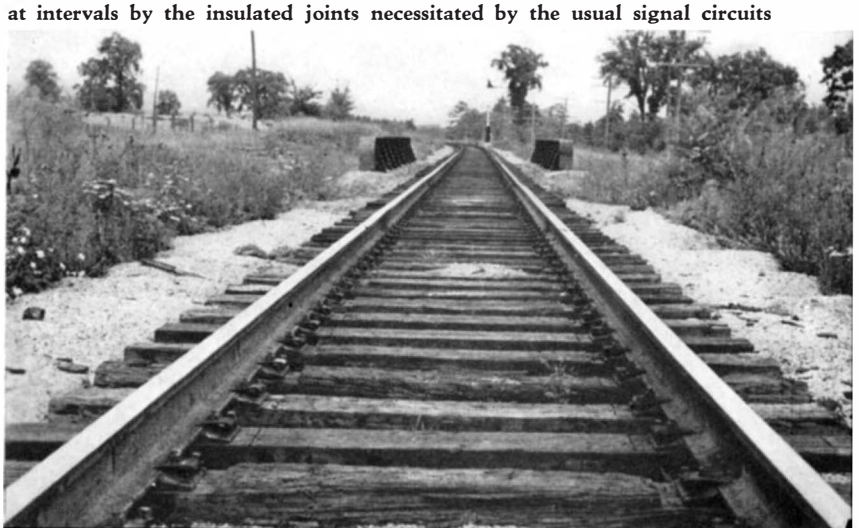
Unloading lengths of welded rails for distribution alongside of a track that they will eventually replace. A cable fastened to the end of one of the rails is anchored ıe ground and the train is hauled away. The rail thus practically "unloads itself"



9 Welded rail in track is firmly fastened to ties by spring clips, each of which exerts a pressure of 2500 pounds on the base of the rail. The resistance to movement produced by the clips and bedded ties is greater than any force of expansion or contraction in the rail. Once laid in track, therefore, welded rail remains rigid

10 Long lengths of welded rail, in position, are joined by Thermit "closure" welds. Heavy clamps hold the rail in alignment while molten metal is poured into the mold. It requires about one hour to make a Thermit closure weld

11 Welded rail in a finished track. Note absence of plates used to join conventional rails. Welded rails are laid in long lengths, broken only at intervals by the insulated joints necessitated by the usual signal circuits



THEY SHALL NOT PASS

Preventive Medicine, Man's Battle with the Germs of Disease . . . Toxins and Anti-toxins . . . Vaccines, Inoculations . . . Disease Is An Insult to Science

By G. H. ESTABROOKS
Professor of Psychology at Colgate University

EARLY in the 16th Century Cortez was having a terrific struggle with the Aztecs. Repulsed from Mexico City, he retired for a year with the shrewd suspicion that his task would not be as difficult in 12 months' time. He was right. In those months about half the Indian population died of smallpox—Spanish gift to the aborigines.

After the capture of Fort William Henry, as described in "The Last of the Mohicans," we hear no more of the Quebec Indians as a force in colonial wars. The reason was diphtheria, raging in the fort. The Indians had massacred part of the garrison, dug up the bodies in the grave-yard for their scalps, and from these bodies picked up diphtheria in the bargain, and carried it back to their villages. That winter was a sad one in the history of the Hurons.

During the early 1870's a terrible scourge hit the Fiji Islands, killing over half of the entire population. The dread disease turned out to be measles. Regarded—then, at least and by some even today—more or less as a joke by the white man, it is terribly fatal to primitive people, and today is probably doing more than any other one factor to exterminate the Eskimo.

THUS, the Eskimo, Indian, South Sea Islander, and other so-called "primitive" races are on their way out—and it isn't the white man's bullets that are doing the trick. Indeed, the white man cannot save these doomed peoples, for his very arrival is their death sentence. He brings with him the germs of tuberculosis, typhoid fever, and a dozen other scourges. The white man is more or less immune to these diseases, but they spell death to the "savage."

A century ago your life expectancy at birth was about 40 years. Now it has jumped to more than 60 and is still going up. Let us see why it is that your chances of living to a reasonable age are now so improved, and why we can't do very much for friend Eskimo, no matter how good our intentions.

We can summarize our statements under the head of preventive medicine, which divides itself very neatly in two sub-topics. First, we have that branch which prevents the microbe from making contact with you; then, we have another branch which thickens your skin, as it were, so that the microbe can't sink in his teeth even when he does arrive.

Most diseases are, of course, caused by germs, and our interest here centers on this group. For 100 years our best brains in biology have been chasing the microbe. Then, when they have backed his lordship into a corner with the microscope, they try to find his life story, likes and dislikes; in fact, anything which may aid in the general problem of keeping him under control. In many cases, brilliant success has attended these efforts; in others, we can't even find the bug, let alone control him; he is so small that our best microscopes pass him by. Even in these cases, however, he may have certain little idiosyncrasies which help, for your microbe is an individualist. The smallpox bug has his own way of doing things and must not be confused with the gentleman who causes scarlet fever. Both would feel deeply insulted if classed with the malaria organism, and certainly would not respond to quinine treatment.

However, all these chaps have in common one point—perhaps the most important single factor in disease control—they live in what we call a "discontinuous" environment. If you get bubonic plague or typhus fever, then either the germ will kill you or you will kill the germ. There is no compromise. Whatever the result, the germ has to find another victim; he has to be continually on the move, for his environment is discontinuous—and here is his greatest point of weakness. Science bends every effort toward the destruction of his lines of communications, so that he can't make the shift. Here, quarantine is, of course, one obvious line of attack. When you get diphtheria or scarlet fever, you are isolated from the rest of society, for a large number of diseases are caught by personal contact. So we try to prevent the microbe from spreading by denying him this opportunity. The ancients early hit on this idea, in handling leprosy.

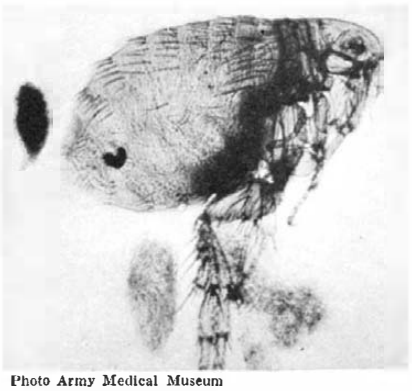


Photo Army Medical Museum

The germ that causes the bubonic plague in man rides on a flea that rides on a rat—an illustration of the "secondary host" compounded

BUT quarantine, in and of itself, was helpful only in certain diseases. Plagues swept humanity, and at such times isolation of the sick had no effect. Then, with the discovery of the germ theory, science hit on a new idea. Germs cause disease, and sickness is spread by these germs. But why can't the germ grow outside the human body and be spread by means of food? Such proved to be the case. Certain microbes do grow in "cultures" quite apart from the body. Milk, for example, is an excellent breeding ground. Once it is infected with, say, typhoid or tuberculosis, the germs in question multiply indefinitely, so that anyone using it stands an excellent chance of becoming diseased. So now we pasteurize our milk and have rigid laws of food inspection. In tropical countries the white man has to be even more careful of his food, since many deadly diseases travel by this method.

However, man found that quarantine and care of food by no means prevented the spread of disease. It helped in some cases but had absolutely no effect in others. So science again scratched its collective head and thought deeply. The water supply was another lead. Water could carry the germs, from the point where they grew, into the human body. So in some of our large cities we drink what often tastes like a saturated solution of chlorine, but we are then pretty certain that our water is pure. Science thus cuts the microbe's line of communi-

cation at another point. Once again it helped, but some diseases remained just as prevalent as ever.

So medicine called in all its allies to a real huddle. Germs of this, that, and the other disease skipped gaily from one human to another, without leaving the vaguest hint of how it was done. Quarantine, protection of food and purification of water had absolutely no effect. Then some real genius struck on a bright idea, tested it in the laboratory and found he was right. Science as a whole raised a whoop of joy and went to work under its great new motto—not *cherchez la femme* but *cherchez* the secondary host.

It was malaria that let the cat out of the bag. This disease was always associated with swamps. Man also observed that it occurred only in conjunction with a certain insect, the malaria mosquito. What better guess than that this particular mosquito sucked up the malaria germ from the blood of an infected human, and that the microbe then grew in the insect's body and was passed on to the next individual whom the mosquito bit? And if this was so in the case of malaria and mosquitoes, then why not in the case of other diseases and other insects?

SCIENCE rolled up its sleeves and won its next round from disease in brilliant fashion. Malaria was not the only culprit which used this concealed-ball play. Yellow fever traveled by another species of mosquito, bubonic—the dreaded black death of history—rode on the rat flea, typhus came riding along on the louse, and many other diseases were found to use the so-called secondary host.

Curiously enough, there is a very clear-cut and specific relationship between any particular disease and its insect carrier—this secondary host. Malaria can travel only by means of the malaria mosquito; all other insects—even other species of mosquitoes—are powerless to spread this disease. Bubonic goes by the flea, typhus by the louse, and yellow fever by its particular brand of mosquito. So with many other diseases—they spread by their own specific means and no other. You can live in the same room as a case of typhus—not typhoid—fever with perfect safety if you haven't a louse holding the joker. If you have, the undertaker will make up the foursome. So we control these diseases by literally swatting, this time, the flea.

Then there is, also, the fly. He is one of our worst disease "carriers," even if not a secondary host. By this we mean that the disease germ does not actually enter his body and multiply, as in those former cases. Nevertheless, if the fly is continually in contact with dirt he can easily pick up very dangerous germs on his body and then spread them just by wiping his dirty feet on your food. Such we know to be the case, and the health officer of any town will always scowl his blackest scowl when he sees flies running over exposed meat or fish in a store window. For the same reason, he will swear at a cockroach and is likely to cuss mildly even at dogs or cats—not your dog or cat, of course, which are doubtlessly very clean, well kept animals, but pets in general who may track some very undesirable visitors into the house from the nearest garbage can.

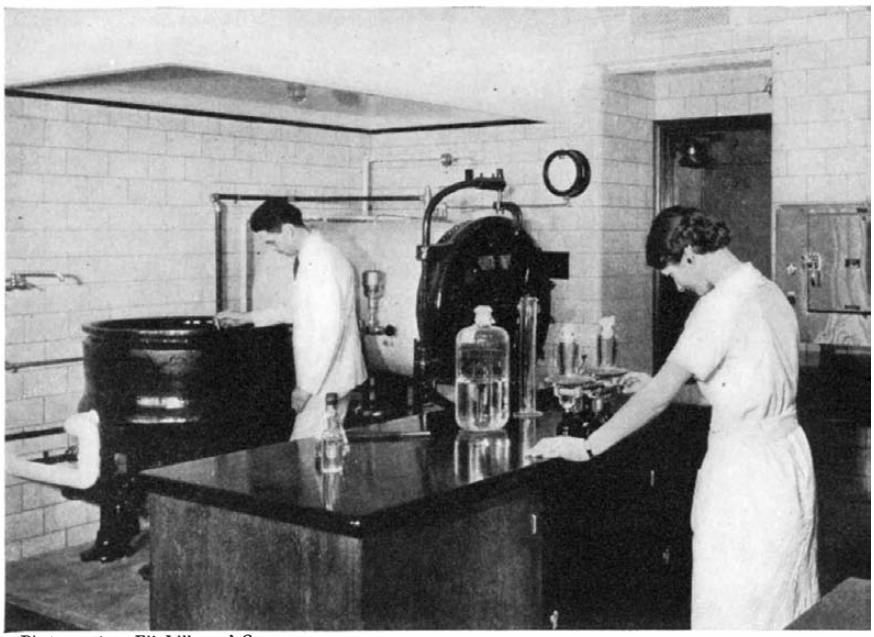


Photo courtesy Eli Lilly and Co.

In spotless laboratories anti-toxins prepared from sleek, healthy horses are processed and made ready to combat diseases that break out without warning

Science does everything in its power to make life unbearable for the said flea and for his carrier, the rat. But fleas and rats have proverbially tough hides. They can take it. Your health officer can make the going tough, but sooner or later a flea-laden rat will elude him, and then he will have a case of bubonic on his hands. This statement applies to any type of germ disease, no matter how it is spread; that is, sanitation may hold it in check but the odd case of diphtheria, smallpox, or typhoid will crop up, in spite of all precautions.

Moreover, for all our research, there are still diseases whose tactics have us baffled. We have not the foggiest notion of how infantile paralysis gets around. Spinal meningitis still holds its secret, and sleeping sickness—not the African type—is in the same class.

So science prepared its second line of defense in preventive medicine. Man has or develops immunity to certain diseases. Could not this immunity be fostered by artificial methods? Obviously, the very best way to handle typhoid is to so treat the human that he can't contract the disease, germs or no germs. This line of attack looked pretty silly at first, but there were certain leads. If you are bitten by a dog, you're just plain bitten; but, if a smallpox bug nips you, well, maybe you are or maybe you aren't. Some people won't take smallpox, or if they do, they take it very lightly. Their hides, or something, are too tough for the microbe to have any effect. We say they have "natural immunity," the result of long centuries wherein their ancestors were exposed to the disease and all the non-resistant members killed off. Nature selected the survivors, and thus we have many cases of individuals or whole nations with natural immunity to certain diseases.

BUT there was another very common type of immunity. It was quickly noticed that, once you had certain diseases, you never took them a second time. After a dose of smallpox, you need have no further worry on that score. You were either dead or immune. So terrible was this scourge at one time that people deliberately had themselves inoculated with a mild type of the disease. It was a terribly risky procedure, for a mild case with me might be fatal to you, but it was one way of developing this "acquired" immunity, and the whole situation gave the scientist food for thought. If acquired immunity, then why not artificially acquired immunity? Here, as in the case of malaria, science followed a promising lead and many diseases have had very slim pickings ever since.

When the doctor stabs you with a hypodermic for typhoid, and gives you this third type or so-called artificially acquired immunity, he is literally fooling your body. Most microbes are themselves really very nice little fellows to whom the body has no objection, but the disease-producing power of germs

depends on certain toxins or poisons which they secrete. For any particular disease, this toxin is very specific. Now your body fights fire with fire. It manufactures an anti-toxin to neutralize this poison, just as you use an acid to offset a base. (This counter poison also, indirectly, kills the germ.) The whole course of any germ disease depends on your ability to turn out anti-toxin.

This body of yours learns fast and doesn't forget. When you have scarlet fever you learn to manufacture the anti-toxin which neutralizes and kills that microbe. From that time your body is very much on its guard. When next you are attacked by this particular germ, its arrival is a signal for the immediate manufacture of anti-toxin in such quantities that the luckless microbe is literally smothered before it can even start business.

So, in order to forestall all this, the doctor rings in a false alarm. He takes some of the toxin or poison of the disease in question, say typhoid, and injects it into your arm. Immediately there is terrific internal commotion. Your body thinks it is being attacked by the deadly typhoid germ and holds up other business to turn out typhoid anti-toxin. At weekly intervals the doctor throws in two larger doses, to keep up the illusion, and then lets nature take its course. When it is all over, your body has learned the lesson of how to manufacture typhoid anti-toxin fast and in large quantities. Should the genuine typhoid bug later arrive he just has time to get inside the door when he is taken very firmly by the scruff of his neck, thrown out and the door slammed in his face.

FINALLY, there is a fourth curious type of immunity which gives protection *after* you take the disease. We mention it here because its application depends on exactly the same principles we have just been noting. It is called "passive" immunity and is used in certain diseases, for the very good reason that we have thus far found nothing better. Nevertheless it is very effective, even if a trifle nerve racking. Diphtheria was, until lately, a case in point. We could not inoculate against this disease. Moreover, it has a very dangerous peculiarity—it is a fast worker. So rapid is the progress of diphtheria that the body has not the time to build up its own anti-toxins. Hence the very heavy diphtheria mortality up to the present century. Then medicine decided on good football tactics. Unable to hold the line, we now allow diphtheria to move right in, take possession and have things all its own way. Then the doctor uncovers his star trick play.

If you can't manufacture anti-toxin, a horse can. We inject diphtheria toxin into the animal, his body builds up anti-toxin in defense, and we keep this for use in just such cases. When the disease is at its height we assist the body by injecting this anti-toxin in such quantities that the diphtheria toxin is completely neutralized and the germs so weakened that the body can mop them up at its leisure—a very dangerous type of delayed play which works perfectly if everyone knows his business. We call it "passive" immunity because the anti-

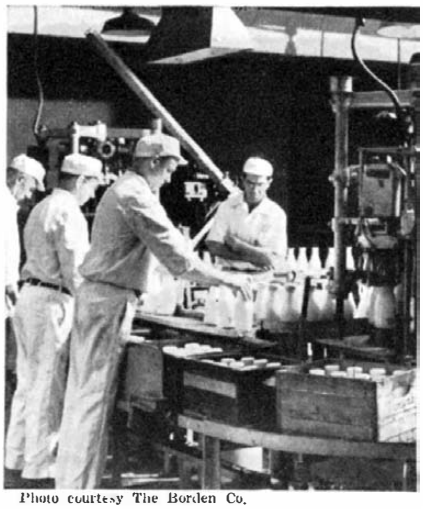


Photo courtesy The Borden Co.

Bottles being filled with pasteurized milk and routed toward the consumer, mainly freed from germs

toxin is prepared outside the body. All you do is act as the guinea pig. We should add that medical science now has a very successful inoculation against diphtheria, a product of the last few years.

Since preventive medicine has made such strides in its struggle against disease, you very naturally wonder that sickness is still a problem. But it is, as we all know, and that for very good reasons. Every disease germ is very much of an individualist. He does things his own way. For example, you could take all the precautions mentioned up to now under the general head of disease contagion—and it wouldn't mean a thing to a hookworm. You contract that disease by walking barefoot over infected ground. This animal burrows in through the skin of your foot, taxis around through the blood stream and finally lands in the digestive tract—just his way of doing things.

We haven't the slightest idea how some other diseases spread. Many a research man would literally give his right arm if he could just find a clue as to how infantile paralysis gets around. That might be the first step towards its control—and it might not. But at least we would have something to work on.

Then there are certain diseases to which you won't develop immunity, even after you have had them. The common cold is a notorious example. German measles is another. For some reason or other, which is still very obscure, the body cannot learn to build anti-toxins rapidly enough to check these ailments.

Other disease germs have certain peculiarities which make the manufacture of vaccines impossible. Tuberculosis is an excellent example. This germ is easily seen under the microscope, will grow outside the human body, and has been the "microbe guinea pig" for 75 years. Here we are pretty much where we started. Either it won't, the body won't, or something won't. We can't seem to get a vaccine which protects against tuberculosis, and the "white plague" is still treated by sunshine, fresh air, and rest.

WE are more or less chasing the microbe into his own back yard and cornering him. The development of better microscopes is helping. Up to lately we could magnify an object 2000 times, which was not bad. Now we can raise the ante to 3000 times, which is better. It helps if you can see the little devils; but many are too small to find, even with the very best of microscopes. Then, again, it improves the situation if you can farm them out, as it were. If you wish to learn the tricks of microbes, then you need microbes to play with. Some will live only in the human body, dying almost instantly when they leave it. Others can be bred in test tubes and examined at leisure. This helps. Some of our most careful research has been aimed at developing a diet on which, say, infantile paralysis would live outside the body. We have failed here but had brilliant success with other germs. And we are making very definite progress.

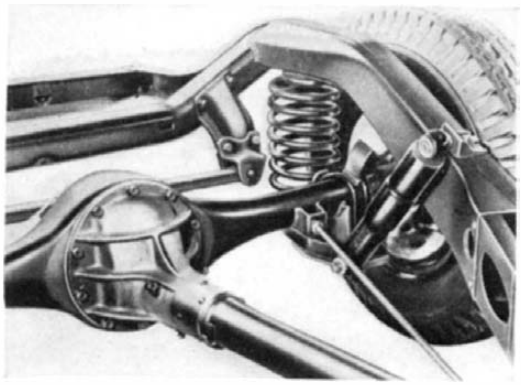
The existence of contagious disease is an insult to science. We haven't the brains to outwit a little germ so small that even the best microscope can't find him. But we are making the going tough. Your local health officer and the state department have him worried. Just a little more co-operation from everyone and we may have many a germ stuffed and mounted in our microscope museum as "the last specimen of the now extinct species *Diphtheriens omnivorens*, trapped attempting to leave this planet for Mars."

Let us close with an appeal for co-operation. We are living in a country which stresses individual freedom. If I don't like vaccination, I can say so. It is my privilege to tell the local health officer he is a chump, or to spend a million to combat vivisection. No one compels me to drink pasteurized milk, while in food matters the only real policeman is the stomach-ache. This is all as it should be.

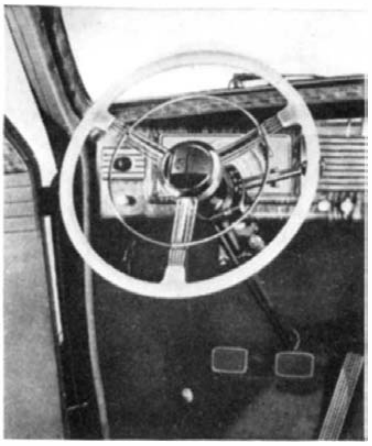
But you can't bluff a bug. My well-intentioned ignorance may start a typhoid epidemic or hold up research on sleeping sickness. Your health officer, like the Mississippi levee, stands between you and disaster.

On Your 1938 Car

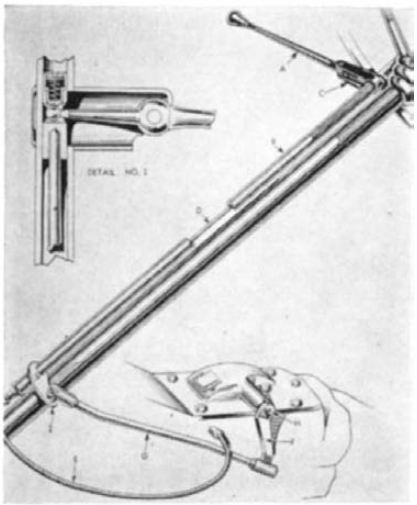
In many of the new cars being brought out this winter, designers have gone to great lengths to eliminate obstructions from the front compartment and to increase driving convenience. For example, the parking brake lever on the new Dodge is located directly under the center of the instrument panel



Coil-spring rear suspension is being pioneered by Buick for 1938. Improved riding and steering qualities are claimed. Photograph shows spring and airplane-type shock absorber at left rear wheel

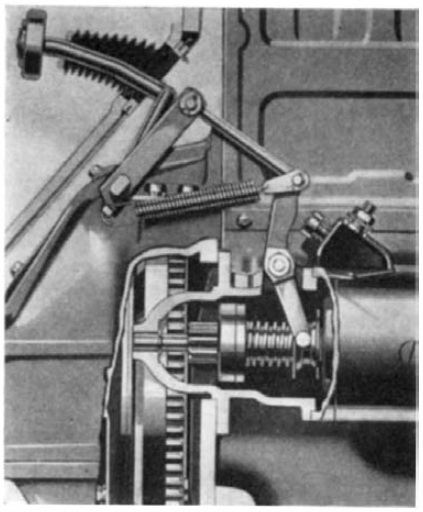


Automatic and semi-automatic transmissions are featured on many of the new cars. In the Buick self-shifting transmission a four-speed planetary system automatically provides the correct gear ratio needed. A lever under the steering wheel selects neutral, reverse, or forward

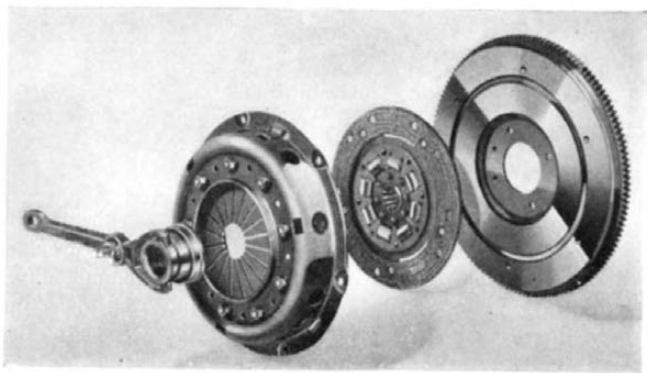


The Pontiac remote-control gear shift eliminates the lever from the front floor and places it under the steering wheel. Here it is operated in the familiar "H" pattern, except that the "H" is on its side instead of flat. The lever under the wheel is linked to the transmission through a movable rod which is held parallel with the steering column. The clutch pedal is used in the same manner as with the conventional gear shift

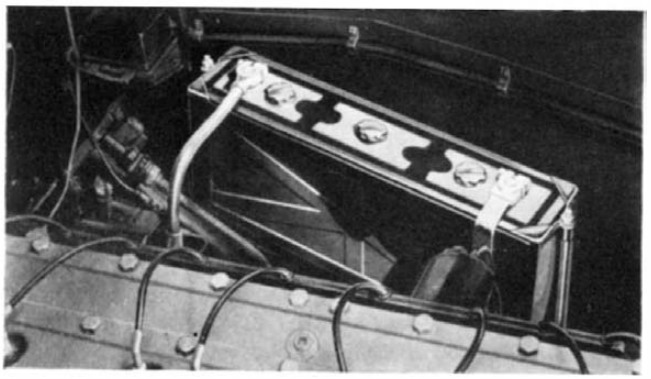
The new dome-shaped "turbulator" piston used in the 1938 Buick engines. It is claimed that the shape of the piston-head controls combustion and permits the use of a higher compression in the engine without detonation and without the use of so-called "premium" fuels



In the new starting mechanism used by Chevrolet, the starting motor is connected to the starting pinion through an over-running clutch. The pinion is mechanically meshed with the fly-wheel gear before the switch on the motor is closed. The photograph shows the pinion disengaged. As the pedal is depressed the linkage moves the pinion into mesh. The same linkage then closes the motor switch and the starting action takes place



No coil springs are used in the new Chevrolet clutch. Instead, a spring-steel diaphragm with 18 fingers bears against the pressure plate, providing even distribution of the driving load



A new battery location and design in many of the new cars adds to the convenience of servicing. The location is between the engine and the side of the hood, as in the Pontiac illustrated

THE NEW HEAVY NITROGEN

Science is Enthused about Some of the Significant Problems which Urey's Achievement Promises to Unravel . . . Opportunities that Surpass its Dreams

By BARCLAY MOON NEWMAN

HEAVY nitrogen with which to label molecules is at hand. A first step has been taken toward tracking the paths and detecting the nature of the dance of invisible particles whose rhythm makes possible the visible phenomena of life—the growing body, the thoughtful brain, the birth of offspring, the upward surge of evolution, the aging that ends lethally. What big advances are to come?

Nitrogen's many rôles in the living thing are of the most profound significance. Amid all the stupefying diversity of earthly life, there exists no form which can dispense with this element. The basic threads out of which all life fabric, every animate shape, is woven are the nitrogen-containing proteins—albumin of egg-white, casein of milk, gliadin of wheat, myosin of lean meat. The center of life-control, the nucleus within every living cell, is rich in protein—therefore in nitrogen. And yet nitrogen remains among the least understood of protoplasm's vital elements.

Now, however, heavy atoms of nitrogen can be used as tags or labels by which to distinguish certain molecules from others of the same kind found in the body. By such tags, molecules can be traced even into the most obscure of life's laboratories within the tissues, and the fate of nutrients and other significant life materials can be brought to light.

THE tag of heavy nitrogen can be attached to the tiny bits, the amino acids, which the organism strings together to make into giant protein molecules. The comings and goings of these bits, how they are strung together into huge particles, what the destiny of these great molecules in the life mechanism, and how the amino acids and their great synthesis, the proteins, co-operate with other important materials—of such fascinating leads to the solution of life's secrets the elucidation has begun.

Besides these long-baffling general problems of the construction and fundamental modes of action of proteins, there are countless special problems of equal interest. Vitamin B, the "nerve vitamin," which prevents the paralysis of beriberi, has nitrogen as a constituent. What is the precise manner of action of this strange compound, essential to existence yet present in remarkably minute quantities? The answer, gained perhaps by the aid of heavy nitrogen as an indicator, should permit bio-scientists to pierce deep into the misty realm of the nervous system, and even beyond, because plants and microbes as well as the higher animals draw a portion of their vitality from Vitamin B.

Unique among live beings, lowly organisms such as the bacteria in the roots of clover, take free nitrogen from the air and fix it to other elements, to give

Prof. Harold C. Urey, of Columbia University, Nobel Chemistry Prize winner, discoverer of heavy water and, recently, of heavy nitrogen

rise to nitrates—valuable in fertilizers and explosives. May not heavy nitrogen teach man how to manufacture nitrates cheaply and efficiently after the way of the nitrogen-fixing bacteria?

Chlorophyll, the pigment which gives greenness to vegetation, makes possible a more important synthesis, photosynthesis, the production of sugars and starches from the soil water and the carbon dioxide of the air, sunlight being the source of energy. Chlorophyll is believed to be the chief enigma in this utilization of sunlight—the storing of light-energy in foods which are practically the sole source of fuel for the world of life. It is now an old dream of the scientist, that he might emulate the green leaf and turn light, water, and part of the air into foods and carbon compounds, both edible oils and fuel oils, and innumerable by-products—again cheaply, and with high efficiency. Coal and oil deposits are traced to ancient photosynthesis. Nitrogen is a component of chlorophyll too, and a significant component. Heavy nitrogen will help realize this dream—though surely not soon, since photosynthesis is among the most complex of animate phenomena.

ONE of the most startling conceptions in the entire history, the entire universe, of science is steadily becoming more firmly established as fact. This conception is of molecules, made like all molecules out of atoms, of course always inanimate, but molecules which can induce the formation of duplicates of themselves out of the surrounding medium, if it is of suitable composition. These molecules are the units that make up chromatin, the material which is the controlling machinery of inheritance—material present in the nucleus of every cell, material assuring that the offspring will be closely similar to its parents. Chiefly because of its chromatin, the hen's egg develops into the chick, which shows species and family resemblance. And the egg arises from a cell within the hen's reproductive organs by a process in which the cell's chromatin makes a copy of itself, handing this duplicate machinery of inheritance to the egg. In order that such a copy may be made, the chromatin's units, or genes, separately or together—and perhaps assisted by the surrounding medium—construct new units like unto themselves. These molecules, intricate and giant, become linked in fragile threads—the chromatin. Since these automatically reproducing particles are protein, nitrogen is involved in a major way. Heavy nitrogen provides new hope that more definite understanding of heredity's astonishing molecules may be forthcoming in the not too distant future.

Heavy nitrogen in concentrated form is the recent epochal achievement of

Dr. Harold C. Urey, professor of chemistry at Columbia University, who was awarded the 1934 Nobel Prize in chemistry for his discovery of heavy water. This achievement is epochal because it brings to experimental medicine and to all seekers of life's secrets a new and invaluable tool of research.

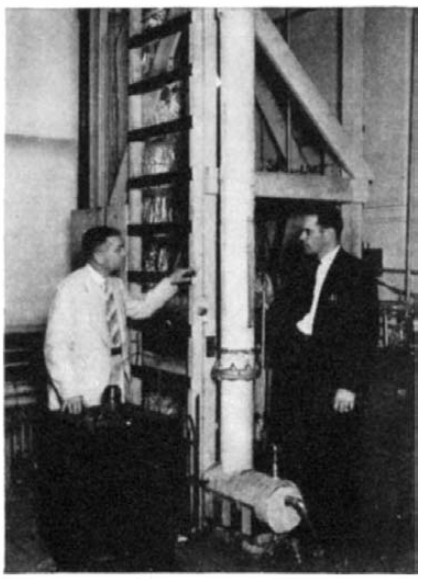
In 1935, Dr. Urey suggested that nitrogen's two varieties—light and heavy atoms—could be separated by the chemical process which he has now brought nearer perfection. The problem was surpassingly difficult, since the two kinds of atoms are almost identical in both physical and chemical properties. And the difference between the weights of the pair is so slight as at first sight to appear meaningless.

THIS unthinkably tiny difference may be simply expressed, however. When the weight of an atom of light hydrogen is taken as 1, then a heavy hydrogen atom—a deuterium atom—weighs 2. On this scale, the weight of a light nitrogen atom is 14, while that of a heavy nitrogen atom is 15. And here we may recall that when we take a breath of air—of which four fifths is nitrogen—we are inspiring atoms of light nitrogen mixed with traces of heavy, but both in trillions so numerous as to defy our mental grasp. Yet scientists have in the last few years learned that upon such wondrously small particles nature's biggest mysteries are founded.

Also upon such minutiae Dr. Urey has built his success, for his process of separation depends upon the almost insignificantly greater weight of the heavy nitrogen. He uses a tube, six inches in diameter and 35 feet high. Twelve hundred small steel plates, arranged in a column, extend up through the tube, and over these a solution of ammonium sulfate is allowed to drip down. This compound, best known as a constituent of fertilizers, contains both light and heavy nitrogen atoms. By chemical reaction at the bottom of the tube, the ammonium sulfate is made to yield up its nitrogen in the form of ammonia, some of which remains dissolved in the solution below and some of which rises, as a gas, through the tube.

The ammonia molecules of the gas are taken up by the down-dripping solution, from which they displace other ammonia molecules—which, of course, are part of the larger molecules, the ammonium sulfate. But the ammonia molecules with the light nitrogen tend to remain in the gas, while the ammonia molecules with the heavy nitrogen go more rapidly into the solution. Thus, heavy nitrogen is increasingly concentrated in the ammonium sulfate solution at the bottom. When this solution is drawn off, the heavy nitrogen is obtained in concentrations of the order of two and one-half percent—as against the few atoms of this variety normally found mixed with the far more abundant light atoms. By this means, the equivalent of about two fifths of a pint of heavy nitrogen gas per day is obtained. The process is slow, the cost high.

Nevertheless, this separation of nitrogen's two variants, though only partial, does provide bio-chemists with enough heavy atoms for extensive and highly meaningful experimentation. Already some of Dr. Urey's heavy nitrogen, in the hands of Dr. Rudolf Schoenheimer,



Dr. Urey (left) and Dr. John R. Huffman with the 35-foot column by which the heavy isotope of nitrogen was separated in quite sizable quantities for the first time

Columbia bio-chemist, and his co-worker, Dr. David Rittenberg, has brought new information about chemical activities within the animal body.

In a preliminary experiment, Dr. Schoenheimer tested the possibilities of heavy nitrogen as an indicator. He synthesized the substance glycine, using heavy nitrogen instead of light nitrogen. Glycine is one of the amino acids—the building blocks of proteins' molecular architecture—and occurs in proteins throughout the organic world. The heavy atoms later identified the glycine molecules so produced.

Next, our bio-chemist combined his tagged glycine with benzoic acid—a chemical sometimes used in tiny quantities for the preservation of food, and a component of many a complex compound which plays a life rôle or which is a waste thrown off in vital reactions. This combination made a bigger molecule: hippuric acid, one of these waste products. He fed this labeled acid to rats. When he was able to discover heavy nitrogen in hippuric acid disposed of by the rats' kidneys, he could be sure that his tagged acid had been absorbed through the walls of the intestine, transported by the blood to the kidneys and there excreted. Hence, for the first time, a nitrogen-containing molecule had been traced through the body by the use of nitrogen 15 as a tag.

In the same series of experiments, Dr. Schoenheimer solved a bio-chemical puzzle. Benzoic acid is set free as a necessary but toxic side issue from life chemistry within the cells. It is rendered harmless by yoking glycine to it, and the hippuric acid so formed is readily removed. Now glycine is a part of almost all proteins wherever occurring. Bio-chemists have wanted to know whether, in order to yoke glycine and benzoic acid into hippuric acid, protoplasm must turn to a glycine-containing protein to get the needed glycine; or whether protoplasm could merely use any available, free glycine that might be present.

FREE glycine and free benzoic acid were injected separately into the blood stream, and the kidneys excreted hippuric acid which must have been synthesized from the glycine injected—for this glycine was labeled with heavy nitrogen. It is to be concluded, therefore, that glycine can be directly utilized in the formation of hippuric acid; the amino does not have to be taken from a glycine-containing protein.

Drs. Urey and Schoenheimer determine the presence and the concentration of heavy nitrogen by means of the mass spectrometer, a device in which a powerful magnet is used to separate heavy atoms from light atoms after they have been bombarded and electrified—that is, ionized—by a stream of electrons. The mass spectrometer can detect, identify, and even measure as little as a hundredth of a millionth of an ounce. It can indicate a 1 percent increase in the ratio of heavy to light nitrogen—an increase, in the weight of nitrogen, of one part in 300,000. Dr. Urey's mass spectrometer is shown in one of the illustrations.

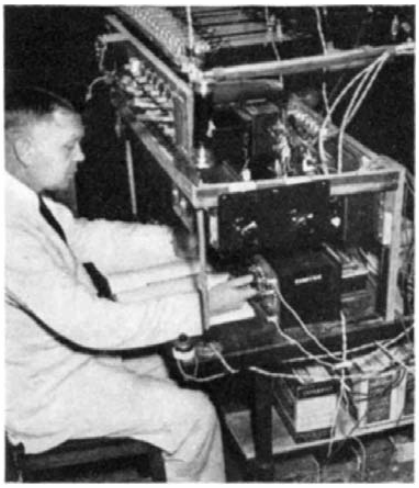
The continued increase in bio-knowledge through the use of heavy hydrogen (deuterium) strengthens the belief in heavy nitrogen's future as an instrument of research. Dr. Schoenheimer, by aid of deuterium, has lately been carrying on very successful investigations of the ways in which animals treat fats. All fats are constructed of carbon, hydrogen, and oxygen. Hence he was able to label fat-molecules by replacing part of their hydrogen with deuterium—and so could keep track of these molecules in the bodies of experimental animals, such as mice. So too he was able to set forth something of the history of fats within the human body, since the physiologies of mice and men are essentially the same. He showed that animals can convert oils into fats which do not so readily melt, that is, into solid fats; and can also, if need be, reverse the process and

transform solid fats into oily fats. Tagged molecules gave the first actual proof of this suspected ability of the animal machine.

Of still greater scientific interest is Dr. Schoenheimer's demonstration that the turnover of fats and compounds derived from them is much more rapid than has been suspected. In mice, and presumably in men, stored fat is removed and replaced every few days—even if no fat is eaten, and must be synthesized by the tissues from sugar and protein. The living body has always been conceived of as constantly active, yet it had been assumed that at least stored materials are seldom disturbed. Now we realize through research with tagged molecules that few, if any, body components remain intact for very long. Life's processes seethe even through the parts of the organism which appear most inactive and most durable.

Unfortunately, much of Dr. Schoenheimer's work, so accurately carried out and by him so conservatively reported to the American Chemical Society, has been widely and grossly misinterpreted to the public through both daily newspapers and weekly magazines. In the course of his experiments, Dr. Schoenheimer noted—as many another investigator before him—that the simpler fuel nutrients, such as oils made up of small molecules, and also butyric acid present in butter, are burned by the body far more speedily than are fats made up of big, complex molecules. Immediately the public was falsely informed, by reporters and editors who did not consult Dr. Schoenheimer, that since butyric acid is found in butter, and is rapidly burned, one could eat butter without fear of putting on weight. Immediately, too, it was assumed that all diets could go into the discard. This broadcasting of misinformation is traceable to neglect of two facts. First, the body may burn certain nutrients more rapidly than others, but any nutrient, if taken in excess of the body's needs, may be stored. And, second, the greater the quantity of light-weight molecules eaten, the greater the quantity of the heavy-weight molecules which is stored as reserve fat: hence butter is a ready means to increase in buxomness.

VARIETIES, or isotopes, of elements that are important to life may be used as indicators of life's secrets because protoplasm apparently treats tagged molecules and the corresponding untagged molecules alike—provided the isotopes are not supplied in concentrations much higher than those to which the organism is normally accustomed. On the other hand, concentrated heavy water, water consisting of ordinary oxygen and the double-weight hydrogen (now called deuterium), has proved toxic at least to certain forms of life, such as tadpoles and the slipper-animalcule, paramecium, microscopic inhabitant of ponds and streams. Biologists thus taught chemists and physicists a thing or two. Varieties of the same element do make a vital difference to life's systems—when these isotopes are present in high concentrations. Once emphasizing physical properties almost to the complete exclusion of all other characteristics, physicists and chemists



The mass spectrometer Dr. Urey uses in determining presence and concentration of heavy nitrogen

have been shown that the other characteristics are sometimes, if not invariably, highly significant in the study of an element's nearly indistinguishable variants. What heavy nitrogen, as opposed to the common mixture of light and heavy atoms, means to the live thing only experimentation will make clear. Perhaps heavy nitrogen will find its place in the production of new drugs, less poisonous to the human body than present ones having mostly light nitrogen, but more potent as heart stimulants, antiseptics, or anesthetics. It may be that vitamin B, made with heavy nitrogen alone, will be found more beneficial, or perhaps toxic, to the body as against vitamin B as we obtain it today. The delicacy of protoplasm is beyond the imagination. We can rest convinced that heavy nitrogen is going to have distinctive effects, however unguessable these effects are now.

Still, bio-chemists most familiar with such considerations believe that, however delicate life chemistry is, it is going to be only insignificantly affected by such comparatively small numbers of heavy atoms as would be introduced into the body in drug molecules. Heavy water, unless in high concentration, apparently is without effect upon the organism. The really valuable researches at present are those in which isotopes are used as labels rather than as modifiers of life activity.

Investigators along such lines are also turning their attention to varieties of potassium, another vital element, a regulator of heart beat and a participator in the basic life phenomena of practically all animals and plants. Potassium has three variants, atoms of weights 39, 40, 41. Atom 40 is the rarest but by far the most interesting. It is the only atom which is at the same time essential to life and, like radium, radioactive; for, potassium 40 emits penetrating rays, *beta* rays, consisting of negative particles of electricity, or electrons, traveling at high speed.

WHAT relation has this radioactivity to the existence of animate beings? Speculation on this score has been great. But the actual known facts are very few and as yet unrelated because so recently found. The radioactive variety has been found in unusually low concentration in portions of the heart—that is, in concentrations below those in other parts of the body, other plants and animals, and the sea. On the other hand, bone marrow, where red blood cells are formed, is relatively richer in the radioactive variety. Seaweed, too, concentrates radioactive potassium—the ratio of potassium 40 to potassium 39 is greater in seaweed's potassium than in the case of the potassium of the surrounding water. What is the meaning of life's selective action upon potassium isotopes? Thus far, no one can guess. We must wait for the results of research under way. And we can be eager for these results, because the very bases of animate existence may be concerned.

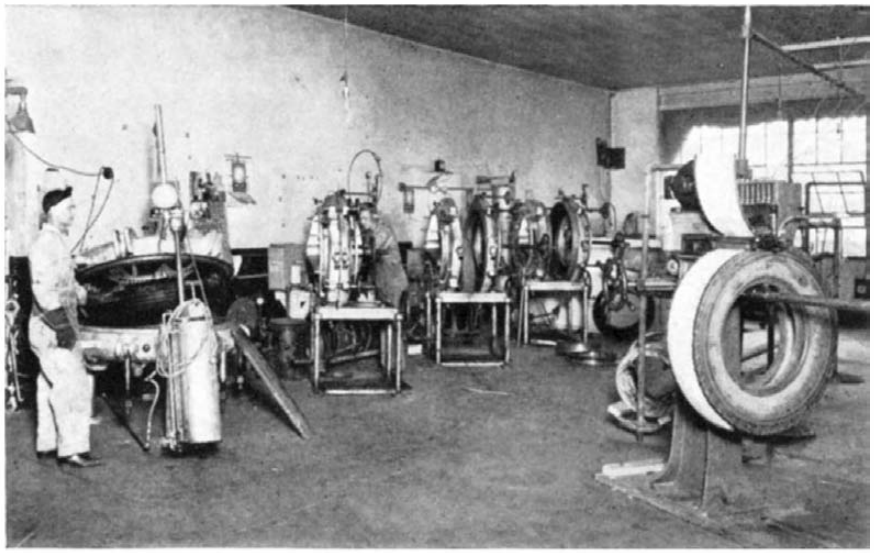
Though radioactive potassium 40 is the only essential or life element which is naturally radioactive, it is only one of a number of radioactive substances used in modern biological work. Not only are heavy atoms used as tags for molecules involved in life processes, but also life elements are being made into labels—by bombardment until they are artificially radioactive. Bombardment is done with streams of particles emerging from atom-smashing devices, such as the cyclotron of E. O. Lawrence. Thus, ordinary or non-radioactive phosphorus atoms can be derived as unstable atoms which spontaneously burst, giving off readily detectable rays. These rays are detected by a photoelectric cell connected with an amplifier; the sensitive metal of the photoelectric cell, struck by the rays, sets up minute electric currents and the amplifier steps them up so as to be easily observable. Such artificial radioactivity does not last very long, only minutes or hours, but is lasting enough to permit of its use in experimentation.

Sulfur can be bombarded and so transmuted into artificially radioactive phosphorus. The phosphorus atoms are combined to form the mineral nutrient, sodium phosphate, which is then fed to rats. After some hours, in which absorption

(*Please turn to page* 380)

New Tires for Old

Retreading and Re-Capping . . . Carcasses Must Be Sound . . . Four Out of Five . . . Of Greatest Value When Cars and Trucks Are in Constant Service



A typical automobile tire retreading plant equipped with a full line of molds to rebuild all sizes of motor car and truck tires and thus double their mileage life

By PHILIP H. SMITH

LAST year over 4,000,000 automobile tires were retreaded to carve away about 13 percent of the new-tire replacement market, yet this business, which seems to promise attractive economies for the American motorist, is one of the least known and least understood in the country.

Retreading is a depression phenomenon—a Topsy-like growth, apparently shrouded in a good deal of mystery. It involves nothing more nor less than replacing with new live rubber the tread which has become worn smooth under the abrasive action of the road. The only real mystery involved is why more people do not avail themselves of the practice and why so little is said about it.

The retreading process of prolonging tire life can lay no claim to newness. Tire manufacturers have practiced it for at least ten years, but they confined it to tires used by bus and taxicab companies which operate whole fleets of vehicles and buy their rubber on a strictly mileage-delivered basis. It took the depression, with its call for travel at rock-bottom cost, coupled with certain technical developments, to bring retreading forward as a mass consumer proposition of more than limited importance.

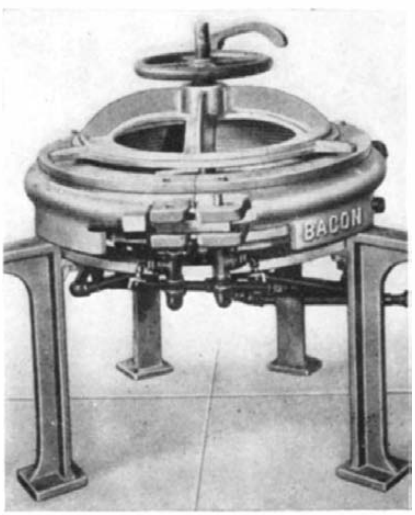
Very strangely, it was improvement in tire construction that made retreading practical. The present-day tire is a masterpiece of rubber engineering, as anyone must admit if the product of earlier days is recalled. Its foundation, the fabric carcass, is so excellent that it outlasts the tread two to one. The carcass has to be strong for, whereas the motorist can comprehend the wearing down of the rubber tread, he regards sudden failure of the carcass as evidence of defective workmanship. Tread wear is faster (relative to the fabric) than it used to be in the days of the high-pressure cord tire, in spite of all advances in the art of compounding rubber to increase durability. This is traceable directly to the decrease in wheel and tire diameters, which means more revolutions per mile of travel, and it follows also from faster driving and quicker deceleration.

The technical advance which made retreading feasible was the development of the full-circle mold which permitted vulcanization of the new tread over the whole circumference of the tire instead of sectionally, as practiced hitherto. Then some enterprising people, located principally on the west coast, opened up retreading establishments and invited the consumer to enter.

He entered because he had little money in his pocket and any economy had strong appeal. Retreading captured California and then spread eastward. Today the business comprises many manufacturers of equipment, independent producers of Camelback (tread material), patches, cements, and all the accessories required by the process, and thousands of retreaders, some devoting all their energies to rebuilding tires, others devoting part time to it and the rest to selling new tires; and, last but by no means least important, there are retreading stations which are operated by the tire manufacturers.

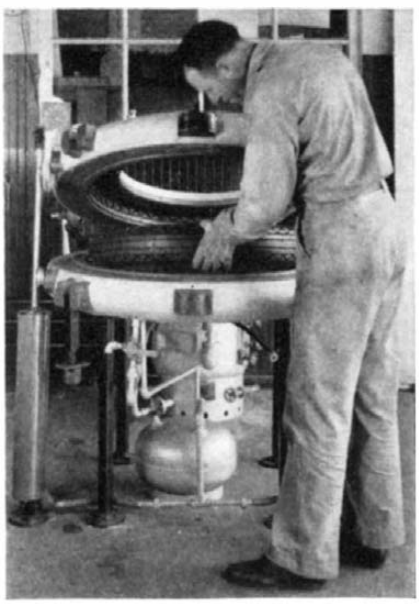
MANY prophesied that retreading would shrink back to insignificance when prosperity returned. Retreading tires is like re-soling shoes, they said, and the public will prefer the new product when it has an income. But the business continued to flourish. What they did not foresee was a rise in tire prices reflecting higher material costs, which maintained the spread between new tire and retread prices.

Now, you may ask, as nearly everybody does when the subject of retreading is aired: "If retreading is successful, why don't we hear more about it?" To which the immediate answer can be given that it is and it isn't, and the rest of this article will be devoted to explaining away the paradox, or, in the vernacular, "to putting you wise."



A re-capping mold in which vulcanizing heat is applied to the tread alone, and not to the entire carcass

Stages in the process of retreading an automobile tire. *Left:* Inspecting the carcass. *Upper left:* Buffing off the old tread down to the fabric. *Above:* Applying cement to the casing. *Upper right:* Putting on the Camelback or new rubber tread. *Right:* Rolling the Camelback to expel air and insure all-over bond. *Below:* Removing the rebuilt tire from the circular retreading mold



Retreading is beset with many pitfalls both technical and commercial. Not all tires can be retreaded—successfully, that is—and deliver a mileage that warrants the outlay. The carcass or fabric foundation must be in good condition, without cuts or breaks. It pays no better to retread a poor automobile tire than it does to re-sole a pair of shoes when the uppers are cracked. In both cases the condition depends upon the care with which the owner travels. If a motorist subjects his tires to overloading or under-inflation, or bumps into curbstones, he might as well forget retreading. By the law of averages this reduces the number of tires fit to undergo the process to a maximum of four out of five.

Another limitation is that imposed by age. Heat, light, and moisture deteriorate rubber and if a tire has not been worn to a state where it is ready for the retreading within three years of purchase, it is wiser to buy a new tire than to superimpose a good tread upon a questionable carcass. This limitation means that retreading is of little value to the motorist who drives only 8000 to 10,000 miles a year, and, conversely, is of greatest value to the owners of vehicles which are kept in constant service.

When a tire succeeds in passing the specifications of soundness, it can be retreaded so that it will give anywhere from 80 to 125 percent of its original mileage. The process is as follows:

Whatever rubber remains on the tread is removed by buffing down to a point where the fabric carcass is exposed to view. The breaker strip and cushion, which are an essential part of construction, are removed and the carcass is then placed in a drying room where it is kept for 12 to 36 hours in a temperature of about 120 degrees, Fahrenheit. After all moisture has been removed, a new cushion and breaker strip are cemented on and allowed to dry, following which the new tread, or Camelback, is affixed and the tire is slid into the clam-shell mold for vulcanization. When the curing process is completed and the tire is taken from the mold, it will sport a non-skid design and to all outward appearance it will be new.

Whether the renewed tire gives the motorist 80 or 125 percent of its original mileage, depends upon the skill exercised in carrying out the retreading process and upon the quality of the materials used—assuming, of course, that inspection revealed the carcass to be flawless. Here is where another hazard creeps in.

It isn't possible always to detect flaws in a carcass, although experience trains men to do an excellent job. A much greater hazard exists in the incompetence of retreaders and in their lack of equipment adequate to do first-class work. The business is still flooded with "gyps" whose main interest is to dress up old tires and pass them on to the consumer rather than to conserve and dispense mileage. This is the bane of the business and one that will take much

time to eradicate. Finding the reliable retreader, therefore, is only one of the many steps to be taken to get satisfaction from retreading, but reliable men are to be found.

The test of the retread is in the mileage it delivers. Promises, guarantees, and attractive show windows are not absolute guides to good workmanship. Some of the dirtiest shops do the best work; some of the most attractive stations deal in the poorest wares. But this is slowly changing to give the outward signs real significance. Retreading is rapidly losing its salvage reputation, to enter into the class of legitimate service business.

At this point the question will arise: "Aren't retreads dangerous?" It takes only one failure to create a lasting impression of hazard, but one failure doesn't tell the story. A good retread is much safer than a tire that lacks its nonskid surface or is worn through to the fabric; a poor retread is dangerous mainly because of the unwarranted reliance placed upon it. Ambulances, fire departments, buses, and hundreds of other services in which reliability is essential, make use of retread tires. Even the motorist who decries their use is likely to ride on them with serenity if he travels by bus or taxi.

In the main there are two classes of users. The first group comprises the same type of consumer who has his shoes re-soled until the uppers are gone. The second group comprises operators of great fleets of vehicles where tire costs are a big item and small economies accumulate to make the difference between profit and loss in operation. It is from these fleet operators who keep records that the figures of 80 to 125 percent of original mileage are obtained, and it is from them again that the possibilities of savings are to be garnered.

If we assume that four out of five tires can be retreaded and that 100 percent repeat mileage can be had, the possible savings incident to retreading run from 30 to 50 percent of new tire cost. No closer approximation can be made, because of the variation in tire prices and charges for retreading. Much depends upon the driver's care of his tires, and drivers are notoriously careless.

Within the past few years another practice has developed which is part and parcel of the tire rebuilding business. The practice is called re-capping and is similar to retreading, but there is this difference: not all the rubber tread is buffed off, nor are breaker strips and cushions removed. The new tread rubber is vulcanized to the old rubber tread and shoulders, rather than to the fabric of the carcass. Obviously, tires which have been worn down to the fabric cannot be re-capped.

The relative merit and demerit of recapping and retreading are now being aired in raging controversy and it is too early to garner any residual fact. The proponents of re-capping declare that a better bond can be had in vulcanizing rubber to rubber; that the process can be repeated many times to give much longer service than retreading, which most will agree can be performed only once. They also maintain that life is prolonged by virtue of the fact that the heat of vulcanization does not penetrate to the fabric or the sidewalls and that leaving breaker strip and cushion intact means less interference with the basic engineering design.

All photographs courtesy *Rebuilt Tire Journal*

Top row, left to right: **Worn tire, old tread removed, new tread applied, and the rebuilt product.** ***Bottom row:*** **Two good examples of before and after retreading**

Opponents of re-capping declare that tread rubber must be removed in order to discover fabric separation and disintegration, and that re-capping permits concealment of defects to be revealed later by failure on the road.

Both retreading and re-capping are being done successfully and it is quite probable that both will end up in serving distinct fields. Perhaps the best carcasses will be re-capped and the more worn ones will be retreaded. Re-capping is attractive because the process requires less material than retreading.

What has been said so far will explain the paradox that retreading both works and doesn't work. A little more must be said to explain why more is not heard about the practice—why it seems to remain little more than a name to the average motorist.

More people are interested in seeing retreading fail than wish it to prosper. The more it succeeds, the more it becomes known, the fewer the sales of new tires; and, as everyone knows, there is a vast organization predicated upon a continuance and expansion of the tire business. Those who are most anxious to see retreading go forward are not financed to push it and word-of-mouth remains almost the sole promotional activity.

ACTUALLY, retreading seems not the calamity that some tire manufacturers envisage, nor yet the millennium that some motorists hope. Its possible expansion can be calculated with some measure of accuracy and that maximum is many years off. Probably under the most ideal conditions retreading could never exceed 50 percent of the total replacement tire production of any given year, and this ultimate point, as well as the rate of approach, depends in large measure upon the integrity of retreaders and their adherence to high standards.

Certainly some readjustments will have to be undergone in crude and reclaimed rubber markets as well as in tire output if and when retreading approaches its full potentialities. Every retread cuts rubber consumption by about six pounds and the sum total could be impressive. We can set it roughly at 80,000,000 pounds annually.

Predictions in this business are highly speculative, but they may still have some value. For example, let us consider possible alternatives. Cheapening the fabric to balance with tread life is unthinkable. It is much more likely that some means will be found to increase tread life; but, of course, this would merely supplant retreading and would have just as profound an effect upon rubber consumption and tire output. Finally, we have no idea what research with rubber substitutes may lead to. Word has come from abroad that buses equipped with synthetic rubber tires have traveled six times the miles formerly covered with natural rubber ones. Perhaps retreading is serving merely as a transitional step in a changing rubber world.

THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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

D. H. KILLEFFER
Chemical Engineer

Foundation Exploration With 36-inch Drills

ALMOST valuable recent contribution to exploration work is the large-diameter core drill which drills smooth-walled holes large enough in diameter to permit the engineer or geologist to enter the hole and examine the exposed section of rock in place. Such is the introduction of *The Reclamation Era* to a discussion of the new Calyx shaft core drills made by the Ingersoll-Rand Company.

Drilling is accomplished by a rotating cylinder of the proper diameter employing shot as a cutting medium or, in soft rock, using steel or hard alloy cutting teeth. The core is broken loose from the bottom of the hole by small charges of explosive inserted at three or more points in the bottom of the circular cut, or by wedges driven between the core and the side wall of the hole. The latter method has proved more successful when the rock is soft and susceptible to shattering by the explosive. The core is then lifted by an eyebolt wedge device inserted in a small-diameter hole drilled in the center of the core, or by means of a cable sling around the core when the material is too soft to permit the use of an eyebolt. In soft, friable, or broken material which does not permit extraction of cores intact, sections of the cores are broken and the materials removed by a large auger with scarifying teeth. The finely broken material is lifted on the auger itself.

Exploring with a 36-inch drill

Drill core from a 36-inch hole

These large drill holes afford a means of inspection of rock in place which is superior to any method available. For instance, the side walls of shafts put down by the usual mining methods are generally shattered and disturbed by the explosive used and much of their area must necessarily be hidden by timbers. In drilled holes, a smoothly cut, in some cases, almost polished, continuous surface of undisturbed rock is available for examination. The spacing and tightness of joints, seams, and fissures can be observed, and the existence and nature of soft layers not ordinarily recoverable in small-diameter core drilling is disclosed in a manner not possible in the broken walls of test pits or shafts.

The Ingersoll-Rand Company furnishes machines for diameters up to six feet and for depths of 1000 feet or more.

Polarizing Material

A LIQUID polarizing material, which is capable of being directly applied upon the surface of transparent bodies, such as glass, has been discovered by Maurice Zalma and Harry A. Silverman. When dry the material adheres to the pores in the surface of the transparent body and expands or contracts, through changes of temperature, with the body. This obviates the possibility that the polarizing medium will become buckled or distorted by heat during use.

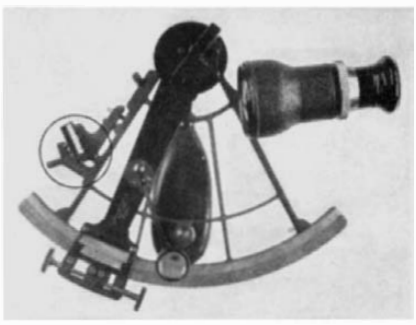
It has been demonstrated practically that polarized glass prepared with this material gives no distortion of light, which favors its use in microscopic, photographic, and scientific work. Because of the comparative simplicity of production the cost can be materially reduced.

A direct and important application of the discovery is in the field of color photography. It is now possible to produce colored polarized light filters as a single unit, and the employment of separate color and polarizing filters will no longer be necessary.

Mirrors For Sextants

THE conventional mirror for sextants for marine navigation is made of glass, with both sides ground parallel and optically flat. The rear surface is silvered and given a coating of paint for weather protection. Mirrors of this sort are excellent as long as the silvering remains in good condition and the surface of the glass is not scratched or otherwise damaged. Moisture, however, soon penetrates the protective coating.

In its hydrographic surveying, the United States Coast and Geodetic Survey uses sextants not only for navigation but for measurement of horizontal angles. The instruments are subjected to frequent wetting from spray, with the result that the salt water soon destroys the silvering.



New mirror (circle) in a sextant

To remedy this trouble, experiments were conducted with mirrors made of the non-ferrous alloy known commercially as Stellite. This is an extremely hard metal which does not corrode easily, which takes a high polish and has good reflecting properties. Some apprehension was felt that a metal mirror might give trouble by warping and a careful check has been made upon this detail.

At first, some trouble was experienced with a cloudy appearance in the mirrors, due to large numbers of extremely small holes. The makers were able to remedy this defect and after some years of use, the Survey finds that these mirrors are almost universally as good as new. There is practically never any sign of corrosion or staining. The material is so hard that it does not scratch readily and can be easily wiped clean, when wet or dirty, without damage.

Careful check with a quartz optical flat has not divulged any case of warping, and the fact that these mirrors are front reflecting, not rear reflecting like the glass, means that there is no loss of light because of transmission through the glass or due to change of medium, nor is there any error due to lack of parallelism of front and rear faces.

While the initial cost of Stellite is somewhat greater than glass, the long life and freedom from expense of resilvering and from loss by breakage or scratching make it an economical mirror to use, where the absolute maximum of reflecting power is not required.—*D. L. Parkhurst.*

A literal bath of electrical fire surrounds these porcelain bushings on test at the Derry, Pennsylvania, Works of the Westinghouse Electric and Manufacturing Company. Flash-over takes place at 200,000 volts, the test being made to insure efficient service of bushings and insulators in high-voltage transmission systems

CINNAMON

CINNAMON trees once grew in what is now Texas, millions of years ago, when there were dinosaurs to browse on their leaves.

Saving in Dead Loads of Buildings

IN building design, the reduction of useless dead loads is even more important and has more far-reaching effects than it does in fast railroad transportation. However, there is a parallel in both these modern trends. In railroading, it means a gain in speed or a reduction in power costs, or both. In building construction, there is far less tonnage to handle and fabricate, and the work is speeded up with a consequent saving in both labor and material.

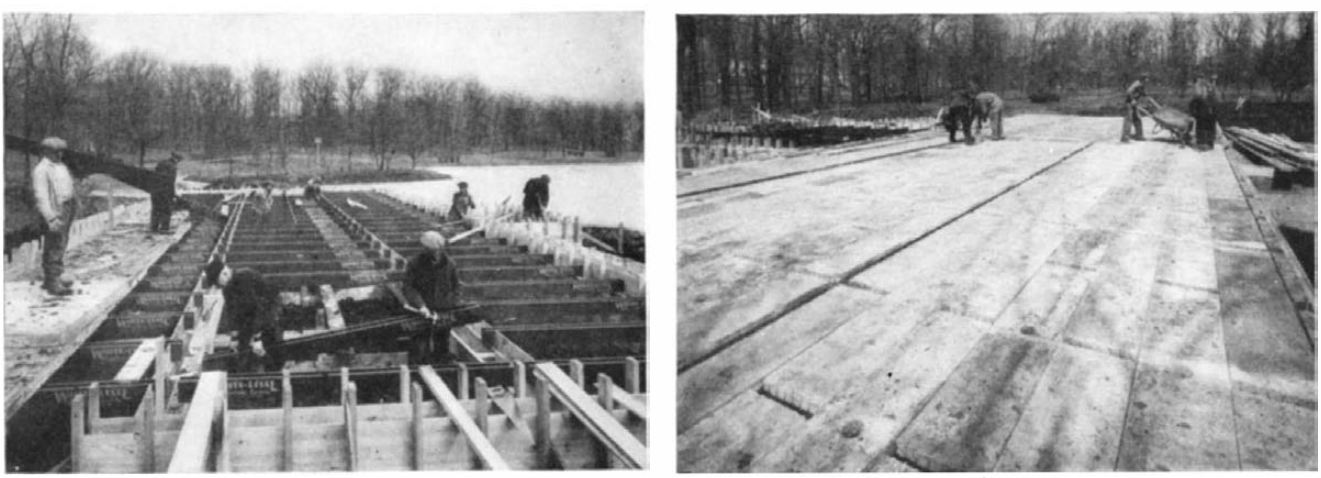
Startling claims are made for the latest improvement along these lines—a saving of 40 percent in construction costs. A new design of floor and roof deck construction has been perfected and patented by Eugene B. White, engineer and architect, which is known as the White-Steel Monolithic System. Dead loads are cut in half as compared with conventional concrete floors, it is claimed, and full strength is developed with only 20 to 25 pounds per square foot of roof deck and floor areas, including the weight of the beams.

For both floors and roofs, the system is fireproof and steel purlins are eliminated in the latter. This, in itself, results in a marked lowering of construction costs. Lightening the dead loads carried, results in the reduction of the tonnage of structural steel required; also, in the size of the foundations.

As is well known to engineers and contractors, one of the largest cost items in connection with concrete floors and roofs is the form work. This is entirely eliminated in the White-Steel System. In place of it, hollow sections of light gage, cold formed steel are provided in which to cast the beams. These are full span length. While light and inexpensive, they are strong enough to provide an adequate working deck before the beams are poured.

On these hollow steel sections are placed pre-cast slabs of light-weight, reinforced concrete. The strong reinforcing mesh projecting from the ends of these slabs is turned down into the empty beam form from both sides, constituting a stirrup and making the reinforcement continuous through the beams and slabs. Then, the beams are cast with concrete poured on the job, a space being left between the slab ends for this purpose. Pouring is continued up to structural floor level.

For ordinary loads and spans, the beams are four and one half by six inches, spaced three feet center to center and reinforced with tension bars in the usual manner. A dowel-stirrup is placed through a hole in the center of each slab, projecting into the concrete beam beneath.



Placing hollow steel sections and (right) light-weight concrete floor, in a new building system

The use of these light-weight pre-cast slabs eliminates at least 70 percent of the concrete poured on the job and greatly speeds up the work. While the structural steel framing is being fabricated for the building, the light-weight concrete floor and roof slabs are being cast in a large, modern plant with special facilities for controlling the quality and strength of the concrete, such as steel forms, automatic water-control, vibration equipment for breaking and testing, et cetera. This pre-casting is of special advantage in cold weather which interferes but little with construction where the White-Steel System is used.

The system has been adopted as standard design on all new Y.M.C.A. construction throughout the United States.

SHEEP

TEN thousand sheep were recently transported by plane across the Kara Kum desert in U.S.S.R. Expensive as air transport is, it is claimed that it is cheaper to take the sheep on the three-hour trip than it would be to drive them 325 miles across the desert, where food supply and protection constitute major problems.

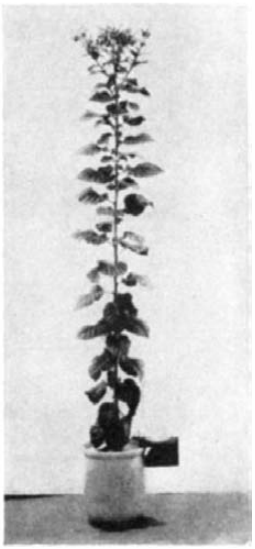
Tracking Down Vibration

STUDY of vibrations in various types of equipment is an essential part of laboratory research and factory production. A device now available for conducting such study is so sensitive that it will pick up the vibrations from the escapement of a wrist watch, yet is rugged enough to withstand vibrations up to an amplitude of 1/16 of an inch. Briefly stated, this vibration pick-up uses a bimorph crystal mounted in an aluminum case and connected to a vacuum tube amplifier which operates either an oscilloscope or a loudspeaker. The prod, which is placed in contact with the machine or other equipment under test, causes the case to vibrate, whereupon the crystal flexes of its own inertia and sets up voltage impulses of exactly the same wave-form as the mechanical motion. This is reproduced either by the oscilloscope or by the loudspeaker.

A partial list of applications on which vibration study with this setup may be carried out includes: Production testing of electric motors, ball bearings, crankshafts, gear trains, fans, air-conditioning equipment, and locating sources of vibration in reciprocating or rotating machinery; checking relative smoothness of surfaces, such as paper, polished metal, gages, glass plate, and so on; checking longitudinal rods for fracture, and the relative efficiency of materials for deadening sound.

Bottle-Fed Turkish Tobacco

CHEMICAL cultivation of Turkish tobacco in the laboratory, from a seed the size of a grain of sand to a giant flowering plant six feet tall, is reported by Professor Sam F. Trelease, head of the department of botany of Columbia University.



A tobacco plant that was bottle-fed

"Analysis of the soil of the Near East, natural habitat of the plant, revealed the exact proportions of a large variety of nutrient salts needed for the growth of the tobacco," Professor Trelease said. "Through tank culture in an earthen pot of pure silica sand we are able to duplicate the conditions of the soil by means of a carefully prepared chemical solution.

"The tobacco plant's dependence on the minor or 'tonic' elements is one of the most important of recent discoveries, and it may in a way be compared with the need of the human body for vitamins. Although but a very small quantity of either the chemicals in question or the vitamins is necessary, the need on the part of both plant and human being is actual and fundamental."

The tobacco plant, which requires four months to reach its full height of six feet, is fed one drop of chemical solution at a time through an elbow feeding tube connected to a Mason jar. The solution drips into the silica sand and is absorbed by the roots of the plant. The quantity of solution supplied varies from one to two quarts in 24 hours.

Using the same method of culture, but varying the ingredients of the plant food to suit the particular needs of each, Professor Trelease has also cultivated beans, green corn, and tomatoes. In addition, 16 different varieties of garden flowers, including larkspur, petunia, snapdragon, phlox, heliotrope, sweet pea, fuchsia, and nasturtium have thrived on chemical feeding in the Columbia laboratories.

MOVIE

IN the first motion picture ever to depict the story of radium, platinum forceps and a special lead wall were used in order to protect actors, directors, and cameramen against dangerous emanations from the radium.

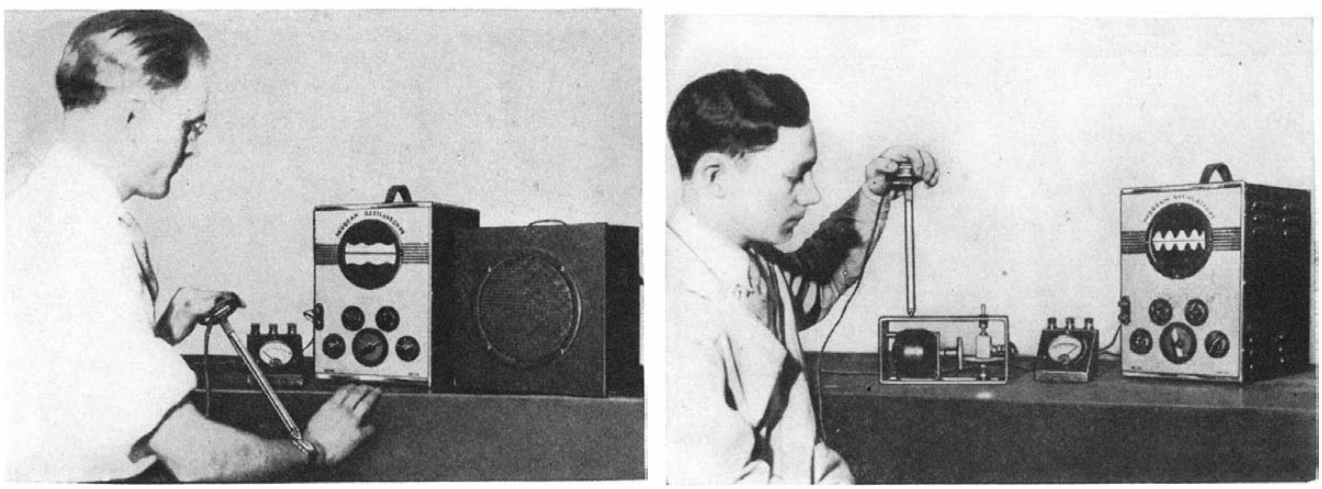
Electrolytic Scale and Corrosion Prevention

BY placing an insulated anode in a boiler and making the boiler metal itself the cathode, pitting and formation of scale are prevented. The current consumption varies from 0.4 to 2 kilowatt hours per day per thousand square feet of boiler surface and the installation is extremely simple. The effect of the treatment is to prevent any significant corrosion or pitting and to keep scale-forming minerals in suspension so that they are easily flushed out. Direct current, of course, must be used.—*D. H. K.*

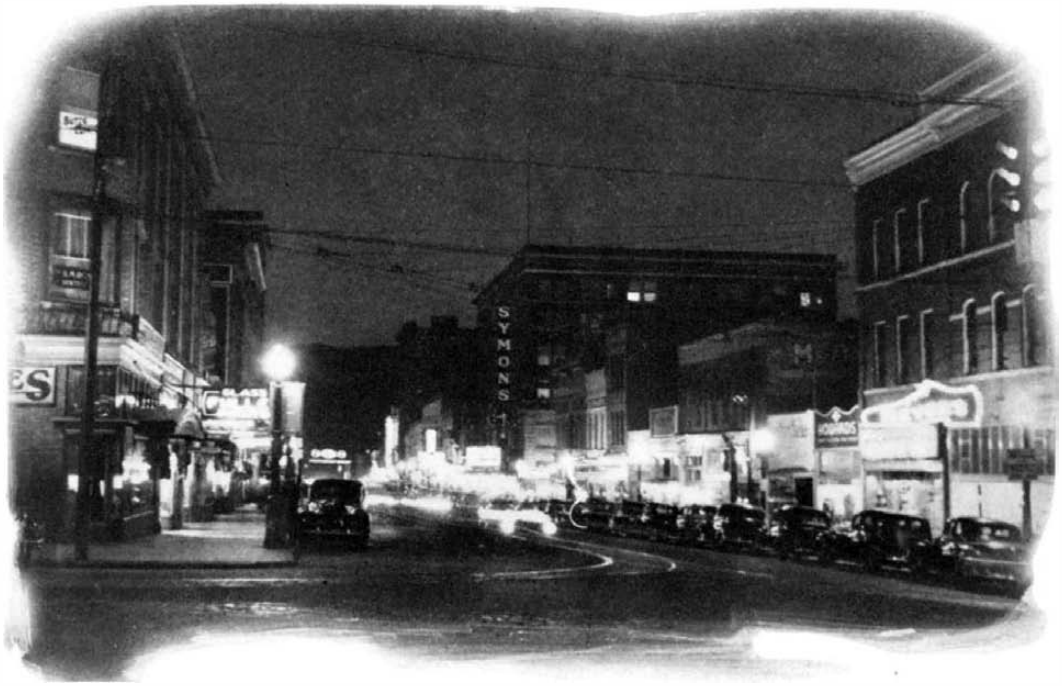
X Rays for Sinus Disease

THE important part that X rays can play in diagnosing unsuspected sinus disease and in treating the condition in some cases is reported by Dr. Fred M. Hodges of Rich-

(*Please turn to page* 358)



Detecting vibration in a wrist watch and (right) in a small electric motor



Home Address: MAIN STREET, U.S.A.

IN THE showrooms of General Motors dealers everywhere the new 1938 automobiles of the General Motors family are now on display.

When you view these cars we believe you will find many fresh instances of the sound and steady progress which General Motors, since its inception, has sought to bring to automobile design.

You will note that new standards of performance have been set, and that new qualities have been added to the ride.

You will observe that improved appearance is uniformly characteristic of all our cars. Factors of safety, comfort and ease of operation have been enhanced through continuance and development of such features as Knee-Action, No Draft Ventilation and the Unisteel Turret Top Body by Fisher.

Each car in its field, we sincerely believe, represents a new high in utility and value.

• • •

Tonight, in Alabama, a cotton planter will go to bed quite unaware that he has helped to build an automobile.

A silver miner in Colorado, a cattle rancher in Wyoming, a sugar cane planter in Florida, a machine tool maker in Connecticut, will go about their daily lives feeling no part, perhaps, in the enterprise which is General Motors.

But the truth is, in every state in the Union, such men by the hundreds of thousands contribute to and reenforce the basis of General Motors merit.

For our products begin in the mines, mills, fields and factories of all America—in the raw materials there produced.

Before a single wheel turns in any GM plant, our purchases have already begun the process of moving money to Main Street—to the pockets of farmers, the tills of factories, to bank accounts from which many a pay roll is met.

• • •

But this is not the only way in which the products of General Motors are native to Main Street.

In recent years we have pursued a definite policy of decentralization—in order to create more jobs for more people in more places.

We have found that living costs go down and living standards up as industry is wider spread—that sometimes the opposite happens when industry is too closely massed.

We have learned that the problems of unemployment, seasonal or otherwise, are less acute when plants are broadly distributed—that both value and service to our buyers are enhanced, that our employes enjoy greater real wages and better, easier lives.

So we have sought to extend the benefit of General Motors investments, General Motors pay rolls and General Motors employment into many communities and many sections.

• • •

Today no less than thirty-eight cities are home towns to active producing units of General Motors.

In fourteen states, spreading from New England to the South and through the great Middle West to the Pacific Coast, General Motors is a vital *local* industry, giving employment to local people and better trade to local business.

How broad this distribution of industry is—how truly it cross-sections the entire country—is shown in the listing elsewhere on this page of cities in which General Motors plants are located.

• • •

It is quite natural that when you view the new General Motors cars your first interest should be what they have to offer of immediate benefit to you and your family.

But we believe you will find these new models of even greater interest if you likewise look at them in the light of what they mean in a larger sense.

By providing work for your neighbors, a market for many local industries, increased opportunities for the country at large, they have served your broader welfare even before they begin to serve you.

It is the policy of General Motors to continue this extension of service to the nation, even as we continue to extend the service of each car to its purchaser.

Alfred P. Sloan, Jr.

Chairman

GENERAL MOTORS CORPORATION

HOME FOLKS TO ALL THESE TOWNS

To picture how truly the home address of General Motors products has become "Main Street, U. S. A.," you have only to consider this list of the cities and towns in which General Motors plants are located:

ANDERSON, IND.
ATLANTA, GA.
BALTIMORE, MD.
BAY CITY, MICH.
BLOOMFIELD, N. J.
BRISTOL, CONN.
BUFFALO, N. Y.
CHICAGO, ILL.
(LaGrange)
CINCINNATI, O.
CLEVELAND, O.
DAYTON, O.
DETROIT, MICH.
FLINT, MICH.
GRAND RAPIDS, MICH.
HARRISON, N. J.
INDIANAPOLIS, IND.
IONIA, MICH.
JANESVILLE, WISC.
KANSAS CITY, MO.
KOKOMO, IND.
LANSING, MICH.
LINDEN, N. J.
LOCKPORT, N. Y.
LOS ANGELES, CALIF.
(Southgate)
MEMPHIS, TENN.
MERIDEN, CONN.
MUNCIE, IND.
OAKLAND, CALIF.
PONTIAC, MICH.
ROCHESTER, N. Y.
SAGINAW, MICH.
ST. LOUIS, MO.
SEATTLE, WASH.
SYRACUSE, N. Y.
TARRYTOWN, N. Y.
TOLEDO, O.
TRENTON, N. J.
WARREN, O.

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Nothing makes more acceptable gifts than practical books

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

2. **THE FORD V8 CARS AND TRUCKS**—*By Victor W. Pagé.*
   A comprehensive discussion of the Ford V8 car which literally tears it apart and shows how every tiny detail of it may be adjusted and repaired.—**$2.65** postpaid.

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   A book by a scientist not primarily a mathematician, intended as a help to millions who have "forgotten their mathematics". For laymen who would like to remember easily.—**$3.95** postpaid.

4. **THE NEW MAGICIAN'S MANUAL**—*By Walter B. Gibson.*
   Contains over 100 complete and easily followed instructions for tricks of parlor magic. A bound-in envelope contains all the actual apparatus needed for these tricks.—**$3.25** postpaid.

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   A "make money with your camera" book of 112 pages telling what to shoot, how and where, with directions for submitting photographs to magazines. Over 1800 markets listed.—**50 cents** postpaid.

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   More than a dozen authors contributed to make this book a comprehensive review of the field of electricity, its fundamental laws and their practical applications in business and industry.—**$2.15** postpaid.

8. **GARDEN FLOWERS IN COLOR**—*By G. A. Stevens.*
   The 400 brilliant and life-like color plates make this book of the greatest value. It is the only book of its kind dealing with cultivated flowers. With it almost every popular garden flower can be identified. It includes annuals, perennials, vines and shrubs. Formerly $3.75. Now **$2.20** postpaid.

9. **WILD FLOWERS**—*By Homer D. House.*
   This superb book has 364 color plates and 340 pages of text. Hundreds of wild flowers in all parts of the United States can be identified through the pictures and the descriptions which were written by this noted authority. Formerly $7.50. Now **$4.45** postpaid.

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    Eighty full-page illustrations from paintings by Louis Agassiz Fuertes illustrate this renowned bird book. Complete information on 200 bird species is given. Formerly $2.50. Now **$1.10** postpaid.

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

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SCIENTIFIC AMERICAN

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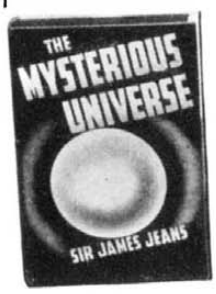

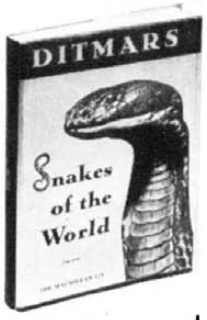

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An important book by a distinguished authority. Probably the most readable, attractive and extensive discussion of the subject yet offered to the general reader. It discusses the more than 2000 different kinds of snakes, the largest proportion of which are non-poisonous. The poisonous kinds are minutely described. The book contains a superb collection of illustrations. —Cloth, 8vo. Formerly $6.00. Now **$2.10** postpaid.

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A practical guide to sex and marriage covering by question and answer those questions most often asked the authors by their consultants.—**$2.65** postpaid.

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Inarticulate people will be tremendously helped by the reading of this book by a man who is a brilliant conversationalist. It will help remove that inferiority complex.—**$2.65** postpaid.

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

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Operation and maintenance of modern Diesel power plants answering, in addition, problems concerning wiring hook-up and electrical equipment.—**$2.15** postpaid.

THE SCIENTIFIC AMERICAN DIGEST

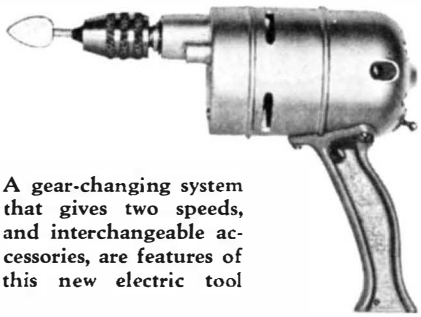
(*Continued from page* 352)

mond, Virginia. For 15 years it has been his practice to make a "scout sinus film" in every case sent in for chest examination, unless the condition found by X-ray pictures of the chest was sufficient to explain the symptoms.

"In this way," Dr. Hodges says, "a large number of unsuspected sinus infections has been found. Almost every common cold that failed to clear up after a reasonable time showed definite evidence of sinus infections."

Two Speeds in New Electric Tool

SINGLE-SPEED utility electric tools are not new, but, by an ingenious gear arrangement—which combines two different speeds—a much wider range of usefulness is now available in a newly designed tool. The normal speed is ideal for heavy-duty



A gear-changing system that gives two speeds, and interchangeable accessories, are features of this new electric tool

work as in drilling, drum sanding, cutting, and so on; the high speed, four times the normal, is perfect for precision work as in carving, grinding, engraving, polishing, etching, and so forth.

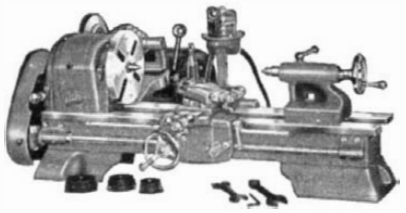
This new tool is fitted with a universal motor, operating on any 110-volt AC or DC circuit, with ball bearing thrust for smooth operation, a self enclosed cooling system, and a die cast alloy frame. The complete tool weighs 3½ pounds. Chuck is a 3-jaw coil-spring universal type and takes all sizes of shafts up to ¼ inch. There are over 200 accessories available, and they are instantly interchangeable.

New Small Metal Lathe

LATEST development for the fast-growing army of metal working hobbyists is a new back-geared screw-cutting lathe with the construction features of an industrial machine tool scaled down for accurate machining of small work. It was designed for the shops of inventors, small-part engineers, modelmakers, jewelers, and homecrafters.

Early working tests class the new lathe as a sturdy machine tool. It swings diameters up to six inches and is available in two sizes, one accommodating 12 and the other 18 inches between working centers. On work within these dimensions it has the versatility which has made the modern lathe the basic machine tool. Handling such operations as turning, facing, threading, tapering, boring, knurling, cutting-off, and mica undercutting, these machines should receive

a hearty welcome from not only the novice in metal working, but also from the advanced operators who tackle such projects as model engines, racing boats, airplanes, locomotives, and telescopes, cameras, radios, and so on.



Ideal for the small shop

Here are some of the construction details which make these new machine tools worthy of notice: reversible power feeds for carriage, complete V-belt drive, tapered roller spindle bearings, countershaft attached directly to the lathe, range of 16 speeds, and provision for maintaining permanent accuracy.

Farm Battery or Power Radio Receiver

A NEW radio receiver especially designed for rural families living in areas where electric power is a possibility, but not yet an actuality, has been developed by the RCA Manufacturing Company. The Rura-Lectra radio, as it has been named, is a five-tube superheterodyne table model which will operate on either 110-volt AC power or a 6-volt storage battery.

The change-over from battery to power operation is automatic. The battery wires are disconnected and the power cord plugged into the electric socket for immediate operation. This new set will reach a large potential market in areas where the possibility of early or eventual electrification has made residents hesitant about buying ordinary battery operated radio sets.

Two tuning-band ranges of from 540 to 1720 kilocycles, and 5800 to 18,000 kilocycles, respectively, provide reception of domestic broadcasts and the short-wave and foreign entertainment on the 49, 31, 25, 19 and 16-meter bands, in addition to police and amateur calls.

Kidney Infections Yield

THE new chemical germ fighter, sulfanilamide, which gives promise of conquering deadly streptococcus infections such as childbed fever, is apparently also winning the fight against infections of the kidneys and bladder.

Successful use of this chemical and its relative, Prontosil, in the treatment of these common and often refractory infections was reported by Dr. Russell D. Herrold of the University of Illinois College of Medicine at a recent meeting of the Society for Experimental Biology and Medicine.

"This drug would seem to be the first definite advance in the use of chemicals to combat infections since the discovery of the chemical treatment of syphilis," *Science Service* quotes Dr. Herrold. "It opens a new field in the fight against infectious diseases. It is startlingly successful, often in as short

(*Please turn to page* 370)

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Figure 1: **Mrs. Wells' Gregorian**

WIVES who painfully watch their husbands making telescopes seldom seem to acquire the same bug themselves. However, Mrs. Dana W. (Nora L.) Wells, 16 Van Campen St., Dansville, N. Y., tells another story:

"I became interested in making a telescope through watching my husband make his 9″ Newtonian. In the beginning I had no thought of making a compound telescope, but gained my first practical experience by grinding and polishing a 6″ mirror made up of layers of wind-shield plate, which, true to what has been said of its type, proved in the final polishing not to hold its figure.

"My husband supplied the tube and mounting, the latter being of pipe-fittings welded to a fly-wheel as a base. The eighteen-sided wooden tube is made of lattice strips.

"My primary mirror is 8″ in diameter and is pierced for the Cassegrainian and Gregorian set-up. The Newtonian focus is slightly over *f*/4½. The Gregorian secondary is approximately 10″ from the Newtonian focus. I ground, polished, and figured both mirrors, also ground and polished a pair of plano-convex lenses for a Ramsden ocular of approximately 2″ *e.f.l.* The finder was made of reading glasses of the pocket variety.

"As it could be figured directly without the primary, I completed the Gregorian secondary first.

"My Gregorian is somewhat difficult to keep on a star, but I have spent many enjoyable evenings with it. I get sharp, beautiful detail on the moon; and Saturn's rings, Jupiter's zones, belts and satellites, as shown by the telescope, are of never-ending fascination to me. The making of my telescope has not been easy. At every phase of the procedure I experienced the telescope-maker's usual troubles. What I do not know about optics would fill many a book, but that I have, by the liberal use of 'Amateur Telescope Making,' been able to fashion a workable instrument, gives me considerable satisfaction."

CEMENTED skeleton glass disks may or may not hold their figure. Often, when they do, it is difficult to ascertain whether the front disk held its shape without actual aid—the other parts then being mere excess baggage—or whether an actual structural unit has been created: In ATM, p. 308, there is a note bearing on cemented disks. Thomas A. Martin, resident at 126 Monroe Ave., in the famous Wisconsin center of gravity of the overall industry (see Figure 2) says:

"I am sending you a picture of my latest telescope. Total cost, $15. The mirror is made of two 12-inch disks, five-eighths of an inch thick, cemented together with 12 glass blocks between. It took 16 hours to complete the mirror with what I think is a pretty fair parabola.

"The mounting is constructed entirely of used two-by-sixes—very inexpensive but remarkably stable. The whole thing rolls out of the garage on four bed casters. The tube is made of 22-gage iron. The top 18 inches, holding the eyepiece, can be turned to the most comfortable position."

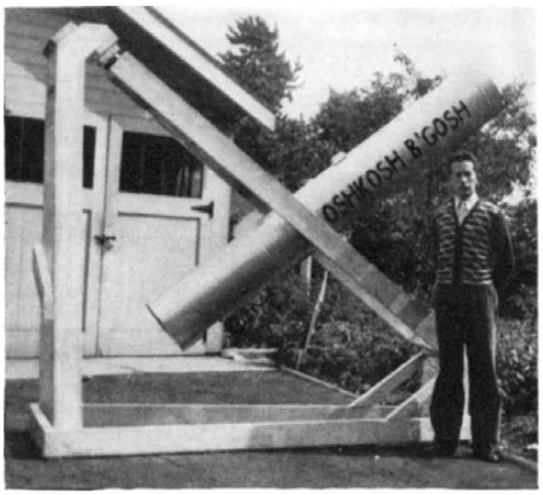


Figure 2: **Martin of Overall City**

Having gone so far as to equip his telescope with bed casters, the maker may have missed a trick in omitting the bed itself—especially as the bed of the mounting has just about the right proportions to receive one. Seriously, R. W. Porter, years ago when working out the indoor telescope shown in ATM, at *V* on p. 51, tried to arrange it so that he could use it from bed. This would be the very *summum bonum* in telescopes and the problem is passed on to others who may care to lie abed and expend gray matter on it.

WHATEVER a man designs and makes, brings his own inner character tangibly and visibly into the open where all may inspect it. Some amateurs' telescopes are roughly designed and inefficient, others roughly designed but efficient; still others are smooth in appearance but mechanically lacking at some vital point or points, while a few are both well designed and easy to look at. The one shown in Figure 3 was noted at the *Stellafane* convention, where it was brought last summer, because it seemed to fall in this fourth category, and the following data were given by its maker, Philetus Allen, 45 Sheridan St., Glens Falls, N. Y. It is a 6″ and has heavy axes, the PA being 1 15/16″ and the Dec. axis 1 11/16″ in diameter. The heavy base casting weighs 105 pounds and is of solid bronze—a beautiful metal. Allen made his own pattern. The main ring around the tube's waist is 6″ wide, ⅝″ thick and is of solid bronze, as are the two end rings. The tube is finished in antique bronze. The whole job has a sleek, clean appearance—good taste, both mechanical and aesthetic.

Figure 4 shows the adjustable eyepiece rack which carries with it the prism mounting—an old idea but an efficient one, cleanly worked out.

SMOOTH also is the 7″ Cassegrain shown in Figure 5, the optics by A. Priselac, the machining by Emir Kelly, members of the Amateur Telescope Makers of Pittsburgh. "This one really works as nicely as most refractors," we are told by Leo J. Scanlon—"splendid definition, smooth mounting, professional touches."

AMONG amateur telescopticians (isn't that at least as good a word as mortician?) there is a group having an interest in clock drives, and a more or less refined mathematical interest in gear trains that will split fine hairs in accuracy of time keeping. E. C. Stanton, Washington, D. C., writes:

"How's this for a polar axis telescope

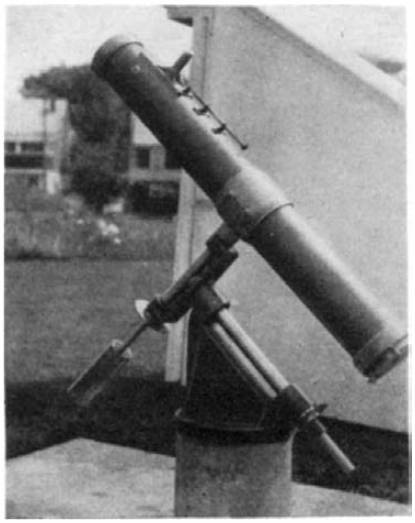


Figure 3: **Allen's 6″ reflector**

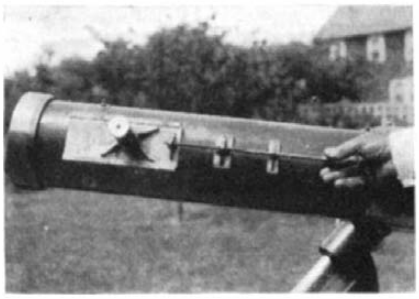


Figure 4: **Allen's sliding unit**

drive? Starting with 1 revolution per minute, given by any clock motor, the drive shaft connects with a gear of 44 teeth, meshing with another with 179 teeth on a worm shaft; the worm wheel is on the polar axis and has 353 teeth. This mechanism will rotate the axis in 1436 3/44 minutes, equal to 23 hrs., 56 min., 4.091 sec., which is the length of a sidereal day to the last decimal place given in the Ephemeris. In a tropical

Figure 5: **Made in Pittsburgh**

year of 365.24219879 days the axis would be revolved 366.24219721 times, an error which amounts to 1 degree in 1760 years.

"This is offered to your fans with my compliments—and a challenge to beat it in accuracy."

Of course, at this point or sooner, the question becomes mainly one of the pursuit of the ultimate for its own sake rather than a practical one, but even this is of much interest to those who enjoy refinements of method. Hence we reprint a part of a letter which appeared a year ago (Nov. 28, 1936, p. 931) in *Nature* (London). Its writer is the same F. Hope-Jones who is prominently mentioned in ATMA in connection with the Synchronome clock (pp. 427-446), and it looks as though the Dr. Comrie mentioned in it, a mathematical astronomer at the Greenwich Observatory, had beaten the challenge mentioned above, even before it was issued.

"The problem involves the precise expression of the ratio between the sidereal and mean time in the form of a train of gear wheels. Since one mean solar day is $24^h\ 03^m\ 56{\cdot}555\ 36^s$ in sidereal time, the ratio of sidereal to mean is 1·002 737 909 3.... This ratio must be expressed by a fraction; for our purpose the numerator and denominator of this fraction must both be factorizable into factors not exceeding a few hundreds, as the number of teeth on any wheel cannot

reasonably exceed this. Moreover, the number of factors (or suitable combinations of them) in the numerator and denominator must be the same, as wheels must work in pairs.

"The first to accomplish it was George Margetts, a member of the Clockmakers' Company *circa* 1800. It is in the form of a large watch and is to be seen in the Company's collection in the Guildhall. It has separate dials for hours, minutes, and seconds, each having a smaller dial mounted concentrically with the larger ones. These inner dials were gradually revolved backwards by gearing, so that the same three hands indicated simultaneously mean time on the outer dial and sidereal time on the inner dial. His train includes a wheel of 487 teeth so fine that they are invisible to the naked eye. The ratio is $\frac{1465}{1461} = \frac{5 \times 293}{3 \times 487} = 1{\cdot}002\ 737\ 85$, which is correct to the sixth decimal. The sidereal component would lose at the rate of $1{\cdot}8^s$ in a year.

"In the Science Museum there is a clock designed by Joseph Vines a hundred years ago (1836), with two dials coupled by the ratio $\frac{43 \times 247}{32 \times 331}$. This is 1·002 737 915 4, which is correct to the seventh decimal. It will take 5·2 years for the sidereal dial to be in error relatively to the solar dial by one second.

"Paris adopted a train by Ungerer, of Strasbourg, $\frac{119 \times 317}{114 \times 330}$, which is 1·002 737 905 4, and correct to the eighth decimal; it will be 8·2 years before it is a second wrong.

"Sir George Airy contributed to the *Monthly Notices of the Royal Astronomical Society* in 1850 a train by Dr. Henderson, $\frac{50 \times 182 \times 196}{30 \times 211 \times 281}$, a ratio of 1·002 737 908 5. This is very close, being correct to the ninth decimal, and requiring 40 years to accumulate an error of one second.

"At this stage of the investigation, I was fortunate in interesting Dr. L. J. Comrie who, as a result of 'a pleasant week-end's arithmetical recreation,' summed up the whole matter and contributed a solution which we may accept as final. He gives the true ratio as 1·002 737 909 265, plus the centennial term, and a wheel train of $\frac{45 \times 71 \times 257}{29 \times 151 \times 187}$ which is the value of the precise ratio required in the year 1955, namely, 1·002 737 909 297. The error would amount to one second in about 100,000 years."

At this point hard-headed extraverts who may consider all this sub-splitting of ultra-microscopic hairs a trifle over-refined for us mere amateurs with plain back-yard telescopes which may or may not even sport an alarm clock drive are entitled, if they wish, to offer the yarn about the Yankee salesman who was working hard on a western farmer trying to sell him a cornsheller. At great length he urged its purchase but the farmer, throughout the sales talk, wore a puzzled expression; and finally, when the torrent weakened a bit, he managed to say: "Yeah, but what's the purpose of it?" Came the reply: "Why, man, think of all the *time* it will save your hogs in eating." His eyes at last brightening up with a sudden inspiration of understanding, the farmer answered: "Haw haw! What's time to a hog?"

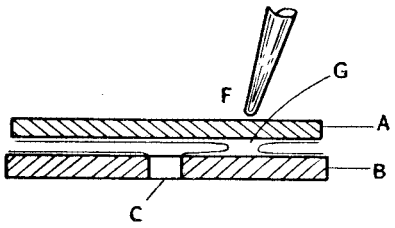
Nevertheless that outstanding one second in 100,000 years is a challenge to all mathematically-minded introverts. It's scandalous!

When the above letter was first published in *Nature* the *London Times* stated that "A new clock whose error is only one second in about 100,000 years is described in *Nature* by Mr. Hope-Jones." The Astronomer Royal soon pointed out that one second a year was the clock record, and that there was no actual clock of that refinement; the calculations merely tell what could be—if other sources of inaccuracy did not far outrank this one.

ONE function of this telescoptical columnist (or telescoptimist) is to keep a weather eye on scientific journals of limited circulation, and reproduce here items from them that may interest other amateur telescopticians. Hence another letter from *Nature* (Aug. 21, 1937), by Dr. James Weir French, of Barr and Stroud, Ltd., optical manufacturers, Glasgow, Scotland:

"It is not generally known that by a simple device so-called optical contact can propagate itself.

"Contact is usually produced by the application of considerable pressure, first on the center of the plate and thereafter in a spiral path outwardly to the periphery. If, however, the test plate is pierced by a small hole and pressure is applied at one point and



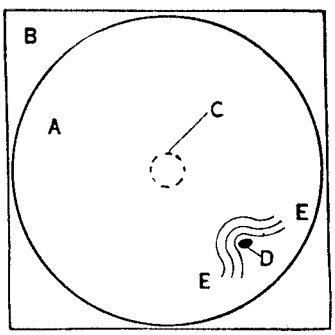


Figure 6: **A contact experiment**

then withdrawn, the surfaces, without further manipulation, will move together into optical contact.

"In Figure 6, *A* is an optically polished glass disk, lying upon a test plate *B*, pierced by a hole *C*. Pressure is applied, say, at *F*, and then withdrawn. The Newton rings around the point, without further assistance, expand and disappear, leaving the surfaces in pseudo-contact and in darkness devoid of colors. A small speck of dust, such as *D*, will not arrest the movement. It is interesting to observe the rings at *E* attempting to encircle the speck and ultimately doing so, leaving around it two small bluish white rings, separated by a mottled dark one. These white rings suggest the following explanation of the phenomenon under consideration:

"Optically polished glass surfaces, unless they are specially treated, have surface layers of something akin to grease. Pressure at *F* bends the plate *A* sufficiently to join the grease films, as at *G*. Surface tension forces around *G* expel the air and extend the liquid continuity over the whole surface. Light falling upon the area *G* passes through more or less completely, according to the equality of the refractive indices of the grease and

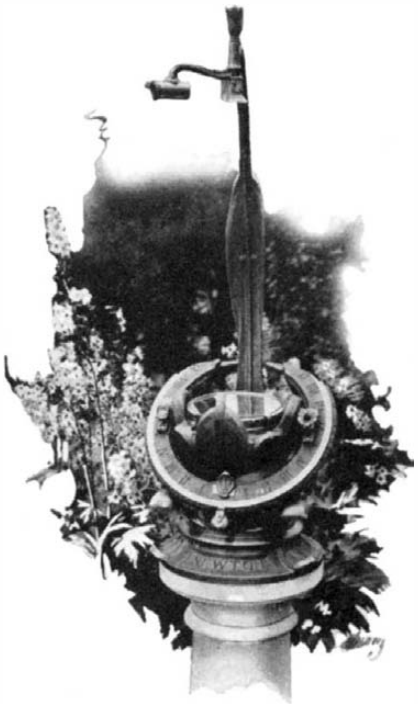
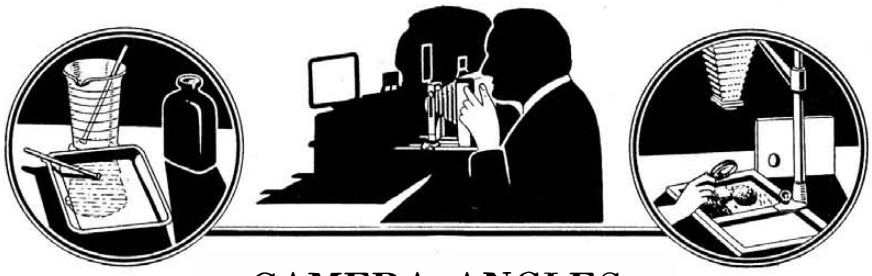


Figure 7: **The Garden Telescope**

glass. Viewed from above, the liquid region *G* appears dark and, from below, bright.

"Light is reflected from the rounded surface tension contours, which regions appear bluish white. Newton rings may appear in the remainder of the area. From measurements made by Sir Isaac Newton, I reckon the thickness of each grease layer to be less than one millionth of an inch."

HOW many of the more recent amateurs have ever heard about the Porter Garden Telescope? Figure 7 shows one of these handsome decorative bronze mountings. About 1923, when R. W. Porter was optical associate of the Jones and Lamson Machine Company, in Vermont, and before this magazine had adopted the infant amateur telescope making hobby, he designed, made, and his company sold, 75 or 100 of them. They had 6″ mirrors and were *f*/4, and sold for 400 dollars. Many of the mirrors were figured by a local lad named Wilbur Perry, whom Porter trained to do this work, and he took to it like a duck to water. Later, Perry took a position making diffraction gratings with Prof. R. W. Wood of Johns Hopkins, and is doing that ultra-skilled work today. For the Garden Telescope Porter employed his split ring equatorial principle which has been adopted for the 200″ mounting. None of these telescopes are to be had today, in case any reader suspects this of being a subtle advertisement. The irregular swelling of the spinal column is a representation of a leaf, and another leaf swings down under the mirror and part way up again. These were handsome instruments.



CAMERA ANGLES

Conducted by JACOB DESCHIN

Pictures on the Highway

SOONER or later, you were bound to learn this department had acquired an automobile. So, get ready; you're in for it right now. All that the car needs is a built-in darkroom and our joy would be complete. Of course, you know that two or three heralded trailers (doubtless some unheralded ones, too) are thus equipped—photographic gypsies, they might be called. And that, to us, is just about the peak of photographic bliss—taking and making pictures on the road.

Here's the way we squared it with our conscience and the lady who wears the trousers. For a city feller like us, cooped up in New York, with a job and duties, a car seemed the only way of getting out at least over week-ends to the open spaces

"The Road Ahead"

where picture material abounds that is seldom obtainable within the limits of a great city. City pictures are often very fine things, but at least once in a while a fellow should hie himself out to the country and shoot some pictures where the green grass grows and nobody is ever in a hurry.

You could go out via bike or take a picture train, or maybe a bus, but if you used a bike it would take a good part of the day just to get out of the city, not to speak of trying to get back again in the crush of cars returning to the city on Sunday night. You would do better with a bus, but you have to have a destination, and that's always bad because the adventuring picture-taker doesn't always know where he's going, if the truth *must* be told. He looks for pictures along the way and if he never gets

"Rustic Peace"

to whatever destination he may loosely have decided upon, that's all right too. It's the picture that counts.

The Sunday picture train is a recent innovation which goes a long way toward making up to the city chap for the things he misses because the circumstances of life, or perhaps even his own inclination, keep him all week in the city. We have a note farther on in this department about the picture train. This is probably the best thing yet; but now that we have experienced the joys of picture-taking via car (someone has even given it a name, "motographing"), we must say, for our part, that, be it ever so humble, there's nothing like it.

"Take My Pitcher, Will Yuh?"

"All in a Row"

The illustrations constitute part of our first harvest. The letter boxes are a common sight, but it's not always that one meets with a row of them lined up and lighted in the way we found them one Sunday morning, and not the least of the picture's attractiveness was the variety of box sizes, shapes, and their supports. "The Road Ahead" puts over the feeling of the leisurely motorist who has escaped to the byways. "Rustic Peace" is another fairly common sight along the road, and if you don't find horses, there are sure to be cows. Of course, they are not always as close as this particular subject, but climbing a fence should not be a misdemeanor if your mission is as peaceful as that of photography. The slightly aslant chap leaning against the truck saw us hunting about with a camera and bluntly asked to have his picture taken and here you have it.

More anon about our "motographing" expeditions.

For Makina Owners

SEVERAL changes have recently been made in the complete Makina outfit. A special, separate leather case is now included to hold the Tele-Makinar F:4.8 and the Wide Angle Orthar F:6.3, together with view finder masks. This is supplied with a shoulder strap and may therefore be carried independently of the complete Makina case when desired. Also included is a specially designed lens shade and the special tripod head for properly balancing the Makina when using a tripod. The lens case, lens shade, and tripod head may also be obtained separately.

Greeting Card Time

THIS is the time of year when greeting cards assume major importance in the life of the amateur photographer. Since the work involves more than ordinary pains, some are content to turn out a fair-to-middling job and let it go at that. As in everything else, the job may be done well or badly. To do it well doesn't require much more effort than to produce the makeshift, so why not take the extra trouble and do it right? The results will more than pay for themselves in the satisfaction you will get from turning out greeting cards that are at least to some degree original and beautiful.

Look through your negative file and see what it offers in the way of suggestions. Perhaps toning will help, or lettering on the print, or a combination of two negatives. A snow picture taken last winter makes a swell subject, and a happy baby's smile is always a winner. Or you may find it more satisfactory to make some new negatives. Try a table-top with some materials selected at the five-and-ten. Whatever you decide to do, make it good. Everybody will appreciate it, yourself included.

Servicing Electric Exposure Meters

THE growing use of electric exposure meters among the great mass of camera owners has introduced the problem among the principal distributors of electric meters of how to educate the photographic public in the proper care and handling of these instruments. The extreme responsiveness of the meters to every change in intensity of light reflection indicates a delicate construction which, indeed, compares with that of the workings of a watch. The fine hair springs by which the exposure indicator is controlled will not stand undue jars and general carelessness in use.

When something does go wrong, it is imperative that the user should not attempt to make any repairs himself, any more than he would attempt to repair a watch. Experienced hands used to the task of adjusting or repairing the particular meter in question are the only ones that should repair the invalid meter. The layman who attempts repairs himself is very likely to cause more damage.

Completely equipped servicing depart-

ments, manned by experts, are maintained by the two leading distributors of electric exposure meters in the United States—the Weston Electrical Instrument Corporation, Newark, New Jersey, distributors of the Weston Exposure Meters, and Photo Utilities, Inc., 10 West 33rd Street, New York City, importers and distributors of the Mini Photoscop. Both invite photographers to send in any meters that need attention, but require that the owner state frankly just what has happened to the meter (where the user is able to give this information), and to say whether the meter has been dropped or has been tampered with in any way.

Frequently these organizations are approached by owners of foreign meters which have no regular representation in this country and are therefore difficult to service because replacement parts in many cases are not available. Depending on the circumstances and the extent of the required repairs, these companies are sometimes able and willing to help. They do not, of course, assume any responsibilities in the case of any meters except those distributed by them.

Leica Show Rules

ANNOUNCEMENT is made of the rules governing the submission of prints to the forthcoming Fourth International Leica Exhibit, made public by this department in a previous issue. No entrance fee is required and no limit placed on the number of prints that may be submitted by any one prospective exhibitor. The rules follow:

1. The name and address of the photographer, plus the following data (if possible), should be included on the back of each print or mount:
   a. Lens and aperture used
   b. Exposure
   c. Film used
   d. Developer for above
   e. Filter, if any
   f. Other accessories used in making the picture.
2. Prints may be sent mounted or unmounted, conforming to the following sizes: 8 by 10 inch prints on 13½ by 17 inch mounts; 11 by 14 inch prints on 16 by 20 inch mounts; 16 by 20 inch prints on 22 by 28 inch mounts.
3. Contact prints should accompany entries but should not be pasted on mounts.
4. The closing date for the receipt of prints is Nov. 30, 1937.
5. Packages containing prints should be sent to E. Leitz, Inc, 730 Fifth Avenue, New York, N. Y., and should be marked "Exhibit" in the lower left corner.

Many Buyers But Few to Sell

TIME was when one could buy any camera or photographic gadget on the market provided one had the cash to pay for it. At worst, there was only a short delay. Today we are living through the paradox of many willing to buy and pay but few available cameras and accessories to sell. It isn't any one camera or two or three, nor does this condition apply only in the case of imported cameras. Even camera manufacturers in this country are unable to keep production to the pace of the buying demand.

There are those who see in this phemonenal enthusiasm an unhealthy state, an ar-

tificial condition which must soon wear itself out and cause a reaction. It is not our province to act the seer nor would we care to argue the point. We do hold, however, that no enthusiasm is unhealthy and if photography some day falls away in general favor, what does that matter? It will come back again, and again. Let it not be forgotten that photography was not born yesterday. It is 100 years old, and still going strong, stronger today, in fact, than ever before. In any event, the real enthusiasts will remain—the others don't count.

In the Park

TAKE your camera with you every time you visit the parks. You probably do it anyway, but some of us are often discouraged because sometimes it seems there isn't

"Master and Pupil"

"a thing to take." That's where you're wrong. There's plenty to take. Trees are beautiful, and so are certain aspects of the water, of flowers and bends in the road. And if all these fail to attract you because the lighting is bad or whatever, how about "shooting people in the back" engaged in some such pose as that shown in "Master and Pupil"?

Pergrano 35 mm Film

RATED at 17 degrees Scheiner and declared to be almost 100 percent grainless, a new 35-mm film emulsion is now available under the name Pergrano, the latest addition to the line of Perutz films, which includes, besides the new film emulsion, the following: Perpenso, Perpantic, and Peromnia. Pergrano is described as having "a fully balanced panchromatic emulsion of beautiful gradation" that "will do justice to the finest lens made" and "may be developed, fixed, and dried quickly." The new film is available in daylight loading spools for 35 mm, vest pocket, and 6 by 6 cm cameras.

Photography Marches On

THE tremendous interest in photography that is apparent on every hand today was recently the theme of a radio interview by Karl A. Barleben, Jr., F.R.P.S., director of the WHN (WLW network) "Behind the Lens" Camera Club of the Air program,

with Joseph Dombroff, president of the Photographic Dealers Association and vice-president of Willoughby's. Mr. Dombroff, speaking from an experience of 27 years in the business of supplying photographic amateurs and professionals with equipment and materials, gave an inkling of what is going on today from the viewpoint of the man behind the scenes.

"In 1910," he said, "the camera fan was a bit different from what he is today. I remember the time when to possess a camera was *something* . . . whereas now, it's nothing for a real enthusiast to possess three or four. And you should see the exchanging that goes on, too. Fellows swap their cameras with one another all the time these days."

Photography, he continued, is growing "by leaps and bounds, because nowadays photography is a hobby in which everyone can indulge himself—rich or poor, young or old. Anyone can make a good picture, and the technique can be easily acquired in no time. I think photography has so much to offer—it gives pleasure to the fellow who takes the pictures, and just as much to those whose pictures have been taken. And its use has spread over practically every phase of life—industry, art, advertising, news, science, exploration, even war. It is the best means of perpetuating memories of the past, and unlike brush and paint, or type and ink, requiring the expert user, it is possible to enjoy photography and the taking of good pictures, no matter how much of a novice one may be."

Photographic magazine "consumption" by amateurs has increased greatly, Mr. Dombroff disclosed.

"Twenty years ago our organization sold about a dozen copies of the leading magazines a month. Today we sell well over 3000 copies a month. And that's plenty of progress. I've found, too, that the individual is not content to read just one of the magazines—he'll buy and read at least four or five different ones each month. This, to me, shows that our modern picture snappers are seriously interested in adding to their photographic knowledge, and also accounts for the higher grade of photography seen on every hand."

Mr. Dombroff also mentioned the interesting fact that the King of Siam, or, rather, the former King, whom he met in a business way during one of his visits to America, owns more cameras than any other single individual in the world—more than 300 of them!—"And he takes many of them with him on all his trips."

Square Negative Hint

WHOSE side are you on? The fellows who say they find the square format disturbing when they try to compose for the ultimate rectangular print, or on the side of the square negative champions, who say there is nothing like it because they don't have to alter the position of the camera when taking vertical pictures? On one side or the other, here's something for users of square-format reflex-type cameras to think about. Cut a piece of metal, cardboard, or other suitable material about ½ inch wide and about 2¼ inches long. Drop it onto one side of the ground glass and there you have your rectangular image. If you cover the ground glass at the right you will have a vertical picture; for the horizontal, the upper edge of the ground glass should be covered with this mask. The mask may be supplied with a glued handle of some sort to facilitate its removal and insertion.

Contrast

WE mentioned the attractions of contrast in picture material in this department once before, but the subject is so intriguing we cannot resist reverting to it again this month, especially since we need some excuse to print the illustration, "Lyric Touch." The tower in the background and the commercial clock and sign in the lower right-hand corner unmistakably give the flavor of business, while the tree branches in the foreground, leafy with the first signs of spring,

"Lyric Touch"

provide that atmosphere of nostalgia and "spring fever" that is as strongly familiar at the noon hour to the high-powered executive as to the humblest office boy. The upward tilt of the camera slanted the building to give body and some essence of solidity to the background.

THE PICTURE TRAIN

EVEN the railroads are recognizing the fact that photography is all the rage these days. So they have instituted the "Picture Train" idea, and it is evidently a huge success. You leave about 8 o'clock in

"Picture Train"

the morning and come back at night. The train takes you to places which promise good picture shooting and returns you home with your pockets bulging with work for the darkroom. We are told that the first two trips attracted about 250 camera fans each, while the third time this number was almost tripled.

ROBOT TABLE-TOP TRIPOD

A MINIATURE tripod, specially designed to accommodate the Robot camera in table-top work, has the appearance, when closed, of a "stick" eight inches long by about 5/8ths of an inch in diameter, provided with a carrying strap.

The distributors further describe the tripod as follows:

"One end of the stick carries a screw thread which fits in the underside of the camera, so that the stick itself can be used as a handle for the camera when this is used in the hand. By unscrewing the other end, an inner chamber is revealed containing 3 chromium plated rods, each 6 inches in length, which screw into a head and form a tripod.

"Sold separately is a ball and socket head which screws on to the table part of the tripod and permits the camera to be moved and set at any angle. The height of this table tripod with the ball and socket joint in place is 13¾ inches. For low work or in conditions where the full height is not required, the stick can be screwed off and the camera attached immediately above the tripod legs. The whole device is very well made and finished, and while it is primarily designed for the Robot, will take any other miniature camera."

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 359)

a time as three days. Its action apparently is somewhat different from that of another useful urinary tract antiseptic, mandelic acid, which has become quite generally used in the past six months. It is destined to replace the acid almost completely.

"The new compound is much more palatable to the patient," Dr. Herrold said. "In one-tenth of cases, mandelic acid cannot be used. The new chemical has revealed no such limitations yet."

The chemical is taken by mouth in tablet form and, in serious cases, is made into a solution for hypodermic injection.

Cashew By-Products

IN India, where the comma-shaped cashew nuts, so popular in the United States, are grown, efforts are being made to utilize the fruit producing the nuts for other purposes. Actually the nut grows outside a fruit very much resembling an apple. The demand for the nuts has left large quantities of these "apples" as waste. Lately the juice of this fruit is being concentrated, decolorized, and deodorized to yield a syrup industrially. Although this operation has been carried on in the past as a home industry, large-scale manufacture is being undertaken to produce a syrup for use in preserving ginger and mangoes. The shells which surround the nut itself are being utilized to yield germicidal soaps.—*D. H. K.*

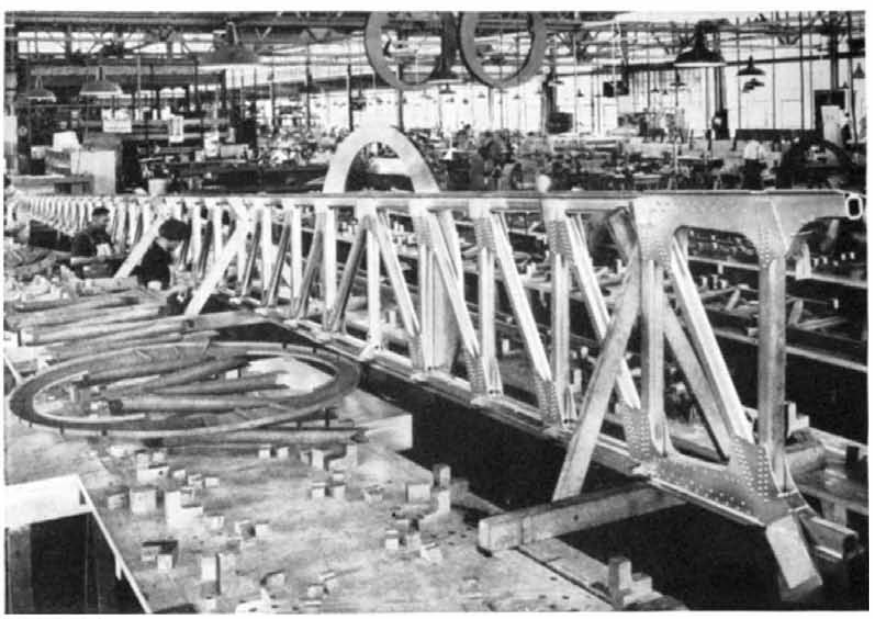
How a Giant Clipper is Built

THE construction of a huge flying boat resembles far more the construction of an ocean liner than, for example, the production of an automobile. Such construction calls for strength in combination with the utmost refinement of design, and for a very high degree of skill among the workers. There is not the slightest doubt that airplane mechanics are virtually a race apart

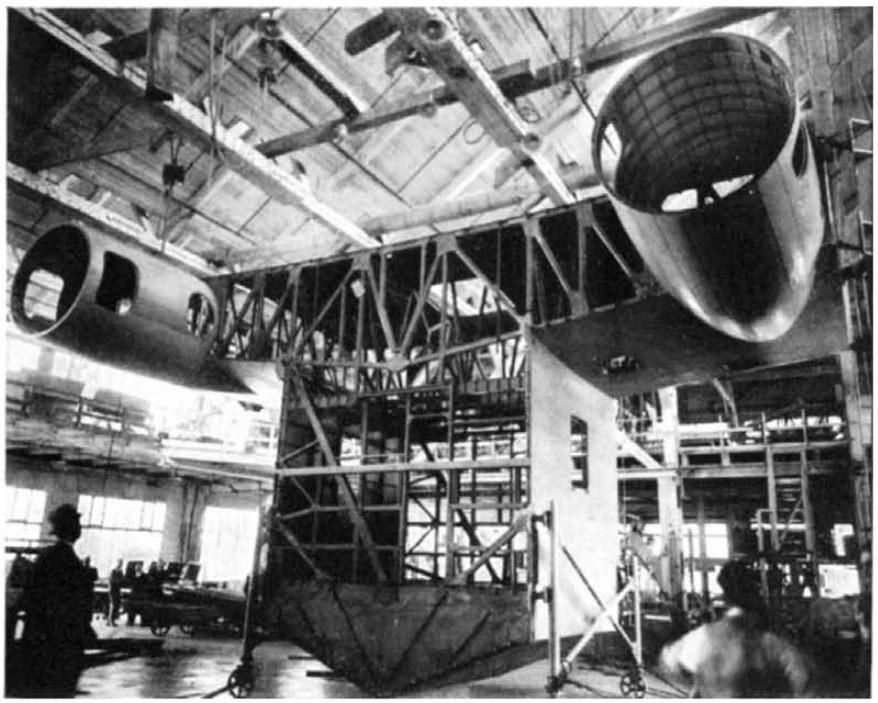
Riveting up the aluminum frames of one of the huge engine nacelles

in their intense interest in their work and their absorption in the problems of aviation. Yet their work is far from easy, and entails typical factory noises and other discomforts. In the old days, the construction of an airplane involved a few sketchy drawings, followed by rough-and-ready methods in the shop, with wood as the predominating material and many hasty changes as the work progressed. To-day, aluminum alloys and high-strength steel alloys have replaced wood; when construction is ready to start every part of the ship has been calculated, tested, and designed in detail by engineers and draftsmen before a single part is fashioned in the shop. Our photographs give an excellent idea of the assembly and construction methods in the largest American flying boat yet to be built, the Boeing *Pacific Clipper* which will carry 72 passengers. The wing span of the new boat will be 152 feet, and it will be powered with four 1500-horsepower Wright Cyclone motors.

Naturally, when the width of the span reaches 152 feet, the loads on the wing and hence on the wing beams become very heavy. No wonder, then, that the truss-type wing beam is almost as high as a man at its inner end and has the solidity of appearance of a bridge girder. The wing is first assembled on a special jig and then riveted up, with thousands of rivets to be inserted and headed over by the mechanics.



A truss-type wing beam for the Boeing *Pacific Clipper*



Center section wing beams of the *Pacific Clipper,* attached to the hull

The center section wing beams are rigidly attached to a portion of the huge hull. That portion of the hull illustrated contains the dining salon on its lower deck. Space above the center section of the wing structure will be used for cargo. On the outer ends of the center section of the wing are shown the two inner engine nacelles, which stand 25 feet above the assembly floor. All four engine nacelles will be accessible during flight by means of wing companionways.

Nothing gives a better idea of the size of the engine nacelles than the picture of the men standing practically erect inside them, busily at work riveting up the aluminum frames.

Every process known to modern machine science is pressed into service in this construction work—drop-forging, rolling, pneumatic riveting, stamping, and so on.—*A. K.*

Kites to Carry Radio Antenna

THE kite is perhaps the very earliest form of flying machine. Invented by the Chinese, it has been regarded for centuries as a fascinating toy for boys. But Benjamin Franklin used the kite for electrical investigations; the Wright brothers used it for obtaining aerodynamic data. Now Hugo Leuderitz, Chief of Communications for Pan American Airways, has put the kite to another practical use, by making it carry a radio antenna after an emergency landing at sea. The trailing wire antenna is, of course, useless when once the aircraft is on the water, and the antenna stretched between wing and tail surfaces is not high enough in the air to be really serviceable.

After practical research, Mr. Leuderitz has developed a practical six-foot kite with a red cloth cover. The kite will lift in a moderate wind, will fly from the back of a *Clipper*, and will function when soaked with water. The kite is packed in a six-foot aluminum mailing tube, with a simple reel of strong line; the whole device can be made ready for use in a few minutes by screwing up a wing nut, and inserting a few safety pins. Red cloth is used so that the kite may serve as a flag as well as an antenna carrier.

While no emergencies have yet occurred to test the system, all the experimentation to date indicates that Mr. Leuderitz has developed a useful safety device.—*A. K.*

Improved Trainers for Blind Flying

WE have had occasion to describe the Link trainer in its early stages, when it was considered simply an introduction to the handling of the flying controls. It was mounted so that it could rotate through 360 degrees, pitch, roll, and simulate all the attitudes of actual flight. Then the Link trainer received a hooded cockpit and a full complement of instruments, and became useful in preparing men for blind or instrument flying. In its most modern version the trainer has radio facilities, and is used for teaching the difficult art of flying by radio. United Air Lines is making wide use of the device in its latest form.

A highly experienced instructor sits at a special control table of the trainer and simulates radio range signals, marker beacon signals, two-way radio communication, flying attitudes, and varying wind conditions. On the airway chart in front of him there is a movable instrument which constantly records the artificial flight path that the student in the Link cockpit has achieved on the basis of the signals given to him by the instructor. The instructor adjusts the control panel to duplicate the radio pattern of a particular part of the airway network, and then requests the pilot in the cockpit to orient his position and "fly" the plane to a given destination. The pilot must compensate for simulated wind and weather conditions, take the gasoline supply into consideration, work out problems in navigation, and so on. The instructor checks and criticizes.

Major R. W. Schroeder has told us that

he would much rather train a man to fly blind in a Link trainer first, and that the actual air flying would then be merely a logical corollary. We can quite believe that Major Schroeder is right in his views—though the first flying lessons will still be given in an actual airplane for many years to come.—*A. K.*

Using Exhaust Gases to Aid Propulsion

TWO officers of the Royal Aircraft Establishment at Farnborough, England, are developing a form of jet propulsion whereby the air used to cool the engine, and the heat energy of the exhaust gases, will both be utilized to increase the propulsive effort in an airplane.

The entire engine, with its exhaust manifolds and the radiator, is enclosed inside the airplane wing. Air enters at the leading edge of the wing and passes through the tubular radiator and then over finned exhaust manifolds. In this manner the air cools the radiator, and at the same time takes up energy from the heat of the exhaust. Subsequently it is allowed to expand and is ejected at high velocity through slits in the trailing edge of the wing.

If air is ejected at high velocity at the trailing edge, then a forward thrust must be produced. In other words, the heat of the radiators and the heat of the exhaust have been converted into propulsive energy.

More detailed information, calculations, and tests are necessary before the invention can be accepted completely. But it sounds plausible and may have important possibilities.—*A. K.*

A Long-Range Ground Direction-Finder

IN its over-ocean flying, Pan American Airways has no radio beacons to rely upon. But its engineers have, as a result of nine years of experimentation, developed a remarkably accurate long-range direction-finder system with a stationary antenna array approximately 150 feet square. Direction of the incoming signal is determined by a search-coil goniometer and errors are kept to a minimum by selecting an electrically satisfactory site. An outstanding achievement of the system is the utilization of short waves for radio direction on ranges up to 3800 miles, a feat hitherto considered impossible. The use of ground direction-finders permits, of course, the installation of far more precise equipment than is possible when the finder is installed in the limited space of an airplane. The airplane transmits a long dash, the ground station determines its bearing position and direction of flight and reports back by wireless. Thus the flight crew is relieved of complex navigational problems. Through Bendix Corporation, the equipment will be made available to other American companies.—*A. K.*

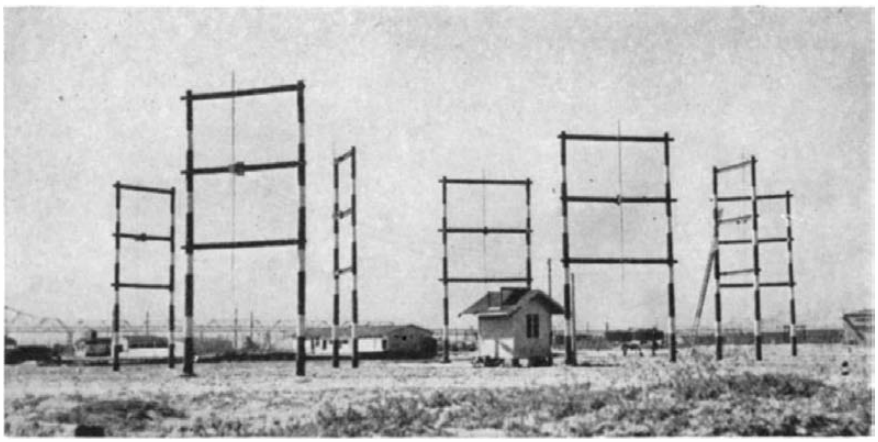
The Doctors Warn Us

SPEAKING at a recent meeting of the American Medical Association, Dr. Allan L. Barach issued a warning in regard to "oxygen want" which may be experienced in high-altitude flying. The results of breathing for 20 minutes at an altitude of 15,000 feet may be quite serious for persons with latent angina pectoris or other heart troubles. Pilots, picked men of splendid physique, are not likely to be bothered with heart trouble, latent or overt, but their judgment may deteriorate if oxygen is deficient; when a pilot ceases to be alert the way is open to accidents.

Dr. Barach is perfectly right, and his warnings should not be disregarded. But the air-transport operators are fully aware of the perils of "oxygen want." Thus, when pilots are forced to fly at high altitudes for some reason or other for a considerable period of time, the stewardesses are required to watch passengers carefully for any signs of physical difficulty, and to tell the pilot immediately of such symptoms. Pan-American Grace Airways, when flying over the Andes, provides oxygen tubes for both pilots and passengers. On all airlines, co-pilots are carried to give the chief pilots adequate rest. And, finally, airplane constructors are turning to what is the best solution of all—the air-conditioning of cabins by compressing the air almost to its sea-level density by suitable cabin superchargers. Thus the warning of the medical men is being fully met by the precautions of the engineers and operators.—*A. K.*

Pure Vitamin A by "Molecular Distillation"

A NEW method of distillation, called "molecular distillation," is now being used to distill pure vitamin A from fish-liver oils on a commercial scale. Not only is vitamin A removed as a pure chemical compound from fish-liver oil but the residual oil is at the same time freed from fishy



Antenna system of the ground direction-finder at Alameda, California

odor and rancidity in the process. Already this method has yielded vitamin-A esters of 500,000 U.S.P. units per gram and vitamin-A alcohols of 3,000,000 units per gram on a scale large enough to supply about one tenth of the United States' requirement for this vitamin.

Special interest attaches to the method of distillation used. This consists in heating a film of oil moving over a surface to a moderate temperature (100 to 200 degrees, Centigrade), placing a cool surface close to the heated oil film (about 1 cm.), and producing an extremely high vacuum (about 10^{-3} mm. of mercury) in the intervening space. The molecules of the heated oil tend to jump out of the layer, and, since the vacuum has removed obstacles to their free travel, they strike and are caught by the cool condensing surface. By making the path between the hot and cool surfaces shorter than the mean free path of the molecules being distilled and by removing from the intervening space as many as possible of the gas molecules which would otherwise fill it and obstruct the travel of those ejected from the oil layer, one can distill materials which cannot be volatilized in ordinary stills and at temperatures far below their decomposition points. This method of molecular distillation has been applied in the past to the separation of mercury's isotopes (atoms of slightly different atomic weights), and to the separation of the heavy hydrocarbons of lubricating oils. Its application to numerous other problems of separation is expected as developments proceed. Its important characteristic is that distillation occurs by the travel of individual molecules which are uninfluenced by others which may be in a mixture. Hence no mutual effects of the different constituents of a solution or mixture are encountered as in ordinary distillation.—*D. H. K.*

HOW A COUNTRY GETS RICH

IN 1908, the average employee of one of the largest tire producers was receiving 40 cents an hour. He could buy a tire for a small motor car for 35 dollars. At that time this tire would run an average of 2000 miles in its lifetime at an average cost of 1.75 cents a mile. A little calculation indicates that an hour's labor would pay for only 23 miles of use of that tire. Thus to run the car with four tires a distance of 23 miles and merely pay for the wear and tear on the tires the worker had to work for four hours. Obviously, few workers owned cars.

In 1936, the average wage of all employees of this plant was 88 cents an hour. Had this been the only gain which took place in the interval, the laborer would still have had to work one hour to secure 50 miles of use from a tire, or one hour's work would have yielded enough income to pay for the wear and tear on the four tires over a 12.5-mile stretch. Car driving would still be a pastime for a few rich people only. However, several other things happened. Instead of the tire costing 35 dollars as it did in 1908, it cost about eight dollars in 1936. Instead of running only 2000 miles, it would run on the average about 20,000 miles. A calculation will indicate that in 1936 an hour's work would pay for not 23 miles of use but 2200 miles, a 95-fold improvement.

Thus under the stress of competition the

TRANSPORTATION SECTION

price was greatly reduced and the life of the tire increased by 1000 percent. The real gain to labor (and all tire consumers) came not through wage increases primarily, but through a lowering of prices and an improvement in the product. Similarly, the gains have been broadly shared in the case of the motor car itself, electrical appliances, light bulbs, and a host of other things. The rise in the standard of living comes not primarily in forcing upward money incomes, but in raising real incomes.—*Barron's.*

16 Cylinders—135 Degrees

AN important development in the multi-cylinder motor-car field is the unusual new 16-cylinder Cadillac engine that will be used in the 1938 models. The engine has been built so compactly that it occupies less space than the average straight eight. Its output of one horsepower per 5.7 pounds of weight affords a ratio far better than previous automobile ratings.

To illustrate clearly the engineering behind the new 16, its characteristics are below compared with the 16 that powered the largest Cadillac in the 1937 series:

	1938 model engine	1937 model engine
Horsepower	185	185
Weight	1,050 lbs.	1,300 lbs.
Displacement	431 cu. in.	452 cu. in.
Dis. per 100 lbs.	41 cu. in.	35 cu. in.
Length	36 in.	46 in.
Height, excluding accessories	16 in.	29 in.

The V-type principle is applied in the new 16. Here, however, much of the similarity with earlier V-types ends. Cylinder barrels are mounted at an angle of 135 degrees. Two independent sets of accessories, including two cooling systems, are installed. The bore and stroke are amazingly small.

Through use of the 135-degree angle, engineers have been able to achieve a power unit that is virtually flat. This has obvious advantages. First and foremost, the shape creates an extremely low center of gravity. Since the engine is the biggest item of weight in an automobile, its center of gravity largely determines the roadability and safety of the car. Second, with a "flat" motor, the dashboard can be moved forward, increasing leg-room and comfort of front-seat occupants. Third, better cooling is possible. Cylinder banks no longer hamper free air circulation over the top of the engine. The fourth advantage is that the wide "V" offers a roomy and natural cradle for engine accessories.

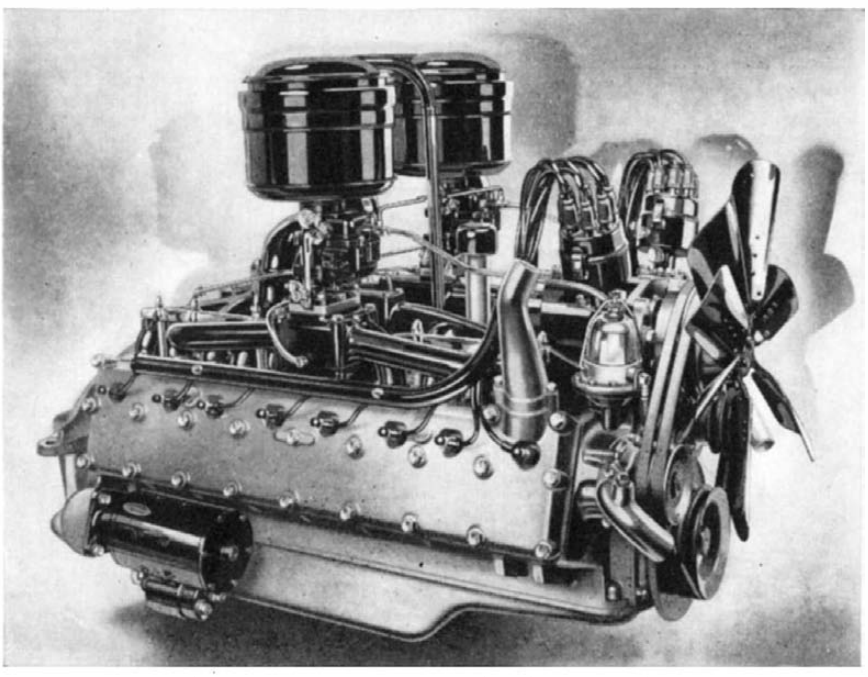
The bore and stroke have the same measurement—3¼ inches, the stroke being the shortest on any automobile and a guarantee of economy and durability. Figures show that each piston inside its cylinder travels only 1590 feet to each mile covered by the car. The average piston travel for 33 American cars over that distance is 2200 feet.

Greater rigidity and increased smoothness have been accomplished by casting the motor in one piece, thus reducing the number of joint surfaces subject to leakage or gasket troubles.

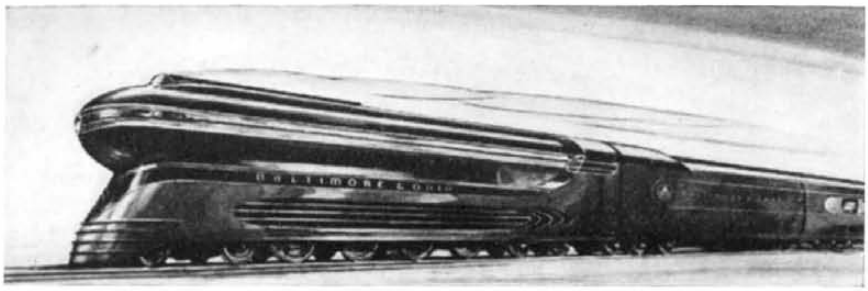
16-Cylinder Steam Motored Locomotive

THE design of a powerful new locomotive, which is a radical departure from the conventional type, but which nevertheless incorporates fundamental engineering and mechanical principles whose efficiency has been amply proved, has just been completed by the Baltimore and Ohio Railroad.

Built with 16 cylinders arranged for constant torque propulsion, the locomotive will produce a continuous flow of power similar



The latest in V-16 engines, used in the 1938 Cadillac



How the B&O 16-cylinder locomotive will appear when in service

to that of a multi-cylinder automobile—with smooth running and minimum vibration. It is believed that it will develop 5000 horsepower, and that it will be capable of handling 14 standard Pullman cars at a speed of 100 miles per hour on straight, level track.

The locomotive will have a 4-wheel front truck, four pairs of drivers, a 4-wheel trailer truck, and a tank mounted on two 6-wheel trucks and carrying 23 tons of coal and 22,000 gallons of water.

Each of its four driving axles will be driven by a Besler steam motor and each motor has four cylinders directly geared to its axle, so that there will be a total of 16 cylinders with 32 power impulses for each revolution of the steam motors. No counterbalancing of any kind, and no main and side rods and crank pins, will be required, this new design thus entirely eliminating the hammer blows on tracks that result from counterbalance weights. The absence of main and side rods and other motion work, will also make it possible for the driving wheels, with their independently mounted 4-cylinder steam motors, to accommodate sharper curves than will locomotives of conventional design.

The gears and all other motion parts of the steam motor will operate continuously in a bath of oil forced by a pump to the wearing parts, as is done in the modern automobile. The cut-off position of the valve gear, together with forward and reverse motion, will be automatically regulated from the locomotive cab by means of an electro-pneumatic control.

Total weight of the locomotive will be about 400,000 pounds, with 260,000 pounds on the drivers. The starting tractive power will be 72,500 pounds, giving a factor of adhesion of 3.6, which is more than ample where there is constant torque.

The boiler will be of the Emerson water-tube firebox type with 775 square feet of heating surface in the firebox, and a total heating surface of 5800 square feet. It will have a superheating surface of 1530 square feet, will be equipped with feed water heater, and will have a capacity of 115 percent. The Besler steam motors operate on a guaranteed rate of 14 pounds per horsepower-hour, so that when the locomotive is developing 5000 horsepower, the cylinders will require 70,000 pounds of water per hour while the boiler will evaporate 80,500 pounds. The working pressure of the engine is 350 pounds.

The new locomotive will be very flexible. It will have outside frames and spring rigging; also outside journal boxes, which will be oil lubricated. Each pair of driving wheels with its attached steam motor can be quickly removed on the drop pit for necessary repairs, such as turning of tires, adjustment of driving boxes, and so on.

The locomotive will be streamlined on the pattern developed for the Baltimore and Ohio two years ago by Otto Kuhler, consulting engineer of design, and which has been used in an adapted form for the streamlining of the railroad's Diesel-electric locomotives and its New York train-connection motor coaches.

BLACK

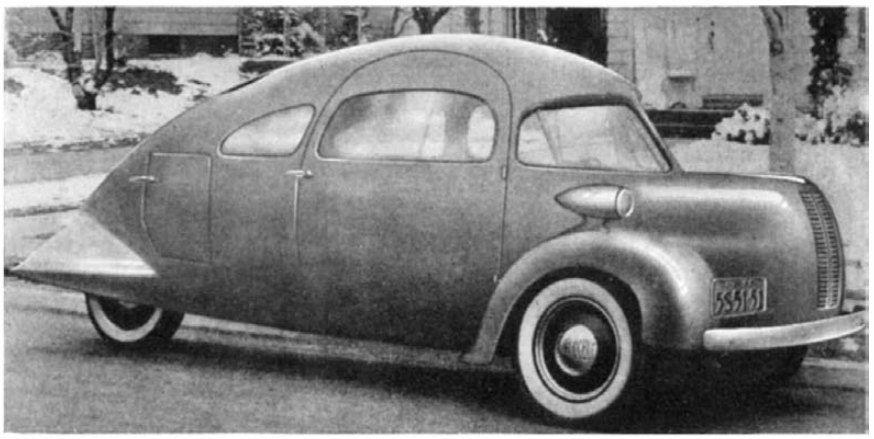
ONE motor car company reports that black is gradually losing its place as the favorite color for automobiles, the indications being that the American public is going in for greater diversification of color. Gun-metal gray, in fact, led black up till last January on the 1937 cars of this maker.

ARE YOUR BRAKES RIGHT?

TESTING the efficiency of a motor car's brakes is now as simple a matter as checking the oil, through the development of the Decelometer, a little instrument that flashes a green signal when the car stops within a safe, legal distance, and a red signal when the brakes are inefficient.

Declared to be more accurate than previous types of instruments designed for the same purpose, the Decelometer checks within 0.7 percent degree of error, as against 10 percent which hitherto has been regarded as commercially acceptable for gages performing a similar function. It has already been approved by motor vehicle authorities of the states of New Jersey and Connecticut, as well as by members of the Society of Automotive Engineers, and safety engineers

Using the Decelometer



The "Airomobile"—three wheels, front-wheel drive, streamlined

of the National Bureau of Casualty and Surety Underwriters, according to R. J. Alden, its inventor.

Developed in collaboration with engineers of the General Electric Company, who designed its intricate molded plastic parts and deceleration-actuated mercury-switch mechanism, and scientists of the U. S. Bureau of Standards, who resolved the mathematical equation on which its operation is based, the Decelometer resembles in general appearance a common, tubular two-cell flashlight. On its face are two small circular windows, one green, and the other red. Inside is the working mechanism.

During the testing operation, the Decelometer is placed on the floor of the car, directly in front of the inspector. A sharp set screw at the rear of the instrument holds it firmly fixed in position. When the brakes of the car under test are applied, the motion of the vehicle propels a column of mercury forward in its channeled groove, thereby effecting a mercury-switch action, and establishing contact with one or the other of the signal lights, operated by dry cells. If the forward motion caused by quick stopping is sufficiently fast to indicate proper braking efficiency, the green signal flashes; if not, only the red signal shows. The complete test requires only a few moments.

Another Teardrop

THE car in an accompanying illustration, representing almost the acme in streamlined design, is the "Airomobile," designed and built by Lewis American Airways, Inc. It has recently undergone strenuous road tests, and is expected shortly to go into production. The main features are the use of three wheels instead of four, front wheel drive, air-cooling, and light weight (1500 pounds empty—which, with the "tear-drop" design, enables it to run 40 miles to a gallon of gasoline at normal speeds). It is said to be capable of a safe driving speed of 80 miles per hour, and is designed to sell at an extremely low price when in regular production.

The motive power is a four-cylinder, opposed, 60-horsepower engine, produced by the Doman-Marks Engine Co., specialists in air-cooled design. In the gears of the transmission, which is furnished by the New Process Gear Company, as well as in other vital parts throughout the car, such as valves, crankshaft, and so forth, nickel alloy steels were specified to secure dependable strength and light weight.

A leading feature of the Airomobile motor is the use of "Ni-Resist" cylinder sleeves, which are pressed into the aluminum alloy cylinders. Ni-Resist has practically the same coefficient of expansion as aluminum, hence extremely close tolerances (.001 inch maximum) are permitted between the pistons and liners. With ordinary cast-iron cylinders or blocks, and aluminum pistons, it is necessary to allow a .003 inch clearance when cold, which gives rise to "piston slap" before the engine is warmed up; but the use of the Ni-Resist sleeves obviates this difficulty.—*Nickel Cast Iron News.*

Inter-Continental Highway

BLAZING a trail across two continents, which may overcome, within half a dozen years, many of the present physical barriers between the two Americas, the Brazilian Highway Expedition recently visited several of the leading industrial plants of Akron, Ohio, while en route to New York, northern terminus of the proposed inter-continental highway.

It was nine years ago that the expedition set out from Rio de Janeiro and the only contact the members have had with their home country since 1928 was a telephone conversation from Chicago, three months ago, with the editor of a daily newspaper in Rio.

In their travels through 15 countries, they have been received by 14 presidents and expect to have an audience with President Roosevelt at Washington. They have prepared 34 maps and charts of the proposed route of the Pan-American Highway and, at Washington, expect to offer a complete set of their maps and other information to the Pan-American Union.

About 10,000 miles of the 16,182 miles on the proposed highway are now open to motor traffic and, from assurances of cooperation by the various countries traversed, it is expected that the route will be opened south to Honduras within two years and that the entire project will be completed in six years.

The Pan-American Highway would enter the United States at Laredo, and extend from there to Austin, Dallas, Little Rock, Memphis, St. Louis, Springfield, Chicago, Detroit, Cleveland, Akron, Pittsburgh, Washington, Philadelphia, and New York, enabling South American visitors to this country to traverse the most important industrial and commercial centers.

The expedition has received both moral and financial support from all of the countries in which it has made surveys and studies of the route, and several of the countries have already improved their sections of the 16,000 mile highway.

Where more than 30 similar expeditions have attempted the same undertaking and failed, the present expedition sees the end of the nine-year trip already in sight. Besides Commander de Oliveira, its members are Francisco Lopez de la Cruz, of Rio de Janeiro, observer; Mario Fava, mechanic and technician; and S. W. White, of Dallas, Texas, interpreter and editor and publisher of the *Pan-American Ambassador*, of Monterey, Mexico.

The expedition travels in Model T Fords, in which they traversed almost impassable stretches of country in Central and South America. For weeks at a time, they lived on parched corn, roots, and had no drinking water except what they obtained from stalks of the bejuco tree.

When gasoline was not available they ran the cars on kerosene mixed with alcohol and lubricated them with hog-lard. At times they had to hew tunnels through dense vegetation just large enough for the cars to get through but so thick overhead that sunshine could not penetrate.

Upon their arrival at New York, they expect to return to South America by boat to continue their efforts to complete the huge project.

(End of Transportation Section)

New, Mysterious Disease

THE strange case of a man whose bones have turned pale red is reported by Dr. Eugene Freedman of Cleveland. The patient's bones show other changes besides that of color, and the bone marrow has been replaced by fibrous connective tissue. Hip bones, vertebrae, and shoulder blades are affected. The condition has been going on for 12 years, starting when the patient was 16 years old. Although the disease has been progressing, the young man is not incapacitated by it. Dull, aching pains in the back and joints are the symptoms that have brought the patient into the hospital from time to time for treatment. Each time thorough study by X-ray, chemical, and microscopic methods have been made, but the doctors still do not know the true nature of the disease or its cause.

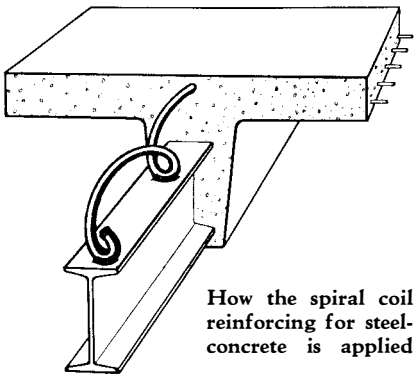
Alcohol From Artichokes

UTILIZATION of farm crops for industrial purposes has focused attention on the Jerusalem artichoke as a potential source of sugar to be converted into alcohol. Recent experiments in converting these tubers into alcohol have been made at the Iowa State College with very attractive results. The yields of artichokes per acre are high, varying from 15 to more than 20 tons per acre in the state of Washington (the best of three test locations). The average yield for test farms in Illinois, Washington, and District of Columbia varies from 11 to 14 tons per acre. The tubers contain 15 to 18 percent sugar. Under favorable conditions of fermentation and alcohol recovery, average crops produce from 240 to 375 gallons of alcohol per acre. In comparison with corn, which yields from 30 to 35 bushels per acre from which 75 to 87 gallons of alcohol can be made, the advantage of artichokes is apparent. The Jerusalem artichoke (*Helianthus tuberosus*) is a native American crop and has been suggested as a source of levulose (fruit sugar). The present effort to grow this crop as a raw material for alcohol manufacture appears as a promising method of increasing farm income through the production of an industrial raw material.—*D. H. K.*

Spiral Reinforcing for Steel-Concrete

A NEW method of concrete construction which insures a positive bond with reinforcing steel, called the "Alpha System," has been introduced by the Porete Manufacturing Company. Use of this new system permits the contractor to obtain the advantages that are inherent in both steel and concrete construction.

In the Alpha System a spiral coil is welded to the top of the I-beam so that the concrete slab is solidly anchored to the steel beam, as shown in the illustration, and both work in unison. To carry the same load as before, a much smaller steel beam can be used, because the concrete slab takes care of the compressive stresses produced by the superimposed load, the same as in a reinforced T-beam. This results in a saving of 40 to 75 percent in the weight of the steel and a great saving in the cost of the complete construction. This system combines the greater rigidity of reinforced concrete with the simplicity of steel construction, and is adaptable to all kinds of fireproof buildings, particularly those with heavy loads and long spans. It is particularly recommended also for bridge construction.



How the spiral coil reinforcing for steel-concrete is applied

Fire Resistant Lacquer

MATCHES, cigars, and cigarettes do not affect a new baking lacquer recommended for finishing metal ash trays and similar articles. The lacquer also resists perfume, alcoholic liquors, and other ordinary hazards.—*D. H. K.*

X-Ray Snapshots

A NEW device for use with ordinary X-ray machines to take X-ray snapshots of the heart and lungs is described by Dr. Siegmund Strauss of Vienna. The new device is called the Telecord and is controlled by the heart.

Ordinary X-ray machines are not quick enough to take a clear picture of the heart in a single phase, that is, during either one contraction or one dilatation. The fine de-

tails necessary for diagnosis of certain heart disorders, particularly during early stages of the ailments, are lost. Very powerful machines have been built which will take X-ray snapshots, but the advantage of the Telecord is that, when it is used with the ordinary machine, well-defined pictures of the lungs and clear contours of the heart are obtained.

"The essential thing about this equipment," Dr. Strauss explained, "is that not only one single exposure but four or five short time exposures in rapid succession immediately dictated by the pulse can be taken. These partial exposures add up and cover each other on the film in such a way that all partial exposures equal one total exposure."

The pulse or beat of the heart is picked up at the wrist by a compression cuff, transmitted to the machine, amplified, and used to control the apparatus.

Enamel for Concrete

A NEW enamel for concrete, which prevents dusting, produces a high permanent gloss and is resistant to moderate wear, is now being made with a synthetic resin base derived from rubber. Its superiority over oil paints is due to the fact that no chemical action occurs between the lime salts in the concrete and the resin itself.—*D. H. K.*

Brightness Meter

BRIGHTNESS and brightness-contrasts are of fundamental importance in making objects visible; hence brightness meters are important measuring tools. A new compact brightness meter weighing only 2½ pounds, in a Bakelite case 1¾ by 4¼ by 8¾ inches, has recently been developed by M. Luckiesh and A. H. Taylor of the Lighting Research Laboratory, General Electric Company, Nela Park, Cleveland. The range of brightnesses which can be measured is over twenty million to one, and includes all brightnesses from the low level of pavement brightness on the street at night up to the bulb brightness of a 100-watt frosted lamp. Objects as small as one foot wide can be measured from a distance of 500 feet.

The photometric field of the meter, viewed through an eye-piece at one end, consists of two small trapezoids in a larger circular field. They are separated by a narrow vertical space. By means of an adjustable lens the test-object to be measured is brought into sharp focus in the space between the trapezoids and in the surrounding field. The brightness of the trapezoids may be varied until they match in brightness the object being measured. The brightness scale is viewed through an eye-piece just below the one through which the photometer field is viewed. Two brightness scales are seen, giving the brightness in candles per square inch and in foot-lamberts.

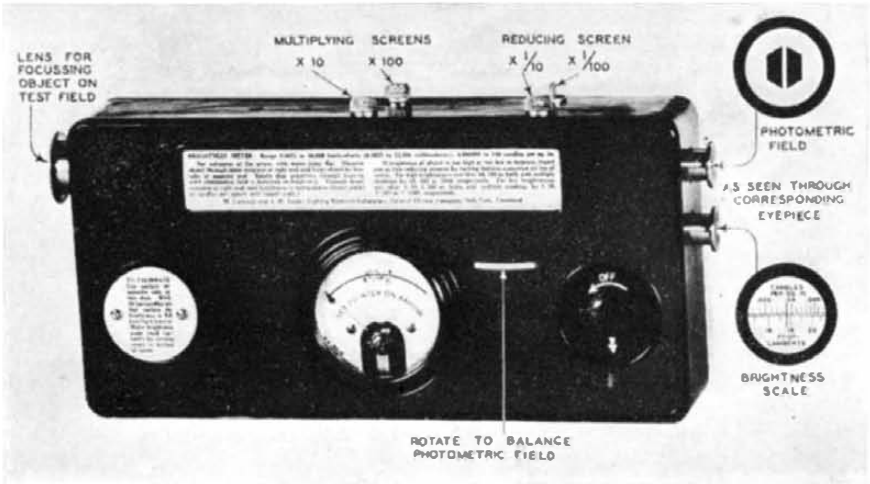
Because of its portability and great range the meter should prove very useful in many fields, both indoors and outdoors. For example, it can be used to measure the brightness of the street pavement at night in appraising visibility and lighting; to measure the brightness of various objects indoors, including lighting fixtures; and in photography, to measure the brightness of objects to be photographed so as to gage the exposure.

SQUARE

IT would be quite proper to call 1936 the squarest year because—1936 is the square of 44, 1 is the square of 1, 9 the square of 3, 36 the square of 6, 16 the square of 4, 196 the square of 14, 361 the square of 19, 169 the square of 13, and 961 the square of 31.

Skilful Reading Requires Fewest Eye Motions

MORE than 100,000 eye muscular adjustments are required by the average good reader in a single hour's perusal of non-technical material, it was made known by Bureau of Visual Science experts of the American Optical Company, in announcing results of a study just completed demonstrating the huge muscular load placed upon eyes of persons engaged in near-point work. The Bureau based its figures on such a reader being able to scan and comprehend the written word at the rate of 350 words per minute. In the case of what it classed as "poor" readers, the Bureau estimated the number of required eye muscular adjustments more nearly to average the huge total of 200,000 per hour.



A new, compact brightness meter that weighs only 2½ pounds

CURRENT BULLETIN BRIEFS

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

PRINCIPLES OF PUBLIC ADDRESS SYSTEMS, by M. N. Beitman, the second revised edition, gives a complete background for setting up and operating various types of public address systems. It is supplemented by a series of circuits involving varied numbers of tubes for sound amplification. Complete and thorough-going. *Write for Bulletin 1237A, Scientific American, 24 West 40th Street, New York City.—50 cents.*

DISEASES OF FUR ANIMALS, Farmer's Bulletin No. 1777, is of particular interest to both fur farmers and the fur trade. Standardization and intensification in fur production and a more critical market are calling for pelts of a quality that can be produced only by animals in good health. The progress that has been made in treating fur animal diseases is presented in this 22-page illustrated bulletin. *Superintendent of Documents, Washington, D. C.—5 cents (coin).*

STEEL HARD-FACING PROCEDURE tells briefly and concisely how the oxy-acetylene torch is used in hard-facing steel with Haynes Stellite. Step-by-step instructions are given, and the text is amplified by pertinent photographs and drawings. *Write for Bulletin 1237B, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

BLACK LIGHT EQUIPMENT is a folder telling of the uses of black light lamps in connection with luminescent paints. It also describes the lamps and accessories. *Science Laboratories, Inc., 424 East Fourth Street, Cincinnati, Ohio.—Gratis.*

MORE MONEY IN RADIO is an informative booklet dealing with the present opportunities in the radio field. It outlines the numerous branches where opportunities exist and the possibilities for men who are equipped with the necessary knowledge and background. *Sprayberry Academy of Radio, 2548 University Place, N. W., Washington, D. C.—Gratis.*

LITERATURE on vibration pickups of typical piezo-electric Rochelle salt crystal design is now available. These devices are applicable to the study of noise and vibrations in various industrial applications. For literature address *The Brush Development Co., 3311 Perkins Avenue, Cleveland, Ohio.—Gratis.*

STATUS OF RURAL-SCHOOL SUPERVISION IN THE UNITED STATES IN 1935-36, by W. H. Gaumnitz, has been published to show the progress that has been made in the "little red schoolhouse." Pamphlet No. 72 of the United States Department of the Interior, Office of Education. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

COMMUNICATIONS is the first issue of a magazine which combines three others that have long been well-known in their own fields—*Radio Engineering, Communication & Broadcast Engineering,* and *The Broadcast Engineer.* The fields covered by the three publications had become so definitely linked that a single magazine covering these overlapping fields was an obvious venture. *Bryan Davis Publishing Co., Inc., 19 East 47th Street, New York City.—Subscription price $2.00 per year in the United States and Canada, $3.00 in foreign countries.*

PAPERS PRESENTED AT THE TWENTY-FOURTH ANNUAL CONFERENCE ON HIGHWAY ENGINEERING presents some of the thoughts of the country's foremost authorities in this particular field. It covers such phases as highway planning, landscaping, the beautification of city streets, co-operation in highway research, safety, traffic signals, and so on. Circular No. 30, *Engineering Experiment Station, University of Illinois, Urbana, Illinois.—50 cents.*

MASTER ANTENNA SYSTEM MANUAL deals with the theory, installation, and operation of up-to-date radio antennas for apartment houses and other large buildings, as well as for individual dwellings. *Write for Bulletin 1237C, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

ARCHEOLOGY OF ST. LAWRENCE ISLAND, ALASKA, is a detailed study of the Eskimo culture of an island near Bering Strait. *Smithsonian Institution, Washington, D. C. —$2.00.*

THE FINEST AUTOMATIC HEAT THAT MONEY CAN BUY is the title of an illustrated booklet that presents facts about automatic coal heating in the home. A number of illustrations amplify the text and show what may be expected with the use of automatic heating. *Request Book 1469-B from Link-Belt Company, Stoker Division, 2410 West 18th Street, Chicago, Illinois.—Gratis.*

CLAROSTAT SERVICE MANUAL is a pocket-sized book, containing over 200 pages, which gives circuit diagrams, servicing hints, ballast data, and other valuable information for the radio service man. *Free to service men writing on business stationery to Clarostat Manufacturing Company, Inc., 285 North Sixth Street, Brooklyn, New York.*

SAFETY SEALED IN CONCRETE presents a plea for the use of concrete in the construction of highways, and shows the safety features of this type of surface. *Write for Bulletin 1237D, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

LOCAL BIRD REFUGES, by W. L. McAtee, deals with the establishment of local refuges as a means of attracting birds. It is adapted for use throughout the entire United States. Farmers' Bulletin No. 1644, *Superintendent of Documents, Washington, D. C.— 5 cents (coin).*

IRVING DECKING, THE OPEN STEEL MESH PAVEMENT FOR BRIDGES presents in short text form, illustrated with many photographs, the advantages of this open mesh pavement, which is handled in units and is easily riveted together on the job. When

finished it becomes virtually a one-piece open steel mat over the entire bridge floor. *Write for Bulletin 1237E, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

FACTS AND FIGURES OF THE AMERICAN CHEMICAL INDUSTRY is published as Part II of a regular edition of *Chemical & Metallurgical Engineering*. It gives voluminous data on the subject indicated in its title. *Chemical and Metallurgical Engineering, 330 West 42nd Street, New York City.—75 cents.*

DEVELOPMENT VS. EXPOSURE, by Herbert C. McKay, explains why no photographic developer is a complete processing factor in itself. The photographer must always consider the influence of the exposure, the speed rating of the film itself, and quality vs. fine grain. The subjects discussed include development control, stabilization, surface development, length of developer life, and so on. *Write for Bulletin 1237F, Scientific American, 24 West 40th Street, New York City.—3 cents.*

PROBLEMS IN BUILDING ILLUMINATION, by John O. Kraehenbuehl, deals particularly with lighting problems as they may apply in the industrial, commercial, and public building fields. It does not deal with specific solutions, but with the general principles that underlie the necessity for good lighting and with the problems presented in obtaining such lighting. Circular No. 29, *Engineering Experiment Station, University of Illinois, Urbana, Illinois.—35 cents.*

THE NEW HEAVY NITROGEN

(*Continued from page* 346)

and use of the phosphorus take place within the body of the rat, the animal can be killed and its various tissues analyzed. The photoelectric cell indicates the presence of the phosphorus whose rays label it. By this method, it has been determined that, for all their apparent stability, the bones are continually exchanging old atoms for new atoms. Soon after feeding, radioactive phosphorus was discovered to be already part of the bony structure—an entirely unsuspected phenomenon. Even teeth, sooner or later, trade their constituent atoms for fresh arrivals. Still more astonishing, ten hours after the administration of radioactive phosphorus to rats, their brains had incorporated the tagged atoms into living brain substance! Further, the brain molecules of which phosphorus forms an important part do not give one phosphorus atom in exchange for another. It must be concluded, therefore, that, contrary to earlier theory, these phosphorus-containing brain-molecules are in constant turmoil, being broken down and synthesized anew every few instants. Labeled molecules are helping us directly to read some of the answers to the most mysterious of all problems: how atoms, by merely hopping to and fro can realize—be conscious of—their activities; and in the form of brains use their fellow atoms to learn more about mind's place in the universe.

On the more immediately practical side, similar determinations are improving our understanding of the differences between healthy and diseased tissues, and upon the action of certain drugs administered in medical practice. It has been proved that cancer cells retain more bismuth than do healthy cells. Bismuth and also lead are helpful portions of certain drug molecules. How does the body dispose of these metals and how quickly? Artificially radioactive bismuth and lead are providing this information, which will lead to more efficient medical methods. And, of even greater significance to medicine, the most exact measurements of blood volume and rate of blood circulation in the history of science are being set forth—as only atom-tags could.

In this great new field of science, the opportunity for discovery surpasses the imagination—no one can guess the complexities of life's activities. Yet, even the first and comparatively simple discoveries which have been made indicate that physics and chemistry are experiencing a startling awakening, like their awakening at the beginning of this century. About 1895, scientists were saying that the only work left for them was more precise measurement—all the great principles were already on the library shelf. The force of gravity, the speed of sound and light, the weight of a given atom: increased accuracy here was thought to be the whole dry-as-dust future. Then, in relatively quick succession came our great discoveries of radioactivity, the intricacy of the atom's heart, the transmutation of the elements, relativity, and the transformation of matter into energy. So today the future is black with vast hosts of baffling problems.

While physics and chemistry were being reborn, the science of life was progressing rapidly too: the application of physico-chemical methods to biology explained life secret after life secret. Hence scientists began to say: Life is no more than an example of the play of the laws known to physics and chemistry. But in the last few years, bio-science has been teaching rather than learning from physics and chemistry. Bio-scientists have, to the amazement of the scientific world, exhibited molecules of genes, viruses and enzymes that not only reproduce like a living thing, but even control the activities of countless other molecules, and with supreme harmony. Now, chemists and physicists are learning from biologists that there are important physiological—and perhaps chemical—differences between varieties of the same atom. Finally, and above all, it is being made clear, especially by studies with tagged molecules, that on the plane of life practically every known law of physics and chemistry is involved—in phenomena that are the highest illustration of the play and interplay of the forms of energy known to physics and of the forms of matter known to chemistry. Mendelejeff first satisfactorily grouped the chemical elements into families. If he were alive today he would, in revising his classification of the elements, take especial note of their rôles in the loftiest drama of which physics and chemistry are aware: the drama of life.

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

Patent Injunctions

WHEN a patentee prevails in a suit for infringement of a patent he is entitled to an injunction restraining further infringement of the patent.

The question frequently arises as to whether a patentee can obtain a preliminary injunction restraining infringement pending the trial of the case. As a general rule the courts refuse to grant preliminary injunctions in suits for patent infringement unless the validity of the patent in suit already has been sustained in prior litigation or unless there is very strong proof of long acquiescence by the trade in the validity of the patent. Thus, in a recent suit for infringement of a design patent the plaintiff applied for a preliminary injunction restraining infringement pending the trial of the case. The patent had not been litigated before and as it was but recently granted there was no evidence of long acquiescence. The court accordingly refused to grant a preliminary injunction, stating:

"The mere presumption of validity attaching to the patent from the fact of issuance by the Patent Office is not strong enough to win an injunction on the threshold of the suit. An adjudication by a court in a prior contested suit is generally accepted as settling the point of validity sufficiently to warrant a preliminary injunction in a later case, provided also, of course, the proof of infringement is convincing; and long acquiescence in the trade may serve as well as a prior adjudication."

Shredded Wheat

THE manufacturer of the well-known biscuit, Shredded Wheat, was awarded an injunction by the Circuit Court of Appeals for the Third Circuit, restraining a competitor from using the name "Shredded Wheat" and from advertising or offering for sale a biscuit in the same form and shape as the Shredded Wheat biscuit.

The case involved several important points of law. As a matter of fact the issues were so complicated that the Court first refused to award an injunction and then upon a re-argument it reversed itself and granted an injunction.

One of the principal defenses was that the product known as Shredded Wheat had been patented in 1895 and that upon the expiration of the patent the name passed into the public domain along with the product, with the result that the defendant and the rest of the public had the right to use it. The Court gave this defense serious consideration and agreed that where during the life of a patent a name has become the generic name of the patented article the name passes to the public with the expiration of the patent. However, it found that in the case under consideration the public failed to avail itself of the right to use the name after the patent had expired and thereafter, due to the extensive advertising of the manufacturer of Shredded Wheat and also due to the failure of the defendant and the rest of the public to avail themselves of the name, the name "Shredded Wheat" had become exclusively identified with the product of the plaintiff. The Court then concluded that the trade mark "Shredded Wheat" was valid and was the exclusive property of the plaintiff.

Even more far reaching was the portion of the decision which restrained the defendant from advertising or offering for sale a biscuit in the form and shape of plaintiff's biscuit. It appears that the biscuit had formerly been protected by a design patent and that the design patent had expired. Under general principles of patent law, upon the expiration of the patent the subject-matter thereof becomes public property. The defendant naturally contended that since the design patent had expired he had the right to make a biscuit in the exact form shown in the design patent. The Court rejected this contention on the grounds that the design patent had been adjudged to be invalid prior to its expiration, and on the further grounds that the plaintiff and its predecessor had used the particular form for the biscuit for 40 years and equity would not permit it to be copied.

No Remedy

A SUIT cannot be maintained for infringement of a patent application. The monopoly provided for in the patent statutes is not effective until a patent is actually granted. This is so elementary that the question seldom arises in the courts. However, the question recently was presented to a district court in a suit brought by a dress manufacturer against a competitor, charging infringement of a design patent application. The Court dismissed the suit, stating:

"No patent has been issued for the dress style in question. Until a patent has been issued, an infringement suit will not lie."

Not Fair

IN a recent suit brought by the New York World's Fair Corporation, a publisher was restrained from using the title "World's Fair News" on a magazine.

The New York World's Fair Corporation is a quasi public corporation organized to plan and operate the World's Fair in New York City in 1939. The court found that so much publicity has been given to the World's Fair that the words had acquired a secondary meaning and indicated the particular World's Fair that is to be held in New York City in 1939. On the ground that there was danger of confusion between the publisher of the magazine and the New York World's Fair Corporation the use of the name "World's Fair" on the magazine was enjoined.

Price Discriminating Contracts

A NEW York State Court has held that a plea of violation of the Robinson-Patman Act is not a defense in a suit for breach of contract for the sale of merchandise.

The Robinson-Patman or Anti-Price Discriminating Act is a Federal law amending the Clayton Anti-Trust Act and it prohibits discrimination in price, under certain circumstances, in the sale of merchandise in interstate transactions. In the case under consideration the defendants pleaded that the contract violated the Robinson-Patman Act in that the plaintiff had charged lower prices for identical merchandise to competitors of the defendants. The court held that the Robinson-Patman Act did not render the contract illegal and that it was enforceable under the laws of the State of New York.

Telephone Directories

A COPYRIGHT on a telephone directory was held to be valid in a suit decided by the Federal Court of Appeals in California.

The telephone company had prepared a telephone directory of the usual type and had duly copyrighted it. From the list of names and numbers contained in the telephone directory the infringers prepared a directory in which the telephone numbers were arranged in numerical sequence followed by the names of the subscribers. The telephone company charged that rearranging the listings of the telephone directory in this manner and publishing them constituted copyright infringement. The infringers claimed that the copyright on the telephone directory was invalid and that regardless of this, since their directory radically differed from the telephone directory, their use of the telephone directory as a source of information was fair use, and did not constitute copyright infringement. The Court rejected both of these contentions. It first held that directories were proper subject matter for copyright and in this connection stated: "That a directory may be copyrighted is well settled. The principle is recognized in the statute ****"

With regard to the defense that the defendants had made only fair use of the telephone directory the Court stated: "The inversion, without license, is not permitted merely because the holder of the copyright has not so used it."

A question of human, if not legal interest also arose in this case. The infringers were husband and wife. The wife presented the further defense that she was merely an employee of her husband and exercised no discretion, judgment or responsibility as to the conduct of the business. The Court held that this defense was without merit, and found that the wife took an active part in the conduct of the business.

Books
SELECTED BY THE EDITORS

NEW FRONTIERS OF THE MIND
By J. B. Rhine

THE card matching and calling tests at Duke University—some described in this magazine, others in technical books that were rather hard to read, still others in the new magazine *Parapsychology*—are now famous. Taking the investigation of telepathy and clairvoyance wholly out of its old environment of hocus-pocus, and into the scientifically controllable surroundings of the laboratory of the university, the author has shown that both telepathy and clairvoyance do occur (which is not by any means to make claim that whatever the charlatan says he has done is likely to be so). The present volume tells in a plain, straightforward and entertaining style—just as one might tell it orally—how all these tests were conducted and what happened. There is nothing whatever about alleged physical psychic phenomena—table tipping, trumpet stunts, materializations, and so on—or of spirit communications. This research is confined strictly to a study of extra-sensory perception between the minds of ordinary living persons, chiefly average college students and instructors; also perceiving inverted cards. There is no smell of occultism or medieval mysticism about the Duke experiments.—$2.65 postpaid. —*A. G. I.*

THE NEWER ALCHEMY
By Lord Rutherford, Prof. Exper. Physics, University of Cambridge

IN this little book the famous physicist describes the different methods used in transmuting the elements, and discusses the considerations surrounding the subject.—$1.60 postpaid.—*A. G. I.*

THE AMERICAN ANNUAL OF PHOTOGRAPHY, VOLUME 52
Edited by Frank R. Fraprie

PHOTOGRAPHIC annual time is here again. First of the lot to reach this reviewer's desk is the 1938 edition of the dean of all photographic annuals. As usual, it presents a series of almost 100 outstanding photographs which were selected by the editor from over 7000 prints. Accompanying them is a series of articles on up-to-date phases of modern photography, written particularly for the serious-minded amateur. One of these that deserves special mention is entitled "Studio Portraiture with a Miniature Camera." In this particular section the reader is shown the various types of portraits, and accompanying

drawings indicate exactly how they were lighted. There is, of course, the usual helpful appendix of the latest formulas and photographic information.—$2.40 postpaid.—*A. P. P.*

SCIENCE EXPERIENCES WITH HOME EQUIPMENT

By C. J. Lynde

CUT several tiny boats out of paper with a slot at the stern of each, place a piece of camphor in the slot of each and watch the boats propel themselves in a tub of water. Invert a tumbler quickly over a piece of burning tissue in a vessel filled with water and watch the water being forced upward into the glass. These two samples of simple home tricks easily explained by simple physical laws are given to show the general type of the 200 experiments in this volume. Each experiment is illustrated with drawings which show exactly how it is performed. A key to the reasons for each phenomenon is contained in the back of this neat little volume. For young boys and grown-up boys.—$1.35 postpaid.—*F. D. M.*

THE MAKING OF A SCIENTIST

By Raymond L. Ditmars

RECOLLECTIONS and adventures of a famous naturalist. Easy, pleasant reading, humorous and chatty, covering incidents connected with boyhood collecting and attempted menagerie keeping in a New York apartment, also later episodes with rattlers, monkeys, bears, giant bats, snakes, the paradox frog, and other animals. A book that would make an elderly reader wish he had been a naturalist, or lead a youth to decide to become one.—$2.90 postpaid.—*A. G. I.*

THE TRAFFIC IN HEALTH

By Charles Solomon, M. D.

A DISCUSSION, rather lively and pointed, of patent medicines and cosmetics. The patent medicine racket and what to do about it; disease and its treatment; habit-forming, sleep-producing, and pain-killing drugs; the science of nutrition and the lunacy of diet fads; the habits of the digestive tract; too fat or too thin; infections and antiseptics; cosmetics—these are the contents. Other books, written by laymen, have lambasted the quack racket, but the present one is by a physician. The author is fearless—names names without evasion or equivocation.—$2.95 postpaid.—*A. G. I.*

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July to December 1937

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EDITORIAL STAFF · ORSON D. MUNN, EDITOR

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L. WARRINGTON CHUBB, Director of Research Laboratories, Westinghouse Electric and Manufacturing Company.

JACOB DESCHIN, Amateur Photography.

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IRVING LANGMUIR, Associate Director, Research Laboratory of the General Electric Company, Schenectady.

M. LUCKIESH, Director, Lighting Research Laboratory, Incandescent Lamp Dept., of General Electric Company, Nela Park, Cleveland.

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Bread, Butter, and Jam for 13,000,000 People

ARE you one of these 13,000,000 people? Does the income which supports you come from making or selling automobiles, radios, electric refrigerators, or movie films? If so, you are one of them. You are one if that income comes from the rayon or aluminum industry, or any of the other industries which have grown up in a single generation.

Automobiles, radios, gasoline, aluminum—these and many other products exist today because industry sought new products and better ways of building old ones. And after unearthing these new products, industry developed them, found ways to build them better, means to sell them at lower prices.

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GENERAL ELECTRIC

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