WHAT IS LIFE? The Biggest Puzzle in Modern Science

SCIENTIFIC AMERICAN

April · 1937

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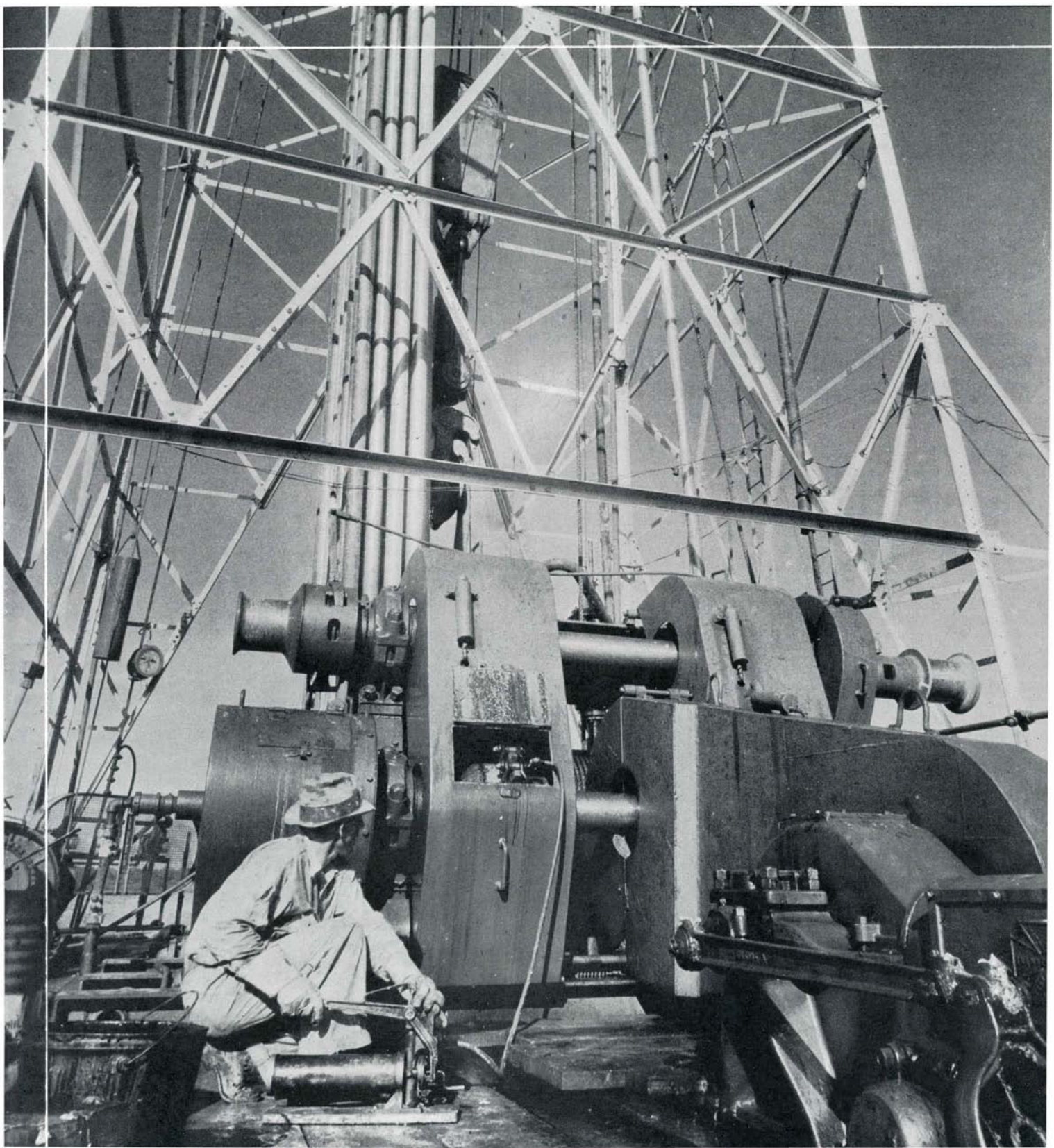

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SCIENTIFIC AMERICAN

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NINETY-THIRD YEAR • ORSON D. MUNN, Editor

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MOLYBDENUM, familiarly known as "moly," is one of the latest and most important allies of the metallurgist. The story of its development and diversified applications is told in the article starting on page 230 of this issue. Our cover illustration shows a part of the equipment used in modern oil-well drilling wherein the shafts, subjected to severe service over long periods of time, are made of a moly-alloyed steel.

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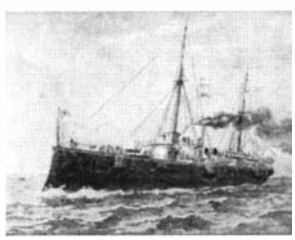
50 Years Ago in . . .

Scientific American

(Condensed From Issues of April, 1887)

H. M. S. "MERSEY"—"This ship, built at the Royal Dockyard, Chatham, is the first of a new class of 'protected corvettes,' strongly armed, to act as swift cruisers, and presents some structural characteristics which entitle her to be regarded as an innovation in admiralty ship building in England. . . . All the vital parts of the vessel —engines, boilers, magazines, and steering apparatus—are inclosed within a steel hexagonal hull, the plates varying from two to three inches in thickness. . . . Her armament, including two 8 inch and ten 6 inch breechloading guns, torpedoes, and ram would make her a formidable opponent for any unarmored ship. . . . Her engines, of the horizontal compound pattern, are of 6,000 indicated horse power. She is provided with twin screw propellers, and her speed will be 18 to 19 knots. . . . The principal dimensions of the ship are; Length between perpendiculars, 300 feet; extreme breadth, 46 feet; mean draught of water, 17 feet 9 inches; load draught amidships, 19 feet; load displacement, 3,600 tons. Her crew will number 300 officers and men."



CAR LIGHTING—"The regular Boston 'special,' on the Boston and Albany Railroad, was, last week, lighted by electricity and heated by steam—an arrangement which adds much to the comfort of passengers and removes altogether the danger from fire, always imminent in trains lighted and heated in the old way. . . . In every car there are twenty incandescent lamps, each of sixteen candle power, this being equal in intensity to a five foot gas burner. As these lights glow in a vacuum without combustion, there is no danger of their setting anything afire in case of accident. Indeed, the entrance of oxygen through the breaking of a globe puts an instant end to the life of the lamp."

DESERT BLOOM—"Respecting the plan of Colonel Landas for fertilizing the African desert by means of wells, Sir R. Lambert Playfair, in the course of a consular tour in Tunis, has visited the ground where the first well was sunk, and reports most favorably as to the success of the project. A space of 375 acres has been cleared, and sown with cereals and lucerne, a vegetable garden been made, and a nursery of young trees planted."

SUEZ—". . . No steamer is allowed to start on a night transit (of the Suez Canal) that is not fitted with an 'electric projector' which is capable of throwing a light for at least 1,200 meters ahead. And on the upper deck, too, there must be an electric lamp and shade powerful enough to light a circular area some 600 meters in circumference. Big steamers are beginning to carry this apparatus, but there is a company both at Port Said and Port Tewfik which lets out the necessary projectors and lamps on hire."

PROJECTILES—"The first lot of 12 inch chrome steel armor-piercing projectiles, manufactured by Messrs. Holtzer, have been received at Woolwich, and the trial took place on March 26, at Shoeburyness. Two selected projectiles were fired at 16 inch compound armor plates, manufactured by Sir John Brown & Co., Limited, and these passed through the targets, being found entire at the back. The plates were exceedingly good, being some of the hardest made by Messrs. Brown & Co., but the shells completely shattered them. This settles the question as to the value of these projectiles in the destruction of armor-plated vessels."

BOOK COVERS—"Another application has been found for metal, which is now being substituted for cardboard in bookbinding. . . . The metal is, of course, covered with the leather usually employed in bookbinding and the finished book presents no difference in appearance except in the greater thinness of the cover."

OTTO ENGINE PATENT—"The Gas-motoren-fabrik Deutz, of Deutz, Germany, who own the 'Otto' patents in Germany, and have attracted attention by the large sizes of Otto engines furnished to city water works and electric light stations, have just obtained a decision in their favor in their suit against Moritz Hille, of Dresden, a manufacturer, and several of his clients and users of infringing engines."

TABLE—"This extension or folding table is . . . designed to fold partly against and partly within a hollow side wall of a car. The wall of the car next the floor is made hollow to provide an inner space, at the top of which is journaled a roller, over which the flexible part of the table top passes. The top consists of slats glued to a flexible backing. The outer portion of the table comprises a shelf fixed to an ornamental leg provided with a ring or knob for drawing the table out fully into position for use. On the bottom of the leg are a roller and a couple of pins, which do not touch the floor when the leg rests on the roller; but when the table is drawn out the roller enters a recess, and the pins drop into holes in the floor."

NEEDED INVENTION—". . . A fortune awaits the inventor of a successful perfect dash or buggy lamp, or a lamp to be attached to a horse's breast. One that will not go out when most needed, and with sufficiently strong reflector to light the road for some distance ahead of the horse."

ASBESTOS PAPER—"Mr. Ladewig has devised a process of manufacturing from asbestos fiber a pulp and a paper that resist the action of fire and water, that absorb no moisture, and the former of which (the pulp) may be used as a stuffing and for the joints of engines."

GAS HEAT—"In applying his skill to the heating of railway carriages, Mr. William Foulis, M. Inst. C. E., the manager in chief to the Glasgow Corporation Gas Commissioners . . . (brought) the heat that is developed in the roof of the carriage while the gas is alight down to the floor of the compartment, so as thereby to keep the feet of the passengers comfortably warm, and the whole atmosphere of the compartment at an agreeable temperature."

AND NOW FOR THE FUTURE

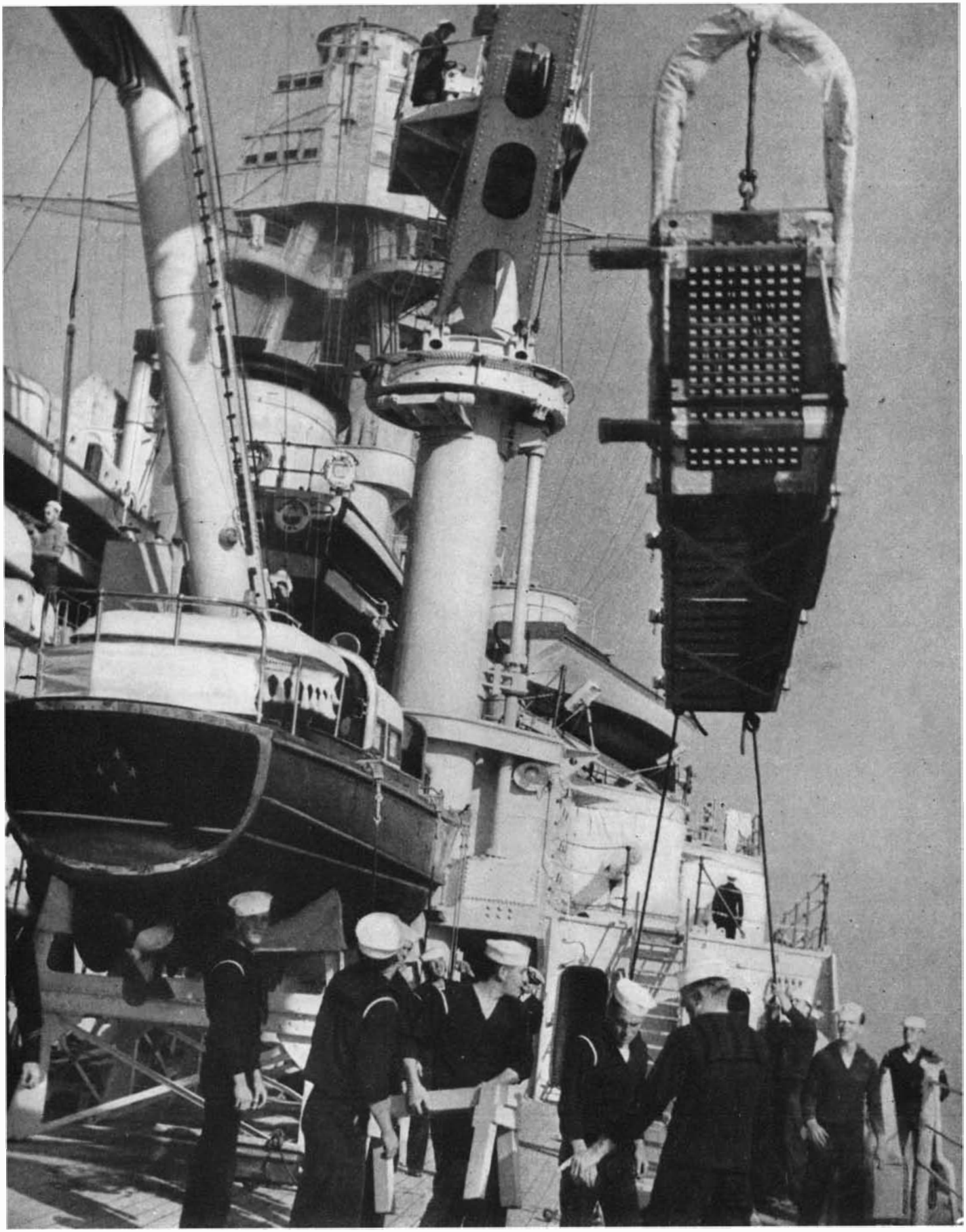
¶Hydroponics: All About "Dirtless" Farming, by its Originator, Prof. W. F. Gericke

¶Charles F. Kettering on the Future of Industrial Research

¶War Gas Abroad: Parisian Preparations for Civil Protection

¶What Is Life?—More Light on the Subject Discussed on Page 234

¶Excavations in "The Promised Land" of Western Asia, by Jotham Johnson



RIGGING OUT THE STARBOARD GANGWAY

APPROACHING San Pedro, the flagship U.S.S. *Pennsylvania* is made ready for landing parties. This splendid U. S. Navy official photograph shows clearly some of the complicated deck structures of one of our finest "battle-wagons," as battleships are often affectionately called. The absence of the now outmoded basket mast is particularly noticeable.

IMMUNITY FOR THE WITNESS

Immunology, a Science which Often Goes to Law . . . Identifying Blood Stains . . . Animal or Human? . . . What the Bio-chemist Does in the Laboratory

By CLENNIE E. BAILEY
Department of Zoology, The University of Denver

NO doubt practically every one, in his or her life, has at one time sat in a court room during a murder trial and listened to a chemist testify that he had identified blood spots associated with the crime. Such testimony concerning positive species identification of blood spots is in reality an account of tests based on the phenomenon of immunity.

To most of us the science of immunology is associated only with serums and vaccines, infections, and epidemics. As a matter of fact it is more far-reaching in its applications than warding off disease; it not only plays an important rôle in the field of preventive medicine but it also comes into the court room and, in the witness chair, often furnishes evidence which helps to free or convict the accused.

In this latter rôle it identifies species of blood spots, ferrets out meat adulterations, fixes guilt on rapists and, in its newest function, sometimes straightens out tangled parentage situations.

It might well be asked how such widely diverging applications can be based on one branch of science. The answer to this question lies in the fact that the principle which underlies immunity is the same no matter whether it is preventing diphtheria from developing in a child or whether it is identifying species of blood stains. The working unit of this principle is a peculiar type of biological chemical known as *antibodies*. They enter into both the disease-preventing and the medico-legal rôles.

Consider an actual case in the latter field: Two men went hunting and one of them was killed. The survivor told a tale of finding the body of his partner under circumstances which suggested accidental shooting. A reconstruction of the tragedy seemed to fit his story but the widow was not satisfied with the evidence presented and demanded an investigation.

DURING the inquest the suspect was questioned about some dark brown spots on his hunting coat. He claimed they were made by blood from a deer which he had dragged into camp. For confirmation the district attorney asked a bio-chemist to identify the stains and be ready to make a report at the trial.

When the garment was turned over to the chemist he took it to his laboratory, cut out pieces containing the stains and soaked them in a salt solution. As a preliminary to his real problem he had to prove that the spots were made of blood—that is, blood from any species. This he attempted first by the use of a microscope. With this instrument he looked for red corpuscles in the salt solution. But the stains were too old—the blood cells had disintegrated. Next he looked at the solution through a spectroscope. There were the tell-tale black lines! These told him the solution contained blood. As a check he made some chemical tests and they, too, were positive. Having proved conclusively that the stains were blood, he then set about determining the species of animal from which they came. This he did through the use of antibodies mentioned above.

But antibodies—several kinds of them—have to be manufactured for this work and they cannot be produced in test tubes or bottles. They have to be manufactured in the bodies of warm-blooded animals, and this means long hours of painstaking work which goes on in the laboratory away from the court, the judges, and the jury.

The chemist carries on this tedious task in the animal room where from 25 to 50 rabbits are kept in separate cages.

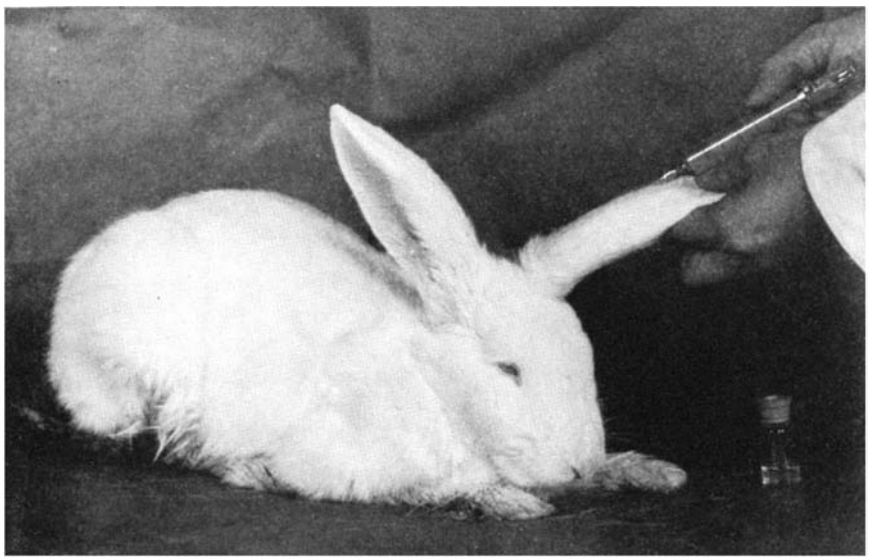


Figure 1: **Injecting serum from a given animal into a rabbit's ear. This causes the production in the rabbit's body of antibodies specific for serum of that species**

Each cage is numbered, and the chemist has already spent about three weeks immunizing the rabbits against bloods from other animal species. He has done this in anticipation of just such cases as the one he now has to work on. Rabbit Number 1 has been immunized against dog blood; rabbit Number 2 has been immunized against horse blood; rabbit Number 3 against human blood, and the others against as many kinds of blood as there have been rabbits used. (Figure 2.)

First, you will probably wonder how rabbits can be immunized against *blood*. It is like this: When a foreign material is introduced into the body of a living animal (or human) and this material stimulates the tissues of that animal to produce chemical substances known as antibodies, that animal is said to be immunized against that foreign material. When a physician, for instance, wishes to prevent his patient from contracting smallpox, he introduces the specific germs (weakened) into the body of the patient. The presence of these germs stimulates the tissues to manufacture antibodies against smallpox germs and the individual is said to be immunized. Likewise, when the chemist introduces bloods into the bodies of rabbits, their tissues begin manufacturing antibodies against the bloods, and the rabbits, too, are immunized. Each rabbit, of course, is immunized against the particular blood which was introduced into its body.

IN case of the smallpox vaccination and in the rabbit immunization, the antibodies are the working units. It is the method of using these antibodies which makes the applications of the principles of immunity appear so diverging. When human beings are immunized against germs the task is done: the body is protected because it has a vast army of antibodies floating around in its blood stream ready to kill any specific germs with which they come in contact. On the other hand, in order to make use of rabbit's antibodies, the chemist has to get them out of the animal's blood stream and into test tubes. His next step, then, is to secure some of the immunized rabbit's serum. This he does by pricking the rabbit's ear vein, collecting the blood, allowing it to clot, drawing off the serum and placing it in separate bottles, numbered according to the rabbits from which it is taken (Figure 3).

Since antibodies remain in the serum, bottle Number 1 will contain antibodies which react against dog blood; bottle Number 2, antibodies which react against horse blood, and so on down the list of animals used in the immunization process.

The serums are now ready, excepting for one more step, to be used in identifying the blood stains. It must be proved that they actually contain antibodies, a fact which cannot be determined merely by looking at them, for serum containing no antibodies at all looks exactly like that which contains a large amount.

Although all serums from the immunized rabbits have to be checked for antibodies, ten will suffice for a demonstration showing how the chemist carries out the procedure. First, he sets out ten test-tube racks and in each he places ten tubes. In the first rack of tubes he pours some anti-dog rabbit serum. In the second rack of tubes he pours anti-horse rabbit serum. Continuing in the other eight racks of tubes he pours serums as shown in Figure 4. He now has 100 tubes with ten different kinds of immune serum.

To these tubes of serum he next adds bloods. It should be noted that he does not add bloods in the same order in which he distributed the serums. This is important. To the *first tube* of each of the ten racks he adds dog blood. To the *second tube* of each rack he adds horse blood. Continuing with consecutive tubes of each rack he adds bloods from eight more animal species to the remaining 80 tubes. This order of addition is also shown in Figure 4. Thus serum from each of the immunized rabbits is mixed with blood from each animal species used in the immunizing process. The tubes are shaken thoroughly for mixing and, for a few minutes, set in a water bath at 37 degrees, Centigrade, the temperature of warm-blooded animals.

THE checking process requires a very great amount of mental concentration in order that there shall be absolute accuracy. One incorrect mixture could send an innocent person to the electric chair! But in the hands of a trained expert this never happens, and for this reason only a bio-chemist whose professional reputation has been established is allowed to prepare these tests for evidence.

When the tubes are removed from the warming bath a very striking change is

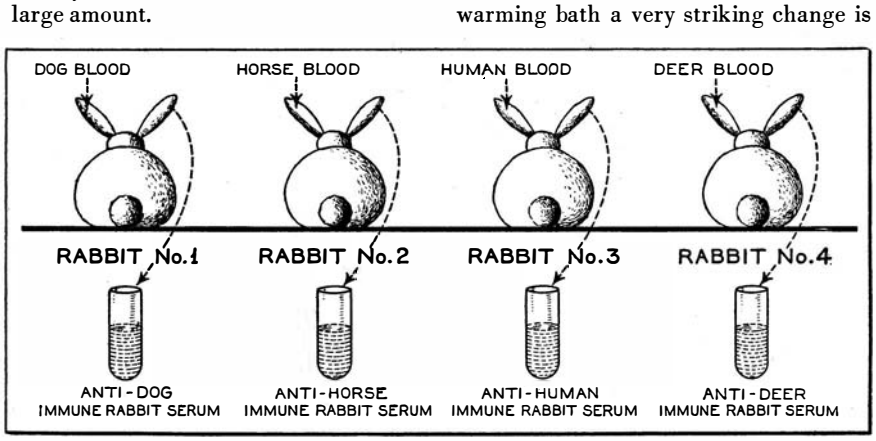
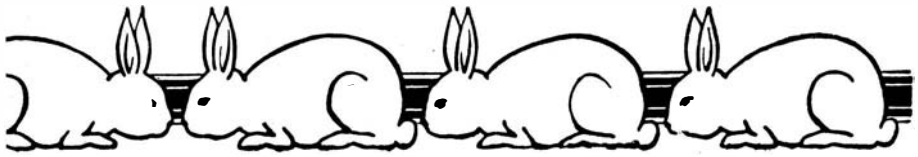


Figure 2: **With a series of rabbits, the blood of several animals may be used, and thus each rabbit is immunized against one single, specific animal's blood**



seen to have taken place in some of them. This change clearly shows the significance of making the preliminary check tests. A heavy white precipitate has formed in tube Number 1 of the first rack, in tube Number 2 of the second rack and continuing consecutively to tube Number 10 of the tenth rack.

What does this prove?

It proves that immune rabbit serum contains something which, when mixed with the specific blood used in the immunizing process, causes a precipitate to form. That *something* consists of antibodies, or, more specifically, precipitins. A lack of precipitation in the other tubes proves that immune serum does not contain precipitins for the blood of animals not used in the immunizing process. In other words, anti-dog immune rabbit serum will produce a precipitate *only* when mixed with dog blood. Anti-human immune rabbit serum will produce a precipitate *only* when mixed with human blood.

WHEN the chemist took the pieces of cloth into his laboratory these specific immune serums were all ready for him to use. All he had to do was to pour a few kinds of immune serum into test tubes and mix with them some of the salt solution in which he had soaked the stains. Had a precipitate formed in the tube containing anti-deer serum it would have shown that the stains were made by deer blood. As it actually happened in this particular trial, a precipitate took place in the tube containing anti-human serum, and it was just enough evidence to send the man to the penitentiary. The records are full of similar cases.

Thus antibodies work in the field of immunity. Under the guiding hand of the physician they can become mighty guards protecting human beings from pestilence and plague. Under the guiding hand of the chemist they can become instruments of precision which point with deadly accuracy at stains and say: "This human being has the blood of a fellow man on his hands!"

Consider another example—one in which precipitins ferret out meat adulterations: About two years following the World War a government chemist walked into a restaurant and ordered a hamburger sandwich. At first the savory odor of onion and sauces drowned any foreign gustatory sensation he may have experienced. As he continued to masticate, however, a never-to-be-forgotten taste began to force itself upon his consciousness. Eating stew in a German prison had left him with a memory—a memory not unmixed with the flavor of a livery stable.

He got rid of his bite but put the remaining portion of the sandwich in his pocket. Later, in his laboratory, he soaked the meat in salt solution and added it to tubes of immune rabbit serum. The rabbits had previously been immunized against solutions of meats of various animal species. The precipitation tests confirmed that which his memory and taste buds had pointed out.

The restaurant owner learned, when arrested, that using canned horse meat, meant for exportation, was a source of lucrative income until precipitins caused him to pay a stiff fine or go to jail!

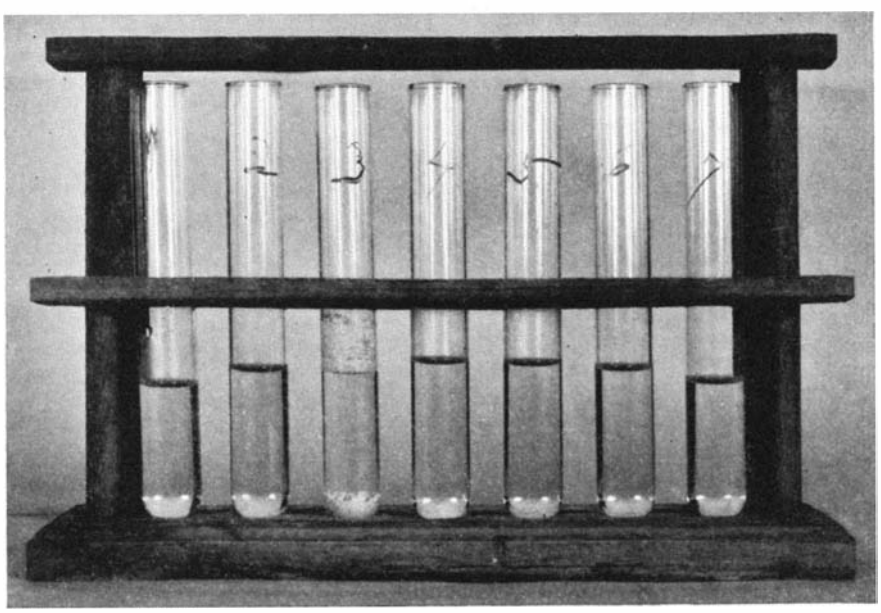


Figure 3: **Some of the unknown blood was added to several kinds of immune rabbit serums. No. 3 alone gave a precipitate: It was from a human being**

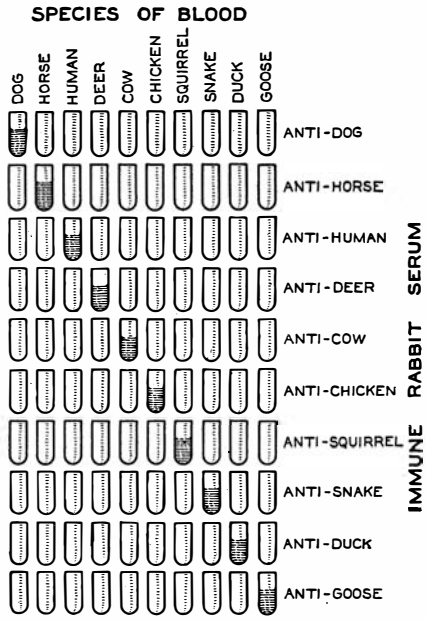


Figure 4: **How the solution is pursued through 100 separate tests**

Similarly, precipitin antibodies play a part in rape cases. Stains on clothing sometimes have to be identified as to whether they are seminal fluid. Essentially the same procedure is followed by the chemist as in identifying blood stains or meats. Anti-seminal fluid immune rabbit serum is mixed with a solution from the spot on the garment in question. If a precipitate forms in the mixture the spot had been made by seminal fluid. If no precipitate forms the evidence is in the negative. Such evidence may help to convict or free a man on trial of this kind.

IN parentage tests the procedure is also based on antibody reactions but is quite different from the types of cases described above. This kind of test involves blood groups and is too complicated to be explained in the short space allotted here. [See "Whose Baby?", by Prof. Laurence H. Snyder, Scientific American, May, 1934, pages 229-232.—*Ed.*] Suffice it to say that the test gives negative evidence (when any) instead of positive, but can be very valuable where the father of a child is disputed and where there has been an accidental exchange of babies in a maternity hospital ward.

The applications of the principles of immunity, then, depend on these unseen chemical substances, antibodies. One kind of antibody floats around in the blood stream of human beings and prevents small-pox, diphtheria, typhoid fever and many other diseases. Another kind of antibody floats around in the bodies of animals and finally comes to the witness chair and helps balance the scales of justice at courts of trial.

OUR POINT OF VIEW

It Can Be Done

FIRST glance at the motor vehicle accident figures for 1936 is likely to give an erroneous impression of the effect of the tremendous amount of effort that has been expended in "safety drives" in recent months. The motor vehicle accident fatality figure in 1936 jumped to 38,500 as against 37,000 in 1935, an increase of approximately 4 percent. This might seem to be an indication that the educational campaigns and safety drives have been worse than useless, but a careful consideration of the many factors involved indicates that such is not the case.

It is significant that 1000 of the 1500 increase in fatal accidents occurred during the last two months of 1936. During this same period of time it is usual for motor vehicle traffic to be reduced in volume because of inclement weather; in 1936, however, open roads and fair weather permitted heavy traffic in the northern part of the country during these two months. Then, there is the additional factor of the increased number of motor vehicles on the road throughout the year. Although traffic deaths rose 4 percent during 1936, automobile registration jumped 8 percent to a total of 28,270,000 registered motor vehicles. According to the American Petroleum Institute this record-breaking number of vehicles traveled 225,000,000,000 miles in 1936 or 22,000,000,000 miles more than in any other year.

The year 1936 saw a far greater activity in all kinds of safety promotion but it was also a period in which a larger number of vehicles traveled a larger number of miles than ever before. In spite of this, and regardless of the total increase in fatalities throughout the country, many cities and states made possible a sizable reduction in accident deaths by carrying out well rounded safety programs. Mile for mile, says the National Safety Council, American motorists operated more safely in 1936 than in 1935.

Figures show that 18 states and the District of Columbia reduced traffic deaths 7 percent in 1936, although gasoline consumption in these areas increased 10 percent. The remaining 30 states, with gas consumption up 12 percent, reported a 9 percent increase in deaths.

It is to be noted that all but two of the 18 states in which traffic deaths were reduced carried on either a complete program of safety engineering, legislation, law enforcement, education, and safety organization, or have done excellent work in one or two of these lines. Of the 30 states which showed increased death totals, more than half have not performed notable work in any important branch of traffic safety effort, although several have started.

In the face of an increasing traffic death record, it is difficult to appear optimistic. Such optimism, however, is not at all out of place as the record definitely proves that something can be done about it if only coordinated efforts adequately directed are applied to the entire motoring situation.

Flood Curbs

HYSTERICAL thinking is always so prevalent during a major emergency that logic is submerged in a plethora of contradictions. Such was the case during the worst of the flood which overwhelmed sections of the Ohio and Mississippi Valleys in January and February. The greatest catastrophe of its kind ever to befall this country, this record-breaking sweep of turgid waters through populous cities and thousands of square miles of fertile farm lands elicited numerous impromptu plans for curbing these waters.

Just as though *now that it has come to our attention*, the government could forthwith take in hand and solve the flood problem, a friend asked the editor: "What are they going to do to prevent another such flood?" Just like that! The answer is, of course, that the problem is older than America, as such, and no one trick will presto the solution. Having fought these two wild rivers for generations—mainly by levees which offered incomplete protection—the government has, for several years, been constructing the unified, inter-linked system of protection devised in its entirety by the late Major General Edgar Jadwin. His plan, costing so far more than 300,000,000 dollars, comprises heightened and strengthened levees, emergency floodways, spillways, and "fuse plugs" which permit spreading of crest waters into catch basins. Most of this work was completed as the flood roared down from Pittsburgh but one spillway was half completed and one not yet started.

This may indicate the magnitude of the problem. It indicates also the typical fashion in which we tackle a great problem when once its seriousness overcomes our apathy. But even as General Jadwin planned it, the system of protection is not enough. Record crests at many points testify to that fact. We must take stock once more, enlarge General Jadwin's program re-plan levees, build strategic retaining dams on tributaries, heighten levees near cities, and re-forest adjacent lands to prevent too rapid run-off of rain waters. Years of hard work are ahead and hundreds of millions of dollars must be spent on the job with no certainty that it will ever be finished, no assurance that the Ohio and Mississippi will ever be completely controlled.

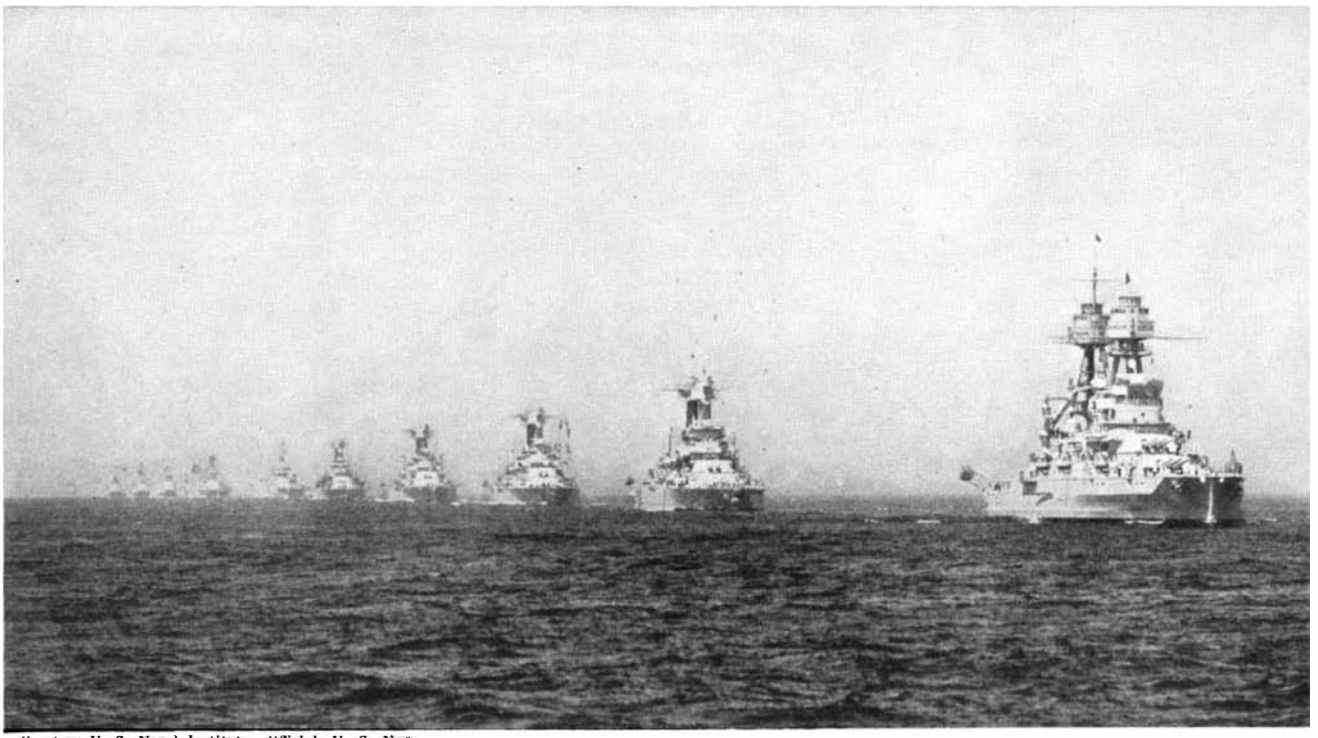
There is one thing that is beyond question: we *will* continue this fight. Just suppose it *is* a fight against Nature in her angriest, most destructive mood? Are we then to evacuate the two valleys, as one professor has suggested? Hardly! That is not civilized man's way. Those rivers and their ever-so-often flooded bottom lands have added billions of dollars to the wealth of the land, have provided a livelihood for many millions of people. And, anyhow, while we're abandoning these rivers to their own whims, why not abandon also most of those in this country?

The Biologist Looks at the Motor Car

NOW that the motor car has grown up and taken on some of the mature, finished design characteristics of its middle age, the designers are on the hunt for further ways to make it a really perfect gentleman, and one of these is the small beginning already made toward the safety interior.

The car itself is made of materials which are rigid and unyielding, but what of the passengers? What is a human being but a lump of mush—protoplasm—sixty percent water and the remainder a colloidal substance dispersed in that water? What a contrast to the car itself. When you suddenly stop a rapidly moving car, so that the protoplasmic passenger, obeying the second law of Newton, continues on, his protoplasm spatters. The problem, then, is to protect mush against sudden impact.

Walk blindfolded into a door at two miles an hour and your forehead derives a nice goose-egg. Run blindfolded into it at ten miles an hour and you are knocked out. But when a car brings up against something solid at 40 miles an hour the force of the blow, by the square law, is 20 squared, or 400 times the two-mile force and you are goose-egged all over! Obviously, then, a biologist, looking at this problem, would urge that we go not a little way but as far as practicable in making the whole interior of a motor car a safety interior.



Courtesy U. S. Naval Institute—Official, U. S. Navy

THE BATTLESHIP RETURNS

Theoretically Obsolete a Few Years Ago, the Big Fellow is Back . . . All Powers are Building Battleships . . . New French "Dunkerque" Set the Pace

By WALTON L. ROBINSON

FRANCE has recently completed the world's newest battleship, the powerful and swift 26,500-ton *Dunkerque*. She brings to three the number of post-war battleships in service; the other two, Great Britain's mighty 33,500-ton super-dreadnoughts *Nelson* and *Rodney*, entered service in 1927. Just over a year ago, France completed one of the finest transatlantic liners in the world, the fleet *Normandie*, and now she can boast of possessing one of the fastest and most powerful warships in existence.

The *Dunkerque* was constructed as a reply to Germany's three remarkable 10,000-ton "pocket battleships." A sister ship, the *Strasbourg*, is now under construction; when ready, she will ensure France's superiority over the German vessels.

The first of Germany's trio, the *Deutschland*, was completed late in 1933; the second, the *Admiral Scheer*, in the year following; while the third, the *Admiral Graf Spee*, was commissioned for service in January, 1936.

No doubt many readers of Scientific American know of the extraordinary military qualities with which the German naval designers endowed these ships. Whereas at the time their designs were prepared other nations were constructing 10,000-ton cruisers armed with eight, nine, or ten 8-inch guns, the new German ships, on the same displacement, were to mount a main armament of six 11-inch guns. As the weight of a shell hurled by one of these is about 670 pounds as compared with the 250-pound shell of the 8-inch gun, it can be seen that a single broadside from one of the German ships would weigh 4020 pounds to the 2000, 2250, or 2500 pounds of that of a 10,000-ton "treaty" cruiser, the type built by the United States, Great Britain, Japan, France, and Italy. The German ships, moreover, were given a fair protection against shell-fire, something which many of the 10,000-ton cruisers, especially the earlier ones, sadly lack. A *Deutschland* would be able to absorb numerous hits from 8-inch shells, but a few of her 670-pound, 11-inch projectiles would suffice—if they found their mark—to send to the bottom any dashing 10,000-ton cruiser which chose to put up a fight.

Superior speed is the only advantage possessed by the 10,000-ton cruiser over the German ships. The *Deutschland* and her two sister vessels have a maximum sea speed of 26 knots. The slowest "treaty" cruisers yet built, Britain's *Kent* class, are capable of 31.5 knots, and the fastest, Italy's *Trento* and *Trieste*, are good for over 36 knots (in August, 1928, the *Trento* reached 38.7 knots).

From the above remarks it should not be difficult to understand France's consternation at the mere announcement some years ago of Germany's intention to construct a division of *Deutschlands*. The French "treaty" cruisers then built or building had the speed to bring to action one of the projected German ships, but they lacked the offensive and defensive power to defeat them. The six French dreadnoughts (battleships), on the other hand, carried a heavier armament and were more stoutly protected than the *Deutschlands*, but their low speed of only 20 knots would have made it impossible for them to bring the faster German ships within range of their powerful guns.

With her battleships too slow to catch the proposed German ships and her cruisers too weak to fight them, it was obvious that France would have to build a number of large, powerful vessels capable not only of overtaking the "pocket battleships," but also of sinking them. After studying for a number of years the best means of solving this problem, the French naval authorities at last decided on the design of the 26,500-ton *Dunkerque*.

This ship, now attached to the French battle squadron in the Atlantic, is immensely superior to any of the three German vessels. She has a designed speed of 29.5 knots, which would enable her to overtake any fleeing "pocket battleship" (officially classed as a *panzerkreuzer*, i.e., an "armored cruiser") while her powerful armament of eight 13-inch guns should make short work of one of them. At a single simultaneous discharge of all her 13-inch guns the *Dunkerque* can hurl about 9600 pounds of steel and explosives for a distance of well over 20 miles. Thus from the standpoint of offensive power alone the *Dunkerque* is more than twice as formidable as the *Deutschland*.

THE French ship's main armament is arranged in a novel manner. The eight big guns are mounted in two huge turrets, both located in the fore part of the ship, number two turret being behind and above number one. These are heavily armored and only a direct hit by a large projectile could put one of them out of action.

The secondary battery, the principal mission of which is to repel torpedo attacks by enemy destroyers, is excellent both in quantity and quality. It is composed of 16 5.1-inch guns, grouped in three quadruple and two twin gun-houses. These guns have a high angle of elevation and can also be employed against airplanes. The anti-aircraft defense proper is constituted by 12 3.9-inch guns and a number of multiple medium guns.

On the quarter deck (after deck) there are two catapults for launching into the air the four planes carried. These latter are for "spotting" purposes; that is, they will observe the fall of shot around the enemy ship, and report back to their own ship so that its gunnery officers can make the necessary range corrections. This method permits very accurate fire even at extremely long ranges.

Armor defense is very complete. Amidships, on and above the waterline, is an 8.75-inch armor belt over 300 feet in length, extending from the foremost 13-inch gun turret to the after 5.1-inch gun-house. The hull is subdivided into numerous water-tight compartments and there is a 1.5-inch longitudinal torpedo bulkhead. These elaborate underwater defense arrangements would control damage inflicted by one or more torpedo hits or mine explosions. There are three protective decks for defense against airplane bombs and plunging shell-fire when fighting at extremely long range. The upper deck has a thickness of five inches and the lower ones of three and two. The armor on the two big-gun turrets has not been divulged, but it is certainly formidable. The total weight of all this armor amounts to some 10,000 tons. Such a large percentage of displacement devoted to protection has never before been attained in a capital ship.

The designed speed of almost 30 knots is attained with engines of 100,000 horsepower. On trials the ship exceeded these speed and horsepower figures. There are six boilers. Oil fuel capacity is sufficient for an extreme cruising radius of 7500 miles at 15 knots.

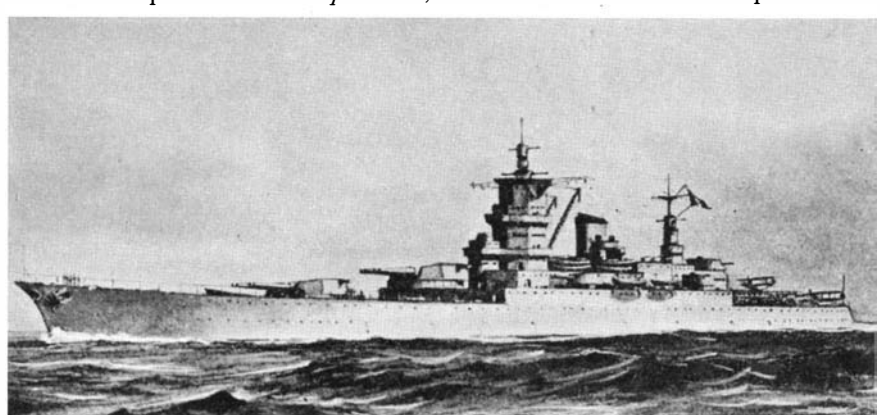
The length of this splendid ship is 686 feet on the waterline (702 feet overall) and the beam 101.75 feet. The draught is 28 feet. The ship was built in a dry dock. Being too long for the dock, the stem piece was constructed separately and attached to the hull after floating out on October 2, 1935.

As noted before, the construction of a second ship of the *Dunkerque* class, the *Strasbourg*, has been undertaken. She was laid down in November, 1934, in response to Germany's decision to continue the construction of "pocket battleships" (a year later the two supposedly "10,000-ton pocket battleships" laid down in 1934 by Germany turned out to be vessels of 26,000 tons!).

This capital ship competition between Germany and France has caused the world's leading navies to take fresh interest in the big ship and they all have begun or soon will commence the construction of new battleships to replace the old and more or less obsolete ones now in service. Just as France was obliged to lay down her two *Dunkerques* in answer to Germany's *Deutschlands*, so Italy felt the necessity to build ships capable of facing France's new 26,500-ton vessels. At first the Italian naval authorities planned units of about the same size as the *Dunkerques*, but later they decided to go France one better and build much more powerful ones. These, the *Littorio* and *Vittorio Veneto*, are now under construction and are expected to be ready in 1938. They will displace 35,000 tons, have a speed of over 30 knots, and they probably will be armed with nine 15-inch guns, mounted in triple turrets. As can easily be seen, these ships will possess almost as great an advantage over the *Dunkerques* as these do over the *Deutschlands*.

This decision on Italy's part naturally upset the French calculations and has obliged them, in turn, to make an adequate reply to the Italian ships. Consequently, in November, 1935, the French undertook the construction of the 35,000-ton battleship *Richelieu*. A similar ship, to be named *Jean Bart*, will be laid down this year. Their general characteristics are expected to be 30-knot speed and a main armament of 12 13-inch guns.

Germany, determined not to be left behind by her old enemy, decided to break the naval and military clauses of the Versailles Peace Treaty and now is building a pair of fast battleships of about the same size and speed as the *Dunkerques*. These new German ships, the *Scharnhorst* and *Gneisnau*, will probably carry nine 11-inch guns.

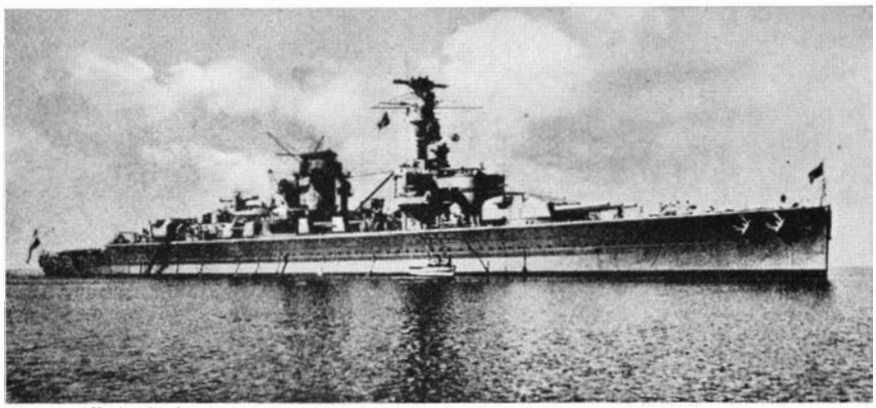


Courtesy *Jane's Fighting Ships*

The French *Dunkerque* which has started new battleship building by the nations

This extensive battleship building by European powers disturbed Great Britain. She announced, therefore, that early in 1937 she would lay the keels of two 35,000-ton dreadnoughts, the largest size permitted by the London Naval Treaty of 1936, signed by this country, Great Britain, and France. As soon as our Navy learned of Britain's decision, the Navy Department sought and obtained permission to build two ships of equal size and power. They will be commenced this year, in all likelihood.

Japan has been officially silent as regards her future battleship construction plans, but it has been rumored that



Courtesy U. S. Naval Institute

The German "pocket battleship," *Deutschland*, first of three remarkable ships

she is contemplating laying down a huge super-dreadnought of 45,000 to 50,000 tons, mounting 18-inch guns. If she should actually carry out this plan it will force the United States and Great Britain to tear up their 35,000-ton blueprint battleships and design and lay down units of the size and power of the proposed Japanese giant. This can be done without violating the afore-mentioned 1936 London Naval Treaty, for in it was included an "escalator" or "escape" clause which permits ships larger than 35,000 tons should any nation outside the treaty, as is Japan, decide to exceed that limit. Such action will inevitably lead to an unrestricted naval race between the world's three greatest naval powers, a race for superiority both in size and numbers. And the *Dunkerque*, fully described in this article, is the real forerunner of this expected naval marathon, for although Germany's *Deutschland* caused France to build the *Dunkerque*, it is not likely that such a world-wide competition would have developed so soon as it has had not France answered with her now completed ship.

OTHER nations, while marveling at the wonderful fighting qualities of the *Deutschlands*, were not worried by problems these would create for them. France, Germany's most probable opponent in a naval war, was the nation most seriously affected by the advent of the "pocket battleships." Britain had no great fear of them, nor has she now, for the Royal Navy possesses three giant battle cruisers, the *Hood*, *Repulse*, and *Renown*, each of which is capable of catching and blowing out of the water any of the three German ships. The other nations—United States, Japan, and Italy—are so located geographically that they have little to fear from German sea power.

Aside from the feverish new construction under way or planned, all the world's navies, large and small, which possess capital ships, have modernized them or plan to do so. These modernizations in most cases have included improved under-water protection (usually by the addition of "bulges" or "blisters" outside the hull); redistribution of armor; increase of anti-aircraft batteries; provision of "spotting" airplanes and the requisite catapult; adaptation of boilers to burn oil fuel only; and alterations in superstructure: masts, funnels, bridges, and so on.

The United States Navy has thoroughly modernized its 10 oldest battleships. Work on the remaining five has been postponed due to the unsettled international situation—just a matter of "keeping the powder dry," for a complete modernization requires withdrawing the ship from active service for from one to three years. The cost of one of these modernizations varies from about 5,000,000 to 7,000,000 dollars.

Great Britain has completely refitted all of her capital ships save her two post-war giants, *Nelson* and *Rodney*. The recent refit (1932-36) of H.M.S. *Repulse* cost in excess of 6,000,000 dollars.

Japan has thoroughly modernized at least once all nine of her capital ships, and several of them twice. Alterations to some of these ships have given them a very ugly, freakish appearance.

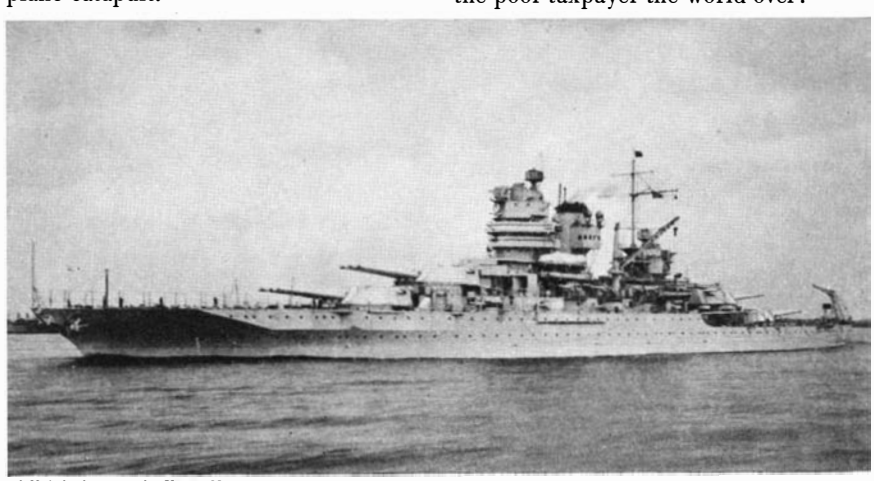
The French have periodically patched up their existing dreadnoughts. In the case of the *Lorraine*, they went so far as to remove the amidships 13.2-inch gun turret and replace it with an airplane catapult.

Italy has but four battleships completed. The two oldest of these were recently refitted. As in the case of the French *Lorraine*, the amidships turret was removed, and a catapult mounted in its place. Speed was increased from the original 22 knots to 26. It was intended to take the other two ships in hand for similar alterations, but the Ethiopian War and diplomatic difficulties with Great Britain have caused this plan to be abandoned, for the time being at least—another case of "keeping the powder dry."

Soviet Russia in recent years has been tinkering with her four much-neglected dreadnoughts, left-overs of the Czar's old Imperial Navy. Three of these ships have now been put in fairly satisfactory condition, and it is hoped to repair the fourth so that she, too, can go to sea.

THIS revival of interest in the capital ship by all the leading naval powers is especially remarkable in view of the fact that it was only a few years ago that some of them, notably France and Italy, apparently had decided to forego future battleship construction and concentrate exclusively on fast cruisers and destroyers, submarines and aircraft. It was the opinion of the naval staffs of these nations that the battleship had outlived its usefulness, that it had been made obsolete by the new inventions: the airplane and submarine, which with their bombs and torpedoes could easily sink the most powerful dreadnought. But faith in the big, heavily armored ship appears to have definitely returned. Maneuvers of all the important navies have demonstrated clearly that without battleships to fall back upon for support, even the most numerous light forces can accomplish little.

Yes, the big fellow is back—with his huge guns, his thick armor, his complement of a thousand or more highly trained officers and men, and, last but not least, his millions of dollars of initial cost and annual upkeep. Woe to the poor taxpayer the world over!



Official photograph, U. S. Navy

The U.S.S. *New Mexico*, one of our Navy's three most recently modernized ships

THE POPULATION OF INTER-

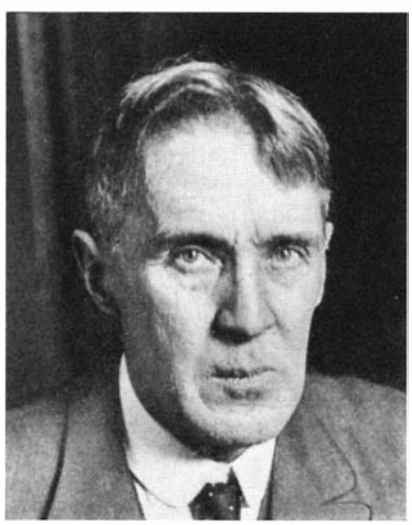
There is Evidence that Galactic Space Contains Extremely Tenuous Material — Scattered Atoms of Gas — and is not Wholly Empty . . . Its Source?

THE vast empty spaces between the stars tempt the imagination. Here and there, scattered within them, are clouds of dust—revealed only because they hide the Milky Way behind them—and thinner clouds of gas, visible only when the light of hot stars stirs them up to shine as nebulae. But in overwhelmingly the greater part of interstellar space there is nothing that can be seen by direct observation. We know, however, that these open spaces are not altogether empty. Distant stars of the same type of spectrum appear a little redder, if they lie near the Milky Way, than if they are near its pole. There is very good reason to believe that such stars are really of the same color, and it is therefore generally admitted that there is a stratum of very tenuous material lying in the plane of the Galaxy which absorbs blue light more than red. From a star near the galactic pole, the light comes in crosswise through this layer, and the effect is very small; but when the rays come in at an oblique angle their path in the layer is longer and the star looks redder.

A very similar effect is produced in the earth's atmosphere, and stars, planets, moon, and sun look redder when they are low in the sky. Indeed, the few miles of air above our heads produce about as big an effect as the whole interstellar stratum, which must be hundreds of light-years thick.

THIS suggests that the density of matter in interstellar space may be less than that of the air in the ratio of a mile to a hundred light-years, or, roughly, as one to a million billions. But even this is too high an estimate, for it corresponds to about 25,000 molecules per cubic centimeter. Eddington showed years ago that if all the stars in the region near the sun (where we have a pretty full count) could be expanded into a uniform layer of gas, there would be only enough stuff to provide two hydrogen atoms per cubic centimeter, or a correspondingly smaller number of heavy atoms. Now the total amount of diffuse interstellar matter may be greater than that which is concentrated in the stars; but it cannot be much greater, or its attraction would affect the motions of the stars to a degree inconsistent with the facts. Hence, on the average, there can be only a very few atoms per cubic centimeter in interstellar space. If these atoms were as heavy as air molecules (which is probably an exaggeration) a layer of interstellar matter a thousand light-years thick would have to be compressed to a thickness of *one foot* in order to make it as dense as ordinary air!

The whole amount of stuff encountered in their journey through space by the light-rays of the remotest stars visible to the unaided eye is probably no greater than that which intervenes between the reader's eyes and this page. The wonder is not that space is transparent, but that so very small an amount of matter can produce any observable effects at all.



Professor R. W. Wood, whose diffraction gratings are world-famous. In the text reference is made to his new ones made on aluminized glass

The most powerful effect that might be anticipated is selective absorption of light—such as gives the dark lines in the solar spectrum. In an electric arc in the laboratory the outer and cooler flame, though but a fraction of an inch in thickness, often absorbs the light from the core strongly enough to produce conspicuous dark reversals of the principal spectral lines, and a corresponding number of atoms should do so in interstellar space.

Such an effect was first observed, many years ago, by Hartmann, who found in certain spectroscopic binaries that the H and K lines of calcium did not share in the periodic shifts produced by the orbital motion. They were evidently produced, not in the stars themselves, but in some cloud of gas between us and them, and far enough from them not to be perceptibly affected by their rapid motion. The fact that the "stationary" lines were narrow and sharp, while the stellar lines were broad, indicated that the medium which absorbed the former was of very low density.

Further observation has detected sharp lines of this sort in the spectra of hundreds of stars. Only two pairs of lines—until recently—have been found to behave in this way—H and K in the violet, due to ionized calcium, and the D lines of sodium in the yellow. They are observable only in hot stars, since, in the cooler ones, these same lines are produced strongly in the stars' own atmospheres, and swamp the narrow sharp "detached" lines. But they are almost invariably found in the spectrum of hot stars—except the nearest of them—and are stronger for the remoter objects. This, along with other evidence, has led to the conclusion that they are produced throughout interstellar space, which contains scattered atoms of calcium and sodium throughout its extent. The distribution appears to be somewhat patchy, but not violently so, and the strength of the "interstellar" lines may be used to give fairly good estimates of the distances of remote objects such as some recent novae.

WHY should these metals, rather than other elements, reveal themselves in this fashion? There are two necessary conditions: first, the element must be an abundant one, and second, it must have its most strongly absorbed lines in the observable part of the spectrum. This restriction cuts off the chance of finding some of the most abundant elements. Hydrogen, helium, carbon, nitrogen, and oxygen all have their strong absorptions in the remote ultra-violet, while for magnesium and silicon these are still hidden by the opacity of our atmosphere.

The action of ultra-violet starlight on the isolated interstellar atoms may be expected to ionize them, and keep most of them ionized, and this weakens our chances of finding iron and aluminum.

STELLAR SPACE

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.

whose strong lines, when ionized, are at wavelengths too short for us earth-bound observers. Sodium is easily ionized, and there must be a lot of it in space to permit the D lines, which come from the neutral atoms, to be observed.

To find other elements, the search should be extended beyond the limits of every-day observation, into the deep red and the near ultra-violet. Adams and Dunham have recently done this at Mount Wilson, with notable success. Even with the 100-inch reflector to collect the light, it is not easy to get well-exposed spectra in these difficult regions; but they had a great advantage in a new grating, ruled by Professor R. W. Wood of Johns Hopkins on an aluminized glass disk and having grooves (made by the ruling diamond) of such a form that a very large fraction of the light was thrown into a single order of the spectrum. With this beautiful instrument, spectrograms of several remote stars of Classes O and B were obtained, extending into the ultra-violet beyond λ3100. These showed a multitude of rather diffuse stellar lines, and a few sharp lines of characteristic interstellar appearance. A close pair of these, at λ3303, were at once recognized as sodium lines. Like the D lines, these are absorbed by the sodium atom in its normal state; but the absorption is much weaker, and their presence increases the evidence that sodium is (relatively) abundant in interstellar space.

Two other sharp lines agreed perfectly with two of the strongest lines of ionized titanium; and two more lines of this element were detected by longer exposures. Another constituent of the interstellar gas was thus discovered. Titanium is but little harder to ionize than calcium, so we might expect that, in its case, too, most of the interstellar atoms should have lost an electron.

A very curious phenomenon now appeared. For these ionized titanium atoms the "ground-state" of smallest energy is quadruple, having four components very close together. All the observed lines correspond to absorption from the lowest of these four states. Absorption by atoms in the neighboring states, though it gives still stronger lines, both in laboratory sources and in the stars, was entirely absent.

This unprecedented behavior has been elegantly explained by Dunham. The higher components of the group which we have been accustomed to call the ground-state do not really deserve the name. They are really metastable states, like those involved in the production of the "forbidden" nebular lines.

An undisturbed atom may remain in such a state for seconds, or even minutes—an "almost infinite" time compared with a hundred-millionth of a second for an ordinary excited state. But it will not remain there indefinitely; given time enough it will spontaneously revert to some lower state, emitting the stored energy as radiation. In the very lowest state, the atom has nowhere else to go, and will remain indefinitely, until disturbed from outside.

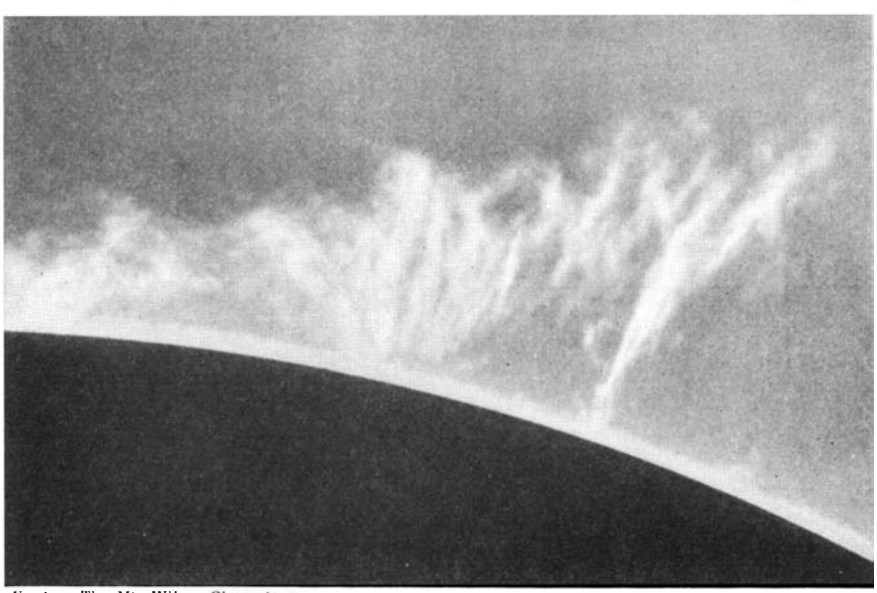
The "mean life-time" for the higher states, before such a change takes place, can be computed by quantum mechanics. Houston, for the case of titanium, finds it to be about 30 seconds.

NOW, in the exceedingly rarefied interstellar gas, collisions between atoms should be rare. Dunham calculates that the average interval should be several weeks. Other disturbances of the atom should be rarer; it would get a chance to absorb starlight less than once a century, and be hit by a cosmic ray perhaps once in a million years. If, then, the titanium atoms had, by any means, got into one of the higher energy states, they would drop back again into the lowest, or the ground-state, so soon that practically the whole of them at any time should be in this state; and only the lines absorbed from this state should appear.

The downward transition should cause the radiation of forbidden lines by the interstellar gas, but there can be no hope of observing these, for the principal one has a wavelength of 106 microns—more than a tenth of a millimeter.

This discovery clarifies the search for other interstellar lines, and improves the chance for finding them; for, instead of the complex multiplet groups which appear under ordinary circumstances, we have to look for fewer lines, which would individually be stronger. Dunham has already reported that potassium has been detected by its lines in the deep red, and other discoveries may follow. It is probable, indeed, that many, if not all, kinds of atoms are represented among the population of interstellar space.

There is no difficulty in seeing how they may have got there, if they were not "originally" present, for the actual expulsion of great masses of hydrogen and calcium from the sun has often been observed in eruptive prominences. Titanium is also found in prominences, and similar ejections from the stars may have borne a large part in keeping interstellar space from being utterly and completely empty.—*Princeton, February 5, 1937.*



Courtesy The Mt. Wilson Observatory

A solar prominence 80,000 miles high. Much matter thus shot out by the sun and into space may account for the material to be observed in the space between the stars of our galactic universe. The attentive reader will note that Professor Russell confines his present discussion to that scope—our galaxy

More Efficient Locomotives

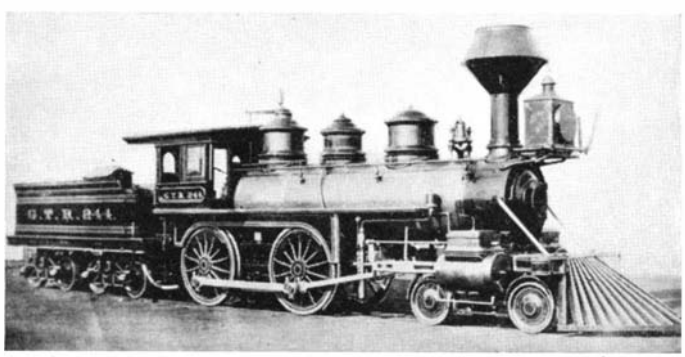
Steam Locomotive Still Supreme . . . Fewer in Service . . . More Power . . . Greater Efficiency . . . Engineering Improvements . . . Newer Rail Power Units

By EDWARD C. SCHMIDT
Professor of Railway Engineering, University of Illinois

IT has taken about 110 years for the steam locomotive to develop its present effectiveness and capacity. For the first 80 years its supremacy was unchallenged; it had no rivals. With the advent of the electric locomotive and the beginnings of railway electrification 30 years ago it met its first competitor, and in the popular opinion of the day its doom was then sealed. Today less than 2 percent of the locomotives in service in the United States are electric and the limitations of railway electrification are well understood. Its more recent rivals have not impaired its position, and the steam locomotive is to-day, and is likely long to continue to be, the power mainstay of railroads the world over.

The locomotive is a traveling power plant; it must not only haul its train and provide it with light and heat and with compressed air for its brakes, but it must in addition move itself and carry its own fuel and water. These facts impose upon it serious limitations, and it is subject likewise to hampering space limitations. Because of the dimensions of bridges and tunnels its height cannot be more than about 17 feet, nor its width more than 12; its length is limited by the flexibility required to pass around curves, and cannot at present be more than about 70 feet. Its weight furthermore is limited by the strength of track and bridges and may not exceed about 35,000 pounds per wheel. It is greatly to the designers' credit that within these limitations they have succeeded in producing a machine which will develop 5500 horsepower and exert a drawbar pull of 140,000 pounds. Further comparison with stationary power plants will presently be drawn, but it is pertinent to remark here that no stationary plant can show a ratio of power to space occupied which approaches this ratio in the locomotive. It must be admitted that this output has been attained at some sacrifice of efficiency, but it is none the less remarkable. It has been attained by raising the intensity of the processes of combustion and steam production far above that which prevails in stationary plants.

The present-day locomotive produces its steam in a fire-tube boiler, uses it in reciprocating engines which exhaust it at a little above atmospheric pressure. Its combustion is maintained by exhausting the steam from its cylinders into its stack; and its cylinder power is directly transmitted to its driving wheels, and thence to its drawbar. Notwithstanding a great difference in external appearance and size, in these fundamental features of design it is like the locomotive of 1840—a fact which in the minds of those unfamiliar with its intervening history is still a matter of reproach. It is hardly necessary to add that in power, efficiency, and in general adaptation to its work it is vastly better than its 1840 prototype. It weighs to-day from 10 to 15 times as much as it weighed then; uses steam of 250 to 300 pounds pressure instead of from 70 to 100 pounds; produces a drawbar pull of from 60,000 to 140,000 pounds instead of about 5000; and can develop about 20 times as much horsepower as the locomotive of 90 years ago.



Fundamentally, the locomotive of today, yet far inferior: an American 4-4-0 type of 1873 by Baldwin. Cylinders, 17 inches in diameter with a 24-inch stroke. Tractive effort of this locomotive was 12,600 pounds, and its weight 70,000 pounds

This great increase in capacity has been attended by a correspondingly great increase in efficiency, so that to-day the expenditure of coal and steam per horsepower is but a fraction of what it was then. Within this interval there has been also a great improvement in details of design and in the quality of materials which have reduced maintenance costs and increased the steam locomotive's reliability and availability.

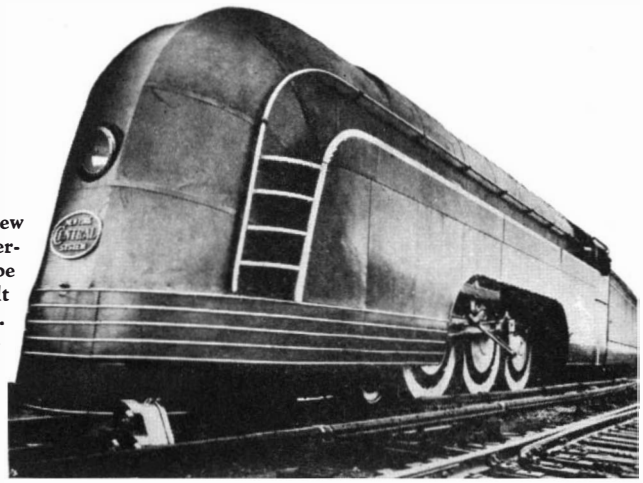
The most notable improvement has been in the use of superheated instead of saturated steam, which has decreased the steam consumption by from 20 to 25 percent, and the coal consumption almost as much. No locomotive is built today without it, and very few old ones in service have not had superheaters applied. In promoting economy, superheated steam (for the steam pressures now prevailing) does nearly all that multiple steam expansion could do, and its use is consequently responsible for the practical disappearance of compound engines in American locomotives.

AMONG other improvements should be mentioned the combustion chamber, the brick arch, the thermic syphon, the feedwater heater, and various improvements in the front end for producing and controlling the draft. All of these have improved the performance of the boiler by increasing its steam output or enhancing its efficiency, or both.

Economy in the use of the steam has been improved by the use of continually increasing steam pressure, and by constant improvement in valves and valve-operating mechanisms. Auxiliary or "booster" engines have been added to increase the tractive force in starting and at low speeds. As a result of this century of improvement the steam locomotive of to-day, under the best conditions, will produce one horsepower for the expenditure of 12 pounds of steam, or 1.5 pounds of coal per hour.

The performance of the locomotive is frequently compared with that of stationary power plants, although they are not really comparable. The comparison is invariably limited to a consideration of their relative thermal efficiencies, that is, the ratio of the heat equivalent of the work performed to the heat units in

the fuel consumed. In this respect, the locomotive is inferior to the stationary plant and it is likely to remain so. The implication of this comparison is, frequently, that the locomotive's efficiency could and should be brought up to that of the best stationary plants, ignoring the inescapable disadvantages imposed by the conditions under which the locomotive works, and failing to take into account capital charges and maintenance costs which must enter into any valid criterion of the economic efficiency of a plant or machine. Aside from the wide and sudden variations in load to which the locomotive is subjected, the major differences between the stationary plant and the locomotive are three: first, the former uses steam turbines instead of reciprocating engines; second, the turbines exhaust into condensers at from one to two pounds absolute pressure per square inch, whereas the locomotive's engines exhaust against a pressure of from 17 to 20 pounds, or more; and finally, the stationary plant furnishes its turbines with steam at pressures up to 750 pounds while in the locomotive pressures above 300 to 350 pounds have thus far proved impracticable, and the more common pressure is 250 pounds. All these differences operate to the disadvantage of the locomotive; its designers are well aware of that fact and attempts to obviate or escape them have occupied their attention for a generation.

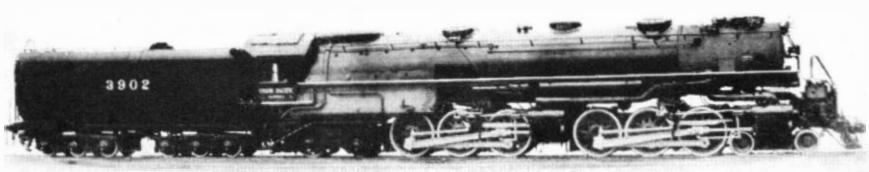


"The Mercury," a New York Central train operated by a Pacific type steam locomotive built in the road's shops. This is one of the earliest steam streamliners

IN recent years a few attempts have been made to provide condensers for locomotives. The ordinary stationary plant condenser is a vessel containing numerous tubes which divide the condenser into a water space and a steam space, the latter communicating with the exhaust passages of the turbines or cylinders. Cold water, circulating within the tubes, condenses the surrounding steam, producing and maintaining a partial vacuum into which the used steam from the turbines or engines continues to flow. In some condensers the steam and water are directly mixed. The amount of cooling water required is very great; for a large modern plant it taxes the imagination. When, for example, the Cahokia electric generating plant which supplies power for St. Louis and its environs was first fully under way its condensers, drawing cooling water from the Mississippi River, used daily several times as much water as the daily water consumption of the city of St. Louis for all purposes. Obviously a water supply on such a scale is not available to a traveling locomotive and it would require a condenser of a different type. In the attempts which have been made to apply a condenser to locomotives the condenser is carried on a separate vehicle and consists of finely divided steam spaces cooled by a limited supply of water, which is recirculated after being itself cooled by the circulation of air induced by the movement of the locomotive, supplemented by fans. Six condensing locomotives have been built abroad. They were designed with great care and forethought, but they all proved costly and highly complicated and there is little in their performance to warrant the expectation that these disadvantages can be soon overcome, or that, except perhaps in situations where the fuel cost is unusually excessive, they can be offset by the economy in fuel. Nevertheless, a turbine-driven condensing locomotive is now under construction in this country.

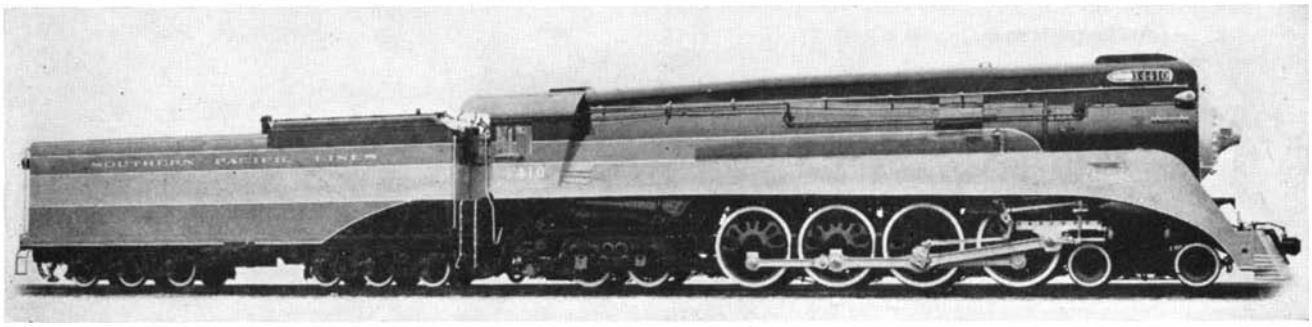
Various attempts have been made on European railways to develop steam locomotives driven by turbines instead of by the usual reciprocating engines, but the resulting locomotives have either been definitely abandoned or are still in an experimental stage. The turbine has an attractively low steam consumption provided it can be kept running at its optimum uniform speed. A locomotive must, however, operate throughout a great range in speed, and if its turbine is to operate at one speed for economy's sake, the driving mechanism between turbine and driving wheels is thereby complicated—especially in view of the large amount of power required in a locomotive. Furthermore, since the turbine is not reversible, the backward motion of the locomotive must be obtained by further complication of the driving mechanism, or by the use of a separate reversing turbine.

A typical modern engine built by the Baldwin Locomotive Works for the Lehigh Valley. Cylinders are 27 by 30 inches; steam pressure, 275 pounds; tractive force, 66,500 pounds; and weight, 435,000 pounds. Roller bearings are on the axles



A 4-6-6-4 type, articulated freight locomotive for fast mountain service built by the American Locomotive Company for the Union Pacific. Its four cylinders are 22 by 32 inches; steam pressure is 255 pounds; and it can exert a tractive force of 97,400 pounds. Its weight is 565,000 pounds; driving wheels 69 inches

The use of higher steam pressure makes for greater economy in any steam-driven prime mover, and the standard



One of six "largest and most powerful streamlined steam locomotives in the world" built by Lima Locomotive Works for the Southern Pacific. Top speed is expected to be 90 miles an hour. Engine and tender total 108 feet, 11 inches in length

modern power plant uses pressures as high as 750 pounds per square inch. Used in reciprocating engines, however, pressures above the usual locomotive steam pressure necessitate multiple expansion with its consequent complication in design and added cost of maintenance. A much more serious obstacle to its use in locomotives is that pressures above about 300 pounds require radical changes in the design of the standard locomotive boiler.

Beginning 12 years ago, four high-pressure locomotives have been built for the Delaware and Hudson Railroad. All four have boilers of special design; one uses steam at 350 pounds pressure, one at 400 pounds, and the latest two at 500 pounds. Three of these locomotives have compound reciprocating engines, while the fourth uses triple expansion. They are all still in use in regular service. A fifth American high-pressure engine was "Locomotive 60,000" built for experimental purposes in 1926 by the Baldwin Locomotive Works. Its boiler, of special design, generated steam at 350 pounds pressure which was used in compound cylinders. In the test plant and during road tests it gave an excellent performance and developed 4500 horsepower—the greatest power until that date recorded for any locomotive. It has since been retired from service. A few other locomotives carrying steam pressure up to 350 pounds, with boilers constructed of special steels and with some modifications in firebox design, are in service on American and Canadian roads.

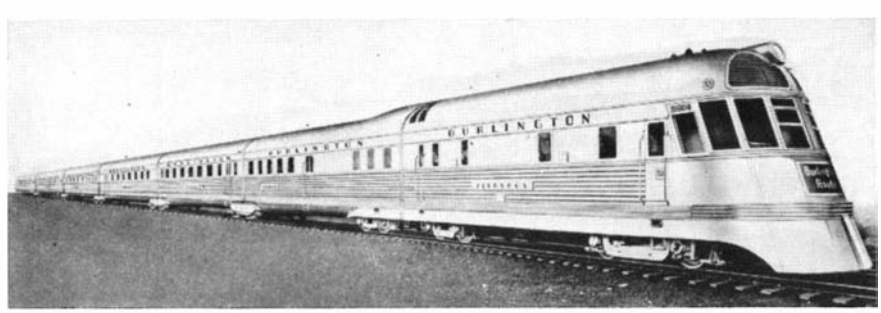
Abroad on British, German, and French railways the experiments with high-pressure steam have been more numerous and more varied. Pressures as great as 1700 pounds have been used in these experimental locomotives, which have developed high efficiencies—at the cost, however, of very expensive complication. It is significant that the German Railway Administration has definitely abandoned further experimentation with extreme high pressures and will hereafter limit its development work to locomotives with not over 350 pounds pressure—and in the majority of instances, about 300.

After years of painstaking experimentation the fundamental features of steam locomotive design remain, for the present, what they were before, with the very important exception of the use of superheated steam. Simplicity of design has prevailed over complexity, and has demonstrated that it promotes general economy and reliability, even though it entails some sacrifices of thermal efficiency. The present-day locomotive continues to have a boiler of the fire-tube type, producing superheated steam at pressures from 200 to 300 pounds, and this steam is used in reciprocating engines which exhaust to the atmosphere. In the United States and in Canada these are generally simple engines, except in some of the articulated locomotives which, having four cylinders in any case, use them as compound engines, expanding the steam in two stages. Abroad, compound engines are more common, especially in France—a fact which is to be attributed to the higher cost of fuel there, which makes even a slight additional gain in fuel economy worth the added complication.

DURING the past decade the standard steam locomotive has continued to develop, although the development has been hampered by the fact that during this period, because of the depression, fewer than the usual number of locomotives have been built. There has been a notable general increase in its capacity or tractive force. In 1925, the average tractive force of all locomotives in service in this country was 39,900 pounds; whereas in 1935 it was 48,400 pounds. This increase of about 22 percent does not fully represent the actual increase in capacity of locomotives built within the decade, for they constitute only 9 percent of the total number in service. The average tractive force of those built within the decade exceeds the average of those in service at its beginning by nearly 40 percent.

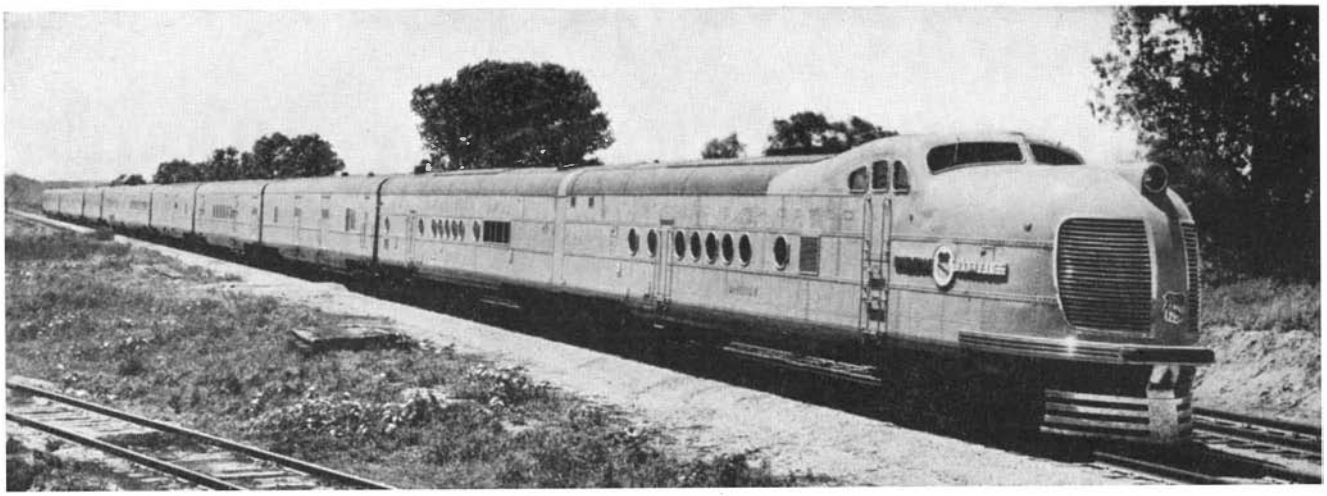
Ten years ago, the maximum recorded horsepower of any locomotive was 4500; to-day it is approximately 6500, which is the measured output of a freight locomotive built last spring by the Norfolk and Western Railway. All this has been accomplished without commensurate increase in weight, and the steady increase in capacity has been accompanied by an almost equally uniform increase in efficiency. In the freight service of Class 1 railroads of the United States, the coal used per thousand ton-miles was 140 pounds in 1925 and 120 pounds in 1935—a decrease of over 14 percent, a large share of which is attributable to greater locomotive efficiency, although it is partially due to improvement in the conditions of operation.

Within the decade there has been a general increase in the length of the locomotive's run and in its availability, which reflect the constant improvement in the details of its design. Other developments include the extension of the use of special steel alloys, particularly in the boiler and in the main rods and side rods. In the boiler they permit the use of higher steam pressure and in the rods they permit reduction in weight, thereby decreasing the difficulties of



Courtesy *Railway Age*

One of two streamlined trains operated by the Burlington System replacing two smaller, similar trains that had been operated since the spring of 1935. Each train, built by Edward G. Budd Manufacturing Company, consists of an 1800-horsepower Diesel-electric locomotive and six stainless steel passenger units



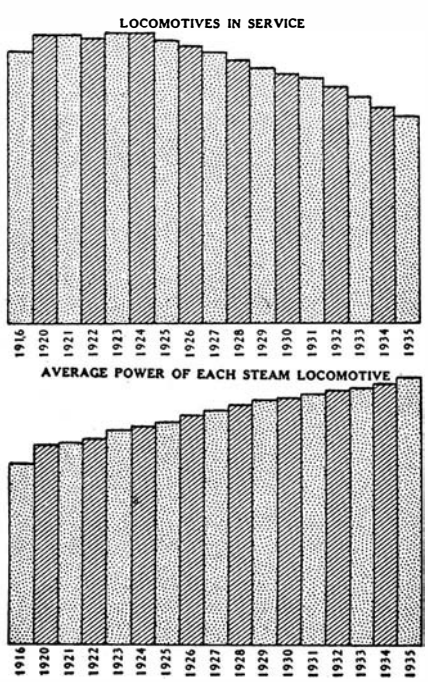
The Union Pacific Railroad's "City of Denver," one of two operating between Chicago and Denver, covering the 1048 miles in 16 hours. Its Diesel-electric locomotive consists of two units, each of 1200 horsepower; the remainder of the train comprises 10 units. Of the high-speed, light-weight trains, these are the longest and have the greatest carrying capacity

counter-balancing. Roller bearings have been applied in increasing number to recent locomotives, chiefly in the main axle bearings, but in a few instances to the main and side rod bearings. Dynamic counter-balancing is being more frequently resorted to. Poppet valves which, under certain operating conditions, improve the steam distribution are being very generally used on European railroads.

THE steam locomotive's latest rival is the Diesel locomotive, which is a locomotive equipped with multi-cylinder Diesel engines driving electric generators, the current from which is used in electric motors carried in the locomotive's trucks and connected to the axles of its driving wheels. The Diesel engine is about 40 years old; its thermal efficiency is very high (four or five times that of a steam locomotive); it is about as constantly available for service as the ordinary automobile engine; it is quiet; and it makes no smoke. Its inherent economy brought it first into use in stationary plants in places where fuel was scarce and costly, and in marine service where fuel storage space is so valuable. Its first use on the railways in the United States (in 1925) was for locomotives in switching service in situations where the appeal of its economy was reinforced by the demand for smokeless and quiet operation. More than 150 Diesel switching locomotives are now in service in this country; they range in horsepower up to 2000.

The Diesel locomotive's initial entry into main line train service came in the specially-constructed high-speed train which was put in service by the Union Pacific Railroad in 1934. This was soon followed by numerous similar trains operating at schedule speeds above 60 miles per hour and reaching actual running speeds well above 100 miles per hour. Probably nothing done by the railways within the recollection of living persons has so aroused public interest and so stimulated the popular imagination as the installation of these trains. They not only satisfy the current demand for high speed, but the whole train has been designed anew to provide many novel features and comfortable accessories.

Aside from its economy in fuel consumption, the Diesel engine's chief claim for selection as the motive power of these new trains lies in its almost constant availability, which is especially fortunate in view of their great cost. The steam locomotive must frequently be withdrawn from service for a few hours to have its fire cleaned out and renewed, its boiler blown down, and its machinery inspected. As far as the high speed requirement is concerned, it can be equally well met by the standard steam passenger train locomotive; indeed the standard locomotive has, in emergency, frequently run at these high speeds during the past 50 years. All it has needed is a light enough train. Of course, if it were being designed to run regularly at very high speed, certain simple changes would be made in details; the diameter of its driving wheels, for example, would be increased. It has not been difficult, therefore, for the steam locomotive to meet this new competition, and many of the recent high-speed trains are being operated with standard locomotives —modified in some details, and shrouded to decrease the air resistance; but without fundamental design changes.



Locomotives and their power

THE first of the Diesel-motored high-speed trains, the Union Pacific three-car train, during a test run, attained a maximum speed of 111 miles per hour. Even before this train was put in service, however, a standard passenger steam locomotive of the Chicago, Milwaukee, St. Paul and Pacific Railroad, with a train weighing five times as much as the Union Pacific train and running in regular service from Chicago to Milwaukee, covered the intervening 86 miles at an average speed of 76 miles per hour, ran 61.4 miles of that stretch at an average of 92.6 miles per hour, and reached a maximum speed of 103.5 miles per hour—all this with an engine in regular service hauling five standard cars. New York Central locomotive No. 999, hauling the famous "Empire State Express," is reported to have attained a speed of 112.5 miles per hour over one mile of its run back in 1893. Comparably high speeds have been attained in regular service on British and French railways for many years.

Good examples of this recent adaptation of the steam locomotive for very high speed are offered by the engines which draw the New York Central Railroad's high-speed train, "The Mercury," running between Cleveland and Detroit;

(*Please turn to page* 248)

UNSCIENTIFIC MEASUREMENT

Are Famous Track Records Inaccurate? . . . Effects of the Earth's Gravity and Rotation . . . Even the Latitude Has Effects That Alter the Records

FOR every person who knows accurately how long it takes the earth to travel a lap of its long race around the sun a hundred individuals could probably state the best time of the reigning champion in the 400 meter run. Likewise, for one who can recite the distance from the earth to the moon it is likely that a whole frat-houseful could shout the distance of the Olympic broad jump record in chorus. This distribution of knowledge, or ignorance, is cited not to view with alarm but to emphasize the proposition that from a popular standpoint the statistics of sport occupy a position of prominence outranking those of the sciences or of scholarly studies in general. The speed of Malcolm Campbell's automobile or Jesse Owens' legs make conspicuous headlines, while a determination of the speed of light rates a small announcement on an inside page.

But when the data of sport are examined with the critical and skeptical eye which is continually focused upon the data of science, it is found that athletic measurements have not been guarded by the scrupulous precautions against error which are commonplace in the laboratory. In view of the widespread and even worshipful interest which is accorded to athletic records it seems unfortunate that they are not maintained upon as high a plane of scientific accuracy as is reasonably possible. To this end, those in charge of the technical background of sport might appropriately borrow a leaf or two from the notebook of the man of science, particularly the physicist.

Athletic administrators and instructors are, for the most part, practical persons and probably few of them feel the need of a scientific brain trust, including professors who would have trouble lifting the 56-pound weight from the floor to the lecture table. It is true that these advisers could not guarantee results in the form of new and greater track and field performances, but assuredly they could guarantee for accepted records a higher validity than some now possess. They could frown upon the practice of announcing the speed of an automobile in six or seven digits (see, for example, the 1937 "World Almanac") when neither the length of the course nor the elapsed time is known one tenth so precisely. They could and would point out such inconsistencies as that observed in some of the events of the 1932 Olympic games when races were electrically and photographically timed to 1/100 of a second but with the starting gun fired from such a position that its report could not reach the ears of the waiting runners until three or four one-hundredths of a second after the official start of the race. In this case electrical timing was used only as an unofficial or semi-official supplement to tenth-second hand timing, but it is easy to see that a systematic error of a few hundredths of a second will frequently cause stop-watch timers to catch the wrong tenth.

SCIENTIFIC counsel on the field would immediately advise judges of the high jump and pole vault to measure heights from the point of take-off instead of from an irrelevant point directly below the bar. They would suggest equipping judges of weights with surveying instruments for determining after each throw, not only how far the implement traveled but also the relative elevation of the landing point and the throwing circle. Certainly it is meaningless if not deceptive to record weight throws to a small fraction of an inch when surface irregularities may be falsifying the true merit of the performance by inches.

In shot putting, for example, a measured length will be in error by practically the same amount as the discrepancy in elevation, since the flight of the shot at its terminus is inclined at about 45 degrees to the horizontal (Figure 1). For the discus the effect is some three times as serious because of the flatter trajectory employed with this missile, while broad jumpers under usual conditions must be prepared to give or take as much as one half foot, according to the luck of the pit.

At the 1932 Olympic Games an effective device was used to grade the broad-jumping pit to the level of the take-off board before each leap, but the practice has not become general. Athletic regulations, indeed, recognize the desirability of proper leveling in all the field events, but in actual usage not enough is done about it. Since sprinters are not credited with records achieved when blown along before the wind, there is no obvious reason why weight hurlers should be permitted to throw things down hill.

The rule books make no specification as to the hardness of the surface upon which weights shall be thrown, but this property has a significant effect upon the measured ranges of the shot and hammer, since it is prescribed that measurement shall be made to the back side of the impression produced by the landing weight. In a soft surface this im-

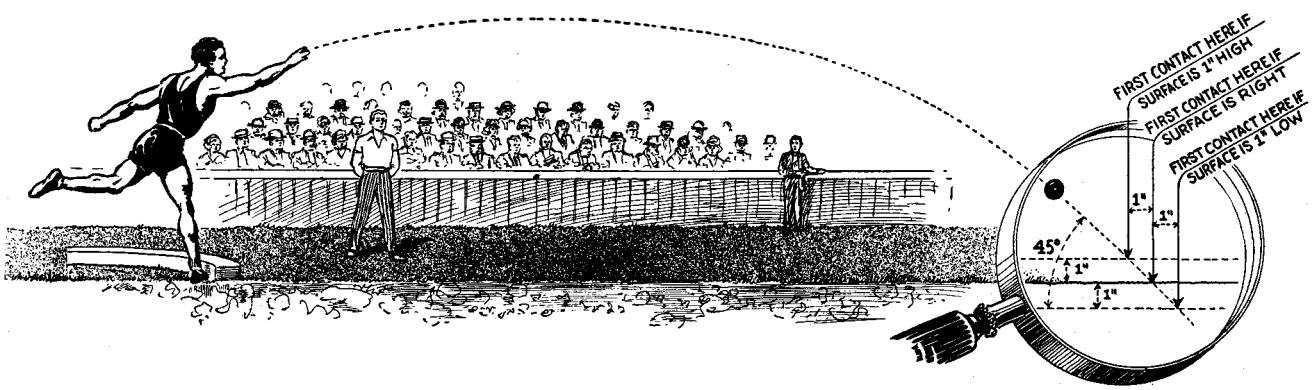


Figure 1: **In order to justify measurement to the common one eighth inch, it is evident that the leveling of the ground should not be in error by more than this amount—which is too much to expect even of the average gymnasium floor**

In Athletics

By PAUL H. KIRKPATRICK
Associate Professor of Physics, Stanford University

pression may be enlarged in the backward direction enough to diminish the throw by several times the ostensible precision of the measurement.

AMONG the numerous errors afflicting measurements in the field sports there is none which is more systematically committed, or which could be more easily rectified, than that which pertains to the variation of the force of gravity. A hypothetical athlete with ideally machine-like form could be expected to throw a weight identical distances upon all attempts made at a given time and place, but he should *not* be expected to repeat his standard performance identically in all other parts of the world, since the weight will be heavier in some places than in others.

Every toss of a weight is a contest between the heaving athlete and the force of gravity, and the result which ensues depends jointly upon the contestants. If gravity were to give up altogether the weight would never descend, while if it were to take on the preposterous values existing on some of the stars the thrower's toes would be in danger. No such fantastic variations disturb terrestrial athletic competitions, but the well-known local variations which do exist are quite sufficient to wield a balance of power in a close contest with the record books.

The shot putter from the Finnish coast, for example, who journeys to Rome or Hong Kong for competition has every scientific reason to expect that a heave which would have yielded 50 feet at home will be good for an extra inch at the lower latitude, solely because of the diminished pull of gravity upon the thrown weight (Figure 2), and with the discus, hammer, or javelin, it will be good for more—exceeding one foot in the case of the javelin. An inch is not a great deal of extra distance but it has sometimes been enough to cause a record to change hands. It must be remembered that the "profits" in the business of athletic competition are realized only in the last percent or two of the output, the rest being in the nature of necessary overhead.

Continuing southward to the equator, but remaining at sea level, the northern athlete gains a second inch, and by climbing a mountain of middling height, still a third. These illustrations are in accordance with the simple principle of ballistics that the range is inversely proportional to the acceleration of gravity, a principle which applies with high accuracy to athletic artillery when all other conditions, including the work done on the weight by the thrower, are held constant.

Similar effects naturally occur with all the thrown weights. Hammer throwers with Olympic aspirations may take satisfaction in the award of the 1940 games to Tokyo rather than to Heslingfors, for a well-thrown hammer will go some four and a half inches farther in Japan than in Finland. However, if the Olympiad were to be located for the sole benefit of the weight records, Tokyo would not constitute an ideal selection, for, by moving southward to Java, hammer throwers would be benefited to the extent of an additional three or four inches, with other weight men profiting similarly in proportion to their respective ranges.

A jumper is also a projectile, even though he be hoist by his own petard. Broad jumps are frequently measured and recorded to the final eighth of an inch and such precision of measurement is to be commended, but in comparing the results of these measurements one should realize, as apparently one never does, that any reasonably good broad jump is three eighths of an inch broader in Texas than it would be in Massachusetts. The values of the acceleration of gravity which produce such inequalities as these are on record for practically every spot on the habitable world, so anyone who is disposed to do so can rectify the records at his pleasure.

A FURTHER geophysical phenomenon with a small but noticeable effect upon athletic performances is the rotation of the earth. Physicists and artillerists have known for a century and more that projectiles fired from the surface of the real rotating globe do odd things which could never happen if the earth were at rest. Freely falling bodies (except at the poles) do not fall parallel to the plumb line but deviate to the east as they fall. Bodies projected straight upward—that is, parallel to the plumb line—do not return to the point of origin but fall slightly to westward. The range of a projectile which is shot upward at an angle will agree with the usual elementary calculations if the experiment be performed at one of the poles, but not elsewhere except for certain selected directions of fire.

These effects have nothing to do with the drag of the air and are in addition to any consequences deriving from the fact that gravity itself depends partly upon the centrifugal forces of our rotational motion. They are due rather to the fact that the gravitational pull upon the projectile is applied in a constantly changing direction as the earth turns, and to the further fact that the landing surface does not await the arrival of the projectile in any such relative position as it occupied when firing occurred, but instead drops away from the projectile to the eastward or rises to meet it from the west, thus either extending or curtailing the measured range.

In Figure 3, for example, four riflemen are shown at the equator, on a

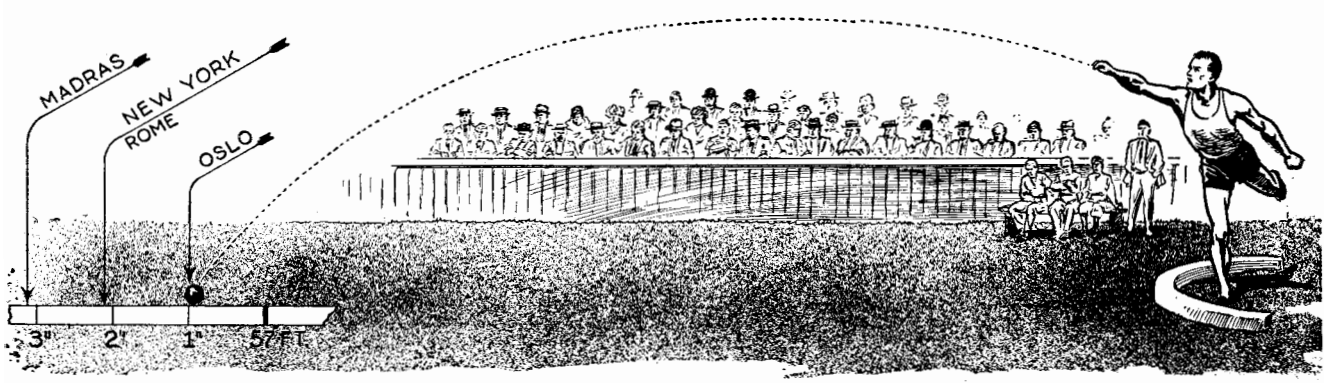


Figure 2: **Jack Torrance made his great shot put of 57 feet, 1 inch, at Oslo, Norway, but the scale shows what it would have measured if he had done it elsewhere. Here variations in the attraction of gravity due to latitude are alone shown**

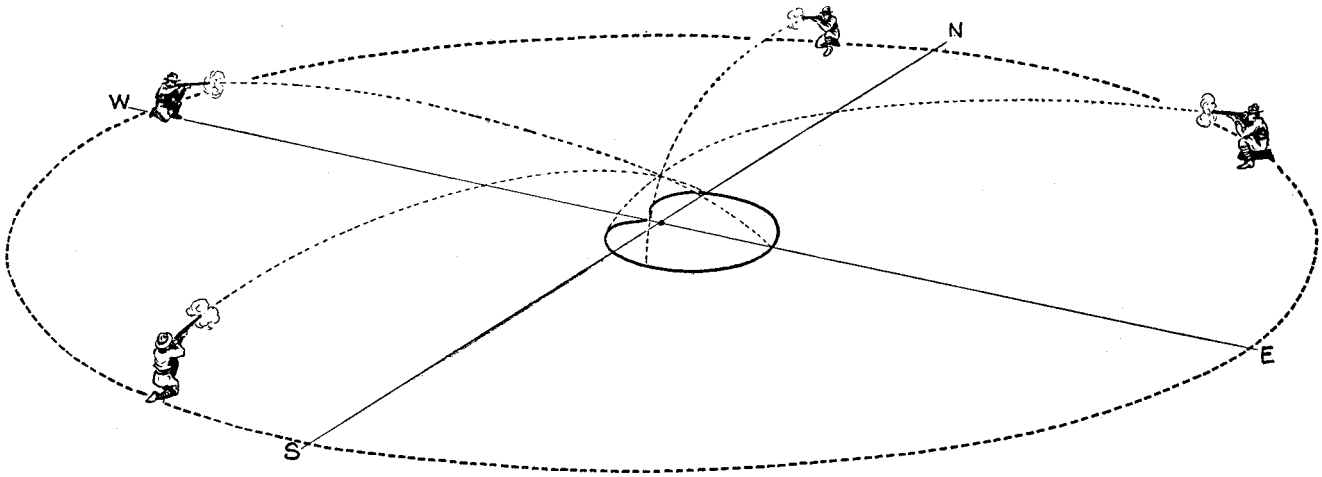


Figure 3: **Showing the effect of gravity and rotation of the earth on the range of a projectile. An "air view" of a circle of riflemen firing with identical arms toward the center of a circle. The relative sizes of the outer and inner curve have been distorted in order to facilitate making the drawing. Actually the outer circle has a radius of about a mile and the inner one a diameter of about 60 feet—though the inner one, because of the effects of earth spin, is not actually a circle but is an interesting lop-sided figure with a dimple on one side and known to geometers as a "limacon of Pascal," as explained in the text**

level plane, firing with identical arms toward the center of a circle of 1592 meters radius. If this experiment were conducted at one of the poles the projectiles would just hit the center, but at the equator the central curve shows the actual landing of the bullets, ignoring the effect of air resistance. All bullets tend to go farther at the equator than at the poles because of the lower value of the force of gravity. Thus the locus of the landing bullets would be a circle about 16 meters in diameter, except for an added complication due to the earth's rotation effect. This extends the range of east-bound bullets and diminishes that of west-bound bullets, though not affecting the range of north- or south-bound bullets because these are not affected by earth-spin and show only the normal increase of range due to low gravity. The curve is called a limacon of Pascal, and the one shown in Figure 3 is approximately correct for a bullet with initial speed of 300 meters per second, fired at a 5-degree elevation.

To correct the performance of, say, a discus thrower for the effect of the earth's motion, it is necessary to take account not only of the latitude at which the throw took place but also of the direction in which the implement moved. We read that the Olympic record for this event was set up by John Anderson at Los Angeles with a throw of 162 feet, 4⅞ inches. If we are to deal in small fractions of an inch it becomes of interest to know whether this throw was made in an easterly direction, thus gaining half an inch through the assistance of the earth's motion, or to westward, giving away a like amount. Since it has never been customary to record this information it is hardly practicable to make the small adjustments of past performances with the hammer, javelin, and discus which are logically indicated in consequence of terrestrial rotation.

THE effects of gravity and rotation introduce no unfairness into a competition as ordinarily conducted at a given location, but when achievements from one place are compared with those from another (Figure 4) the effect is to impose handicaps upon the performers who were obliged to strive against the larger gravity or the more adverse rotational influence.

In all cases where adequate data are at hand the method of redress is by simple arithmetic, in conjunction with two or three venerable formulas which are commended to the attention of coaches, athletes, and diplomats of sport.

The labors of Newton and Copernicus have been complete for some time now, but news sometimes seems to travel slowly in precisely those quarters where it is significant.

To some the contentions raised above will seem hair-splitting, and such indeed they are. The splitting of hairs has ever been an essential part of the technique of accurate measurement, without which the measurer runs serious risk of misleading himself as well as others. If the ultimate eighth of an inch of John Doe's hammer throw or broad jump is to be entered in the records at all, it would seem sensible to try to get it down correctly. In case this seems to be too much trouble, it would be both honest and informative to adopt for sporting data the standard scientific practice of accompanying the recorded measurement by a kind of shorthand clew indicating the extent to which it should be believed.

Apparently athletic administrators have got into the business of precise measurement without at all realizing the elaborate precautions which must be observed when anything at all is to be measured correctly to better than a tenth of one percent. It seems improper to keep up the appearances of accurate and comparable measurement in field events without striving to obtain the reality, and this can be obtained only by putting the matter on a scientific basis.

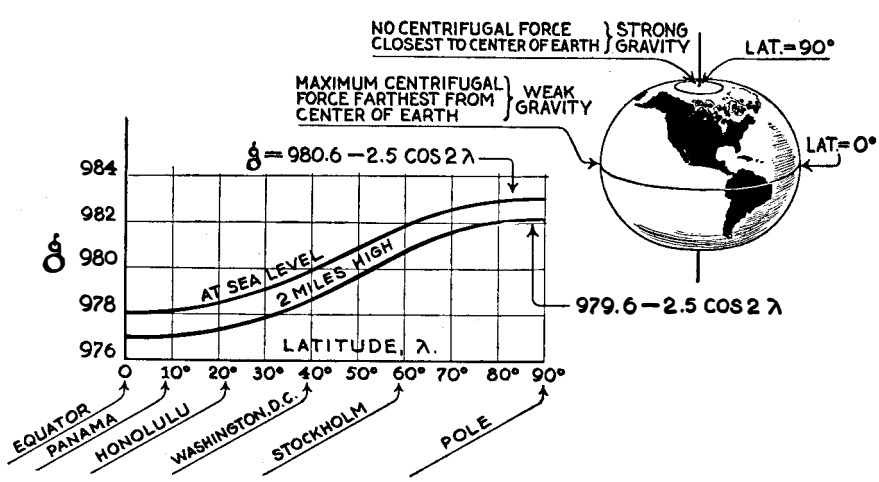


Figure 4: **Illustrating the variations of gravity due to differing latitude, differing elevation, or both. The symbol *g* represents the downward pull of gravity per gram of matter. The earth's amount of polar flattening is shown exaggerated**

Improved Shore Defenses

Permeable Jetties . . . Better Than Solid Ones . . . Trip Waves Without Stopping Them . . . When Water is Slowed Up, it Deposits Sand, Builds Beaches

By R. G. SKERRETT

SHORE erosion has become an acute problem along the water fronts of the Great Lakes, where the advance of the water upon the land has averaged, over a period of years, as much as four feet annually.

When Lake Michigan was exceptionally high some months ago, a series of severe summer and fall storms drove the waves violently against the exposed shores, smashing jetties, piers, breakwaters, bulkheads, and sea walls, and undermining bluffs and numerous buildings close to the water front. Millions of dollars had to be expended in making repairs and in rearing new defenses against subsequent storms.

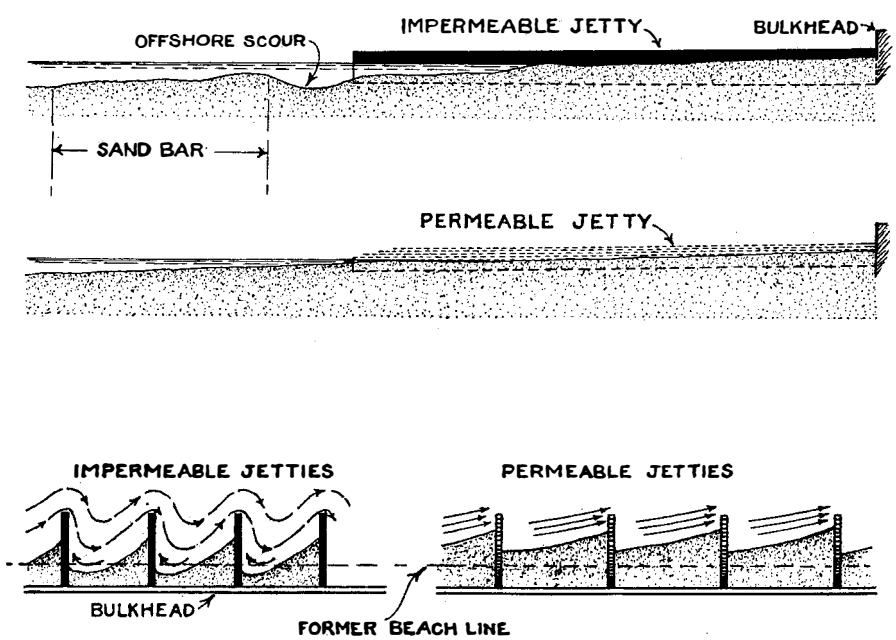
Town authorities and property owners generally, along the west shore of Lake Michigan, had previously relied upon conventional forms of man-made obstructions to withstand the assaults of pounding waves; when most of the solid jetties built out from the beaches were wrecked, there was doubt about what to do next in an effort to arrest or at least to rob the billows of most of their destructive might before breaking on the beaches or reaching the innermost of the defenses. Then it was that a new type of permeable jetty was developed and progressively improved to meet just such situations. The results have been astonishingly satisfactory.

The problem involved is twofold: First, gradually to bring about the upbuilding of a gently sloping beach that will reach farther and farther offshore so as to trip up oncoming waves by reason of an extended area of relatively shallow water, and thus sap the waves of their strength so that they have little remaining power to do damage by the time they arrive at the shoreline; and second, to induce the ordinarily erosive currents that travel parallel with the shoreline to deposit material and to extend beaches instead of cutting into them and carrying their substance away. The permeable jetty of the new design has shown that it will do both of these desired things and do them more effectually than the usual solid and abruptly obstructing kinds of jetties.

The permeable jetties recently built along the west shore of Lake Michigan rise from shallow trenches excavated in the underlying clay stratum of the beaches and extend from the shore out into sufficiently deep water to serve the purpose at each location. The jetties are composed of precast concrete bars, laid horizontally, and held together by perpendicular steel rods. The bars are arranged to form a stable and somewhat open cribwork that increases in its permeability from the shore outward and from the base upward. The unit bars weigh from 1000 pounds to 4000 pounds.

The winding passageways through the jetty allow the littoral currents to make their way through the jetty without being deflected sharply offshore, and the currents are thus slowed up just enough to cause them to precipitate on each side of the jetty some of the sand carried by them and thus to upbuild the adjoining beaches on both sides. The solid jetty, on the other hand, benefits only the windward beach and brings about reactions that usually erode the leeward beach to a more or less extensive degree. The permeable jetties on Lake Michigan have led to very remarkable results; beaches have been restored and extended in the course of a few months.

THE outer end of a permeable jetty, in the deeper water, stands directly in the path of the unbroken masses of approaching waves, but the open nature of the structure there serves to upset the rhythm of the waves without interposing a rigid obstacle. Therefore the waves are tripped and break shortly afterwards as they sweep onward. In this manner, the permeable jetty, itself, does not invite the destructive impact of the waves where a solid jetty must withstand their full force. Such being the case, it is claimed that the permeable jetty will endure in the face of conditions that would be likely to destroy a solid jetty. In short, the permeable jetty tricks storm waves and prevailing currents into serving man's ends, while the solid barrier, in effect, challenges nature's forces to do their worst without any temporizing on man's part. Experience has shown that nature in the long run is the victor. Because the permeable jetty induces beach building on each side of it, fewer jetties of that type would be needed to protect a given length of shore. Once more the inventive engineer offers an improved way of meeting a situation that menaces shore property where exposed to the repeated attacks of wind, wave, and current.



Sketches showing wave action around solid and permeable jetties. With the former there is much scouring, while the latter permits upbuilding of beaches

A whole mountain of ore where mining is almost as open

POLYGAMOUS

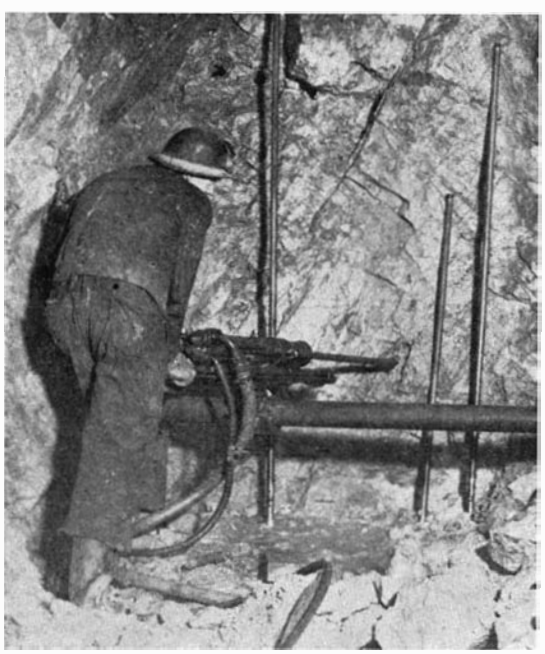
By PHILIP H. SMITH

MOLYBDENUM is a newcomer. It's so new its name is strange to the lay world, yet "moly," as this element is known to its intimates, serves millions of consumers every day. Better automobiles, higher grade gasoline and lubricating oils at prices one can afford, and quality radio tubes are just a few of the present-day essentials which molybdenum has made possible.

The Romans knew of moly, but its commercial debut is a matter of two decades. For centuries it was just a strange substance, frequently confused with lead sulfide because of a similar appearance in its natural state, and having no commercial reality of its own. Today, it is recognized to be an exceptional alloying metal and an element having possibilities worthy of broad exploration, but to win this recognition it had to fight its own way in a world preëmpted by metals of unchallenged worth.

Scientific research and performance under competitive fire are the two factors responsible for moly's dramatic rise, so clearly traced in world consumption which was practically negligible in 1917 and now exceeds 19,000,000 pounds annually. History links these two factors from early times. The story is told that a German metallurgist, hearing that a Japanese sword-maker, one Masamune, made a superior product about 1300 A.D., secured one of the blades and analyzed it. He announced that the presence of molybdenum, presumably as an ore contamination, gave the sword its merit. This determination, mind you, came six centuries later.

Since research had revealed by 1900 that molybdenum improved the properties of steel, why wasn't immediate use made of this finding? There is a very good explanation. In the first place, molybdenum was a relatively rare metal prior to 1918. It was also very expensive, selling at a nominal price of five dollars a pound. There were only a few scattered deposits, and the uncertainty of supply, coupled with high cost, were not conducive to commercial exploitation. The start of its meteoric rise began with the discovery of a mountain of molybdenum-bearing ore in Colorado. That was in 1917 when dislocation of raw materials and unusual demands incident to the war gave impetus to the use of new materials and new processes.



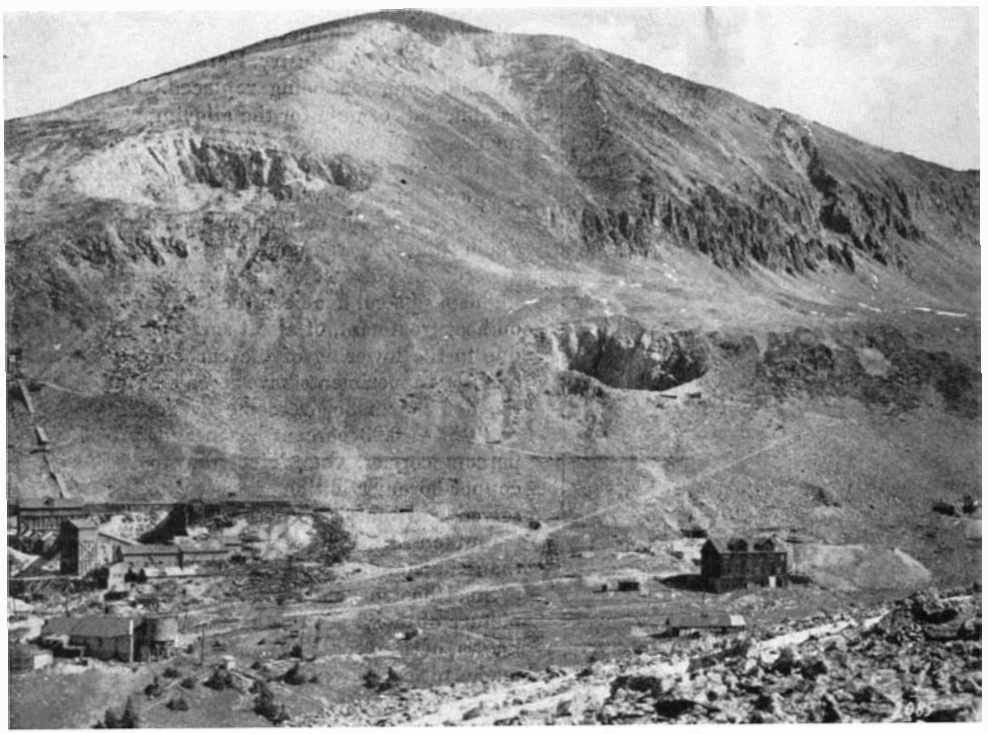
Drilling preparatory to "shooting" in one of the main headings of the huge moly mine

We can pass over this period of introduction when use was sporadic and hesitant. Few people appreciated what was coming about. Perhaps you admired the Wills-Saint Claire motor car in 1921, without knowing that it was the first all-molybdenum steel automobile. None but a metallurgist could have sensed what this car foretold for the automotive industry which was later to become a prime user of moly steels. This was the teething stage; the important thing is the place of molybdenum today and what it contributes to industry.

To the alloy age—the present—molybdenum makes two major contributions. It substitutes for certain other alloys, or combines with them, to produce better steels—better in the sense of possessing superior qualities, better by virtue of lowering costs. In certain instances it makes possible a saving in first cost and it may also produce a steel which can be fabricated at lower cost. When both savings can be had in a single alloyed steel there is a decided overall gain.

HAD the five-dollar price of 1918 been maintained, molybdenum would not be where it is today. It is the 80 cents per pound cost which makes the savings possible. Furthermore, early experiments demonstrated that it was very small amounts of molybdenum that gave the desired properties. A good average admix to steel is now one fifth of 1 percent by weight.

The improvements in fabricating prop-



as quarrying: The world's largest moly deposit, in Colorado

MOLYBDENUM

Versatile Moly . . . Industrial Newcomer . . . Important for Alloying . . . Improves Physical Properties . . . Catalyst . . . Unusual Potentialities

erties which molybdenum imparts, stated as a generality, are a wider forging range without danger of burning, free scaling, and safer wide heat treating. It also offers the distinct advantage of permitting a reduction in the amount of alloys used. This improves physical properties, for it is very well known that the more the alloy, the harder it is to work the steel. Practically all alloy steels produced commercially today have a tendency to develop temper brittleness, and the introduction of molybdenum will diminish if not eliminate this difficulty. But let us get down to cases.

Molybdenum is most widely used in automotive steels where quality and cost come up for closer scrutiny than perhaps in any industry. Ten years ago the carburized steels used for gears, for example, contained about 3.5 percent nickel. Now such steel has been very largely replaced by a nickel-molybdenum steel which contains 1.75 percent nickel and 0.25 percent molybdenum. Here a very small amount of moly has made it possible to reduce the nickel content to produce a steel which costs roughly nine dollars a ton less and has the advantages of better forging properties, free scaling, improved machineability, and less distortion upon heat treatment.

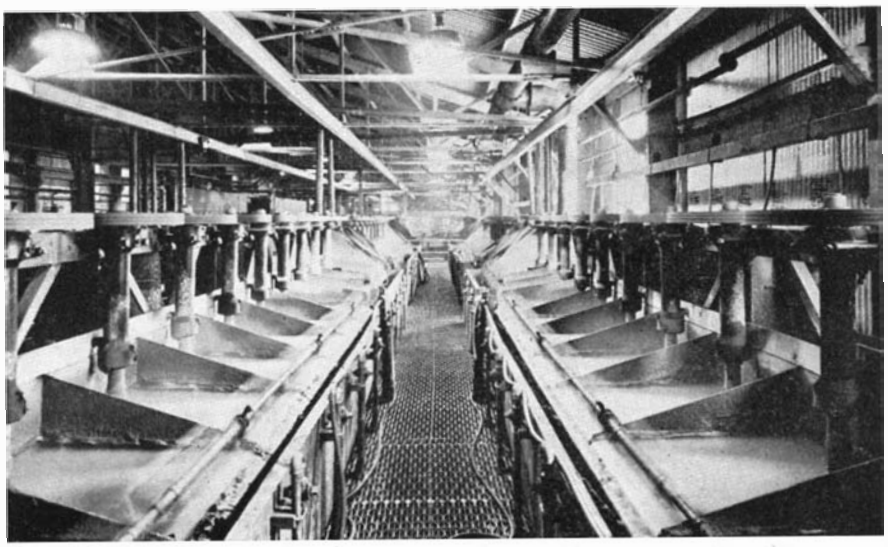
Among other automotive parts in which molybdenum plays an important rôle are axles, steering knuckles, and propeller shafts, parts which must withstand the severest service. Such units were formerly made of chrome-nickel steel—a very high grade steel alloyed with 1.25 percent nickel and 0.80 percent chromium. Today chrome-nickel is being replaced by chrome-molybdenum steel in which the chromium content remains unchanged but the nickel is wholly supplanted by 0.20 percent molybdenum. This new steel costs about one dollar per ton less and is very much like a straight carbon steel in the ease with which it can be handled. It is free scaling, can be forged easily, and machines well, even at high hardness.

Use of the chrome-molybdenum steels is not confined to automotive units. The very qualities which recommend them to America's outstanding industry qualify them for a wide variety of other applications, where ease of welding, abrasion resistance, or good service at elevated temperatures may be desired. Thus we find chrome-moly going into turbine shafts, dipper teeth, welding rod, shovels, saws, dies, castings, and other equipment in severe service.

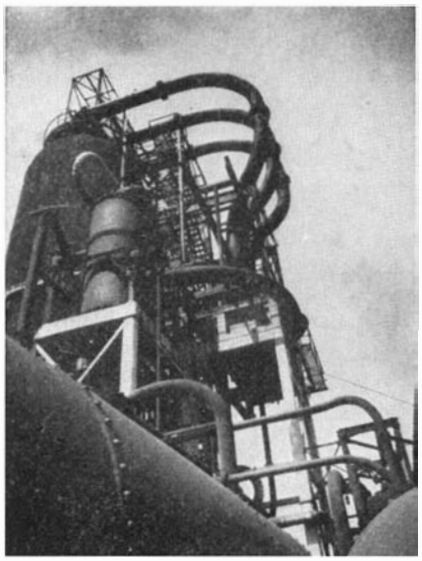
THE possibility of using molybdenum to replace nickel as an alloying element has a significance which goes beyond that of producing a more easily handled steel. Molybdenum is a domestic metal; that is, the largest source lies within our borders, whereas nickel is an imported element.* Substitution, therefore, means less dependence upon an essential import material in time of war. Tungsten is another metal which can be replaced in a measure by molybdenum, as we shall show later, hence replacements give a new meaning to the importance of alloy research.

Molybdenum also is employed in steels used for high-temperature and

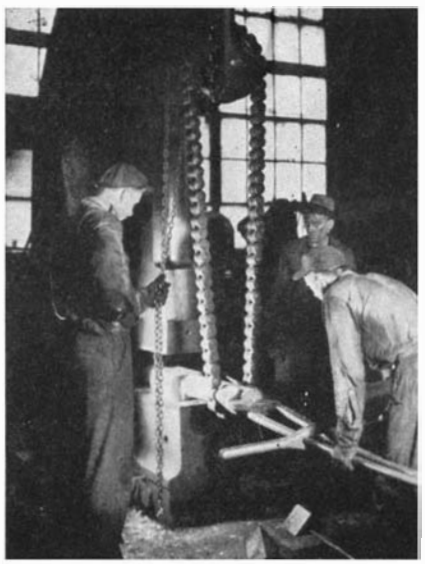
*Scientific American, March 1936, page 139.



The flotation floor in one of the modern molybdenum recovery plants



Moly for high temperature, high pressure service; it reduces "creep"

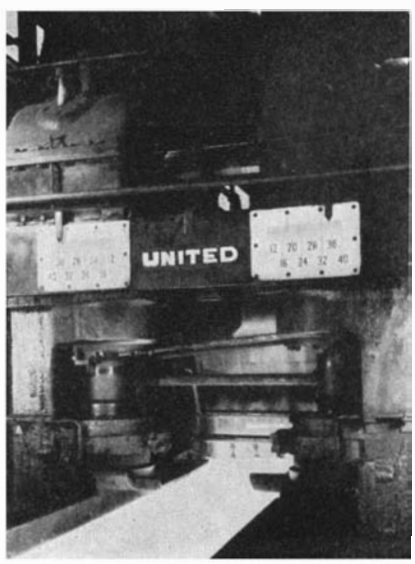


In forging, the new alloying metal permits a much wider forging range

high-pressure service where the phenomenon of "creep," or the elongation of metal, occurs to create a very real problem. Through laboratory research and then through actual test in service, molybdenum has demonstrated an effective capacity to reduce creep. Thus, molybdenum steels are found today in the oil-producing and boiler-making industries. The oil industry desires to operate its cracking stills at high temperatures and pressures because it is more economical. The higher the temperature-pressure combination the greater the yield of desired products and the better the quality. Since 1920, the operating temperatures have been pushed up from 800 to 950 degrees, Fahrenheit, while pressures of 400 to 700 pounds per square inch have been raised to 1000. In vapor phase oil cracking units, temperatures may run as high as 1200 degrees, Fahrenheit. This advance has been made possible by the development of suitable steels, and that means a carbon-molybdenum steel to which some chromium or silicon and nickel have been added to give corrosion resistance.

THE problem of creep at high temperatures and pressure applies to boilers because here, too, higher temperatures are more efficient. Hitherto, steels which had the necessary service qualities could be fabricated only at excessive cost. Today, the molybdenum steels move in because they are easily fabricated, lend themselves to welding, and so provide the necessary properties at low over-all cost.

Of the four standard steels—carbon-molybdenum, chrome-molybdenum, nickel-molybdenum and chrome-nickel-molybdenum—a few words should be said about the last mentioned before passing on to the special steels. The outstanding characteristic of chrome-nickel-molybdenum steel is its fatigue strength



Greater tensile strength, impact and wear resistance in steel mill rolls

and relative immunity to the temper brittleness which is found in most high-alloy steels. It is used for castings and heavy forgings, and wherever products must take severe and unremitting punishment. It is not a cheap steel and when it is chosen it is for quality alone.

Carbon-molybdenum steel has been referred to already as a satisfactory steel for elevated temperature service which classifies it as a special as well as a standard steel. For particular jobs, such as abrasion resistant castings, molybdenum is alloyed with manganese in steels. Other particular service calls for alloying in conjunction with such metals as silicon, tungsten, chromium, nickel, and vanadium.

It is hard to believe that molybdenum also has anything to offer in the way of corrosion resistance, but it has. More and more of the stainless (18-8) steels are appearing with molybdenum in parts requiring special properties, such as in many chemical plants and dye works.

Quite recently, molybdenum has been added to the high-speed steels used in the metal-cutting industry. Here is where we find tungsten being replaced. The established formula for the alloying elements, in percentages, of high-speed steel is: 18 tungsten, 4 chromium, and 1 vanadium. A new formula calls for adding 8 percent molybdenum and reducing the tungsten content from 18 to 2 percent. A defect of this "moly-fied" high-speed steel has been the formation, on heat treatment, of a soft surface skin due to the lowering of the carbon content; but experiments have revealed that the defect can be overcome by adding as little as 0.08 percent boron and 2.75 percent copper. One defect due to the copper-boron addition remains to be solved and that is the recovery loss in manufacture which runs a little higher than the standard formula steel.

Steel has so dominated the layman's picture of molybdenum that he scarcely knows of the contribution that it has made to cast iron. But today gears, cylinder blocks, valves, brake drums, and mill rolls are being produced with a molybdenum content, the purpose being to impart greater tensile strength, and impact and wear resistance. Molybdenum seems to be able to do this better than other alloys because it interferes least with machining qualities.

WHEN you know all there is to know about molybdenum's wedding with iron and steel, you still know only half the story of this interesting newcomer among the metals. It is true that the great growth in volume of consumption is tied to metallurgical progress, but molybdenum shows no inclination to be faithful to steel alone. Chemists have discovered other attributes of molybdenum and have put them to commercial use. This chemical rather than metallurgical phase of molybdenum development is quite recent and promises a dramatic, if unpredictable, future.

As we turn away from steel we discover molybdenum being used in the manufacture of color lakes, pigments, and ceramics, as a catalyst, and as an agent in bright zinc electro-plating. Since there is no particular connection between any of these developments we'll discuss them one by one.

When molybdenum is used as a chemical it is employed in the form of a compound, just as it is in the manufacture of steel where calcium molybdate is dumped into a batch of molten metal. One rarely encounters pure molybdenum. It is found in the ore as a molybdenite (molybdenum sulfide) from which it cannot be refined by orthodox smelting processes because it has a very high melting point (2620 degrees, Centigrade). Most of it is marketed in the form of calcium molybdate. In the vari-

ous uses which we shall now discuss, molybdenum compounds are being used because they give equivalent quality at lower cost, because they do a better job though higher in cost, or because they contribute an entirely new value.

Molybdenum is being used increasingly in the manufacture of color lakes, those insoluble colors made from organic dyes, principally to replace tungsten and thereby to reduce cost without any sacrifice of quality. It is also coming into use for pigments, the inorganic compounds, and the best example is molybdenum orange. In this instance chrome orange is replaced. Molybdenum orange costs about 60 percent more than the chrome compound, but it gives from two to two and a half times the hiding power, so that the net result is an economy.

In the manufacture of glass and enamels, molybdenum now figures as an opacifier. Pure molybdenum trioxide for glass, and lead molybdate or mixed crystals of lead molybdate and other insoluble lead salts for enamels are the compounds used. Researches to explore the merits of molybdenum trioxide and other oxides, when used as a component product for enamel ground coats and for the glass enameling of iron and steel, have proved that the quality of adherence is improved. Until now, nickel and cobalt have been used almost exclusively for this purpose, but molybdenum in conjunction with antimony not only lowers costs but produces ground coats of lighter color. This means that the thickness of enamel coats can be reduced, or that fewer applications need be made.

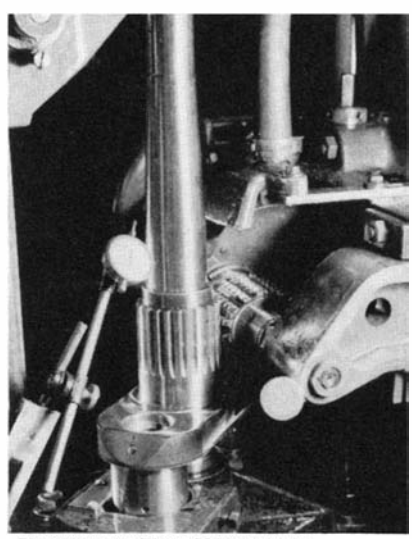
MOLYBDENUM is being used as a catalyst in the chemical industries both here and abroad, but it is still impossible to tell just how because very little, if any, specific data have been published. We can, however, get a hint of what is going on by scanning patents and reading between the lines of scientific literature. These scant sources of information make it definite that molybdenum is being used as a catalyst in vapor phase oxidation, in destructive hydrogenation, and in acid contact production.

It is known from experiments that the action of molybdenum as a catalyst is extremely violent, so much so that other metals have been mixed with it to slow it down, much as sawdust is added to nitro-glycerine to make dynamite. The knowledge of this powerful force has stimulated research to determine whether or not molybdenum might be mixed with fuels to accelerate their combustion and thereby derive greater efficiency from them. At this moment it can be said only that the outlook appears favorable.

We know that molybdenum acts as a catalyst in destructive hydrogenation because it is being so used in coal, coal tar, and mineral oil cracking processes in Germany. Practically every domestic oil refiner is conducting experiments, and again the outlook is favorable.

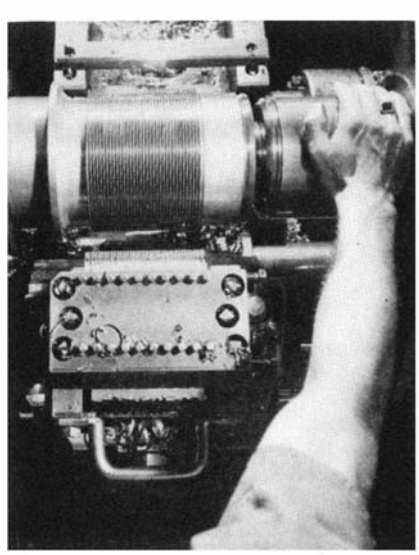
The manufacture of sulfuric acid provides a good example of contact work. A cursory examination of patents indicates that molybdenum does not function alone, but apparently is of some undetermined value as an admix to vanadium and other compounds. Molybdenum will not combine with sulfur at high temperatures; in fact it is not at all easily contaminated in processes like most catalysts and that explains why it is favored for further research.

It is well-nigh impossible to cover in detail the entire range of molybdenum use in industry, yet a true picture of this surprising metal requires emphasis upon the little-known developments for it is here that we derive our conception of its future. Just to mention a few: molybdenum stainless steels are used for fountain pen nibs, while the compounds enter into the manufacture of light fast inks of brilliant hues; the radio industry consumes thousands of miles of molybdenum wire in the production of electronic tubes, and the telephone makers employ it in transmitting apparatus.



Photos courtesy Climax Molybdenum Co.

Engine crankshafts are alloyed with moly for high fatigue resistance

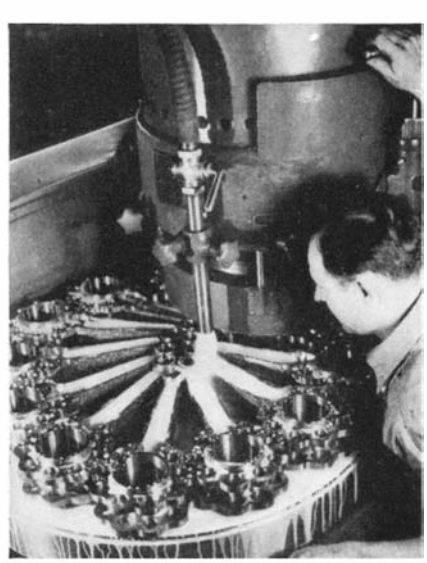


Improved machineability of moly-alloyed cylinders of 'plane engines

THE manufacturers of vacuum tubes have found molybdenum a valuable metal for a number of reasons. Sheet, wire, and ribbon are used in thermionic tubes, usually in very pure form. Occasionally molybdenum replaces tungsten for heater filaments in indirectly heated cathode tubes. The property of retaining its strength at elevated temperatures, an inherent characteristic of molybdenum, made it valuable in this field just as it did in the manufacture of steel.

These varied uses mean very little in tonnage, but they are significant as hinting that molybdenum may be on the eve of tremendous expansion in directions which cannot now be delineated. Patents issued seem to support this view. But if you must know whence new developments are most likely to issue, keep your eyes on colors, rubber, leather, and photography because in these fields research is known to be pushing forward relentlessly.

Molybdenum, perhaps more than any other metal, is a research product, because research gave it commercial reality. What if the Greeks or the Romans did know about it? They couldn't make use of it. Research began with Scheele's discovery that it was an element, then on to Hjelm who succeeded in producing the pure metal four years later—1782, to be exact. It was research that transformed it from a graphite-like substance of no particular value to an element of commercial significance. Once adequate supplies were uncovered, it was workers in laboratories who made possible its front rank position in the world of alloying metals. What more could one demand in an alloy age?



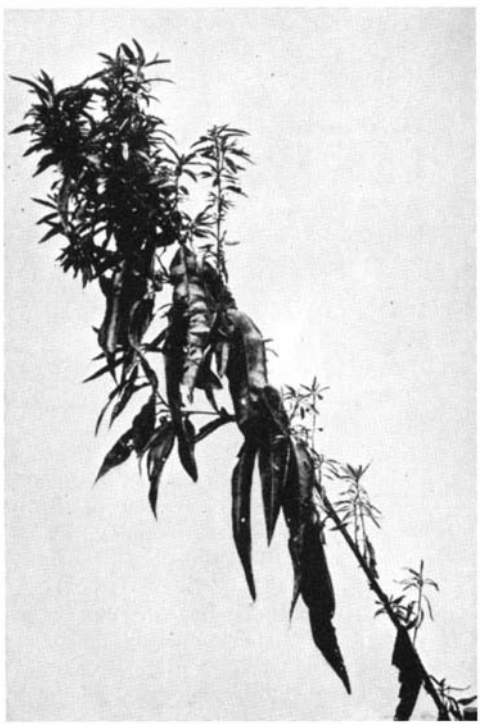
Fatigue resistance is improved in high-speed airplane engine parts

What Is Life?

The Greatest Puzzle of All Science Seems Today to Be Nearing a Solution . . . Yet, As it Breaks Up, its Parts in Turn Form Newer, Baffling Puzzles

By T. SWANN HARDING

THE question: What is life? has baffled mankind for ages. In recent times workers in science have sought not only to discover what life is but, as Sunday supplements tell us, to "create life in the laboratory." Still more recently something definite about that mysterious realm between living and non-living matter is in process of discovery by research workers upon the virus diseases which afflict human beings, animals, trees, and plants.



The effect of the virus disease known as peach yellows: the leaves droop and are wilted. Science may find a way to prevent this, but the main quarry is bigger

The greatest difficulty at the outset is, of course, to agree upon a definition of life. Life is a complex condition made up of a number of properties or characteristics. Set up almost any simple definition and the first thing you know someone will come along with a mineral, hence non-living substance, that will seem to fulfill the requirements. When medieval philosophers solemnly discussed whether such metals as lead and mercury were alive, their definition of life undoubtedly differed from ours.

But what is ours? In his "Life of Reason" the philosopher Santayana defined life as an equilibrium which maintained itself now by undergoing modification itself and now by imposing some modification on its surroundings. One modern scientist describes rather than defines life as a quality which endows certain chemical compounds with permanent existence. Hence complex chemicals like proteins (meat and eggs offer an example) would become stable, that is, would not soon "spoil", if they had the powers of growth and self-replacement.

Dictionaries usually start by blandly begging the question. They say, in effect, that life is that property which distinguishes living from non-living matter. Then they usually go on to say that living matter can grow, reproduce itself, make internal adaptations to its environment, maintain itself by taking in food, building up and tearing down tissues (metabolism) and excreting waste matter, replace its damaged parts, and hand down certain characters in an hereditary way to its offspring.

That gets us somewhere, but even this definition is tricky. For what about a chemical compound that does not ordinarily grow or reproduce itself but which will, if placed in a certain environment or given a certain food, grow, reproduce, and maintain itself? Is it living or non-living? It has some of the properties of a living thing. Must it have all of them really to be alive, and have them all the time?

Modern chemistry holds that living and non-living substances may differ very little in chemical structure. The difference is sought rather in some new geometrical arrangement of their atoms or molecules. Hence what we regard as mineral matter, or as a mere non-living metal, may from time to time become "alive" due to some mysterious internal change in the pattern of its atoms and molecules. So it is easily possible to imagine that a complex protein might, under certain circumstances, rearrange itself internally and begin to live.

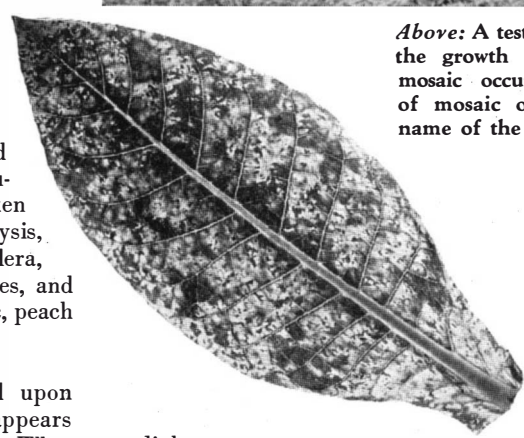
LIVING things may vary in size from a whale, the largest animal of all time, to a single-cell bacterium or a bacteriophage. Most of the organisms that cause disease are very minute, but they are not only alive; they have a very complicated structure, as Alexis Carrel has shown. Some consist of but a single living cell which is the structural or functional unit of the plant and animal world, as the atom is of the mineral world. But even the single cell is by no means the mere "drop of gelatine surrounded by a semi-permeable membrane" carelessly described by some biologists, for a cell has organs: look up its picture in a big dictionary. It contains the full genetic machinery of inheritance, the genes and chromosomes. It contains an elastic-walled balloon called the nucleus, which seems to be full of inert, transparent jelly. It contains numerous small particles which are in continuous violent

A cow, drooling at the mouth. It has hoof and mouth disease, caused by a virus. The only "cure" is to kill cattle thus infected and bury them deeply to prevent spread or a pandemic

agitation. Some have the special function of nourishing the cell; others appear to be granules, globules, and long filaments, whirling and dancing endlessly.

If the structure of the cell is baffling, its chemical composition is still more intricate. Generally speaking, it is said to consist of "protoplasm," but the minute the biologist tries to analyse this it ceases to live and hence is no longer protoplasm, for life is one of its properties. Even the nucleus, which appears to be empty, contains those marvelous but mysterious agents which rule the hereditary tendencies of both cells and men.

We turn to the bacteriophage* and find a still smaller living thing, yet one capable of destroying malignant bacteria. Still smaller, so small that they pass through the biologist's best filters, and elude his highest powered microscopes, are the so-called virus particles which produce human diseases like smallpox, chicken pox, mumps, and infantile paralysis, animal diseases like hog cholera, foot-and-mouth disease, and rabies, and plant diseases like tobacco mosaic, peach mosaic, and sugarcane mosaic.



Above: **A test showing the stunting effect (at right) on the growth of tobacco plants when infection with mosaic occurs early.** *Left:* **Typical mottling effect of mosaic on the tobacco leaf, giving rise to the name of the disease. A sub-microscopic virus causes it**

TODAY attention is focused upon these virus particles, for it appears they may soon answer the question: What is life? In the old days scientists attacked the problem differently. When, in 1828, Wöhler reported having made the organic chemical compound produced by the human body and called urea, but announced he had done so independently of the body, purely synthetically and by artificial means, he himself thought this discovery marked a break with the past. It had been believed that no chemicals elaborated by organisms could be made in the laboratory. Wöhler had proved the contrary. Soon more and more complex compounds would be made in the laboratory and then life itself would be created there. Therefore, many workers tried such things as letting prussic acid stand in water in the sunlight, to find that a number of complex chemical compounds formed spontaneously in the solution. It was shown that sugars could be made in the laboratory from water, carbon dioxide, sunlight, and a coloring matter—just as plants made them "photo-synthetically;" that is, synthesizing them with the aid of sunlight.

But there was a limit to such experiments. Common glucose, if left standing in water, will generate a variety of chemical compounds but that is far from producing life. The new attack of science on this old problem is by way of the ultra-microscopic particles which cause a wide variety of human, animal, and plant diseases—influenza possibly being among them, and measles, range paralysis, and the plant mosaic diseases being notably included.

New and strange findings have been made, which have tremendous significance both from the standpoint of disease causation and from that of the basic nature of life. While a great deal of the work has been done on the destructive mosaic disease of tobacco, which has economic importance to all tobacco growers, that is only because the research worker finds his easiest point of attack here. Human diseases are indirectly but certainly involved.

If we thought the bacterium was small we "haven't heard anything" yet. These infective virus particles are, to make a bull, smaller than the bacteria and the bacteriophage put together. According to Dr. W. J. Robbins of the University of Missouri you would have to place 14 ciphers after the figure 10 to represent the number of infective virus particles contained in 20 drops of the juice extracted from a tobacco plant down sick with mosaic disease.

And is that juice infective? It is so infective that it will still cause disease when one part of it is mixed with 10,000 parts of water! Think that over, remembering all the time that quite similar infective particles spread a whole list of human and animal diseases. Are those particles alive? That is the question, and it leads right to the center of the mystery of life itself.

As early as 1932 our leading medical journal was telling its readers that these infective particles had been crystallized out and found to be a chemical substance, a protein, the kind of chemical we know best as lean meat. The journal called this substance a "pathogenic enzyme," an enzyme being a ferment, hence a ferment capable of causing disease. It said that this work "may be regarded by future medical historians as one of the most important advances in infectious theory since the work of Lister and Pasteur."

THAT sounds startling. What had happened? A protein substance had been found which, in its pure crystallized form certainly was not alive. But put it in contact with normal living tissue cells and, behold, it would begin to act like a disease germ! It began to multiply. It began to reproduce itself, to spread, to cause disease. Had nonliving matter thus suddenly become living? The question is actively debated today.

The work continued. Dr. W. M. Stanley of the Rockefeller Institute for Medical Research took the most prominent part. By the middle of 1935 he reported that he had isolated a crystalline protein from diseased tobacco leaves which would, if injected into healthy plants, produce mosaic in them. These crystals became self-propagating under such circumstances, though they were not, strictly speaking, alive.

**Editor's Note*: An ultra-microscopic, living organism parasitic on bacteria and reproducing itself. Literally the word means "one that eats bacteria." This recalls Dean Swift's famous verses:

> So naturalists agree, the flea
> Hath smaller fleas that on him prey,
> And these have smaller fleas to bite 'em.
> And so proceed, ad infinitum.

There are "smaller fleas" than the bacteriophage (pronounced to rhyme with garage) but no evidence that these smaller "fleas" actually "bite 'em;" which is not, however, to derogate from Dean Swift's amusing verses written years before Twort and d'Herelle's discovery of the 'phage, in 1915, 1918.

Dr. Stanley called this strange substance an "autocatalytic protein." In simpler terms these rather forbidding words mean that virus particles causing plant, animal, and human diseases consist of a proteinlike substance which, ordinarily, is non-living, but which, under certain favorable conditions, manages to steam itself up and to act very much indeed as if it were alive. All right: Is it alive then? Or is life a potential property that may arise almost anywhere under favoring circumstances?

A little later Stanley announced that he had crystallized the same identical protein from tomato plants afflicted with mosaic as he had from the mosaic-affected tobacco plants. He said he could produce mosaic disease in either kind of plant simply by injecting this protein into healthy individuals. That looked as if a non-living protein turned into a living infective agent when once injected into a plant.

COULD anything be done to the protein which would deprive it of its strange power? Could it, in a manner of speaking, be killed? Could its potential life be snuffed out? Yes, it could. For in 1936 Stanley announced that the protein could be "inactivated" permanently by treatment with certain chemicals or with ultra-violet light rays. Just how did this occur?

Well, really drastic treatments changed the protein chemically, partly broke it down, partly destroyed it. But less drastic treatments would deprive it of its power to "come alive" when injected in the plants, yet without making any perceptible chemical change in it. These mild treatments would only make the protein lose its power to cause disease or to become self-propagating under favorable conditions. So Stanley concluded that the enzyme (or the ferment) part of the structure was injured by these mild agents, hence the protein was no longer autocatalytic. So, not only can life be killed, but the potential power to come alive under favorable circumstances may be snuffed out.

But the protein has another interesting property usually associated with living things: It can adapt itself, it can mutate. The offspring may suddenly begin to differ from the parents, as is the case with so many plants and other living things. Variation may set in.

For example, tobacco is afflicted with two different kinds of mosaic disease. One is called "common" and the other "yellow" mosaic. They have different symptoms. But common mosaic often spontaneously changes over (or mutates) into the yellow form on a tobacco plant. Yet, if a plant is affected with common mosaic and is then attacked by the yellow form, the former holds the latter in check. There is also a virus affecting wheat which mutates from a green to a yellow form of the disease.

These strange goings on are not limited to plants. They occur among animals, doubtless among human beings too. For example, there are two very decidedly different rabbit diseases—infectious myxoma and infectious fibroma—both attributed to virus particles. Under certain laboratory treatments scientists have learned that these may be made to mutate. They can transform one virus into the other at will, though one of the diseases is rather mild and unimportant, the other malignant and usually fatal.

SO important is the subject dealt with in the accompanying article—namely, the discoveries of Stanley and others which seem to point toward the solution of the biggest problem of science as well as to practical possibilities like learning better to combat virus diseases in man, animals and plants—that two articles, the second to follow later, are being devoted to it. Everywhere men of science are discussing these deeply significant virus researches, and the feeling is widespread that a new period of biological advance may have been opened up. The purely biological implications are even far wider and deeper than the practical ones. An answer to the old question of what life is might, if found, bring along with it that of the other old question, how did life start? We may learn more about the cause and method of evolution, for the gene or determiner of inheritance is involved, and we might—though this is definitely speculative—learn basic facts about cancer. If life were shown to be "mechanistic" instead of "vitalistic," the repercussion on our philosophy and outlook would almost certainly be heavy. Science eagerly awaits the outcome.
—The Editor.

Undoubtedly the same thing happens in human beings. There are said to be 32 distinct types of pneumonia, and each type is doubtless caused by some subtle change in the chemistry of the infecting organism. Organisms constantly mutate, but they are generally regarded as definitely alive. Now viruses have been found to mutate. Why not regard them as alive? But can a crystalline protein be alive?

A virus can produce a very specific disease, as can a germ. The fibroma virus mentioned above produces a benign, harmless local tumor in rabbits, but the myxoma virus produces a malignant, cancer-like tumor. Yet if "living" virus of one kind is mixed with "dead" virus of the other, the former—mind you—takes on the attributes of the latter and will then produce the rabbit disease usually produced by the latter.

Obviously these two viruses must belong to a single basic strain, or they must be minor variations of a single substance, perhaps a protein. But two proteins may appear to be identical on chemical analysis, yet one may, under favorable conditions, prove capable of reproducing itself while the other may not. Hence it has been suggested that some geometrical rearrangement of the pattern of the countless millions of atoms and molecules constituting a chemical compound may endow it with what we call life.

In this dim, twilight zone between living and non-living matter, Dr. John Howard Northrop of the Rockefeller Institute recently found a germ-destroying protein that acted like bacteriophage. In some strange manner this protein appeared to have acquired the power of self-multiplication, a characteristic of living matter, when placed in the presence—not of living tissue—but of certain bacteria. In acquiring this power it resembled the disease-producing virus particles which also begin to reproduce themselves under favoring conditions.

WILL the next step be the formation of apparently living bacteria themselves from proteins that are ordinarily non-living? The crystallization of a seemingly non-living agent that is capable of producing infection and disease presents a borderline case. The virus appears to stand somewhat nearer to life than to non-life. It is a protein that definitely starts to rebuild itself when placed in contact with living tissues, but it does not seem to possess all the properties we usually associate with life.

Speaking in May, 1936, Stanley said: "The idea that proteins, which suggest meat and eggs to most of us, can be viruses and produce disease, is new and startling. But there is no longer any doubt that this virus activity is a property of the protein itself. The only explanation is that somewhere along the line between life and death there is a middle ground where chemicals have the attributes of living organisms without being themselves alive."

The pill has been too much for the bacteriologists to swallow. They tend to resent the very idea that these proteins which multiply and undergo mutations like living things are also in a sense non-living, yet cause disease. Stanley had little to say about this beyond suggesting that bacteriology may soon have to cede to chemistry priority in the struggle against disease.

Meanwhile the riddle of life remains unsolved, but science is closer than ever to its solution, in so far as the distinction between living and non-living matter is real and not merely verbal.

SNAKE DANCE SECRET BARED

Why Venomous Snakes Cannot Injure the Hopi Indian Priests . . . Explanation Is Simple

A CERTAIN educated Hopi Indian, whose name for reasons of policy shall remain undisclosed, has revealed a secret which long has mystified Americans who are interested in southwestern Indians: the nonchalant immunity with which Hopi priests and medicine-men handle poisonous sidewinder rattlesnakes in ceremonial dances.

Numerous hypotheses have been advanced as probable explanations by curious witnesses of the annual Snake Dance ceremonial. Some have believed the snakes are rendered harmless by removal of fangs and venom sacs; incorrect. Others have believed the snakes temporarily innocuous as the result of previously administered sac-paralyzing treatments; wrong again. A few, observing the be-daubed and painted skins of the half-naked dancers, have conceived the hypothesis that mysterious antidotes were blended with the decorative covering. That hypothesis, too, is unsubstantiated.

As with most baffling natural phenomena, complicated speculative reasoning has led mystified beholders of the Snake Dance by labyrinthine ways from elementary deduction. The simple fact of the matter is that the snakes are goaded into exhausting the venom sacs before the ceremonial dancing has begun.

A few ethnological students have reported certain phases of preparations preceding the public appearance of the Hopi dancers and their scaly "partners." It has been said: "—the snakes are taken to the Snake *kiva* (ceremonial room), where they are washed and prepared for the ceremony." While the "preparation" has been the cause of varied speculation, not even traders in the Hopi villages seem to have gleaned the positive facts, or, if they have, they dared not risk the animosity of the dominating medicine-men.

The educated Hopi who revealed the simple matter openly boasted of his Christianity and laughed at superstitious secrecy concerning matters so elementary—when he was away from the Hopi Reservation. But he requested that his name be withheld from any discussion of the matter for, in spite of government supervision of matters on the Reservation, the medicine-men hold powers of life and death over lesser members of the tribe.

After having been washed according to the ritual laid down by the legendary Snake People of the Underworld, the poisonous snakes are tantalized, infuriated, and caused to strike. The goads are long wooden poles. The targets for the fangs of the snakes most often employed are hearts or livers taken from freshly slaughtered animals. Sometimes the entire carcass of a young jackrabbit or a prairie dog may be used.

The inanimate flesh of the bait absorbs the venom which is discharged by the striking snakes. Again and again the reptiles are permitted to sink their fangs into the bait, until there seems slight chance of venom remaining available for immediate use.

This "milking" of the snakes, performed in the snake kiva under careful supervision of the soon-to-be-performing dancers, is continued until the priests are ready for appearance. The snakes then are thrust into a bag, carried into a cleared space among the buildings on the mesa, and placed, still in the bag, within a pit in the mesa floor. A wooden plank is laid over the mouth of the pit.

After formal preliminary maneuvers in the snake plaza, the line of dancers approaches the pit containing the snakes. The dancers advance in double file. One member of each pair carries a light wand having a tuft of feathers at its free end—a "snake whip," for attracting the snake's attention in the event of too great animosity.

THE companion dancer, priest of the ancient Antelope clan, stamps his feet upon the wooden plank covering of the snake pit, as though seeking admission. After a moment's pause he slips the plank aside, plunges naked hand and arm into the repulsive mass of squirming serpents, grasps the most convenient one and triumphantly waves it above his head.

Timorous onlookers gasp, as the dancer closes his mouth about the body of the snake, which may be a six-foot rattler. It might be, instead, a Great Basin striped racer ("whip snake"), or an Arizona gopher snake ("bull snake"), neither of which is poisonous, both sharing the northern Arizona desert with the poisonous prairie rattlesnake, the sidewinder. But, when he thrust his hand into the bag, the Antelope priest had no chance for selection or comparison of virtues. He clutched the first slippery candidate that came within his grasp.

Stripped of masks and tom-tom throbbing, incantations and pseudo-sorcery, the solution seems elementary as a Sherlock Holmes deduction.—*J. S. M.*

Old Walpi, pueblo of the early Hopi Indians, in Arizona, thought to have been established about 800 years ago. The stone stairway leads to a spring far below the mesa

Photo by Pennington, Durango, Colorado

What Is Personality?

By P. F. VALENTINE, Ed. D.
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PSYCHOLOGISTS have gotten us into a predicament over personality. We have been going along cheerfully with the assumption that personality is the normal property of a human being, but the psychologists, in trying to get at it and find out what it is, have succeeded only in identifying a lot of separate parts and functions. The thing itself—presuming that there is such a thing—dissolves upon analysis, like a wet lump of sugar. Baffled, the psychologists have tried to reassemble the pieces and get personality synthetically. But all the king's horses and all the king's men can effect nothing better than a bundle that refuses to be an entity such as personality ought to be.

It is possible that all this difficulty is due to an unwitting effort to translate an abstract into a concrete. We want to see the thing, define it in space and time, measure it. Learned men were long since troubled in a similar way with respect to the soul. The pineal gland was once pronounced to be the container of the soul substance; we have heard of solemn experiments where human beings were carefully weighed immediately before and after death to ascertain the soul's weight. Perhaps personality defies our efforts at concrete definition for the same reason that the soul does—because it is an airy child of metaphysical birth, a thing that is not a thing but a thought. Our search may always prove as fruitless as that of the lad who sets out to fetch a piece of the rainbow in his lunch basket. The beginning and the end of personality may be nothing more nor less than the state or quality of being a person. In that case it is an abstraction, a thing of the mind, and as such is food for the philosopher rather than the psychologist.

Perhaps the state or quality of being a person cannot be defined. Try to tell what a human being is without using the language of anatomy or physiology. State if you can, without resort to possible synonyms that are equally ambiguous, like mind and spirit, just what the essential of selfhood is.

The abstract personality remains, in spite of its potency, an idea. It may be no more real than Nirvana, but exist only in the meaning of a word, as it would be if we spoke of the "enginality" of an engine or the "ideality" of a temple's architecture. Obviously, this is not the kind of personality we talk about in ordinary conversation. It is not the kind that is advertised by billboard psychologists and publicity agents for movie stars. It is not the kind that is admired, according to one's taste, in super-salesmen, philanderers, sophisticates, orators, ambassadors, crooners, generals, poets, or swamis. It is not, it may be added, the kind of personality that serious psychologists are trying to analyze and describe.

The personality of popular interest and popular ignorance—the personality that challenges the psychologist—is real. There is the fact that each individual makes his own peculiar impact upon others. And there hangs the issue, for, according to the popular notion, this personality is a kind of entity that exists in its own right, while the typical psychologist sees it only as a sum or combination of various distinguishable parts.

THIS impact of an individual upon others is a legitimate problem for the scientific psychologist, for his study is human behavior. The impact is conveyed through behavior, and behavior is open to experimental observation. Also, the conscious states behind it are open to introspectional analysis. By introspection we do not discover a thing at work called personality; we find sensations, pleasant and unpleasant feelings, memories, perceptions, ideas. By the observation of visible behavior we discover a number of things variously called habits, traits, dispositions, behavior patterns, mannerisms.

It would seem, from the results of psychology, that the familiar thing called personality is not a thing but a bundle of things. Or one might say that it is like the quadruped, which, verily, is not an animal at all. Who has ever seen a quadruped ambling by? One has seen a horse, an elephant, a mouse; but not a quadruped. The word is merely a convenient term for the classification of four-legged animals. Personality, likewise, it would seem, is a term of classification.

The personality testers, so far as these are found among reputable psychologists, have long since accepted this principle. None of them tries to measure the thing itself, for they have not found any such thing. To revert to a previous conceit, would one hope to measure the "enginality" of an engine? Or would one not be compelled to content one's self with measuring the horsepower, the revolutions per minute, the compression, and so forth? In the case of personality, the psychologists have been busying themselves with the invention of tests for measuring the parts. As a result we now have hundreds of more or less dubious appraising devices designed for evaluating such constituents as these: intelligence, artistic capacities, interests, knowledge, technical aptitudes and skills, temperamental characteristics, tendencies of ascendancy and submission, introversion and extraversion, emotional dispositions, psychoneurotic tendencies, evidences of volition, and social, moral, ethical, religious, and esthetic attitudes and habits.

In this array there is a startling suggestion that our personality is a pied thing of patches. But the half has not been said. For it now appears that the patches are but collective terms embracing any number of separate parts of their own. Intelligence, for example, is psychologically described as something consisting of an untold number of distinct "reactions." And when it comes to our moral make-up, to cite but another example, we find that it is bad psychology indeed to assume that it consists of traits such as honesty, fairness, obedience, dependability, and the like. For we have discovered that these do not exist in their own right, as moral entities with a real existence. Like the quadruped, each is but a collective term for a great number of things.

Take, for example, honesty. It is commonly believed that a moral person has something that goes by this name. A great deal of careful scientific research has been prosecuted to find out about it. And the result is pretty clear evidence that the so-called honesty of a person fluctuates according to the conditions prevailing at the moment. An extensive battery of genuine tests of honest behaviors was imposed upon thousands of children who did not know that they were being tested for anything, and no evidence of consistency was found. A child honest in some situations would deceive in others. Honesty decomposes into honesties, and there are as many possible ones as there are tempting positions in which an individual may find himself.

At the rate we are going, personality will eventually become pulverized.

In childhood, psychology robs us of our Santa Claus; and when we grow up it robs us of our personality. At Christmas time, however, there is always some compassionate soul who rises up to assure us that after all there *is* a Santa Claus. The writer now proposes to perform the same benevolent resurrection for Personality.

Philosophers long ago thought that they had destroyed apples. They showed with much logic that what we call an apple is but a bundle of qualities. They explained that you can break one down into redness, smoothness, roundness, hardness, odor, taste, and the like. And what is more, they demonstrated that all these qualities really do not exist in the apple. They exist in your mind. Smoothness, for example, is a sensation that happens when the nerve endings in the hand are stimulated in a certain way; it happens in your consciousness. You can thus remove all the qualities of the apple to your mind, and the question then is: What has become of the apple?

One of our modern schools of philosophy is busy restoring apples, and the successful accomplishment of this feat promises to bring lasting glory to certain American philosophers. A similar service to personality seems to be in order, for common sense insists that personalities are as real as apples. The impact of a person upon others has a consistency and a reality about it, we feel sure, in spite of the disintegrating discoveries of the psychologists. The parts make a whole, and the whole is not the same thing as a bundle; it is something different from a mere collection. We have an intuitive conviction that it exists in its own right.

AN intuition is dangerously unscientific. But this particular one is supported by any number of scientific facts, as well as by numerous experiences of common life. These all demonstrate the important principle that related parts form unique wholes which are in no sense a simple association of the parts, but possess a distinctive character of their own.

The simplest illustration of this principle is water. Every schoolboy knows that it is composed of one part oxygen and two parts hydrogen. But how different it is from either of them! Imagine drinking oxygen or doing the family washing in hydrogen. The fact is, of course, that water is a thing unique in itself, created by placing two elements in certain chemical relations to one another.

Chemical compounds illustrate the same principle. Divers elements of extraordinary unlikeness get together and we have entirely new substances, beyond the elements themselves.

Music illustrates the same principle in a strikingly different fashion. Consider a melody. Here we have a collection of parts consisting of notes. Or if you prefer larger parts, say that they consist of phrases. In any case, the parts, as such, by no means constitute the melody. If they did, you would have the melody no matter how you arranged the parts. But the fact is, of course, that you have the melody only when the parts stand in certain relationships to one another. Then each part gives up the character that it possesses when standing alone. It goes into the melodic whole, but the melodic whole changes it. Each part assumes a quality that is aroused by those that precede and by those that are anticipated.

A new biology is being written around this principle. The living cell of protoplasm, ultimate unit of all life, is no longer a mere assemblage of chemical elements. The very fact that it possesses life means that its parts are active with respect to one another in a manner determined in large measure by the cell as a whole. The parts make the whole but the whole governs the parts—strange and paradoxical law of nature!

What is true of the single cell is true in a remarkable way in the mass of cells that form a complex organism. At an early stage in the development of the embryo of a frog, for example, a portion that would normally become skin may be transplanted to the brain region, and it will become brain. In a similar way the fate of various parts may be completely changed. Zoölogists have studied this phenomenon with extreme care, and they have discovered that an organizing influence pervades the living, developing structure. It dominates the structure, determining growth in an orderly fashion and compelling cells to become what they should become in accordance with the needs of the functioning whole.

Perhaps the bearing of all this upon the enigma of personality is beginning to appear. The psychologists left us with personality shredded into parts, and parts of parts—and they couldn't put Humpty Dumpty together again. But now we catch the glimmer of a unifying principle that ought to shine with much light as one traces it through higher orders of nature. A little knowledge of human physiology offers an insight that ought to prove illuminating. One need only take into consideration the amazing balance of functions in the body to realize that it is something more than a collection of working parts. One may select any single function and show that it influences every other one, and is influenced by them. Digestion, assimilation, excretion, circulation, respiration, functioning of ductless glands, liver, and kidneys—processes so involved in reciprocation that explanation becomes lost in the simple, and finds itself only when it turns to the complex! Explanation, here as elsewhere, must be discovered in a principle of organization that emerges from a maze of functions, and upon their diversity bestows an ordered unity and wholeness.

Psychology itself, in some of its recent phases, is yielding to these principles of organization. The *Gestalt* school and the new purposive behaviorism are compelling a radical revision of dominant structural and mechanical theories—psychologies of pieces and parts. Analysis of the behavior of rats and men had given us a picture composed of fragments, and we thought the fragments were the last word. Now we are beginning to see, like workers at a jigsaw puzzle, that the ideally complete picture governs the function of each part from the beginning.

Thus, by the aid of much science and some philosophy, is personality restored. It turns out to be a real something possessing a kind of unity. This conclusion offers no consolation to simple people and mountebanks who have talked of personality as if it were a center of magnetism, a mysterious well of power, or a secret of the mind which, if you but possess the key (price 25 dollars), will lead to success in business and love. No; the unity that is personality is the unity produced by parts existing together in functional relationships. For in such case we have something more than a mere collection of parts. Mutually, the parts have created a principle of organization that extends throughout, and the effect is unification. This is personality.

THE parts thus organized are not mechanical, like those of a machine —not like wheels, bearings, cylinders, cogs. They are psychological: emotional dispositions, habits, social attitudes, temperamental characteristics, ways of meeting various situations, active interests, moral behaviors, esthetic sensitivities, fears, timidities, forms of self-assertion, and what not. These terms all indicate functions of behavior that may, upon this, that, and the other occasion, be identified in persons. They may be identified separately but they are inter-related in fact. They are parts of behavior in the same sense that peculiar sequences of steps are parts of a complicated dance. The sum and substance of it is that each peculiarity of behavior is what it is largely by virtue of the character of the others, severally and collectively.

All in all, we have a synthesis which is personality. Its effect and visible evidence is the familiar impact of an individual. In this, no two people could possibly be alike. Obviously, it is not susceptible of measurement. And it is not a thing responsive to the hocus-pocus of platform psychologists or mystic cultists.

Weather Data by Radio

Our Weather Influenced by the Stratosphere . . . Radio Transmitters Anchored at High Altitudes to Send Out Thermometer and Barometer Readings

PRIOR to the close of the 19th Century, weather observations were confined largely to conditions close to the surface of the earth. In 1899 a pioneer French meteorologist Teisserenc de Bort, made the announcement that the temperature decreased at a fairly uniform rate as altitude increased and that this fall in temperature ceased at from 11 to 18 kilometers above the surface of the earth. The zone above this height is called the "stratosphere," and the lower region in which temperature decreases with height is called the "troposphere."

Radio transmitting equipment is in wicker basket; balloon gondola at center

Since the turn of the century, important progress has been made in predicting weather conditions, and particularly has this been true during the past decade, thanks largely to the rapid development of radio communication. The importance of the stratosphere and the rôle which it plays in the meteorological research is well known to present-day students of the subject. The opinion was expressed as long ago as 1911 by W. H. Dines, a British scientist, that all the atmospheric disturbances close to the surface of the earth are due to the influence of the stratosphere.

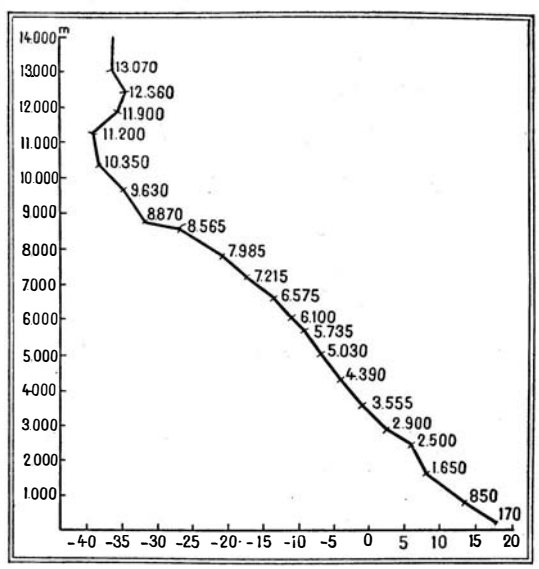
Explorations of the upper air mass, as undertaken by de Bort, among others, paved the way for a systematic study of the stratosphere and its effect upon the climate. In an attempt to gather weather data at points far above the surface of the earth, de Bort made use of sounding balloons as far back as 1892.

During the present century this type of work has been carried on consistently, frequently with the assistance of airplanes, flights of which, however, are severely limited by mechanical considerations. Only by means of sounding balloons is it possible to penetrate the stratosphere and to obtain information that can be put to practical use.

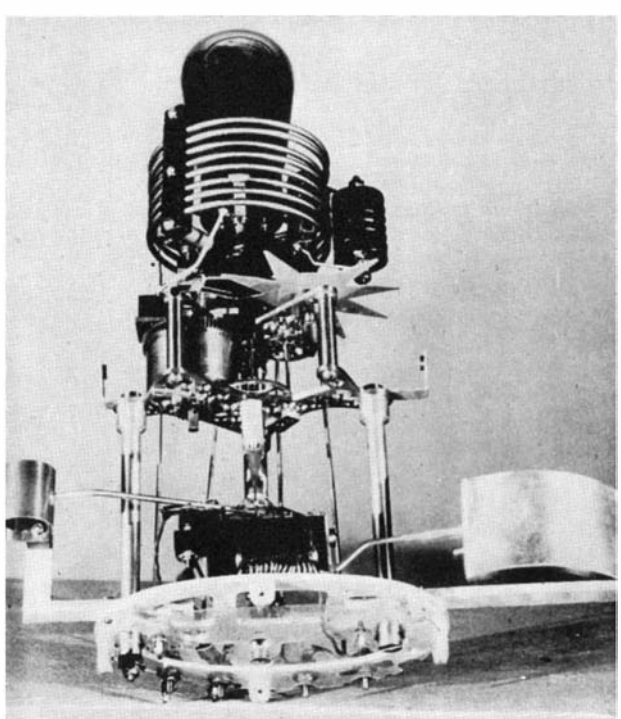
The method generally in use today for gathering the secrets of the upper air is to attach weather instruments to a balloon, which is then set free. When the balloon reaches a certain altitude, it bursts because of decreased external pressure and the instruments descend to earth, their fall broken by a parachute.

While this method has contributed greatly to the collection of weather data, it has several disadvantages. If the instruments are recovered immediately the data will be of maximum importance. Very often, however, there is a delay in the return of the instruments by the finder, as frequently a balloon will have drifted many miles from the point of release. Furthermore, while great heights have occasionally been reached by free sounding balloons, the greater the height, the greater the disadvantage, because the balloon will drift to a greater distance from the point of release.

At Trappes Observatory in France experiments have recently been conducted with a captive balloon equipped with a new type of radio transmitter which continually sends out signals, making possible a constant check upon changes in atmospheric



Temperature decreases as altitude increases



Photographs from Mirzaoff

Star-shaped wheel is below radio instruments. Pressure and temperature units are at the left and the right

From Captive Balloons

conditions at high altitudes. The first record of this type of work is dated March 3rd, 1927, when a balloon carried a barometer and a thermometer to the stratosphere and kept in constant touch with a ground receiving station by means of an automatic transmitter. Since then experiments have been conducted to further the flexibility of this means of weather data collection by officials of the National Bureau of Meteorology of the French Government.

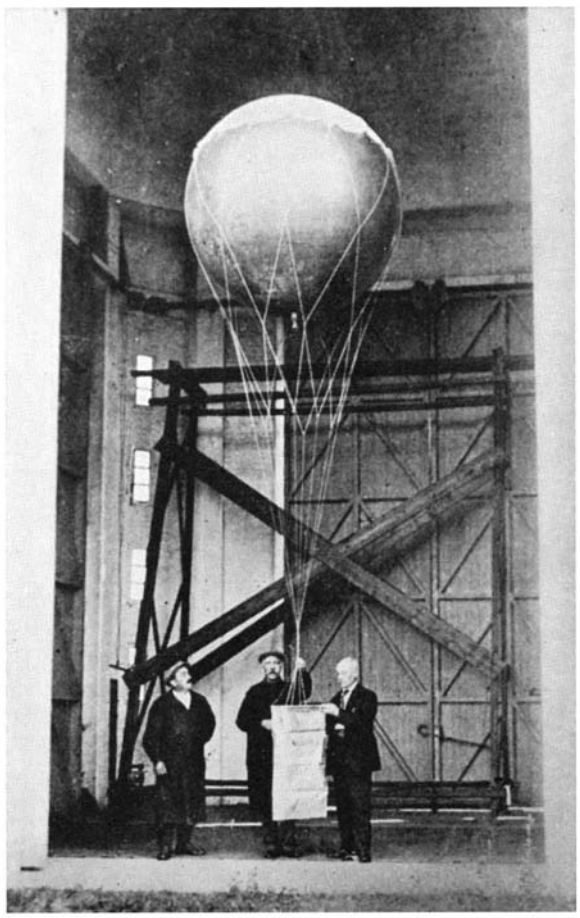
ESSENTIALLY, the radio sounding equipment consists of two recording devices and an automatic radio transmitter. A metallic coil expands and contracts with changes in temperature and a sealed capsule acts in the same manner with changes in barometric pressure. The barometric changes cause radio signals to be sent out, while changes in temperature vary the space between signals. Working along these principles, the French scientists have perfected a light and compact radio transmitting system which has been carried to heights of 14,000 meters by means of a captive balloon and stationed at that point for days at a time.

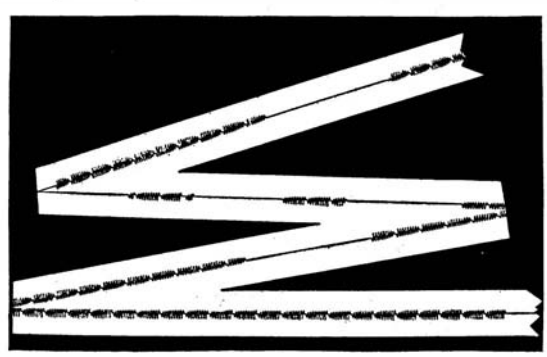
In the equipment which is illustrated on these pages there are a fixed index and two rotating arms which control the radio transmission. The position of these arms governs radio inpulses which are received by the ground station and recorded on a moving paper tape. The equipment is so arranged that it will transmit simultaneously records of both temperature and pressure. The coil and capsule mentioned above are so connected mechanically that they cause their corresponding arms to move around a single vertical axis. As shown in one of the sketches, each arm describes a definite arc upon a so-called "exploration platform." On this platform there is a stationary piece of metal shaped like a fork with a handle and four prongs (F0, F1, F2, F3, F4). The arc between F0 and F1 is covered by the barometric arm, and arc F4, F0 by the thermometric arm. Then there is a "guide" (indicated in the sketch by an arrow) that sweeps over the edge of the platform, making a complete circle. As the guide encounters in successive periods one of the arms or a prong of the metallic fork, an impulse is transmitted which is registered at the receiving end by either a straight or a wavy line. The movement of the guide is supplied by a clock which at the same time rotates another metal disk shaped like a star with ten points. This is parallel with the "exploration platform" and records the angles of both arms.

The star-shaped wheel rotates between the plates of a small condenser, the latter being connected in the plate circuit of the transmission tube. The passage of each spoke, therefore, is translated into a modulation, and the circuit is so arranged that transmission stops momentarily when the "guide" comes in contact with one of the two arms or one of the four prongs of the metallic fork.

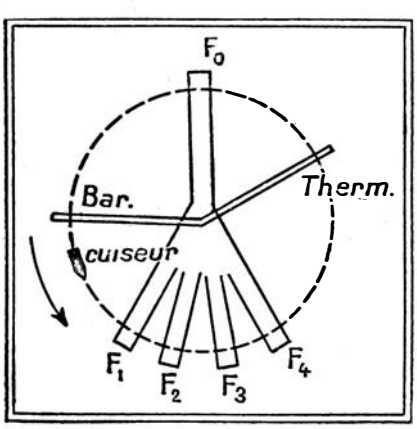
The radio transmitter itself consists of a conventional oscillating circuit in which a single vacuum tube is operated by dry cells. When the impulses are received by a conventional receiving set at the ground station, the signals are fed into an oscillograph which registers the impulses on a moving paper tape, in the shape of straight and wavy lines. A sample record is reproduced herewith, showing wavy line records for barometric pressure and the straight line records for temperature.

One of the greatest advantages of this French system of meteorological research lies in the use of a captive balloon which, held by its light yet strong silk cable, can, under ordinary circumstances, remain at high altitudes for long periods of time.

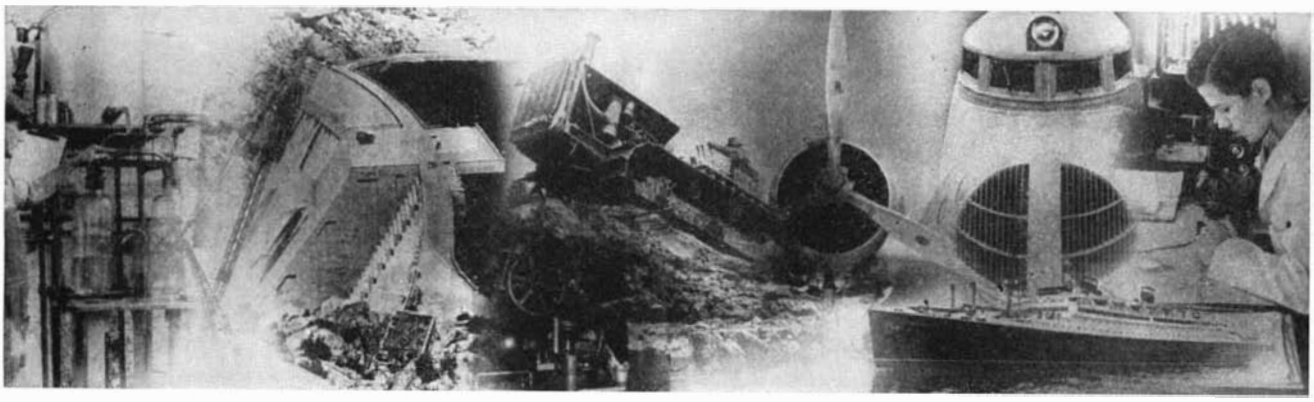




Above: **One of the captive sounding balloons ready for release. In the fabric gondola is the radio transmitting apparatus that will send continual reports to the ground station.** ***Right:*** **Several sections of the tape record made at the radio receiving station**



The fork-shaped contact piece on the "exploration platform." The operation is explained in the text



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

Smoke Out Thieves

IT is now possible completely to frustrate thieves and recover messenger bags containing valuables within a few seconds after a holdup occurs.

The messenger hands over the bag without resistance! Yet, in less than a minute, the bag is recovered, its contents intact and unharmed; and the thief is apprehended.

This protection is afforded by the Tracelarm messenger bag in which is a special noise- and smoke-producing shell.

The Tracelarm shell is a sealed, self-contained unit with a series of four .45-caliber blank cartridge noise-loads giving four rapid detonations and charges of tracer-smoke that issue without interruption for three or more minutes. The shell is equipped with dual-ignition to insure positive operation, and the safety fuse provides a silent delay period of 10 seconds before discharge of alarm or smoke. There are no batteries or other delicate elements to require attention, and the shell will remain in first-class working condition for three years.

Tracelarm messenger bags are simple and easy to handle. A safety key locks the alarm mechanism when the bag is not in use.

Little does the "thug" know that a loud alarm will soon be sounded

To his surprise, gun shots are heard, and a yellow smoke screen appears

Concealed between the handles of the bag is a fine wire cable with a loop that slips over the messenger's forefinger. This cable operates the trigger mechanism within the bag, and its length permits ample free movement.

Should the bag be snatched or taken from the messenger, the loop tightens upon his finger, and the wire pulls away from its connection within the bag. This movement instantly closes the automatic inside lock and also trips the alarm mechanism—without sound.

Ten seconds later the alarm starts. Four detonations in rapid succession are followed immediately by two streams of tracer-smoke, proceeding from outlets in the bottom of the bag. The distinctive yellow smoke is readily visible for a long distance. This smoke is not injurious and does not contain tear gas or obnoxious elements.

Discharge outlets in the bottom of the bag are concealed by a leather cover which comes off when the alarm operates. No damage can occur to the bag or its contents as a result of this discharge, and the bag can be refitted with a new Tracelarm shell.

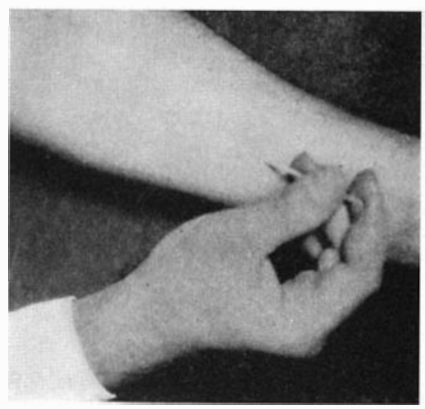
ELECTRON

A SINGLE "atom of electricity"—a single electron—can be detected by the "Geiger-Mueller counter." So small is the amount of electricity carried by a single electron that an ordinary 10-watt electric light bulb requires a billion billion of them every second to keep it lit.

Skin Writing

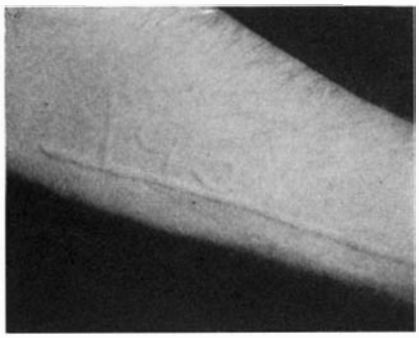
SKIN writing, an unusual phenomenon, is rare among human beings—so much so, in fact, that those exhibiting this peculiarity hire themselves out, at times, for side shows at circuses.

Dermographia, as skin writing is known technically, is due to a hypersensitive condition of the individual toward some source of irritation. This may be found in the form of a drug or some mechanical agent which induces an urticarial reaction due to friction of the rough object with the superficial layers of the skin.



Producing dermographia

Just as some individuals are sensitive to certain foods or the pollen of various flowers, so is the skin writing person reactive toward pressure or frictional effects. Otherwise the individual is perfectly normal.



A fine example of dermographia

The theory that is held by most authorities for this extraordinary condition is similar to that which explains other idiosyncrasies, namely that of anaphylaxis. This implies that the skin of such individuals manifests hyper-susceptibility to an irritating influence. How this may be relieved, medical science is not yet prepared to state.—*Prof. Victor Lewitus.*

Flavor From Wood

A CANADIAN paper company is preparing to manufacture vanillin, the flavoring principle of vanilla beans, from sulfite liquor obtained as a by-product in its paper manufacture.—*D. H. K.*

Artificial Sea Water Test of Concrete

A MINIATURE ocean with artificial sea water and electrically controlled tides is an important part of the equipment in the research laboratory of the Portland Cement Association in Chicago. This Lilliputian ocean was created as a means of studying the effects of continuous exposure of concrete to sea water.

The apparatus includes two 11-foot tanks of concrete, filled with water of the same chemical composition as sea water except that it is four times as concentrated. Electric pumps circulate the water and give the effect of tides. Every 24 hours it's high tide in one tank and low tide in the other. The rise and fall is one foot.

Small reinforced concrete piles of varying quality are placed in the tanks and daily observations made of their behavior. The depth of penetration of the salt water is checked by daily tests with extremely delicate electronic meters.

Each test specimen contains many electrodes in pairs. An electric current of the intensity of one milli-ampere is passed between pairs of these electrodes.

The instrument readings record the amount of resistance to the flow of current in several directions and in various parts of the test specimens. That shows the penetration of the salt water.

The tests will continue for years. The concentration of the water and the longer period of alternate immersion and drying out afforded by the 24-hour tide cycle instead of 12 as in the natural ocean, gives a more severe test than in actual practice.

"Sea walls of concrete have been in service 34 years and more without deterioration," E. C. Shuman, research engineer in charge of these tests says. "In contrast to the rare instances of the disintegration of concrete after long immersion in sea water are many instances of even greater age that show no deterioration. The reason for the greater life is no doubt largely due to the higher quality of concrete used and the better methods of placing and curing. These tests will give us more precise data on the factors which promote a longer life to concrete exposed to sea water."

LAUNDRY MARKS

LAUNDRY marks, invisible by ordinary light, are perfectly legible in the bundle-wrapping room equipped with ultra-violet lamp. The mark fluoresces under light from this lamp.

Living Teddy Bear—the Koala

IF the bored little fellow in our illustration —an Australian koala, or native bear— realized what he is up against, he might not be so nonchalant and ho-hum-ish. For like other members of the southern continent's unique and distinctive fauna, he is threatened with extinction as a species. Valued for his fur, pursued recklessly for "sport," he has been shot almost out of existence. One active human friend he has, Noel Burnet, who at his own effort and expense established Koala Park, near Sydney, N. S. W. But funds are lacking to keep up the work of conservation and Australian statesmen see no way of supplying the desperately needed appropriation to take over the park into public ownership. Koalas cannot even be exported from Australia because they will starve if deprived of the leaves of the one eucalyptus species that they feed on. Most regrettably, these little living Teddy Bears would seem to be traveling the unreturning road—"going west."—*Science Service.*

Tired?

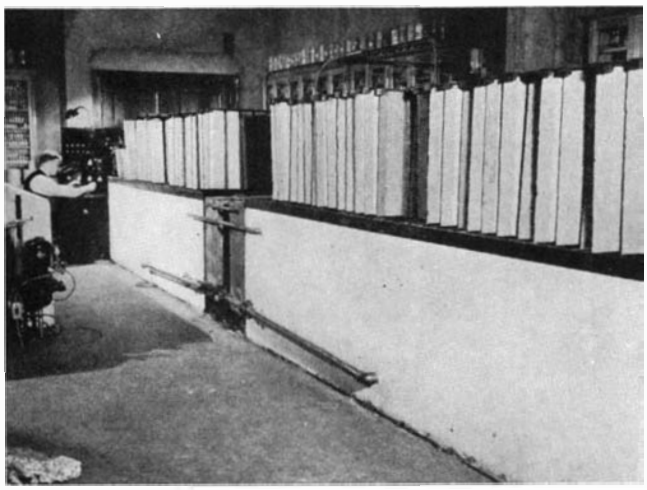
Iodine in Water, Best Antiseptic for Cuts

THE best antiseptic for treating wounds, cuts and abrasions is a solution of iodine in water. This is the conclusion of Dr. Robert N. Nye of the Mallory Institute of Pathology, Boston City Hospital, who has completed a series of experiments on certain commercial and non-commercial solutions ordinarily used as antiseptics for minor wounds and for irrigations.

Four solutions containing iodine, seven containing mercury, two containing chlorine, and three miscellaneous solutions were tested at the same time. On the 16 antiseptics five comparisons were made: (1) bactericidal activity, (2) bactericidal activity in mixtures containing 50 percent horse serum, (3) diffusibility, (4) toxicity, and (5) cost.

The antiseptics that did not measure up as well as iodine included: Mercurochrome, Hexylresorcinol, Listerine, Pepsodent, Zonite, and others.

The results are given in the *Journal of the*



Tanks for testing concrete with sea water, and, *right*, the instrument board of the equipment

American Medical Association. "The superiority of iodine as an in vitro (in a glass) antiseptic is obvious," states Dr. Nye in the medical journal. "The bactericidal strength of any iodine solution is directly proportional to its free iodine content." Iodine was the only antiseptic of the series that retained its bacteria-killing power in the presence of an equal amount of serum. It possesses a high degree of penetration and is not unduly toxic for human white blood corpuscles, Dr. Nye declares. In dilutions suitable for their particular purposes it is inexpensive.

Dr. Nye asserts that some opposition to the use of iodine has developed because it is usually employed as the standard (7 percent) or half strength (3.5 percent) tincture. Such a solution is painful to apply and is irritating to the tissues, partly as a result of its high iodine content and partly because of the alcohol. Iodine in a solution of water rather than of alcohol can be used to advantage, he says. A 1 percent or even a 0.5 percent aqueous solution can be used for wounds, cuts, abrasions, and irrigations. —*Science Service.*

Popularizing Water Flying

THE recent New York Aviation Show was the first held since 1930. Transport planes were too big to take into Grand Central Palace, and war clouds over Europe have so impressed the need for secrecy on our governmental authorities that no new Army or Navy planes were shown. But even without such exhibits the Show proved entirely successful, thousands of people visited the show, there was a constant stream of interesting events—and, what from the point of view of the industry is better still, a large number of airplanes were sold, with checks passed over in payment of deposits right on the floor. In all probability the National Aviation Show will become an annual event, just as is the Automobile Show or the Motor Boat Show. And so it should be.

Not the least benefit of the National Aviation Show was in indicating how water flying could be made more popular. Cities in the United States do not, as a rule, have conveniently located airports. New York City, for example, has to place its main reliance on Newark, New Jersey, to the continued disgust of its worthy Mayor, Fiorello H. La Guardia. But almost every American city, New York included, has a river or a lake front close to its very heart. Therefore, the now widespread practice of building seaplane ramps under municipal auspices is most desirable.

A standard Waco biplane fitted with the amphibious float gear described

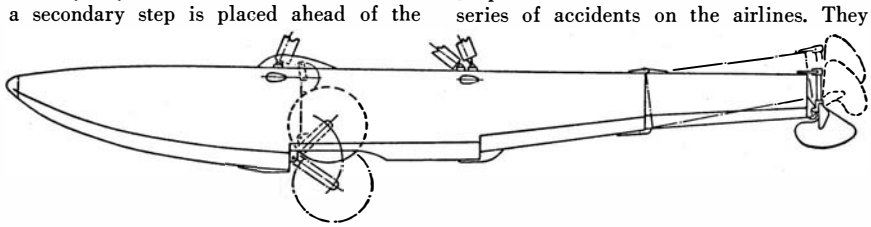
It is also desirable that there should be available machines that can use land or water and can operate in summer or winter. The engineers of Edo Aircraft have made a notable contribution in this regard by the development of an amphibious gear for use in conjunction with a twin float seaplane. The amphibious float gear, exhibited to the public for the first time at the Show, attracted much favorable comment. The gear is shown in the sketch, and in application to a standard Waco biplane in the photographs.

Each of the wheels of the main amphibian landing gear is supported by a pivoted yoke, which connects through a Bendix shock strut to a small crank concealed under the deck of the float. An exposed shaft placed transversely between the two floats is rotated from the pilot's cockpit by a worm gear drive and in turn operates in unison the two cranks placed in the float, turning them through an arc of 190 degrees. Thereby the wheels are retracted wholly within a well in the floats through an aperture in the bottom. Adequate wheel brakes are provided. The wells in which the wheels are carried are made completely airtight so as to provide a "diving bell" effect and to insure that none of the flotation or buoyancy is lost. It will be noted that a secondary step is placed ahead of the wells so as to shield the bottom openings from water interference.

Tests have shown quite definitely that with wheels retracted, or even removed, the machine can be handled successfully as a conventional two-float seaplane. With wheels down ordinary landplane qualities are available.

Space considerations will not permit us to describe the ingenious manner in which the water rudder shown on the right side of the sketch operates, nor how it is brought out of the way for land-plane use. The rear four feet of the float are hinged against a shock absorber; the result is that a large tail wheel for land-plane operation is eliminated and a small roller suffices, placed at the transom, as the extreme rear portion of the float is called. This roller is not shown in the sketch.

The engineers of Edo Aircraft are to be highly complimented on their skilful and simple addition to the possibilities of water flying.—*A. K.*



Drawing of the Edo float gear, showing wheel and rudder positions

"Hindenburg" Sailings

THE German airship *Hindenburg*, shortly to begin her 1937 flights, seems to have settled into a routine of transatlantic crossings that will make air history.

The *Hindenburg's* flights between Frankfort or Friedrichshafen and Lakehurst, New Jersey, will commence with her take-off from Germany on May 3, to be followed by departures on May 11 and 21, June 1, 11, and 22, July 2 and 13, and August 3. The airship will leave Lakehurst on May 6, 14, and 24, June 4, 14, and 25, July 5 and 16, and August 6.

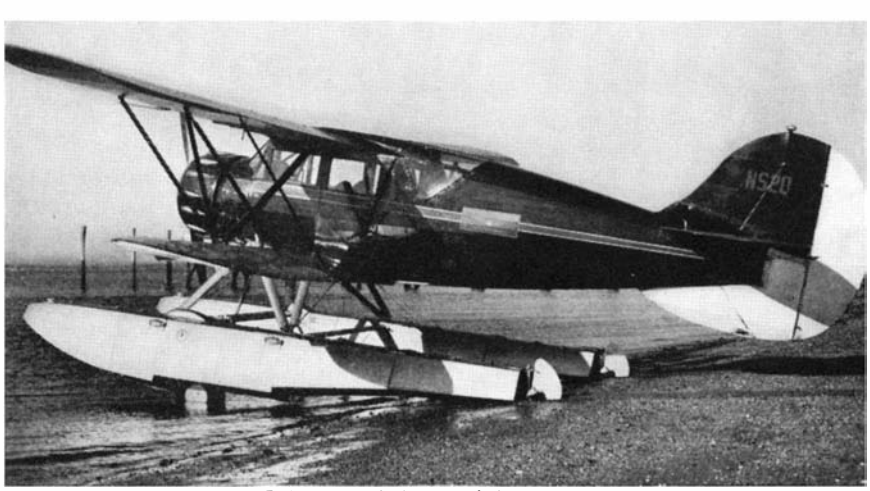
Later flights of the *Hindenburg* will be announced as soon as plans are completed abroad.

To Lessen the Chance of Transport Accidents

INNUMERABLE theories have been propounded as to the cause of the recent series of accidents on the airlines. They were not due to a single physical source, nor to a single group or organization of men. We have quite definite theories ourselves as to these accidents, but prefer to leave discussion to the Safety Conference being held, as these notes are written, in Washington, between the operators and the Air Commerce Bureau.

There is, however, one device which should certainly be put into service on every airliner in the country and that is the shielded, static-proof antenna. After two years of research and experimentation the engineers of United Airlines have conquered a weather and radio problem that has annoyed operators since the very first use of plane-to-ground radio communication.

The antenna consists of a circle of copper tube, 1½ feet in diameter, in which are coiled 100 feet of antenna wire—longer



Side view of the amphibious Waco

Ring antenna for aircraft

than the standard straight wire antenna commonly carried on the airliners. As shown in the photograph, the anti-static antenna is mounted in the nose of the airplane. The copper tube shields the antenna from snow or rain static, and allows uninterrupted reception of radio beam signals. Further, the small copper tube for static shielding also eliminates the difficulty of "icing-up" encountered with the straight wire antenna.

The new antenna is to be installed on all of the 50 twin-engined transports of United Airlines.—*A. K.*

A Splendid Amphibian

FOR the private flyer of ample means, there is nothing more satisfying than the ownership of an amphibian of the flying boat type. Types of amphibians for private use are unfortunately few in number and the Fleetwings Sea Bird was welcomed heartily at the recent Aviation Show. Built entirely of corrosion-resisting high-strength stainless steel, the Sea Bird presented a splendid silvery appearance. It is rather surprising that stainless steel has not been widely employed in American airplane construction. If a machine is specially designed for the use of stainless steel, it will give the same strength for a given weight as one designed in aluminum alloy and avoid the labor and annoyance of thousands of rivets. Stainless steel can be electrically spot welded.

The Sea Bird has the fullest modern equipment, splendid accommodation for four occupants, and with its 52 gallons of gasoline (carried in seamless, welded tanks of stainless steel placed in the wings) provides a range of 450 miles. The gross weight is 3450 pounds and the weight empty is 2320 pounds, which is low for an aircraft of this size and type. With a 258 horsepower Jacobs engine, the Sea Bird has a top speed of 150 miles per hour, and can be operated as a flying boat or as a land plane with equal ease. The excellent performance of the ship is in part due to the excellent aerodynamic design, but the hydraulically operated retractable landing gear contributes to the efficiency. When the struts are raised they disappear completely within recesses in the hull; only the wheels remain as partial protrusions, and these are so covered by fairing that they themselves contribute to the lift.—*A. K.*

Do Pilots Fake Position?

AMONG other points of importance discussed at the Washington Air Transport Safety conference were the two questions: Are pilots forced to "go through," whatever the weather? Do pilots disobey orders and fake positions?

In answer to the first question, only one case of a pilot being over-ruled was demonstrated in the whole history of air transport.

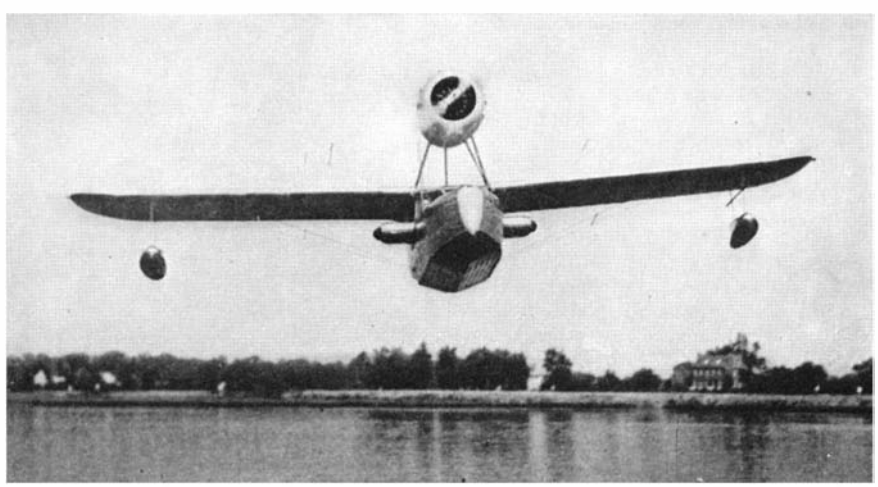
The question of "position faking" by pilots was not so easily dealt with. To meet this problem a new instrument will be put into service to make pilots "altitude conscious" and to check whether they really fly at prescribed altitudes in foggy weather, or whether when they see a break in the fog they come down to dangerously low levels.

This instrument, known as a "flight recorder" and weighing scarcely more than a pound, will be suspended in the baggage compartment or some other convenient part of the airliner and be set in operation at the beginning of each flight. One stylus will trace in ink on a flat card the height maintained at all times for a period of 8 hours. In this respect the instrument is really a barograph or recording altimeter. Another stylus will be connected with the plane's radio-beacon receiver, recording when and for how long the radio beam is used.

Thus the "flight recorder" will be an infallible check on the pilot's position at all times, both as regards altitude and route. It should be a great aid to safety.—*A. K.*

Silicon Impregnation of Steel

A NEW process gives high acid resistance to iron or steel parts by impregnating their surfaces with silicon. The operation is somewhat similar to the case-hardening of steel by carbon, but the result is a case containing as much as 14 percent silicon which is highly resistant to corrosion by acids. Finished parts are treated and show a change of dimension of the order of only one or two thousandths of an inch. High-silicon steels and irons are much used for their extraordinary resistance to acid corrosion. Because of their extreme hardness, these alloys have had to be cast in final form since machining has been impractical. The new method of silicon impregnation of machined parts widens the utility of this highly resistant material.—*D. H. K.*



The Sea Bird in the air and on water

Condor Following the Dodo?

TO keep the giant California condor from the same fate that befell the dodo, the passenger pigeon, the great auk, and the heath hen, Forest Service officials of the United States Department of Agriculture are trying to preserve the last retreat of this bird.

Frequently seen circling the craggy peaks of California's mountain ranges not so many years ago, the giant bird gradually has re-

treated until its only known habitat now is in the Los Padres National Forest of California.

The National Association of Audubon Societies assisted the Forest Service last year in gathering information about the big bird and its habits. In a recent report to the societies, Cyril S. Robinson, Associate Forester, said that "the bird is so constituted as to be handicapped by the very factors that make for its magnificent importance.

"Its size," he declared, "calls for space and easily accessible landing places. The peculiar conditions that must make up its permanent place of abode, and the fact that it returns to the same place to nest and roost year after year, are a few reasons that make it so important that the situation does not change for the worse."

The condor has diminished largely because of its eating habits, Mr. Robinson avers. It lives upon carrion, particularly the flesh of large animals. Back in the days when a cowhide was worth more than a carcass, the condor was supplied with plenty of food. More recently food conditions have become a problem.

The Forest Service is planning to provide undisturbed roosting and nesting places which will have an elevation sufficient to provide timber, and opportunities for bathing and drinking. The study indicated that complete isolation and proper protection from forest fires and invasion of people are necessary if the condor is to survive.

Why Not Long Ago?

AMONG other improvements in automobiles this year is one which seems so obvious that it is strange manufacturers did not adopt it long ago. This is the wider front seat, which has been offered by practically all makers this year. The accompanying photograph, from the manufacturer of Hudson and Terraplane cars, boasts a 55-inch front seat, the demonstrator showing this by means of a "yard" stick of that length.

Gratuitous advice is seldom welcome. However, we cannot resist the temptation to emphasize by repetition the fact that this is an obvious improvement. As a matter of fact, there seems no good reason why seats cannot be even wider than they are at present, for, in our humble opinion, the outside running board is a more or less useless appendage. Cars could easily be designed—as some have been in the past—with the front doors meeting the edge of the running board flush and with the necessary step-up inside the door. Surely the designers could make this change appear fully as artistic as anything being built today.—*Editor.*

Width for comfort

TRANSPORTATION SECTION

A Correction

AN error in the original typing of Mr. J. J. Pelley's article, "Progress on Rails," in our February issue, inadvertently slipped past the editors despite the fact that Mr. Pelley wrote us in plenty of time requesting the correction. We sincerely regret the fact that this went through in incorrect form.

In Mr. Pelley's article, on page 82, line 13, the statement was made that ". . . for each ton of coal consumed in freight service, the railroads hauled 8⅓ gross tons one mile." The word "pound" should have been substituted for "ton" so that the statement would read ". . . for each *pound* . . ."

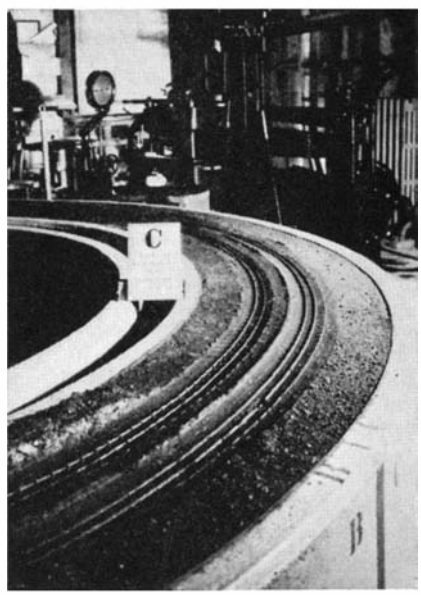
'Round and 'Round

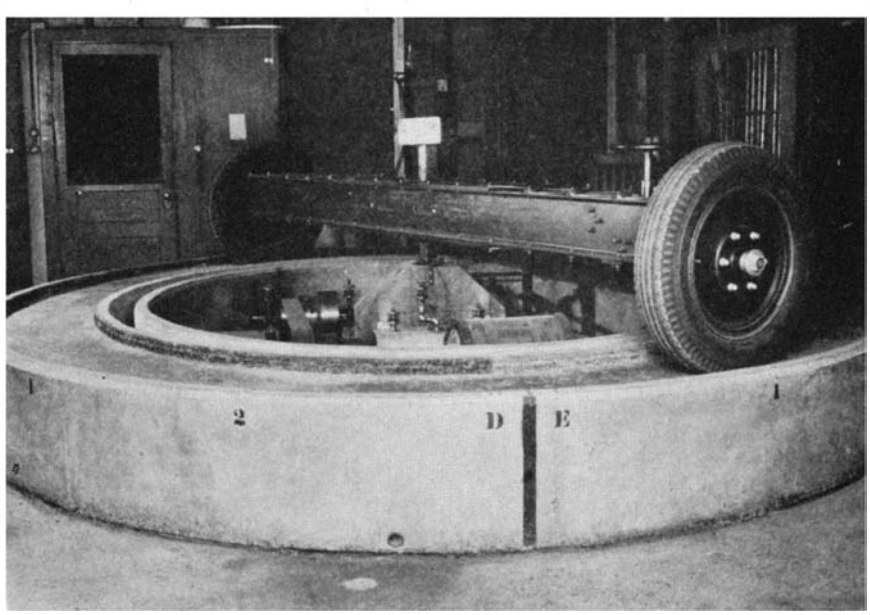
THE popular belief that you never get anywhere going around in circles is being disproved at the Arlington testing laboratories of the United States Bureau of Public Roads, where two automobile wheels rotating on the surface of a small circular track are revealing the relative stabilities of various low-cost road surfaces. There are two of these set-ups, one indoors and the other out, with five or six sections of different bituminous mixtures making up the surface over which the wheels rotate.

Tests are made of one variable factor at a time, such as the quantity or the consistency of the bituminous mixture, and are run until the relative wear on each section reveals the comparative stabilities which result with regard to the several circumstances of the variable. The wheels, which exert a force of 800 pounds on the road surface, are mounted on the ends of a centrally pivoted steel beam which can be driven at three speeds, the maximum being nine miles per hour.

The track itself, laid in a concrete trough, is approximately 37 feet in circumference, 18 inches wide, and has a mean depth of 12½ inches. Distribution of the "traffic" over the width of the surface during compaction is made possible by shifting the pivotal point of the steel beam back and forth by means of a hand-operated wheel, or, in order to accelerate the tests by simulating conditions of high traffic density, the pivotal point may be set off center so that the wheels travel in two concentric lanes five inches apart.

The surfaces may be tested dry or flooded, or the subgrade, which consists of gravel or crushed stone, may be kept moist by the capillary introduction of water through the





The wheels go 'round and 'round, testing low-cost road surfaces in the laboratory of the Bureau of Public Roads. *Above:* A part of the track, showing wear

A new kingdom of music *for you who play the piano.* A concert organ for the home

IF YOU play the piano even a little, the Hammond Organ opens for you a veritable new wonderland of music. For on the Hammond the touch of your finger summons forth not just a single tone color, but an infinite variety of lovely organ voices.

At the keyboard of this remarkable instrument, you give your favorite melodies new, exquisite depth and richness. The simplest tunes are inspiring to you—thrilling to those who listen.

All the varied voices of the organ—strings, reeds, diapasons—are at your command. You shift from one to another to suit your mood.

And this new kingdom of organ music is now for the first time within the reach of families of average income. Producing the full tone range of the concert organ, the Hammond costs no more than a fine piano, fits into any living room.

See and hear the Hammond Organ at the showrooms of any of our dealers—each one the leading musical merchant of his community. You will find an organist glad to play for you. He will demonstrate to you, also, how easily the Hammond can be played by *anyone* who knows the piano. Consult your telephone directory . . . or write to The Hammond Organ, 2943 N. Western Ave., Chicago.

Nearly 1000 churches use the Hammond... it is an appropriate donation for your church

FITS IN A FOUR-FOOT SQUARE

Originating tones by electrical impulses, the Hammond Organ requires no pipes nor reeds. The spinet-like console and the bench occupy only a four-foot square in your living room. The tone cabinet can be placed anywhere. The Hammond can be carried easily by two men and is installed by merely connecting it to an ordinary electric outlet.

THE HAMMOND ORGAN

$1250 and up f.o.b. Chicago —slightly higher for large installations

TODAY, LESS THAN TWO YEARS AFTER ITS INTRODUCTION, THE HAMMOND IS THE LARGEST-SELLING ORGAN IN THE WORLD

lower part of the inner wall of the track.

From the effects produced on the test specimens by these revolving wheels, which travel about 8000 miles per year, engineering improvements are being developed which the motorist will realize in the construction of better highways.

"Painting" a Bridge with Metal

THE problem of protecting steel bridges against brine drippings has increased steadily since refrigerator cars were first placed in service until today it is one of the major maintenance problems on many railroads. A recent issue of *The Metallizer* makes this comment in discussing a report of Mr. B. R. Meyers, Asst. Gen. Bridge Inspector of the Chicago and Northwestern Railroad. On roads carrying heavy volumes of such traffic, track fastenings are destroyed in half the normal life secured elsewhere, while the damage on bridges is illustrated by the fact that a single road is now completing a program of bridge repair and renewal involving the expenditure of more than 1,000,000 dollars, made necessary solely by this form of corrosion on a limited mileage of its systems.

Mr. Meyers mentions in his report certain tests of metallizing which were carried out on a Canadian railway where one girder of a deck plate girder span was metallized and the other was spray-painted. Metallizing, as most of our readers know, consists of spraying molten metal onto a surface, the metal, in the form of wire, being fed automatically into a reducing flame where it is melted, atomized, and projected onto a surface by means of a suitable air blast.

Using as an example the expenditures on the special test job mentioned, Mr. Meyers says he believes that metallizing appears to have merit. The initial cost of metallizing is high, as a very thorough job of sand blasting is necessary for a proper bond. On an annual-cost basis, however, it can be compared with other types of protection, as it is expected that under severe conditions it will give protection for 20 to 25 years. One of the many advantages of metallizing is that, regardless of the thickness of the coat required, it can be applied at one time. Thus the injurious effect of water or cinders falling on fresh paint or of dragging ties back into place before paint is dry is eliminated.

Installed on the Union Pacific's crack train "Challenger," this electric water cooler by General Electric does away with the old method of icing drinking water. No longer need porters bring in chunks of ice, of doubtful purity and cleanliness, and put it in or around tanks of drinking water. Foot pedal operation adds to passenger convenience

A tabulation of the cost in the test shows that including labor, sand blasting and materials for painting the entire structure with three coats of paint totals 17 cents per square foot; metallizing the brine sections only with .009 inch zinc coat, 55 cents a square foot; and metallizing the entire structure with .003 inch zinc coat, 43 cents per square foot.

Railroad Crossing Bump-Stop

THE problem of providing automatic stops for railroad grade crossings to prevent crashes between automobiles and trains has long occupied the attention of engineers and designers. Many ingenious mechanisms have been produced, but most of these in the past have lacked adaptability in certain respects. A new one, announced by the Evans Products Company, does a positive job of notifying the driver of the oncoming automobile that a train is due at the crossing.

This device consists of a hollow framework of cast steel sunk into and across the highway. It is hinged so that, upon the approach of a train, it swings up into the roadway to present a barrier 9½ inches high on the road surface. Should the automobile driver fail to notice the lights that are set against him and the "stop" sign on the barrier itself, he bumps into this barrier with such force that he cannot fail to be warned.

The "Auto-Stop" is mounted on hinges in a reinforced concrete pit with the top of the lid normally flush with the road surface. The drive mechanism, off to one side, consists of a motor, a brake, a circuit controller, and a gear reducer, mounted in a box-like frame of angle bars. A standard red and green traffic light is placed beside the Auto-Stop. The green light burns as long as the crossing is safe, but when a train enters the control limits the red light comes on. Three seconds later the Auto-Stop starts to rise, hesitates for 10 seconds at a height of 4 inches, during which time the lid is easily depressed if the car should continue over it. At the expiration of the 10-second warning interval, the device rises to a height 9½ inches above the roadway and locks at this point. It remains in this position until the train has passed.

A "bump-stop" signal, automatically operated, for railroad crossings

More Efficient Locomotives

(*Continued from page* 225)

and by a streamlined Pennsylvania Railroad locomotive built for similar service. Both are standard Pacific type locomotives and are fully shrouded. These high-speed trains have thus far been extraordinarily popular and are apparently profitable. Whether in the long run their motive power will be Diesel engines or steam locomotives remains to be seen. There is a limit to their number for, taking all factors into consideration, it seems probable that only about one tenth of the mileage of the country is now suitable for such high-speed operation.

Cunard Liner of 30,000 Tons

A CONTRACT for the construction of a new intermediate-size transatlantic ship is now being negotiated, it was confirmed recently by the Cunard White Star Line in answer to inquiries. This ship is destined for the company's service to Channel ports.

The new ship will have a gross tonnage of about 30,000, somewhat in excess of the 27,000 of the *Georgic* and *Britannic*. She will be built by Cammell, Laird and Company of Birkenhead, near Liverpool, England. She will carry cabin, tourist, and third-class passengers and will have a capacity of 500 in each class.

Capable of maintaining a speed of about 23 knots, the new ship will really be a new type, with size and speed between that of the superliner *Queen Mary* and the *Georgic*. Crossings by the new ship will take five and one-half to six days as compared with the usual four and one-half days for the *Queen Mary* and seven days for the *Georgic*.

The gradual all-around increase in the

size of ships is illustrated by the fact that the *Mauretania*, which went into service first in 1907, 30 years ago, had a gross tonnage of only 30,000. This famous speed queen, which held the laurels for the transatlantic crossing until 1929, was the largest as well as the fastest ship of her early years.

The present holder of the Blue Ribbon for the fastest transatlantic passage, the *Queen Mary*, has a gross tonnage of 80,773. A sister-ship for the *Queen Mary*, of about the same size and speed, is already under construction in the Clydeside shipyards of John Brown & Company. The keel for this superliner was recently laid and she is known for the present simply as *No. 552*.

"Pigs is Pigs"

COYOTES have become such a pest that ranchers near Kemmerer, Wyoming, are using specially trained hounds to trail them to their dens. But trailer hounds are hard to get and Newt Sims, rancher of Fontenelle, is highly pleased that he has seven instead of only the male and female that he had ordered from Evening Shade, Arkansas, recently.

There might not have been such a happy ending to the story except for the versatility of Bill Gilchrist, night depot agent of the Railway Express Agency. In handling a widely varied traffic the expressman has to be prepared for all sorts of emergencies. However, on such occurrences he can not help but be embarrassed.

For when No. 21 pulled in one evening, he unloaded the big crates containing Mr. Sims' hounds from the train on his truck and went about his work. The stage that was to take them into the mountains was due soon.

When Gilchrist looked again, he was staggered. There were not just two but seven trailer hounds in that crate. Five little puppies were whimpering around the mother dog. The record doesn't show whether Gilchrist had ever heard of Ellis Parker Butler's "Pigs is Pigs," but he did realize that such an event required some pretty expert work. The hound family was transferred to the warmth of the express depot and the stage left without them that night.

The stage driver told the rancher of his good luck and early the next morning he drove in to receive and care for the family. The youngsters were all healthy specimens and Mr. Sims is confident that ultimately they will play a big part in the decimation of the coyote population in his section of Wyoming.

Australian Roads Are Machine-Baked

FOR several years the Queensland (Australia) Main Roads Commission has been experimenting with a machine invented by L. H. R. Irvine, a Sydney engineer, for baking the surface of formed-up clay and black soil roads. The machine is really a traveling furnace, the heat of which, as the machine moves over the surface of the road, bakes the soil and converts it into a suitable and lasting pavement. The experiments, which have been conducted in the Toowoomba district, have proved so successful that the Commission has purchased a new and larger machine for baking roads throughout the extensive

black soil regions of Western Queensland. The new machine, which embodies many improvements on the experimental model, will weigh when in operation about 27 tons. It is 30 feet long and is able to bake the soil at the rate of approximately 60 feet an hour. Its operating heat is about 1200 degrees, Fahrenheit.—*Australian Press Bureau.*

Biggest Accident Risk for Front Seat Passenger

THE girl in the front seat runs the big risk in motor accidents.

Seventy-five percent of the severe, crushing, facial injuries sustained in automobile accidents occur to the person riding beside the driver, in the experience of Dr. Claire L. Straith, Detroit plastic surgeon, *Science Service* reports. The majority of these victims are young women.

Lacking the support of the steering wheel, which often saves the driver, the guest-passenger is thrown forward more violently at the impact. The passenger's head strikes the instrument board, where projecting handles, knobs, and cranks add to the hazard. Elimination of projecting objects from the passenger's side of the instrument panel should be attempted by motor car engineers, Dr. Straith declares in an article on facial injuries caused by motor accidents, which appears in the *Journal of the American Medical Association.* (Our January article shows that this has already been done to a large extent.)

The use of "crash padding" on the instrument panel might do much to minimize the seriousness and extent of this type of injury, believes Dr. Straith.

Facial disfigurements resulting from such accidents often cause psychologic handicaps that ruin social and business careers, the Detroit surgeon states. He says: "The ranks of the unemployed and unemployable are already large enough without adding to their numbers persons physically and mentally handicapped by preventable or curable facial defects."

The plastic surgeon cannot expect good results in face injuries unless the first aid treatment has been carefully done, asserts Dr. Straith. Plastic procedures, such as correcting scars, crushed facial bones or lost eyebrows, ears and nose, should not be undertaken until two months after every trace of infection has disappeared. He tells physicians how he replaces severed noses, using skin grafts from the forehead of a woman patient and from below the ear of a man patient.

Ready But Nowhere to Go

LIKE a man in the death house awaiting delayed execution while lawyers wrangle over appeals, new trials and other matters, is the S. S. *Leviathan* of the United States Lines, lying at its pier at Hoboken, New Jersey, just across the Hudson River from Manhattan's towering skyscrapers.

The former German liner *Vaterland*—part of this country's visible gain from the World War—has been out of service for many months because it failed to compete with the faster blue ribbon liners of the Italian, French, and German governments. Plenty of bulk but lack of speed laid up the *Leviathan.*

The United States Maritime Commission permitted the operating company of the *Leviathan* to take the liner out of service only on condition that it be kept in good repair until such time as a replacement liner could be built. That time is now drawing near.

Two alternative designs for new ships have just been submitted to the Maritime Commission. One calls for a modernized sister-ship of the liners *Manhattan* and *Washington*, now in service. The other calls for a slightly larger liner now known simply as a "K" ship for identification purposes. Naval and Maritime Commission ship's architects and engineers are now studying the plans of the proposed additions to America's merchant marine.

Although the maintenance of the *Leviathan* expired recently, by agreement, the United States Lines have been notified that they will be expected to continue the "good repair" condition until the final disposition of the out-moded liner is decided.

The Maritime Commission is now trying to turn over its commercial marine white elephant to the War or Navy Departments as a possible national defense auxiliary, or trying to see if the *Leviathan* can be laid up later in some navy yard or war terminal as a reserve ship.—*Science Service.*

(End of Transportation Section)

Synthetic Musical Instruments

WIDE attention is being given by musicians to a violin made of a glass-clear synthetic resin of the acrylate type. This violin, which was assembled by cementing together parts made of the resin in very much the same way that the wood parts of the ordinary violins are assembled, possesses a remarkably clear tone. It has been compared with some of the finest violins but does not possess the strength of tone of the best. Flutes have also been machined from the same resin and it is not improbable that whole orchestras may some day be equipped with transparent instruments of this kind.—*D. H. K.*

Seaweed Tablets No Good in 30 Different Ways

CURE-ALLS are still offered to the ailing. They do not appear so frequently as in the more gullible past, but now and then a particularly offensive one appears, says the Food and Drug Administration.

Recently a case was terminated and fines imposed against John Lee Clarke and William J. A. Bailey of New York, proprietors of the Lee Kelpodine Co., Inc., manufacturers of "Kelpodine Tablets." The tablets were made of compressed seaweed or kelp and were fraudulently offered for the treatment of 32 specific diseases and "other conditions." In this amazing list were included common and general conditions and some of the most stubborn diseases known to the human race. The complete

list for which these fakers recommended their seaweed products is as follows: pyorrhea, headache, indigestion, tuberculosis, cancer of the liver, glandular trouble, nervousness, dental caries, underweight, anemia, constipation, general weakness, melancholia, digestive disturbances, asthma, rickets, bone diseases, chlorosis, eczema, stomach disorders, nervous break-down, migraine, high blood pressure, stomach ulcers, hayfever, liver congestion, subnormal growth, mental exhaustion, neurasthenia, rheumatism, arthritis, obesity, and other conditions.

Dusty Refuse Dangerous

IF an apartment-house housewife dumps dusty refuse into an incinerator chute when there is a fire in the box at the bottom, she is likely to get the surprise of her life and will be lucky if she escapes injury. Dr. David J. Price, chemical engineer of the United States Bureau of Chemistry and Soils, who has made many reports on dust-explosion hazards on the farm and in industry, now calls attention to this hazard in the home.

Many instances where such explosions have occurred are on record, as this type of incinerator is common in apartment houses. One such explosion took place when a woman, having started to bake a cake and found the flour to be wormy, decided to dispose of the mixture of flour and sugar. She dumped the mixture down the incinerator chute and closed the hopper door. An explosion followed that blew open the door, burned the woman seriously and damaged property throughout the building close to the incinerator inlets.

This type of explosion, Dr. Price explains, is similar to the more publicized industrial disasters which have occurred in flour and starch mills and grain-milling plants. In some of them there has been a heavy loss of life as well as of property.

Other domestic incinerator explosions have happened when the dust bag of an ordinary vacuum cleaner or dust from a floor-sanding machine was dumped into the incinerator. In this way fine dust particles are left suspended in the air all the way down to the bottom of the chute. This dust burns so quickly in the limited space that the pressure forces fire and gases through the incinerator doors and vents.

To prevent such explosions, Dr. Price says, all dry dust should be wetted thoroughly and placed in a strong paper bag or carton—one that will not burst in falling down the chute.

Synthetic Rubber Aids Natural Product

A NEW use for the synthetic rubber, Thiokol, has been found in its favorable effect on the vulcanization of natural rubber. Used in connection with thiuram vulcanization accelerators, a small quantity of this synthetic rubber increases the speed of cure of natural rubber.

The vulcanization process as applied to rubber consists of heating the mixture of rubber and sulfur until chemical combination occurs between the two. Numerous additional agents, called accelerators, improve the

finished rubber by shortening the heating period or reducing the temperature necessary for the treatment. Apparently Thiokol, which is a compound of sulfur with chlorinated organic compounds, materially assists this operation.—*D. H. K.*

SCALE

A NEAT little scale enclosed in a red mottled Bakelite molded housing has just been imported from Germany. The new design represents a combination letter

New scale with extra trays

scale and ordinary household scale with a weighing range of 11 pounds. For kitchen use a tumbler top is provided with graduations indicating liquid measurements.

IN THE INTERESTS OF SCIENCE AND PUBLIC SAFETY

THE greatest part of the damage done in the average earthquake is not a necessary result of the earthquake, but is due to our ignorance or indifference. Although it is now known how to build securely against ordinary earthquakes, this knowledge is not sufficiently disseminated. It should be in the hands of all engineers, architects, contractors, and property owners. It would be valuable also to the rest of us, especially to those whose children may be exposed to danger from falling chimneys, cornices, or walls at school.

The effective way to help in the increase and dissemination of knowledge about earthquakes, and to be fully informed on the subject, is to join the Seismological Society of America, its Eastern Section, or both. Membership is open to everyone interested in the subject. Dues in the Society are low, and include subscription to the quarterly *Bulletin*, which contains the results of research and articles of general interest on earthquakes.

GLYCERIN AS A STAIN REMOVER

GLYCERIN applied warm to stains made by mustard, coffee, cocoa, and so on, on delicately colored fabrics is efficient in removing them without damaging the color or the fabric. After application it is allowed to stand for a few minutes and then rinsed off with water.

For removing grease and other stains, a cleaner made by mixing glycerin (1 ounce), alcohol (1 ounce), ether (1 ounce), ammonia (4 ounces), and castile soap (1 ounce) mixed and stirred into enough water

to make two quarts, has been recommended.

Rust and ink spots can be removed by using a solution of two ounces of potassium binoxalate in 88 ounces of water, to which 11 ounces of glycerin have been added. In use, the rust or ink spot is moistened with this solution and rinsed out carefully after three hours. Lipstick stains are said to yield to a mixture of glycerin (1 part), glacial acetic acid (1 part), and methyl alcohol (3 parts). Although this is not unfailing, it is said to be highly efficient.—*D. H. K.*

Alcohol

PERHAPS the best definition of what constitutes a temperate use of alcoholic beverages is the amount that can be taken by the individual without obvious deleterious effect. Because individuals differ so much to begin with, and because the amount of alcohol tolerated by the habituated person is so different from that which can be taken by the abstainer, it is impossible to say what can be taken safely by the average person. As every one knows, there are thousands of men and women who are made dizzy and uncomfortable by two cocktails, and then again there are persons who can drink a quart of whisky in an evening without showing any sign of alcoholism.

It is hard to say also how much alcohol the average person can safely utilize as food. As Mitchell has shown in his excellent analysis of this phase of the subject, the energy of alcohol is to a large extent available to the body. When added to a complete diet, alcohol induces a greater retention of nitrogen as well as of fat. As compared with a similar supplement of sugar, the energy of an alcoholic supplement is only about three fourths as available, probably because of a greater specific dynamic effect. Its growth-promoting power is definitely less than that of sugar. These conclusions were based on experiments on rats.

The effects on the brain of drinking much dilute alcohol can be the same as those of taking a small amount of the concentrated drug. The degree of intoxication seems to be related to the amount of alcohol in the blood and probably to its rate of accumulation in the body.

Water taken with alcohol was found to stimulate its absorption and to cause a more rapid and intense intoxication, but also a quicker recovery. Milk taken with alcohol seemed to be the most effective food in inhibiting intoxication.

It is not yet clear why some persons can tolerate more alcohol than others. Cushny quotes Pringsheim, who showed that part of the greater tolerance of the habituated person is due to an increased ability of the tissues to oxidize the drug. In addition, the sensitiveness of the brain must be altered, because Sweisheimer found that a given concentration of alcohol in the blood induces greater intoxication in an abstainer than in an habitual drinker. Some students of the subject believe that the tolerant person absorbs less of the alcohol. It may be also that in tolerant persons the liver is able to handle a greater amount of the drug in a given time.

That the oxidative demands of the muscles play an important part in removing alcohol from the circulation was shown in the case of a physician whose boat capsized far out in an exceedingly cold lake. When he

(*Please turn to page* 266)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

LAST month this department contained the bare statement—as much as was then known—that Rev. W. F. A. Ellison, author of the main portion of the book "Amateur Telescope Making" and preceptor of thousands of amateur followers of the telescope-making hobby, had died, and expressed the hope that further details would soon become available. To such details we now devote most of the available space in this number.

The following communication has now been received from M. A. Ellison, his son, of Knockamel, Sheeplands Lane, Sherborne, Dorset, England:

"You and other members of the American telescope-making fraternity will hear with regret of the death of my father, W. F. A. Ellison, Astronomer and Director of Armagh Observatory, N. Ireland. At the age of 72, he had undergone a severe operation. He collapsed suddenly and unexpectedly on December 31, last, at a time when he was making a splendid recovery and was hoping to resume his duties at Armagh before long.

"I am glad to say that, up to November, last, he had been most healthy and active. One of the last things he undertook at Armagh was a large and most successful repair job to the 18" Calver reflector. He had also been a member of one of the expeditions to Greece to observe the total eclipse of the sun on June 19, last. He stayed with me at my home in Dorset just after that and was in fine fettle.

"You will remember that I am the youth you met at Armagh during your visit there in 1928. I am now Head of the Army Side at Sherborne School, and run a private observatory here. My father has left to me most of his optical stock and instruments. Some of these will come in useful for constructive work connected with a spectrohelioscope I am building.

"I think I may say that my father valued most highly your friendship and the contacts he was able to make, through you, with amateur telescope makers in all parts of the United States. In his latter years, it was a constant source of pleasure to him to know that he had been able to help so many American amateurs by means of the Scientific American book and in other ways.

"I am enclosing some facts about my father's life."

Mr. Ellison's account follows:

WILLIAM FREDERICK ARCHDALL ELLISON, eldest son of Humphrey Eakins Ellison, Dean of Ferns, and Letitia Archdall, was born in 1864.

He was educated by his father, and entered Trinity College, Dublin, with a Sizarship in Classics in 1883. His father was a man of unusual scholarship and tutorial ability. This is abundantly evident from the fact that William and his five brothers, coached by their father, all gained entrance scholarships to Trinity College, surely a unique record for any university.

He became a Scholar of the House in 1886, and in the next year graduated with Junior Moderatorships in Classics and Experimental Science. He took his Divinity Testimonium in 1890. Four years later he took his M.A. and B.D. degrees, and in 1895 he won the Elrington Theological Prize.

He was ordained by Bishop Westcott for the diocese of Durham in 1890, and he held successively the curacies of Tudhoe and the Venerable Bede's, Monkwearmouth. In 1899 he returned to Ireland as Secretary of the Sunday School Society, a post which he retained until 1902, when he became Incumbent of Monart, Enniscorthy. Six years later he became Rector of Fethard with Tintern.

It was at Fethard-on-Sea, Wexford, that his first observatory and optical workshops were constructed. Telescope making and observing soon came to occupy all his leisure time, and it was then that he commenced that wide correspondence with astronomers, amateur and professional, all over the world, which he continued actively until the end of his life. In this he was greatly assisted by a remarkable command of foreign languages, writing to his correspondents, whenever possible, in their own tongue.

From Fethard also began that steady stream of telescope mirrors and lenses which were celebrated for the excellence of their figures as well as the quality of their practical performance. In the course of his 30 years of optical work he introduced many improvements to the existing technique for the grinding and polishing of parabolic mirrors. This long experience was made available to his fellow-workers in his book "The Amateur's Telescope", and in the Scientific American publication "Amateur Telescope Making." His life was spent, as he said himself, in helping lame dogs over stiles.

His skill at mirror making was developed at the beginning of the present century in close collaboration with Dr. Nathaniel Alcock of Dublin and later Professor of Physiology in McGill University, Montreal. Out of this friendship the infant art grew rapidly, so that by the end of his life Ellison had 142 lenses and mirrors to his credit, while he must have tested and re-

Rev. William Frederick Archdall Ellison

figured very many more at various times.

He was appointed Director of Armagh Observatory in 1918. He brought with him to Armagh his 18″ Calver reflector, which he later presented to the Observatory so that it should find a permanent home. This fine instrument was constructed originally for Colonel Tupman, a well-known English amateur. It was acquired from him by the late John Pierce of Wexford, industrialist, in exchange for a steam yacht. Pierce soon found that the difficulties of erecting an observatory to house such an instrument were much greater than he had anticipated, and soon the telescope became such a white elephant that he was glad to make a present of it to Ellison at Fethard. The latter immediately planned and built with his own hands a light Ruberoid dome, much more suitable for housing an instrument of this type than the massive construction which Pierce had projected. Having refigured the mirror, which proved to be rather too much under-corrected, he used the instrument for observations of Mars and other planets.

At Armagh he also kept up his clerical work, being Incumbent of Kildarton and Canon and Prebendary of Ballymore, Armagh Cathedral.

Canon Ellison married first in 1895, Elizabeth Havelock, daughter of Joseph J. G. Blackburn and grand-niece of Gen. Sir Henry Havelock of Lucknow. By her he had three sons, the eldest of whom was killed in the Great War. He married secondly Kathleen, daughter of the late F. R. Sproule of Dublin, in 1934.

He is survived by his widow and two sons, Henry Havelock Ellison of Elstree, and Mervyn Archdall Ellison, Sherborne School, Dorset.

The late Canon Ellison was a noted Hebrew scholar. His translations of the Psalms from original sources and other works were well-known to the clergy of the Church of Ireland. He possessed, in addition, a phenomenal memory which made him a delightful companion to all who knew him and were privileged to draw upon his wide store of knowledge.

He was a Fellow of the Royal Astronomical Society, a Fellow of the Royal Meteorological Society, Member of the Royal Irish Academy, Member of the British Astronomical Association, Membre de la Société Astronomique de France and a Contributing Editor of Scientific American.

—*M. A. E.*

IN his letter Mr. M. A. Ellison mentioned this writer's visit at Armagh Observatory, in 1928, and possibly a few homely impressions of that brief visit will add to the human side of the picture. Armagh lies two hours inland from Belfast by train through rolling country as green as song and story make the Emerald Isle. Never having seen either Ellison or a photograph of him, the problem of identifying him at the Armagh railway station was a matter of looking for a man who would be looking for a man. A sudden pause was made to study an unusually arresting figure standing in a doorway—a large-framed man dressed wholly in black and with a black beard, the whole giving at first the impression of an immense Spaniard. This proved to be Ellison, who was swarthy in appearance.

A short mile was traversed in the side

car of his motorcycle, ending in the passage of a gateway and the ascent of a hill 100 feet high covering several acres—Armagh Observatory and its grounds. Atop this hill stood the group of fine old stone buildings shown below from the north, also from the west in "A.T.M.", page 359, and surrounded not, as incorrectly stated there, by boxwood trees but by large yew trees—the sturdy timber from which crossbows were made in days of yore.

The place was a veritable museum. Built in 1791, it had for generations accumulated what would elsewhere be regarded as museum pieces. The residential part contained some fine old furniture about which it was felt that a connoisseur of such things would go into ecstasies. Ellison opened a box, revealing one of those old brass-mounted Newtonian-Cassegrainian-Gregorians made by Short and once owned by King George III—the ruler with whom we Americans once had a slight difference of viewpoint. Possibly few know that this monarch was an excellent amateur astronomer, but he knew the stars too well and the British Colonies of his day too ill. Except in jokes, however, all that is forgotten when one visits the British countries.

Ellison's shop contained but little to look at—which is equally true of most optical experts' shops; in fact, the amateur's shop is likely to display more fixings than the professional's, an optician's mainstay being what is under his hat and in his fingers. After some weeks of separation from a whetstone the writer's jack-knife had become dulled, and Ellison at once volunteered to restore its razor edge, and his manner of handling it on his whetstone clearly showed that he was a natural mechanic.

Around the dining table Ellison's family circle happened by good luck to include, in addition to Mrs. Ellison and the son whose letter appears above, and who was then in the University of Dublin, his younger brother F. O'Brien Ellison of the Ceylon Medical College, at that time home on a visit (see "A.T.M.", page 409, and "A.T.M.A.", page 477—methods of silvering in the tropics). Jokingly, family allusion was made to the elder Ellison's keen zest and enjoyment of vigorous published arguments with other telescope makers, for the files of *English Mechanics* are full of letters by him, pertaining to telescopes and telescope making, few of which evidence an inclination to take a back seat. Ellison, in reply, pointed out how sad and empty an Irishman's life would be if there were nothing left to fight about, and he added that in such a contingency something would obviously have to be hunted up. He had a strong sense of humor.

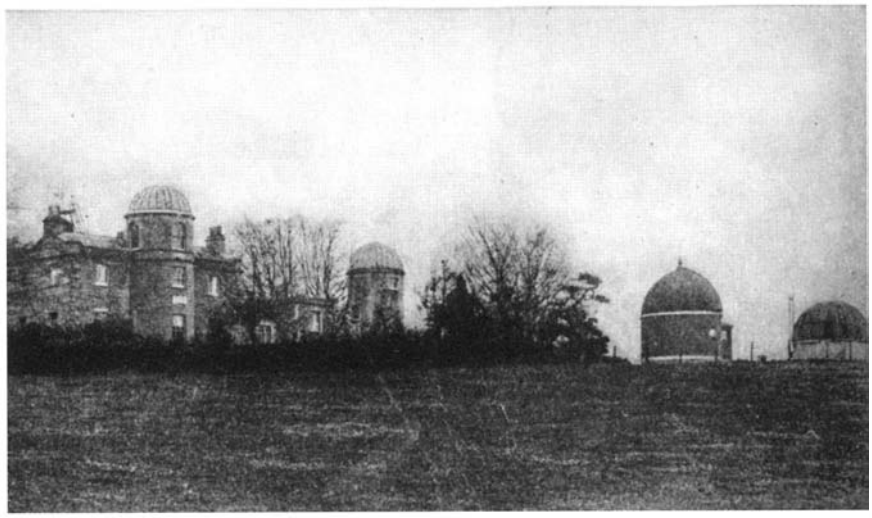
Before leaving, the writer was treated by Ellison to a splendid performance of classical music on the big organ of Armagh Cathedral, as mentioned in "A.T.M.", page 489. The installation of an electric organ and the kindness of the rector had permitted him to indulge in this happy pastime whenever the mood struck him (it is an interesting coincidence that three other coauthors of "A.T.M." and "A.T.M.A." are organists—Messrs. Hindle, Kirkham, and Haviland; perhaps organ playing smooths off the tribulations of mirror making).

Amateurs know of Ellison as a mirror maker but he was primarily a scholar, as was clearly shown by the nature of the reading matter profusely stacked about his study. He was physically a big, square man with large hands—no armchair mirror maker but a man who could do practical things and who did many of them.

The Armagh Observatory was founded in the year 1791 by Richard Robinson Baron Rokeby, Archbishop of Armagh, and 20 acres of land were selected as the site for the buildings and for the use of the Astronomer. The power of nominating and appointing the Astronomer is reserved to the Archbishop of Armagh and Primate of all Ireland for the time being. Ellison occupied the residence, and he built for actual modern use the two domes seen at the right in the illustration. A letter from Ellison, dated January, 1926, just after the telescope-making hobby had become started in this country, makes interesting reading.

"I duly received the Scientific American for November. I have been much interested by the account of the amateur astronomers of Springfield, and should esteem it a favor if you would convey to them my congratulations on their enterprise, and truly American pioneer spirit.

"As you will see by a glance at the embossed stamp above, they have adopted the motto of this ancient observatory ["The Heavens Declare the Glory of God."—*Ed.*], which was founded in 1790, and has done great work in the 136 years of its existence. When I took over, in 1918, it had fallen on evil days, and its revenues had declined so much that it was lucky for me that I



Armagh Observatory. Ellison's two modern domes at right

could make telescopes as well as look through them. Very little of the equipment was in working order; some had to be scrapped as obsolete; roofs were far from watertight, and valuable instruments were suffering from damp. I would have been very glad of the presence of the mechanics of Springfield. But in default, I had to turn my own hands to, and a fine big job I had to tackle, with practically no funds to do it with.

"One telescope, a 6-inch refractor, I made throughout myself; to take the place of an ancient metal reflector, which had lost all its polish, and lain unused for 50 years. A fine 10-inch refractor by Sir Howard Grubb I had to take almost entirely to pieces, clean, repair, and readjust; while I brought with me an 18-inch Calver reflector, my own property. With these three instruments, the 18-inch, the 10-inch, and the 6-inch, together with the transit instrument, we are very well equipped.

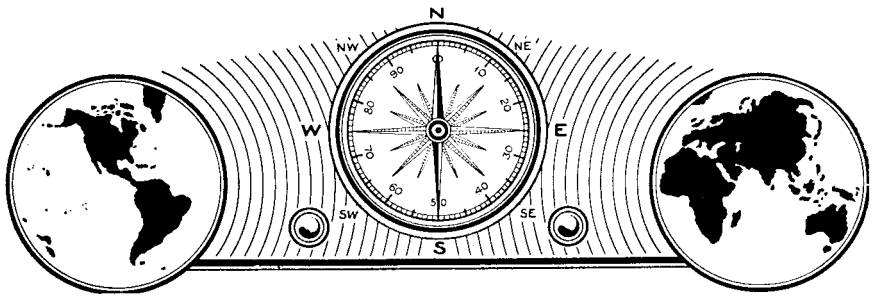
"We have a number of instruments which formerly belonged to George III, King of England, the only crowned head, so far as I know, who ever possessed a private observatory. These include a very fine clock, a mirror by Sir William Herschel, a sort of combination telescope by the famous maker Short, of 150 years ago, being a Gregorian, Cassegrainian, Newtonian, and refractor all in one; the object-glass with which King George III observed the transit of Venus in 1761; and several other articles. The combination telescope can be converted from one form to another by changing the small mirrors, and to a refractor by substituting an object-glass in their place."

In addition to his astronomical work Ellison was active in his Church. The *Church of Ireland Gazette,* kindly sent by Canon F. M. Moeran, Rector of Armagh, states that "since 1934 Canon Ellison has occupied a seat on the Chapter of St. Patrick's Cathedral, Armagh, during which time he regularly attended the Chapter and Board meetings and preached at the morning Service when it was his turn to do so. His loss will be deeply felt by this congregation as well as by the entire Church."

Possibly his congregation is aware of the extent of his prestige among amateur telescope makers the world over, but it scarcely seems likely that this can be fully sensed. Twenty thousand amateur telescope makers in America have looked to him as their chief inspiration. Amateurdom has lost heavily in losing him. His lasting monument is his long series of mirrors in many owners' hands, mainly, of course, in the British nations.

Vale and farewell.

OCCASIONALLY we are asked to publish here monthly maps of the heavens, with pertinent planet data and so on. When we dropped these, several years ago, the total number of protests was less than 100 and we decided that the space could be better used otherwise; especially since the "Observer's Handbook" of the Royal Astronomical Society of Canada, with considerably more data than we had space to present, is so easily available. Amateurs who are not familiar with this book can get it from the Society, at 198 College St., Toronto, Ont., Canada, and once it is got, the owner is more than likely to make a habit of getting it each year. It is a meaty booklet and now has simple star charts.



WORLD-WIDE RADIO

Conducted by M. L. MUHLEMAN
Editor, *All-Wave Radio*

S. W. Reception Hints

THE following notes are a summary of extensive data compiled mainly by experimentation and should be found both interesting and helpful, especially to beginners in the field of short-wave reception. They are contained in the "Guide to Reception of Short-Wave Broadcasting Stations," published by the U. S. Bureau of Foreign and Domestic Commerce—a booklet reviewed in this department last month:

"Broadcast transmission at 49 meters is most reliable when received from a distance of 300 miles or more, although good reception at distances greater than 1500 miles can be expected only when a large portion of the signal path lies in darkness.

"Thirty-one meter stations afford greatest reliability of service to receivers situated at a distance exceeding 800 miles. Good reception from distant stations in this band is possible both day and night.

"Reception from stations operating in the 25-meter band is most common when a span of 1000 miles or more separates the receiver and transmitter. Such transmission over distances of less than 2000 miles will be received best during daylight hours. The more distant stations, however, can still be heard well after nightfall under favorable conditions.

"In the 19-meter band, stations situated at a distance of 1500 miles or greater will be found most satisfactory. Signals in this band will generally be heard during daylight hours—rarely after nightfall or when any appreciable portion of the transmission path is in darkness. Wavelengths below 19 meters are useful only when transmitted entirely through daylight and over long distances (2000 miles or more); ordinarily they cannot be received after sunset."

FCC May Allocate Frequency Hole

IF the request made by the Radio Manufacturers Association is granted, the Federal Communications Commission will, for the first time, allocate a frequency on which transmission will be prohibited. This has been deemed a necessity in view of the fact that the intermediate frequency employed in radio receivers for the purpose of amplification cannot be adequately protected from interference created by commercial stations operating at or near the same frequency.

A protected intermediate frequency on 455 kilocycles is regarded as the best obtainable for radio receiver manufacturers. If this protected frequency is allocated by the FCC, assurances have been given that it will be established as a standard for the industry.

Equally as odd is the group of frequencies temporarily allocated by the FCC to the General Electric Company for the specific use of diathermy machines. The purpose is not to keep the form of interference these machines create out of the short-wave bands, but rather to provide a temporary "parking space" that a study may be made of means for eliminating the interfering radiations that have in the past interrupted reception of radio signals.

"Image" and "I-F" Interference

MANY letters are received by international broadcast station W2XAF from listeners inquiring as to why this station is received at approximately 8600 kilocycles on the dial of a modern superheterodyne receiver in addition to the fundamental assigned frequency which is 9530 kilocycles.

Such reception is known as "image response" and the source of the additional signal is the receiver itself.

In a modern superheterodyne receiver, the intermediate-frequency amplifier is usually tuned to 456 kilocycles. The tuning of this amplifier is fixed and is never altered when turning the station selector dial. The "image" of a station appears at a point on the dial which is removed from the actual frequency of the station by a value twice that of the intermediate frequency. Therefore the "image" of W2XAF which operates on a frequency of 9530 kilocycles will appear on the tuning dial at 8600 kilocycles.

This phenomenon is due to a basic shortcoming of the superheterodyne type of circuit and has nothing to do with the character of the received signal, except that the stronger the signal the greater the chance there is of being image response.

A superheterodyne receiver having no pre-selector (such sets have two-gang tuning condensers) is highly subject to image response, even from comparatively weak stations, and these images may well fall on the fundamental frequencies of other stations, thus causing interference.

A superheterodyne receiver having one stage of pre-selection (set with three-gang tuning condenser) will suffer from image response only on very strong signals. A receiver having two stages of pre-selection (four-gang condenser) is very well protected

from image response and usually will produce an image only in the event that the tuned circuits are out of alignment.

A superheterodyne receiver having no such protection may be improved by the addition of a one or two-stage pre-selector connected externally. The selectivity of the additional unit will so reduce the strength of a given signal at an off-frequency point that no image will appear.

There is no other satisfactory cure for this condition.

Intermediate-frequency or "i-f" interference is quite a different matter and is apt to show up in any receiver operated in the vicinity of commercial code stations working on approximately the same frequency as that of the fixed-tuned intermediate amplifier in the receiver. If the code signals are strong enough to "ride through" the manually tuned circuits they will be amplified by the intermediate amplifier and passed on to the loudspeaker. These signals cannot be tuned by means of the manual control and therefore are heard over a large part of if not the entire dial scale.

The cure for this difficulty is quite simple; the addition of a "trap circuit" connected in series with the antenna lead and tuned to the exact frequency of the code transmitter will prevent the impulses from entering the receiver. Once the trap is correctly tuned, no further adjustments are required.

Any competent radio service man can install and adjust such a trap in a matter of minutes.

Ursigrams from W1XAL

GROUPS of scientists and research workers in all parts of the world will now be able to receive daily radio broadcasts of cosmic data, sun spot changes, and magnetic disturbances via short waves from W1XAL in Boston, Massachusetts. President Walter S. Lemmon (W1XAL) inaugurated the new radio service starting February 1st. At 4:55 P.M., Eastern Standard Time, each weekday, bulletins known as Ursigrams are to be broadcast over W1XAL on 11.79 megacycles (25.45 meters) and will be picked up by laboratories equipped with radio receivers not only in all parts of the North American continent but also in Europe, South Africa, and Australia as well. Weekly summaries of this data will be given each Monday at 8:30 P.M. on 6.04 megacycles (49.67 meters).

Science Service at Washington is co-operating with W1XAL in this work. They have been compiling this scientific data daily for several years. Previously these bulletins have been mailed to selected lists of research workers and also transmitted in telegraph code from NAA, the naval radio station in Arlington, Virginia, to a limited number of points. Now through the world-wide facilities of W1XAL this broadcast service will enable many thousands of scientific observers and amateur astronomers to receive up-to-the-minute information to assist them in their local observations. Through the co-operation of the Harvard Observatory, reports of any unusual celestial phenomena will also be added to the broadcast.

The name Ursigram is derived from the initials of the Union Radio Scientifique Internationale which formulated the original plan for gathering cosmic data.

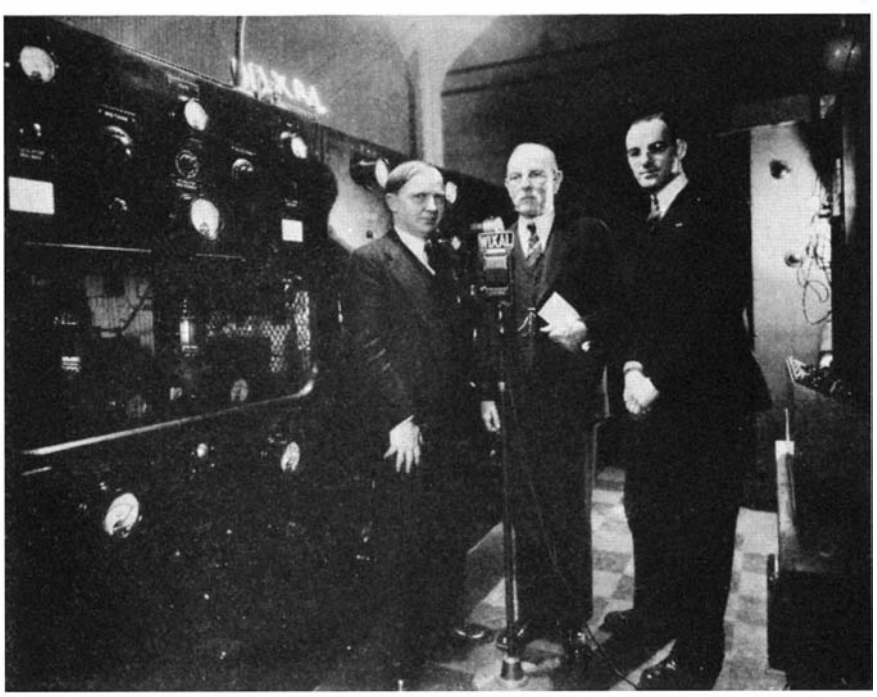
Heredia Operating Daily

FORMERLY known as NRH, short-wave station TI4NRH, at Heredia, Costa Rica, is now operating daily from 8 to 9 P.M. and from 11:30 P.M. to midnight, Eastern Standard Time. The frequency is 9.67 megacycles.

Reports of reception should be addressed to Señor Amando Cespedes Marin, Apartado, 40, Heredia, Costa Rica, Central America.

Ravag Back on Air

THE short-wave station of the Ravag, OER2, has been rebuilt and is now transmitting on a wavelength of 25.42 meters with a power of 1.5 kilowatts.



At the first Ursigram broadcast from W1XAL. Left to right: Prof. Harlow Shapley of Harvard Observatory, Dr. A. E. Kennelly, and Dr. Loring B. Andrews

CAMERA ANGLES

Conducted by JACOB DESCHIN

A Scoop

TIME may march on, but the inventors and the scientists who have made photography a wonderland of modern times go faster still; they fairly leap ahead. No man dare predict what new marvel they will next produce, or laugh at the wildest imaginings of his wishful-thinking camera friends. They may be dreams today, but precious realities tomorrow.

Apropos, we have this month the pleasure and the honor to present what in journalistic parlance is known as a "scoop"; that is, a beat, a tip, an advance notice or, if you will, "inside dope." In other words, a scoop—unless somebody else, willy-nilly, gets ahead of us. And this is it: a reflex camera using 35-mm film, which can be focused at either eye or waist level with provision for easy interchangeability of lenses of various speeds and focal lengths, and at a price within the reach of the serious-minded advanced worker.

This most recent advance in miniature camera design has been named the Kine-Exakta, sister of the Ihagee Exakta (made by the Ihagee Camera Works, of Dresden, Germany) which has gained such a fine reputation for itself in the vest-pocket reflex field. We owe it to the confidence of our friend, Joseph M. Bing, of the Photo Marketing Corporation, that we are able to be the first among our magazine confrères to make this announcement. At the time of this writing, the camera has not yet reached the United States, but it will doubtless be in the stores when this reaches you.

Shaped like the regular Exakta and having about the same dimensions, the Kine-Exakta is equipped with a focal plane shutter permitting speeds ranging from 12 seconds to 1/1000th of a second, as well as delayed action allowing practically the same speeds except in the slower brackets, where the longest possible automatic timing is 6 seconds. There is, of course, as with other cameras, provision for time and bulb shutter operation for much longer exposures. The automatic film transport is coupled with the shutter curtain, preventing double exposures. Being of the single lens reflex type, the Kine-Exakta cannot give parallax trouble.

The camera can be focused at eye-level as well as the usual lower level in a ground glass combined in one piece with a focusing magnifier that enlarges the visible image to 4 by 6 cm, that is, full vest-pocket size. For greater convenience and to insure critical sharpness, a secondary or auxiliary magnifier may be swung over the ground glass to give a magnified image of 6 by 9 cm, or 2¼ by 3¼ inches.

The Kine-Exakta accommodates an attractive variety of lenses in bayonet mounts ranging from the normal 5 cm (2-inch) Exakta F:3.5 and Tessar F:2.8 to a line of telephoto lenses having focal lengths of 12 to 25 cm, and speeds of F:6.3 to F:4.5. With the 5.8 cm Biotar F:2 or the 5 cm Primoplan

The new Kine-Exakta

F:1.9 the new camera becomes the Night Kine-Exakta.

The camera body is beautifully embellished with the popular chromium fittings and takes the same accessories, such as filters, close-up lenses, lens shades, and so on, as the regular Exakta.

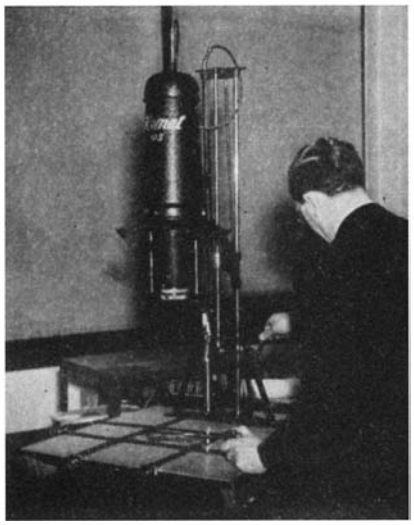
Luster Prints

A METHOD of adding luster to prints and enlargements on matt surface papers as well as of providing a medium for spotting with a pencil that may be new to some of our readers, though old to others, is given below.

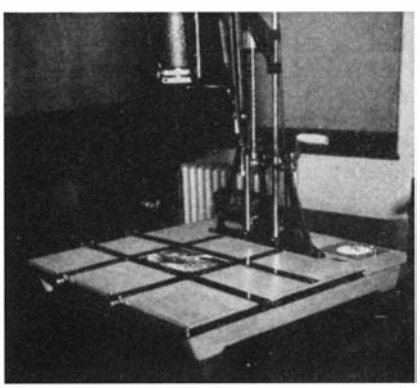
The formula calls for one part mastic varnish, one part linseed oil, and two parts turpentine, all these materials of artists' quality. After this mixture has been shaken, a wad of cotton is dipped into it and then rubbed well into the print, the surplus being removed with clean cotton. After a day or so it will be dry, without surface gloss or stickiness. Spotting with a pencil may then be done where needed, though spotting with water color will have to be done before the treatment is applied.

Another New Enlarger

STILL another piece of news on which we have been able to obtain information in advance of the product's arrival in this country is the advent of the Komet 105, something thoroughly modern in the field of enlarging cameras. Its outstanding features are a built-in light control unit and time switch, a baseboard and easel combined having a working space of 20 by 25 inches exclusive of the portion allotted to the rheostat and the time switch, making possible 16 by 20-inch enlargements and a bit larger



Komet 105 in use



Note the large easel

directly on the baseboard-easel, and a convenient geared handle for raising and lowering the camera for determining image size. The camera is of the condenser type. Focusing is done either with the handle and rotation of the lens mount or automatically by adjusting a scale.

The camera takes films up to 6 by 9 cm (2¼ by 3¼ inches) and smaller, and is normally supplied with a Tessar F:6.3 lens of 10.5 cm focal length, though provision is made for interchanging this in a bayonet mount with lenses of shorter focal length if and when greater magnifications are desired than those possible with the regular lens, which gives magnifications of 1½ to 7 times linear. The diaphragm openings are made clearly visible in a lens barrel designed for the purpose, and the barrel is so designed that successively smaller stop openings may be obtained without examining the stop indicator but merely by "feeling" the stops, a little catch at each stop making this possible.

School Photography

PHOTOGRAPHY in the schools recently had an enthusiastic boost in a successful venture at Lehigh University, Bethlehem, Pennsylvania, where a course in photography is now being given in connection with the regular journalism instruction at the school for candidates for posts on the student newspaper, *The Black and White*. So great has been the response that the class had to be divided into two sections. With the purchase of a miniature camera and the setting up of a regular darkroom, the semi-weekly news photographers were ready to go to work. The instruction, which is given by the assistant in journalism, includes mastery of developing and printing and of what it takes to make pictures under the varied conditions which newspaper photographers face.

The photographic editor of the semi-weekly may call on any member of the class to cover a photographic assignment, as a result of which pictures have been made available to him of all types of student activities, including sports, dramatics, debating, music, pledgings by honorary fraternities, dances, pep rallies, and so on.

Here's a swell idea for other schools to try.

Weighing Scale

A BALANCE capable of weighing from 1/100 gram up to 100 grams is attracting wide attention among photographers. Compact, without loose parts, the Bennett Balance, as it is called, took eight years to perfect and is characterized by fine sensitivity, weighing to one decimal point farther than the usual low-priced counter scales. It has been recommended not only for photographic chemicals, but also for experimental work, organic synthesis, compounding, and so on. It is small and portable. There is available to it two important accessories, a black Bakelite carrying case and a dustproof table balance case made of non-inflammable transparent cellulose acetate, thus furnishing protection from dust, fumes, and injury when not in use. Certainly worth while investigating.

Traveling With Bike and Camera

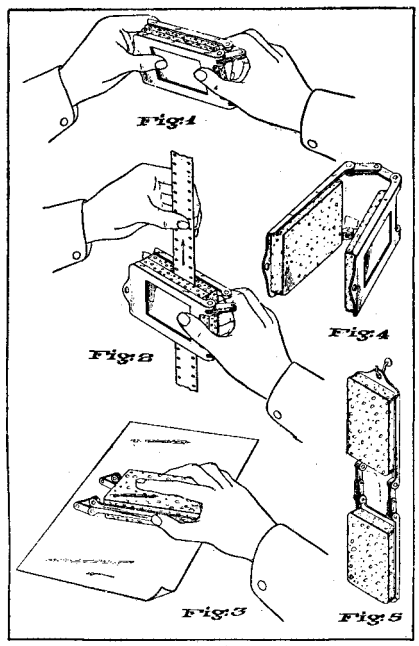
BY the time you read this, spring will be just around the corner and vacation time not very far away. Ever think of taking a cycling trip during those two weeks of release from the routine and cares of a job, and shooting pictures along the way? Lots of people are doing it and, from the news we hear, many more will be taking to this pleasant way of traveling about, whether on vacation or during week-ends. We learn that during 1936 more than 1,200,000 bicycles

A typical vacation "shot"

left the factories, held to be a record. It is estimated that this total is twice the 1935 output and nearly four times the average number made yearly between 1928 and 1934.

Film and Paper Drying

A NEW device for swabbing negatives and prints after washing is now available. It consists of two viscose sponges mounted on a pair of toggle-hinged Bakelite shells and is known as the Duo-Service Sponge-Pack. Each of the sponges when dry measures 3½ by 2¾ by ¾ inches and the combined absorption of both sponges totals eight ounces. The double-function feature of the new device is, first, the convenience of removing surface moisture from the front and back of the film at the same time with one hand, and, secondly, the surface-drying of papers, Bromoils, and any other flat surface. The Sponge-Pack will take film up to 3½ inches width.



Using the new drying sponges

The sketch shows how the two shells are compressed to remove surplus water from the sponges (Figure 1); how film is dried (Figure 2); how paper or any flat surface, such as a squeegee plate, is dried by folding the shells over, back to back, exposing two sponges ready for use (Figure 3); how the Sponge-Pack is rested on its Bakelite edge, free from contact with grit and dust (Figure 4); and how the Sponge-Pack itself is hung up to dry, the Bakelite shells against the wall, the sponges free to the air (Figure 5).

Still Projector

THE inevitable corollary of the color transparency now so popular because of the advent of such color films as Kodachrome and Dufaycolor is the projecting camera for enlarging the picture in full color on a screen. While the projecting camera is, of course, used for projecting black and white stills as well, the manufacturers' revived interest in these machines is doubtless due to the success achieved with modern color film and the consequent demand for viewing the transparency in large size.

The latest projector to appear on the market is the Kodaslide Projector, intended for

users of miniature films and for projecting individual pictures, properly masked and mounted in a 2- by 2-inch glass slide suitably bound. The lighting unit is a 200-watt 115-volt projection lamp backed by a spherical aluminum-coated glass reflector. There is a three-piece condenser lens unit and a 4⅞-inch projection lens.

Filmpack Picture Frame

IF you have ever sighed with regret at having to throw away the neatly made filmpack containers, try using them as picture frames. They are eminently efficient for this purpose and may, with a little ingenuity, be made to look quite attractive. Simply make or trim a print to fit the dimensions of the container, making provision, of course, for the borders which are to be hidden by the "frame" of the container, and slip it in. The spring on the back, which is used for keeping the film flat, will do the same service for your print.

Through the Window

THE camera bug bites hard. With most of us it does the job so well that we start shooting the minute we awake. And here's one proof. This was made with a 35-mm

"Morning in the City"

camera opened to F:4.5 and shot at 1/10th second in order to record some of the detail in the window through which the exposure was made and, deliberately, to show the man and boy in movement. Everything else in the picture is so static that it seemed the only thing to do to make the picture "human" was to show the strollers in motion.

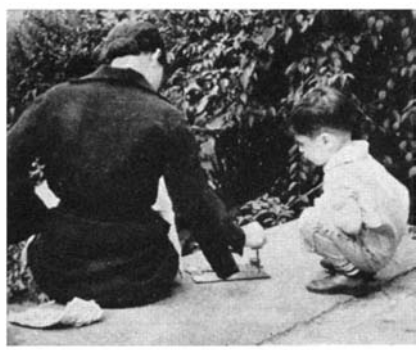
Filing 35-mm Negatives

IF you have been finding some difficulty in filing your miniature negatives in a way to keep them away from dust, see what you think of this idea. This department has found small tins, in which Eastman 35-mm magazines come packed, to be ideal for this purpose, since they are just large enough to take a roll of 36 negatives without waste of space and the cover is deep enough to insure against the entrance of dust. The manufacturers recommend these tins for this purpose but should you not wish to buy magazines because you have some anyway and

purchase your film either in the "paper-leader" style or "load your own" by purchasing your film in bulk, your dealer can get you a supply of these tins.

Child Photography

CHILDREN are still the world's best subjects and they're the easiest to shoot "candidly." The small boy in this picture seems totally oblivious of the camera and to be completely absorbed in watching the artist mixing pigments. Maybe we take too many pictures of children, but that's only because we love them so well we hate to miss a single chance to snap them. However, now and then we get a real corking shot such, for instance, as the contribution shown here. Notice, too, how pleasing is the composition.



"The Budding Artist"

The Weltini

FEATURING a trigger shutter release claimed by the makers to make possible "shutter speeds of ½ second with the camera held in the hand," an automatic return to infinity and a built-in range finder coupled to the lens which also acts as a direct view finder, the 35-mm Weltini using the usual 36-exposure roll of 1 by 1½ inch film is now on the market. It has a Compur Rapid shutter with speeds up to 1/500th second and there is available a choice of three lenses, the Tessar F:2.8, the Xenon F:2, and the Xenar F:2.8, the price of the camera being governed by the choice of the lens.

Microphotography

THOSE who are still in doubt as to just what is the difference between photomicrography and microphotography may find clarification as to the latter in a report that the United States Census Bureau is reducing by microphotography the 50,000,000 names comprising the census of 1880 and contained in 1024 volumes. By this new method a book twice the size of the largest dictionary, weighing 25 pounds, is being transferred to a roll of film four inches in diameter. The complete census record will be stored in 28 ordinary filing cabinets. [See page 266. *Ed.*]

Small Stop for Street Pictures

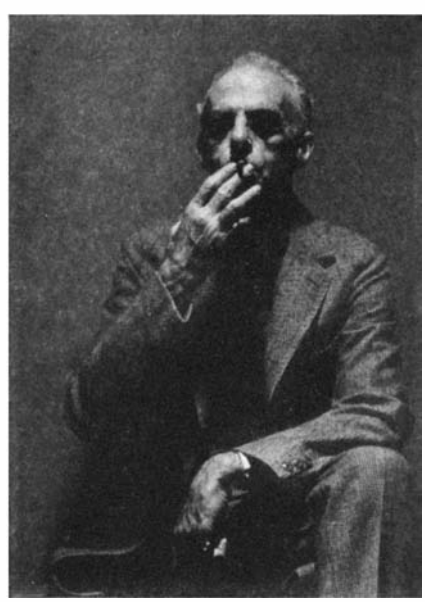
FOLLOWING the suggestion of one of our readers, we hereby pass on to those unfamiliar with the procedure the method used in taking street or similar photographs where it is desired not to include passing subjects. The two essentials are a slow film and a very small diaphragm stop, necessitating, of course, a rather long exposure. The small stop, F:22 or F:32, will prevent the recording of any passing subject, although if some person should decide to stay put for a while and then pass on, he will be included in the picture, though as a "ghost." To prevent this happening, unless you want it, place the cap over the lens if any subject seems to show signs of not moving on in a hurry and uncover it again after he has passed on. You will, of course, have to make a note of the time elapsed when you put on the cap, and resume counting after removing the cap.

Latest Simmon Enlarger

ATTRACTIVELY designed and beautifully compact is the new Omega Enlarger, the second product in this field by the makers of the now famous "suitcase" enlarger, the Simmon Complete Enlarger. Distinctly a "miniature" enlarger, it takes film sizes from 2¼ by 2¼ inches and smaller, individual film holders being supplied for different size negatives. It is equipped with a double condenser system which may be easily cleaned and may be operated from either alternating or direct electric current. The lamp-house is supported by two strong "U" channel beams of aluminum and there is ample clearance between the lens and the supporting post, a heavy tube set in a strong casting which in turn is firmly attached to the 18 by 25-inch baseboard. To facilitate composition, the lamp-house is designed to swing in an arc as well as to move vertically. The enlarger takes a 3-inch lens and is sold either with or without lens, a choice of two 3-inch lenses being available, the Simmon Enlarging Anastigmat and the Dallmeyer Enlarging Anastigmat.

Portrait Lighting Kink

TAKING a tip from the field of sculpture photography, we made a shot of a human subject and found the result rather gratifying—at least to ourselves. A single Photoflood was suspended about three feet over the head of the subject in "Balance" to give the effect shown. Light used in this way will



"Balance"

reveal texture beautifully and dramatically. It is not, of course, suited to all subjects, but in this particular case it seemed to do the trick to perfection.

What Is It?

WHAT do you think? It might be a snake. And then again. . . . The truth is, it is not a snake, but a harmless corkscrew set up against the background furnished by an ordinary paper napkin and shot by means of photomacrography. This method of getting a large image of a section of an object and making it appear like something never seen on land or sea has been mentioned in this department before, but it is hoped that this reminder will encourage some of our readers to try their hand at this fascinating game, if they have not already done so. A wide-angle lens and a little imagination are all the requirements.

"?"

One in a Thousand

THE lads who produce photographs for the daily press must generally have a pretty dull time of it, what with the routine run-of-the-mill stuff they must turn in to "break up" the solid text of a newspaper page or to illustrate an important story. But once in a blue moon somebody with imagination shoots a picture that clicks all around and is reproduced in a great many papers simultaneously. Such a picture was made during the recent floods by an Associated Press photographer on the job at Memphis, Tenn. It showed a group of Negro convicts, chained to each other at the ankles, carrying sandbags for the protecting wall being built against the rising waters. You have doubtless seen this picture no matter what part of the country you live in and what newspaper you read. One of the Negroes has turned toward the camera and smiles broadly, seemingly oblivious of his chains and carrying his sandbag with the air of one on a leisurely hike with his pack of supplies on his shoulder. The point of view, from below, was an inspiration and is, in fact, perhaps the making of the picture. It's a picture in a thousand and perhaps there was an element of chance in its making, but there is no doubt that the photographer had something of the sort in mind or he would not have descended to a low level in order to shoot upward against the sky.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 253)

reached land, suffering terribly from the cold and shivering violently, friends wrapped him up and gave him a pint of whisky. To his surprise this man, who was practically an abstainer and always very sensitive to alcohol, experienced almost no psychic effect from the overdose of whisky. Apparently his quivering muscles utilized the stuff very rapidly.—*Journal of the American Medical Association.*

Filming Census Records

ANTICIPATING the heavy demand for proof of age in connection with social security benefits, the Bureau of the Census recently started copying in microscopic size on film the 50,000,000 names recorded in the 1024 volumes of the census of 1880, according to an announcement by Director William L. Austin. Photographic equipment especially built for the Bureau is being used.

At the same time, machines of a different type are recording on film the 76,000,000 names returned in the census of 1900, which have been transcribed on 33,000,000 cards from the original volumes.

It is these two censuses—1880 and 1900—which contain the facts that will be of greatest value to people attempting to qualify for benefits under the Social Security Act, as well as under similar legislation in force in the various states. The volumes of the intervening census—1890—were destroyed by fire and water. The volumes in the Census Bureau form the only documentary birth record of many Americans, since registration of births by local authorities was not general prior to 1915, even though New Hampshire has birth records on file dating from 1640.

Miniature copying of Census records by photography will serve several purposes. First, the original documents of the human history of our country will be preserved from the wear and tear of frequent handling; second, the serious problem of storage will be solved, as one roll of film less than four inches in diameter will record the 70,000 names contained in a census volume twice the size of a large dictionary; third, the present method of searching for names in the 25-pound census volumes, which have to be removed from vaults for the purpose, will be eliminated; fourth, existence of duplicate records on safety film will be an added precaution against loss by fire or water.

Photographing census books

Photographing loose pages

Cameras eleven feet high are doing the major copying job. Two were designed for photographing loose sheets. A suction roller carries the pages under the lens of this apparatus as rapidly as they can be fed down a sloping tray, and the sheets are filmed "on the move." The other two cameras photograph pages in bound volumes, with a carriage moving the large books back and forth automatically to let each of the two facing pages be "shot" successively.

The specially built cameras being used are products of the experimental laboratories of the Eastman Kodak Company. No equipment to do the work was available and the machines had to be designed and individually built to meet the Bureau's needs.

It is estimated that a 95 percent saving in storage space will result from putting the census records on film. The 8,700,000 pages of census reports now in storage occupy almost a mile of shelving. Copied on film, all of the records could be stored in 28 standard-size file cases.

Improved Magnesia Cements

BY adding 10 percent of finely divided copper powder to the cement made by mixing plastic magnesia with a solution of magnesium chloride, many of the disadvantages of older magnesium oxychloride cements are overcome. Magnesium oxychloride cements have been used for building purposes because of their relatively high strength as compared with Portland cement concretes. They have also been used as adhesives and binders in composition floors, stucco, tiles, and other building materials.

Their principal drawback has been that they dissolve and disintegrate when exposed to the weather or when repeatedly washed. They also show a large change of volume on curing.

The addition of copper powder to the mix overcomes these disadvantages and actually increases the strength and resiliency of the cement while materially increasing its resistance to water. The new cements adhere permanently to stone, brick, concrete, marble, wood, and fibrous materials. Adhesion is generally greater than the strength of the materials themselves. They even adhere tightly to glass. Because of their high strength they are recommended for preformed articles such as tiles, garden furniture and statuary.—*D. H. K.*

Rayon Typewriter Ribbons

TYPEWRITER ribbons made of specially processed fine denier, multi-filament, Bemberg yarns were announced recently by Remington Rand, Inc. It is pointed out by W. H. Mathews, General Manager of the typewriter division, that this is the first time synthetic yarns have been used commercially for this purpose, and opens up an important and heretofore unexploited market. Ribbons used previously for typewriters have been made either of silk or cotton yarns, and for the most part these have been imported materials.

The extreme fineness of the ribbon is exemplified by a filament count of 11,520 filaments per square inch, stated to be an accomplishment never before attained in typewriter ribbons. The ribbon makes possible clear, sharp letters having the appearance of printed type. Uniformly longer ink life than any ribbons on the market, and exceptional durability are important qualities of the new ribbons made possible by the unique properties of this specially processed cuprammonium yarn, it is stated.

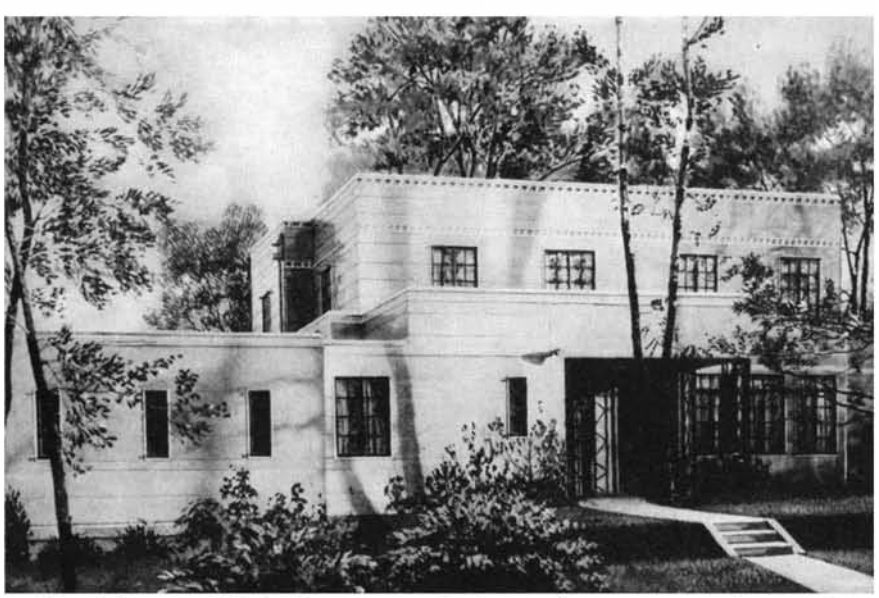
Porcelain Enameled House

EMPLOYING the newest in both style of architecture and building materials, a recently completed St. Paul, Minnesota, house has attracted the attention of building stylists all over the country. It strikes an entirely new note in residential construction.

Gleaming white porcelain enameled steel sheets cover the entire exterior of the residence. Rains or a garden hose will keep it just as white as the day it was built; it will never require a coat of paint.

In keeping with the modern tone of the exterior, this well insulated home is equipped with the latest type of air conditioning and heating plant.

The building was constructed by The Insulated Steel Construction Company, while all metal used in the structure was manufactured by The American Rolling Mill Company.



Porcelain enameled steel exteriors are always clean, never need painting

ICE HEAT

FRESH flowers shipped from the West Coast are "heated with ice." Ordinary wrapping and insulation previously would not prevent temperatures far below freezing from destroying the flowers entirely. A coating of ice holds them to a much warmer temperature—approximately the freezing point.

Trichinosis Greater Problem in United States than Anywhere Else

THE United States has the greatest trichinosis problem of any country in the world, Dr. Maurice C. Hall of the National Institute of Health, U. S. Public Health Service, recently declared. Millions of persons are involved in the problem of this disease that results from eating mealy pork, studies by Dr. Hall and his associate, Dr. Benjamin J. Collins, showed.

Trichinosis is a painful disease that may end fatally. It is caused by worms, called trichinae, which are frequently found in pork. Thorough cooking of the pork kills the worms and protects against the danger of eating the infested meat. Unfortunately, however, pork is not always cooked thoroughly enough to kill the worms, and there

is a growing tendency to eat raw pork. The popular raw hamburger, for example, often contains some pork as well as beef.

One out of every eight Americans, or, 16,250,000 over the age of infancy, have some of the trichina worms in their bodies, Drs. Hall and Collins estimate from their post mortem examinations of hundreds of persons who died in Washington, D. C., hospitals, but who came from every state in the Union and every walk of life. Not all of the millions infested have enough worms to be sick with trichinosis. Probably 769,250 living Americans, however, have had trichinosis, the scientists estimate, and there are probably thousands of deaths from the disease every year.

Boston and San Francisco are the two largest trichinosis centers, and the South is freest from the disease. The reason for this, and for the general high incidence of trichinosis throughout the country, is a matter of how swine are fed. In the North, swine are largely fed on pork scraps, garbage, and swill. In the South, the old custom of letting swine roam at large and forage for their own food, bringing them in for final fattening on peanuts, cuts down the number of worms they get in their feed to a very great extent. There is a very large garbage-fed hog industry on the West Coast, including what is probably the largest plant of this sort in the world. This supplies pork to San Francisco and Los Angeles and probably accounts for the high trichina infestation among persons living there. Control of trichinosis depends on better and more extensive meat inspection and on improving the methods of feeding swine.

Housewives and cooks are another class especially exposed to the danger of trichinosis from infested pork which they often sample in its raw state while preparing it.—*Science Service.*

Freak Accidents

T. A. BURKE, editor of *Public Safety* magazine, vouches for the following freak accidents of recent months:

The acetylene torch operators (two cases) who cut holes around themselves in the top of giant steel tanks and fell through . . . the power drill operator who did the same thing through concrete and landed on the floor below . . . the manhole cover that blew up in Chicago just as a motor car was passing over it . . . the explosion that failed to occur when a California driver of a truck of dynamite (plus the detonator caps) drove over an embankment to avoid hitting a bus load of children . . . the Chicagoan who unknowingly hit a woman pedestrian and carried her three blocks on the bumper, and then was charged with leaving the scene of an accident . . . the eight-year-old Columbia, Missouri, girl who slipped between the ties of a railroad bridge and hung by her head . . . the man who died of heart failure at the wheel of his car in New York and then drove on to kill one person, injure three, and wreck three store fronts.—*Science Service.*

TREES

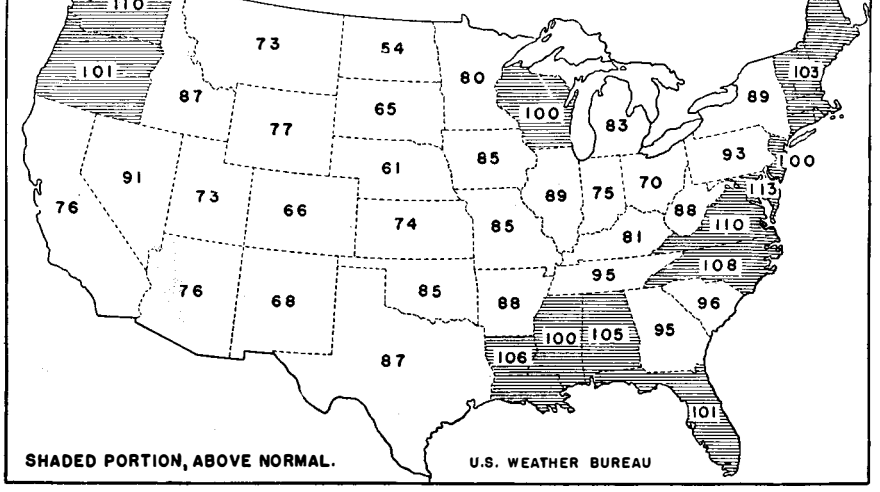
DURING the year 1937 the Soil Conservation Service plans to plant approximately 175 million trees and shrubs as part of the erosion control program.

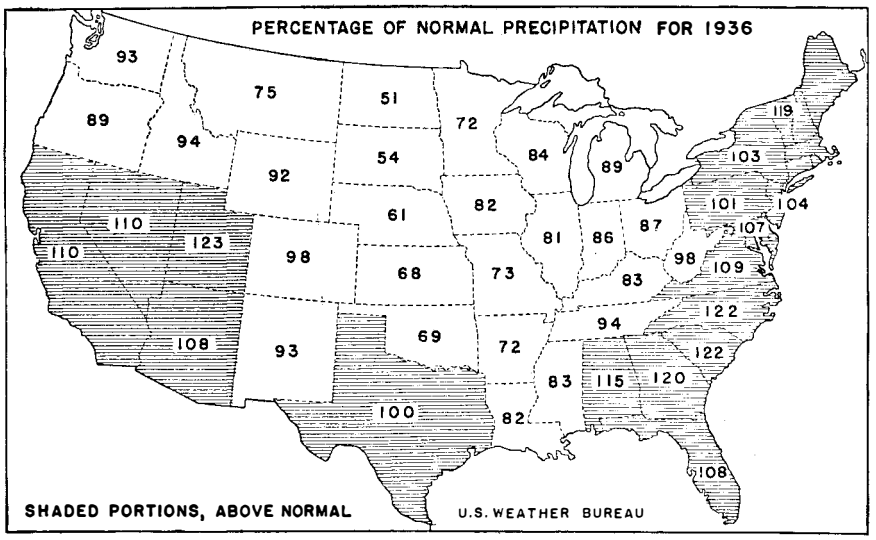
Weather Owes United States Moisture

THE weather owes most of the United States a great deal of moisture, according to J. B. Kincer of the United States Weather Bureau. The year 1936 left a deficit in rain and snowfall somewhat greater than that left by 1934 and in about the same areas—practically all of the interior of the country. Precipitation maps for the two years show rainfall reaching normal only in coast states, and not in all of them both years.

States on the Atlantic and Gulf Coasts had normal or above normal precipitation in 1934 and 1936, except New York, South Carolina, Georgia, and Texas in 1934 and Louisiana and Mississippi in 1936. On the Pacific Coast precipitation was above normal in Washington and Oregon in 1934 and in California in 1936. Nevada, Utah, and Arizona had more than their usual rainfall in 1936 and Wisconsin touched the normal mark in 1934. Everywhere else precipitation was below normal, often far below, in 1934 and in 1936.

These two extremely dry years following 1930—also very dry over large areas—caused a critical moisture shortage in the central part of the United States for the period from January 1, 1930, to September





30, 1936, despite the plentiful rains and snows during short periods, especially in 1935.

The year 1937 seemingly wished to make amends, at least in the Ohio River Valley, with the resulting enormous floods from which the valley will not fully recover for a long time.

APPLES

DESPITE the fact that orange production is up 155 percent since 1915 and grapefruit production 118 percent since 1921, there has been no increase in consumption of apples in this country in the last few years. Since the population has increased, per capita consumption of apples has obviously decreased.

MAKE DRINKING WATER SAFE

PERSONS living in or traveling to areas where the water supply may be polluted temporarily can assure themselves of a safe drink of water by adding a drop of iodine to each glass of water. The ordinary tincture of iodine for first-aid treatment of cuts does the trick of destroying typhoid fever or other harmful germs. A drop will make as much as a quart of water safe for drinking. Persons traveling can carry with them the little ampules made for first aid use. The value of iodine for this purpose was discovered by Maj. A. P. Hitchens of the United States Army Medical School. —*Science Service.*

DYES KEPT FROM "BLEEDING"

YOU might shudder at the odor of a stale egg; or turn up your nose at the smell of a bad fish; or choke on ammonia fumes. But the ammonia which chokes, the hydrogen sulfide gas which makes the egg smell bad, and the phosphine gas which makes the fish smell foul, says *Science Service,* are the basis of the newest test tube "babies" for the textile industry—the "onium" compounds.

Watch particularly the quaternary ammonium, phosphonium, and sulfonium chemical infants. These are complex compounds with hearts of nitrogen, phosphorus, and sulfur atoms. They bring joy to the textile dyer, printer, and finisher, who is responsible for the beautiful color and finish of the clothes you wear.

Does the dye in a dress "bleed"; that is, run when it is wet or contacts perspiration? Just dip it in a warm solution of cetyl pyridinium bromide, rinse, and dry. Notice how fast the dyes become. Water and perspiration no longer make them run.

Did the dyer put the wrong dye on the fabric, or didn't the dye go on evenly? He needn't worry. He can strip the dye completely from the fabric and dye all over again. Trimethyl cetyl ammonium bromide, another one of those new "onium" compounds, does the trick.

Other of the "onium" chemicals whose names need not worry the layman have now made it possible for the dyer to use wool dyes on cotton and synthetic silks. This is helpful for the wool dyes have always been of brighter shades than the others.

Finally, the new compounds have been found to serve, also, as the nuclei out of which new dyes for wool and acetate rayon can be synthesized. Many patents have been taken out here and in Great Britain for the new uses of these onium compounds.

ELECTRICAL APPLIANCES MAY COOL OFF WITH AGE

WHY does that toaster or percolator or waffle iron take so long to do its job? It used to be so fast when new. That frequently posed question can be answered by referring to the "growth" of the heating-element wire which, in turn, increases resistance and thereby cuts down wattage and subsequent heat.

"Growth of alloy wires for heating elements," points out Wilbur B. Driver, "results in permanent increase in length during long heating at high temperatures. It takes place even though the heating element is under no tension or mechanical load. And it occurs in all resistance wires, but more with some alloys than with others. The effect of sag on resistance wire is similar to growth, although here the cause is different. We have the actual weight of the wire which, when heated, is deprived of its tensile strength and therefore droops. A resistance wire should obviously have sufficient hot tensile strength to support its own

weight at operating temperatures. Sagging, as with growth, also causes an increase in length during service and thereby decreases wattage and operating temperature.

"Inexpensive resistance wires used in cheaper grade electric appliances are characterized by such a high rate of growth that they must be discarded before actual burnout. The operating temperature drops so low—as much as 200 degrees, Fahrenheit, in many instances—that such elements must be discarded.

"Nickel-chromium alloy wires used in better grade appliances, will show a useful life almost as long as the life to burnout. Growth and sag are minimized. It therefore pays to insist on a good grade nickel-chrome wire in heating elements that must remain 'hot' throughout a long service life," concludes Mr. Driver.

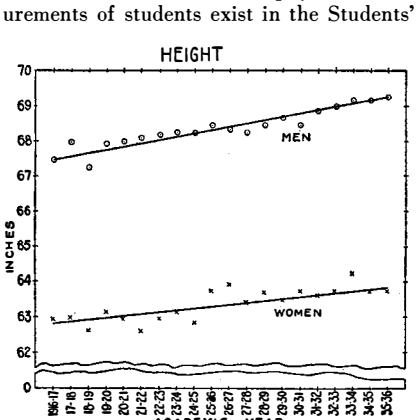
We Grow Taller, Larger

SCIENCE undoubtedly has had more than a little to do with the fact, brought into the clear by many modern observers, that the race is taller today than it used to be. In the *Journal of the American Medical Association*, Laurence B. Chenoweth, M.D., shows new evidence of the same kind.

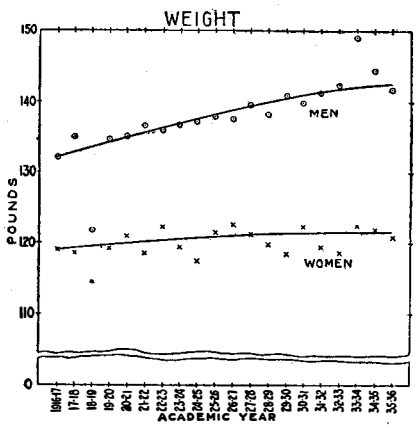
"In 1921," he says, "Clelia Mosher noted that the height of Stanford University women students had increased one inch in 30 years. In 1926, Czechoslovakian children were found to be one year advanced in size over what they were 30 years before. In 1927, Gray found American boys of American born parents to be more than two inches taller than the same type were reported to be 50 years earlier."

He continues: "An interesting study was made at Harvard College several years ago when the records of 1166 fathers of Harvard students were searched out and compared with the present-day records of their 1461 sons. The fathers were measured between the years 1875 and 1910 and were found to have a mean height of 68.6 inches. Their sons averaged 70 inches tall. Similar studies were also made at Wellesley, Vassar, Smith, and Mount Holyoke, and the college daughters averaged 64.8 inches in height, which was 1.1 inches taller than their mothers had been while students. The whole study was conducted by Bowles and published as a monograph. This investigator concluded that stature has been increasing at Harvard for the past 80 years or more and that the mean annual increase has been at the rate of one inch every 32 years.

"Good records of careful physical measurements of students exist in the Students'



We are growing taller



We are growing heavier

Health Service of the University of Cincinnati," he finds. "These records go back to 1916 and contain a history and physical examination for each student. Among other things they show his place of birth, his present legal residence and the place of birth of each of his parents."

Dr. Chenoweth summarizes his findings in the two graphs which are reproduced, and he concludes that:

"The probable causes of the increase in stature and weight of young people are better nutrition in infancy and childhood, less communicable disease, higher standards of living, and a higher degree of health intelligence among people in general."

RIDDLE

WHAT is it that can look two ways at once, swims in the water, has a tail like a monkey, the shell of a beetle, and the head of a horse? The answer is: the hippocampus, or "seahorse." One other peculiarity is that the hippocampus reverses the ordinary way of nature, for the male, instead of the female, gives birth to the offspring.

Sunspots May Be Related to Human Events

EVER since they were discovered, sunspots have been associated with various cyclic terrestrial phenomena, and the maxima have sometimes been stressed as heralds of disaster. Precipitation, rainfall, crop failures, famines, panics, wars, and pestilences have been associated with sunspots. Some of the relationships claimed have been supported by considerable evidence, but most of them cannot be considered as proved.

An outstanding objection is that the sunspots themselves are not primarily causative. They themselves are probably results of deeper forces which, it is quite likely, produce profound effects on the surface of the earth and consequently in human history. Except for two or three exceptions, the relationships between sunspots and terrestrial phenomena are secondary.

The intervals between sunspot maxima have varied from seven to 15 years. The *average*, however, has been approximately 11 years. The intervals between maxima and minima vary between four and seven

years. This appears not to be entirely arbitrary, for a general rule has been found that the more intense the sunspot maximum, the shorter the time required for it to develop from the preceding minimum and the longer it takes to recede to a minimum once more.

Thus, it will be seen, astronomers cannot actually predict the years of sunspot maxima and minima. They can say with considerable assurance, however, that there will be one or both in an 11-year interval.

It is probably of considerable significance, however, that the time from minimum to maximum is considerably less than that from maximum to minimum. The average for increasing spottedness is 4.62 years; for decreasing, 6.51 years.

It might be quite possible to show that there have been major wars during each of the 30 years of sunspot maxima in the past three centuries, or that such wars shortly preceded or followed such maxima. It must be remembered, however, that few years have passed without a major war somewhere on earth. The same can be said for panics, famines, and other happenings. If there is any relationship, it is far too elusive to be discovered at present.

FLAVOR

CANNED grapefruit juice will recover much of its original flavor if, upon opening, it is poured from vessel to vessel several times so that it is aerated.

USE WATER TO INFLATE TIRES!

PNEUMATIC tires are now being partially filled with water to improve traction! We refer, not to the tires you use on your automobile, of course, or to those on your truck, if you own one, but to farm tractor tires, those huge rubber casings which roll over the fields, pulling plow or harrow, doing the work horses once did.

After several years of experiment with tires on farm tractors and other farm implements, one of the greatest problems found was to keep tires from bouncing around, and thus losing their traction, while they were pulling heavy equipment over rough, uneven ground.

Metal weights were in many cases attached to the wheels to weight them down, but these were an additional expense to the tractor operator. Putting them on and taking them off was a constant inconvenience.

So engineers of The B. F. Goodrich Company, after numerous experiments, now recommend the use of water in farm tractor tires. Use of water provides normal cushioning without rebound or bouncing of the tractors or other equipment. They give the tractor greater tractive ability and better riding qualities.

To facilitate putting the water into the tires, the engineers have developed a simple, inexpensive "adapter," one end of which is fitted to a garden hose and the other to the tire valve.

Ordinary city water pressures of from 30 to 60 pounds are usually adequate to fill the tires. Filling may also be accomplished from a tub or barrel by gravity flow, or by means of an inexpensive pressure tank where no water pressures are available.

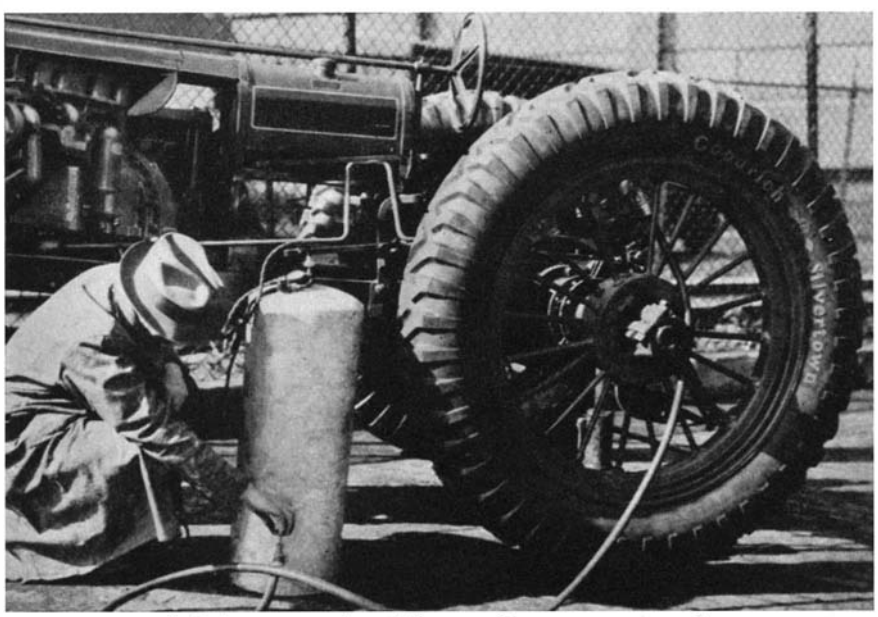
Many farm tractors equipped with rubber tires are operated in freezing weather, and for these are recommended solutions of commercial calcium chloride, ordinarily used for dust-laying on roads.

The tire should be filled with liquid until the level reaches the inflation valve. After that amount has been put into the tire, inflation with air should be effected, just as in ordinary practice. The air pressures in tires in which water is used are the same as the regular pressure.

The amount of water put into the tire ranges from 13.80 gallons to 53.30 gallons according to size. Water used takes up from 74 percent to 78.47 percent of the inner space, depending on the tire.

NEW CELLULOSE ETHERS

NEW compounds made by the reaction of cellulose, treated with caustic soda, with ethylene oxide are reported as having considerable advantages over regenerated cellulose made by the viscose process. The



Inflating tractor tires with water from a pressure tank

new compounds are known as hydroxyalkyl ethers and can be formed directly into films or filaments, or by treatment with acids can be converted into a variety of other useful compounds. These ethers can be formed in a variety of ways and when made into films have a higher strength than the customary viscose films, familiar as cellophane, and are less affected by moisture.—*D. H. K.*

KATHAMOBILE

SOMEBODY is always getting together a lot of odds and ends and making something out of them; this time it was a group of advertising men who wanted a publicity idea for a cigarette company. They gathered some fiber wallboard, some light lumber, four wheels from a hand express truck, a storage battery and a few other things that were not so easy to identify, and got the result seen in the accompanying photograph.

"As anyone can see," they said, "it's *not* an automobile. We didn't know what to call it, so we named it the kathamobile, because it's run by an ordinary Kathanode automobile battery. Because we knew the battery would feel at home pushing a starter motor, we picked up a second-hand one and used it as our power plant."

The accomplishments of this tiny machine are really remarkable, and show the stamina built into the ordinary auto battery with which everyone is so familiar. With the battery, the kathamobile weighs about 185 pounds. It will carry a person of ordinary weight, say about 150 pounds, at a speed of 15 miles per hour, though the advertising model shown is geared to run at a little over half that speed.

The kathamobile will run at its full speed for between seven and eight hours without recharging the battery or checking the electrolyte. To prevent too heavy a load being thrown on the battery at once when starting, the power is transmitted through two V-belts, running from the old starter motor to the gear reducer, and from the reducer to the axle. These slip enough to permit the car to get started before too much of a pull is exerted.

This first model had to look like a high-priced professional job, and therefore cost slightly in excess of what it might have been made for. The gear speed reducer cost, second hand, about $3.50, the old but sturdy starter motor was picked up for less than five dollars, and the battery cost 19 dollars. Wallboard, wheels, bearings, lumber for the chassis, axles, belting and all the miscellaneous articles that were used, plus the assistance of a carpenter and an electrician brought the total cost up to little more than 75 dollars.

Believing that Scientific American readers might be interested in building their own kathamobiles, for their children or for themselves, the men who built the original model have offered us plans and specifications for free distribution to anybody who wishes to write in for them. If you are handy with tools, it should be easy, and a lot of fun, too.

METAPHOSPHATE FERTILIZERS

CALCIUM metaphosphate made by treating phosphate rock with the hot reaction products of burning phosphorus contains the equivalent of 65 percent phosphoric acid and is suggested as a more satisfactory compound for introducing this necessary constituent into fertilizer. Formerly calcium acid orthophosphate made by treating phosphate rock with sulfuric acid was the compound universally used for this purpose. However, this product normally contains the equivalent of only 15 to 17 percent of available phosphoric acid.

Interest in the new calcium metaphosphate for fertilizer use was initiated by the fact that the Tennessee Valley Authority could easily make it by the use of the electrical power available from its developments.—*D. H. K.*

WELDING FOUNDATION

ONE of the richest awards ever established for competition in the field of mechanical science has just been announced by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

To stimulate intensive study of arc welding, 200,000 dollars will be distributed by the Foundation among winners of 446 separate prizes for papers dealing with this subject as a primary process of manufacture, fabrication, or construction in eleven major divisions of industry.

The principal prize winner will receive not less than 13,700 dollars. Other prizes range from 7500 dollars to 100 dollars—the

Kathamobile, here used for advertising, may be made by the home mechanic

The Taylor "Cub," an excellent low-priced plane, aloft and on the ground

latter sum to be awarded to each of 178 contestants who receive no other prize, but whose papers are adjudged worthy of honorable mention.

Formed at the close of 1936 "to encourage and stimulate scientific interest in, and scientific study, research and education in respect of, the development of the arc welding industry through advance in the knowledge of design and practical application of the arc welding process," the Foundation already has won wide acclaim among educators and other leaders in the engineering world.

Prospective entrants among engineers, technicians, designers, and skilled workers familiar with the uses of arc welding are urged to communicate promptly with Foundation Secretary A. F. Davis, P. O. Box 5728, Cleveland, for complete details of the rules and conditions governing the competition awards.

From 1270 Dollars Up

At the National Aviation Show one manufacturer of a popular or "flivver" plane announced a reduction of 200 dollars in price just before the opening, and advertised his machines from 1270 dollars up! The announcements sometime ago of the 700 dollar flivver airplane by the Air Commerce Bureau only served to disturb the light airplane market, and to misguide the public. Now, a group of independent manufacturers, entirely without governmental aid in any shape or form, are bringing the "flivver" airplane closer and closer. Porterfield, Taylor Aircraft, Rearwin, and Aeronautical Corporation of America are doing great things and selling large numbers of their small planes, ranging in price from 1270 to some 1500 dollars, providing excellent flying qualities, cruising range of some 200 or more miles, top speeds of around 90 miles an hour, excellent equipment and real cabin comfort, low landing speeds, and cheap maintenance. It is well known that one of these companies recently placed an order for a million dollars worth of 40-horsepower Continental Aircraft engines of the four-cylinder opposed type, and that the same firm sold its thousandth small airplane just before the show. No wonder that the number of flying clubs is growing rapidly and that young private owners are increasing in number. Our photographs show an excellent example of these light planes, in flight and on the ground.—*A. K.*

STENTORIAN

When you make a long-distance telephone call, say, for example, over a distance of 700 miles, approximately 3000 loading coils are used to amplify your voice. Each amplifier multiplies the volume of your voice tenfold. This amplification is roughly equivalent to the magnification of a single atom of hydrogen to fill the entire solar system.

The Institute of Aeronautical Sciences

At the recent annual meeting of this Institute, members were called upon to listen to the presentation of 54 technical papers (some of them deeply mathematical) in the short space of three days. No wonder

that they suffered some degree of mental indigestion. But it was worth a little agony to learn of progress in so many phases of aeronautics, some of which are briefly touched upon in the following paragraphs.

The Instruments and Meteorology Session was largely devoted to the question of upper-air soundings with the aid of the radio meteorograph. In spite of its formidable name, the radio meteorograph is nothing but a relatively small free balloon equipped with automatically recording instruments and means for transmission of their records to ground observers.

A concentrated attack on the problems of the upper atmosphere is being made by the Weather Bureau, the Harvard Blue Hill Observatory, and other scientific centers. The investigators expect not only better weather service as a result of this research but also definite guidance as to the "optimum" flight path to be taken by a pilot for maximum economy of operation and smoothness and comfort in flying.

But Professor Piccard of stratosphere balloon fame proposes to go one better than the radio meteorograph by going up in person to the greatest altitudes. Professor Piccard, now working at the University of Minnesota, proposes to meet the difficulties of stratosphere exploration by using a "dog team" of large numbers of small balloons, suitably tied together. Preliminary experiments with a few balloons have apparently established the usefulness of the "dog team." The first ascent will be made in an open basket, with a dog team of 80 balloons giving a total lift of 400 pounds. In this trip the scientist will rise to an altitude of about 10,000 feet. If all goes well the next ascent will be made with several thousands of these small balloons, and an ascent in a closed basket, supplied with oxygen will be made to an altitude of perhaps 20 miles—much higher than all previous records.

For landing with such a "team" it is obviously impossible to use the conventional balloon rip cord. Instead, Professor Piccard plans to blast off the strings of many of the small balloons with dynamite caps which will be electrically controlled from the basket. These dynamite caps are of the type used in mines, will not explode hydrogen gas and are thus perfectly safe. Such a personal study is of course more satisfactory than even the best work of the radio meteorograph.

The Institute ranged from recondite theories of the turbulent flow of air to such practical and highly important topics as improvement in engine maintenance. During the World War and for some time thereafter, an operator employing the famous Liberty engine was considered fortunate if it gave him service for a hundred hours before needing a complete overhaul. Today, improvements in engine design and better understanding of the problem of engine maintenance have changed the situation entirely. At the present time oil is changed after 120 hours of flying, and a complete overhaul is made after every 600 hours. Cost of replacements in early overhaul practice was 300 dollars and this was at the end of 100 hours. Today the replacements total 75 dollars at the end of 600 hours. No wonder that flying is becoming both more practical and more economical.

It is a "deep secret"—known to everyone in the industry—that a number of airplane manufacturers are experimenting with planes for stratosphere flight, to be equipped with supercharged passenger cabins. Since the meeting these attempts are as "secret" as ever, except that we know something definite of the development work of one of these organizations, the Glenn L. Martin Aircraft Company. J. S. McDonnell, an engineer of this corporation, presented some interesting facts regarding his experiments with a circular fuselage and a supercharged cabin.

The consensus among the assembled engineers seemed to be that the pressure or supercharged cabin had certain definite advantages beyond the ability to fly at high speed in the thin air of the stratosphere. Among these advantages is the fact that passengers in such "pressure" cabins will be protected from all the unpleasant effects of drastic changes in altitude. Equipped with a supercharged cabin, an airliner could be brought down rapidly from high altitudes, if considerations of either safety or economical operation required descent at a rate which would be torturing to the ear drums and sinuses of all on board a conventional aircraft.

In the course of his experiments Mr. McDonnell placed his "stratosphere," circularly built fuselage in the altitude chamber of the Bureau of Standards, wherein the pressure may be rapidly brought down by pumping out the air. A sudden drop in pressure equivalent to 10,000 feet in 1.4 minutes caused the occupants no discomfort. Even a fictitious climb to 25,000 feet in 14.3 minutes was perfectly harmless, although it produced some eructation ("belching," in vulgar parlance) by the "passengers." It was found that the administration of oxygen through a tube held in the mouth was far less pleasant than the introduction of oxygen into the cabin as a whole.

The circular fuselage, built of high strength aluminum alloy, was found capable of withstanding higher pressure inside than out. Owing to rebreathing possible in such a cabin, and the warmth introduced by the passenger's own animal heat, comparatively little artificial heating will be needed (only one quarter of a kilowatt per passenger) so that electrical heating at the greatest altitude will be possible. Mr. McDonnell thought that only 10 percent of the pay load of an airliner would have to be sacrificed to make the cabin air-tight, to provide supercharger equipment, and so on.

The papers presented at the Institute meeting by our leading aeronautical engineers and scientists will take months for full publication, so perhaps we can give the gist of some of them in a few moments. Stainless steel, properly used, will give a structural weight no greater than that of aluminum alloy, and since stainless steel can be electrically welded, the cost and worry of thousands of rivets will be eliminated. The driving of automobiles can be investigated scientifically at the proving grounds; why should not airplanes and their maneuvers be also investigated by the use of scientific instruments, instead of reliance being placed on just what the pilot says? Gusts in land flying are equivalent to a vertical up-current of 30 feet a second, over the ocean to vertical currents of 25 feet a second, so that over-ocean flying will not really be much smoother than over-land flying.

Altogether, the Institute meeting was of great interest and importance.—*A. K.*

CURRENT BULLETIN BRIEFS

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

NIGHT PHOTOGRAPHY, by Dr. Walther Heering, is a compact paper-bound book of 54 pages that gets right down to the solid meat of its subject and tells about materials, exposures, and results to be expected in all types of photography after dark. It contains 43 illustrations of night photographs, some of which are really remarkable. It may be obtained through your photographic dealer or direct from *Burleigh Brooks, 127 West 42nd Street, New York, N. Y.—One dollar.*

AMERICAN TENTATIVE STANDARDS FOR ACOUSTICAL TERMINOLOGY is of particular value to sound engineers in that it will eliminate confusion in motion picture, radio, and building fields by setting a basis that eliminates the possibility of misunderstanding. *American Standards Association, 29 West 39th Street, New York City.—1 to 9 copies, 25 cents each; quantity prices on application.*

PRACTICAL AND THEORETICAL PHOTOGRAPHY, by Julian M. Blair, contains 107 mimeographed pages complete with pertinent drawings covering all phases of photography, particularly from the angle of the darkroom worker who really wants to know what it is all about and how to do it. It also includes an appendix of formulas and weights and measures. *Dr. Julian M. Blair, University of Colorado, Boulder, Colorado. —One dollar.*

RECEIVING TUBE MANUAL tells briefly of the operation of vacuum tubes in general and of the function of the various elements in the tube. It then describes radio tube applications and how the tubes function in different circuits. Following these sections are complete descriptions of all of the tubes on the market, their characteristics, uses and installation. 192 pages of solid meat including numerous diagrams, characteristic curves, and drawings of tubes. Technical Series RC-13. *RCA Manufacturing Company, Inc., RCA-Radiotron Division, Harrison, New Jersey.—25 cents.*

A NEW WAY TO GET MORE POWER FROM YOUR CAR is a little 16-page pamphlet that takes into consideration what is usually thought of as the least important liquid in the operation of a motor car—water. It deals specifically with the corrosion that is present in any automobile cooling system and tells what to do to prevent it. *Write for Bulletin 437A, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

PROBLEMS IN HUMAN HEREDITY, by Prof. V. W. Jackson, is a compact book of problems on the basis of learning by thinking and doing. Something new, supplementing a general course in biology or genetics. Many original illustrations. *V. W. Jackson, University of Manitoba, Winnipeg, Canada. —50 cents.*

DIRECTORY OF ASSOCIATION MEMBERS lists members of the Association of Consulting Chemists and Chemical Engineers, Inc., and contains valuable details about the work which leading consultants in various branches of chemistry are specially prepared to undertake. Any business man or industrialist who on occasion requires chemical research assistance will find this Directory to be a valuable shortcut to getting the right man for the job. *Association of Consulting Chemists and Chemical Engineers, Inc., 50 E. 41st Street, New York City.—Gratis.*

THE SCHOOL SHOP, lavishly illustrated with photographs and diagrams, gives specific suggestions for laying out machine shops in Junior and Senior High Schools, as well as in Vocational and Trade Schools. An interesting historical sketch—"The Story of the Lathe"—is included. Prices are given on most of the equipment. *Write for Bulletin 437B, Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

THINGS I'VE BEEN THINKING ABOUT, by Henry Ford, is a reprint, in bound book form, of an article which appeared originally in the *American Magazine.* It is essentially a commentary on industrial progress, wealth, and the machine. *Fleming H. Revell Company, 158 Fifth Avenue, New York City.—60 cents.*

LOW-LOSS PARTS BULLETIN lists radio parts for use in critical circuits and assemblies. It includes standard and special forms for coils and high-frequency transformers, mica insulated parts, aluminum shields, and so on. *Write for Bulletin 437C, Scientific American, 24 West 40th Street, New York City. —3-cent stamp.*

OVERSEAS TELEPHONE SERVICE is a pocket-size booklet that tells briefly, yet clearly, the story of telephone service to all parts of the world, including the radio links, scrambling of speech to secure privacy, effects of storms on traffic, and other details pertinent to the subject. *American Telephone and Telegraph Company, Long Lines Department, 32 Sixth Avenue, New York City.—Gratis.*

BETTER TENANT FARMING, by Cornelius J. Claassen, is a 50-page booklet on farm management that is primarily of interest to the absentee owners of tenant farms. It strongly advocates proper management of a farm on a business basis rather than on the haphazard basis that so often prevails. *Farmers National Company, 388 Brandeis Theatre Building, Omaha, Nebraska.—30 cents, postpaid.*

THE MECHANICS OF INSTANTANEOUS ACETATE RECORDING, by Sam W. Hawver, deals with a system of sound recording which makes it possible for anyone to engage in the business or hobby of sound recording at a reasonably low cost. *Cellutone Record Manufacturing Co., 1135 West 42nd Street, Los Angeles, California.—50 cents.*

SAFETY REGULATIONS gives rules governing qualifications of employees and safety of operation and equipment of common carriers and contract carriers by motor vehicle. *Superintendent of Documents, Washington, D. C.—10 cents (coin).*

Books SELECTED BY THE EDITORS

ON YOUR GUARD!

By Carl Warren, B.S., M.S.J.

A PRACTICAL book, mainly about the two great "hush-hush" diseases, gonorrhea and syphilis. In recent months a nationwide campaign has been afoot, and is rapidly gaining velocity, to clean up syphilis, a disease which has been costing human society billions. It has been clearly shown that a disease that was regarded as almost hopeless a generation ago is now curable, and that there is hope of largely whipping it out of the race, much as yellow fever was whipped out. The chief obstacle to such a clean-up has been some kind of short-sighted prudery, forbidding public mention of the word "syphilis," hence we still have the disease with us, for it is impossible to educate the public when it is impossible to talk to the public. "On Your Guard" is a decidedly practical book telling the essential facts about the two so-called "social" diseases, how to guard against them (practical and definitive, not merely a lot of generalizations) and how they are scientifically treated today. It has an introduction by M. J. Exner, M.D., Director of Sexual Education, International Committee, Y. M. C. A., who was in charge of social hygiene education for the U. S. Army during the World War. This book is not hard boiled or cynical, but neither is it mollycoddle. It is a book you could offer your boy of high school age, provided you believe he should know the realities of the world in which he will have to live, and will not necessarily be always a plaster saint when out of your sight.—$1.15 postpaid.—*A. G. I.*

PHOTOGRAPHY

By C. E. Kenneth Mees

PROBABLY no single art has had such an extensive effect on so many phases of human endeavor as has the art of photography. Dr. Mees, who has been actively identified with the development of this art, has produced the present book in non-technical language and has succeeded admirably in giving the reader a review of photography in all of its aspects. A short chapter is devoted to the historical side of photography and then the reader is carried directly into the up-to-date angles of the art. He is taken into the factories and shown how photographic materials are produced and is then taken to the darkroom to show what happens to these materials during processing. Motion-picture photography is dealt with at some length and so also is color photography. While this is no instruction book for the amateur photographer, it is one that the advanced amateur cannot afford to miss because of the broad background which it supplies. The book is lavishly illustrated with photographs and drawings pertinent to the text.—$3.15 postpaid.—*A. P. P.*

THERE IS FUN IN GEOMETRY

By Louis Kasper

WHILE this small volume has been promoted as a collection of brain-twisting, temper-teasing problems, it is really a more practical book than it is an entertaining one. Some mathematically-minded people will, of course, enjoy playing with the 50 complete geometrical problems which are included; many more people will find use in mechanics for these same problems. The solutions are fully worked out in such a manner that they are easily understandable to anyone with a little background in mathematics. Well illustrated with drawings.—$1.90 postpaid. —*F. D. M.*

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PEARY

By William Herbert Hobbs

PROFESSOR HOBBS, the author, gives us a complete biography of Admiral Peary and, as Hobbs has himself been an explorer and is a scientific man (geologist), his account of Peary's many endeavors is written from that point of view rather than from the usual literary point of view. Admirers of Peary will appreciate this excellent work which is illustrated with maps, halftones, and drawings.—$5.20 postpaid.—*A. G. I.*

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By A. Frederick Collins

NEED it be repeated here that, of all the sciences, chemistry stands in a position preëminent in industry today? Such is a fact. So much the more reason for the layman to attempt to understand the fundamentals of this important contributor to progress. In Mr. Collins' book he will get just such an understanding. This volume is written primarily for the individual who has but a smattering of knowledge of chemistry but would like to learn just enough more for him to grasp the significance of the many new chemical developments being announced almost every day.—$3.20 postpaid.—*F. D. M.*

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By Jan Vojáček, Dr. Ing.

UNDER this title there has been published the monograph which was awarded the first prize of the Linthicum Foundation Competition. The author of the monograph is a leading European patent attorney and well known writer on patent law. The procedure governing the issuance of patents in the for-

eign countries as well as the United States, and the rights and remedies after the grant of patents, is clearly yet briefly outlined. There is a survey of the laws giving the various acts covering the grant of patent protection and a comparison of the systems of the various countries. Everyone interested in patent law, and particularly the laws of countries foreign to the United States, will find this book helpful.—$3.15 postpaid. —*C. E. H.*

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IN 1936

By A. C. Eurich & E. C. Wilson

MOMENTOUS events of the year 1936 are covered in this new kind of review. This is a running comment on world politics, business, crime, and international affairs, and though it makes easy and interesting reading, is somewhat in the nature of a permanent reference volume for the library. It is dramatic, terse, and clear in its presentation of facts about 1936.—$2.65 postpaid.—*F. D. M.*

LEICA MANUAL

By Willard D. Morgan and Henry M. Lester

AN instruction book particularly designed for users of a specific miniature camera was first published in 1935 and now appears in a second and revised edition. Although the Leica camera is the basis upon which this book is built, most of the material in it, covering all phases of miniature camera work, will be of value to the advanced amateur photographer regardless of what type of camera he may use.—$4.20 postpaid.—*A. P. P.*

FROM FOREST TO FURNITURE

By Malcolm H. Sherwood

LOVERS of furniture and those who are interested in timbers of unusual kinds will enjoy this book—unless perchance they already know the subject of wood quite well. It is subtitled "The Romance of Wood" and treats 60 kinds of wood—two thirds of them exotic—in as many chapters of friendly, informative writing. A furniture collector would find it a valuable work to possess. Its emphasis is on the beauty of woods.—$3.15 postpaid.—*A. G. I.*

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By A. H. B. Bishop and G. H. Locket

A NEWLY published text book of college preparatory chemistry, as taught in England. It gives evidence that the British lads get a good solid dose of chemistry. Typical "exam" questions, given in an appendix, permit comparisons in stiffness to be made.—$1.90 postpaid.—*A. G. I.*

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Edited by Pay-Lieut. Comdr. E. C. Talbot-Booth, R. N. R.

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WHITTLING AND WOODCARVING

By E. J. Tangerman

IT appears, at least from the advertisements of cutlery people, that whittling and woodcarving are coming back as serious hobbies. This volume proves it. Starting with a discussion of how to make the simplest toys and gadgets, trinkets, and wood chains, it proceeds to discuss the carving of human figures, elaborate chests, plaques, designs, and moldings for furniture. It is indeed a

study of an art. Numerous illustrations showing procedure and the results of hours of painstaking work are scattered throughout the book. There is, of course, a discussion of knives and other tools for woodcarving, as well as a table of 182 kinds of wood with the physical characteristics of each. 293 pages, 450 illustrations.—$3.25 postpaid.—*F. D. M.*

LEICA 1937 ANNUAL

Henry M. Lester, Editor

OF photographic annuals there is little that can be said that has not been said countless times before. This is another one replete with examples of all types of photography done with miniature cameras.—$3.15 postpaid.—*A. P. P.*

RELATIVITY THEORY OF PROTONS AND ELECTRONS

By Sir Arthur Eddington

"IN this book," the author says in his preface, "I have endeavored to give a connected account of a series of investigations in the borderland between relativity theory and quantum theory. It begins where my earlier book, 'The Mathematical Theory of Relativity,' leaves off—at the point where in our survey of nature we encounter the phenomenon of atomicity."

Those few among amateur readers who have successfully conquered the earlier book named will be in a position to "surround" the content of the new one, provided they enjoy a good heavy dose of higher mathematics and know their advanced physics. We mention this fact in order to protect unsuspecting readers who might otherwise think this was another of Eddington's popular books. It positively isn't!—$5.75, postpaid.—*A. G. I.*

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SHADOWLESS FIGURE PORTRAITURE

By Fred P. Peel

ONE of the newer phases of photography is so-called "shadowless lighting" in which the source of illumination is such that a minimum of shadows are present in the reproduction of the subject. The technique is evolved through the use of high key lighting in an endeavor to attain delicacy of texture and particularly a pleasing quality in flesh tones. Shadowless lighting requires specialized equipment and in the present book the author not only shows excellent examples of this particular technique but also gives specific directions for the construction of lamp housings of special types for the work under discussion.—$2.90 postpaid.—*A. P. P.*

HOUSE-FLAGS AND FUNNELS OF BRITISH AND FOREIGN SHIPPING COMPANIES

Drawn and Edited by Pay-Lieut. E. C. Talbot-Booth, R. N. R.

HERE we have primarily a book for identification, showing in color most of the steamers on the seas today—some from each nation—while the house flags of several hundred important shipping lines are also shown in color in combination with a picture of the design on the funnels. Shipping people will find this an invaluable reference.—$2.65 postpaid.—*F. D. M.*

LEGAL HIGH-LIGHTS

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

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

Design for Dying

IN a recent case involving a design for a tombstone, the United States District Court for the Middle District of Pennsylvania discussed the distinction between design patents and copyrights.

In that case the plaintiff was the owner of a copyright on a design for a tombstone which the defendant was alleged to have infringed by selling a tombstone embodying the copyrighted design. The defendant contended that a copyright was not the proper type of protection for a tombstone and that the plaintiff should have secured a design patent. The court disagreed with the defendant, however, and held that it was a proper form of protection for the design and that the defendant had infringed it.

This case exemplifies the type of subject matter which gives rise to the question as to whether it should be protected by design patent or copyright. The copyright statute is intended primarily for the protection of works of art, such as the creations of an artist, or writings of an author, while the design patent law is intended to afford protection for ornamental designs of articles of manufacture. There are many cases in which it is difficult to determine whether the subject matter is a pure work of art or an article of manufacture. In such cases, the courts usually hold that the author or inventor may secure either type of protection but that he can not secure both types of protection.

In the case under consideration the court found that it was difficult to determine whether the tombstone should have been protected by a copyright or by a design patent. It then stated: "In a case which comes under either statute it becomes a matter of choice by the author or owner whether he will seek protection under the patent or copyright law."

Sky High

THE doctrine that the owner of real property owns from the center of the earth to the sky has frequently been announced by American and English courts. If this doctrine were carried to its ultimate conclusion, it would seriously interfere with modern air travel; an airplane passing over a man's property would be in the same position as an automobile riding over the front lawn. Under this view the airplane operator would be a trespasser upon the owner's property and the owner should be entitled to restrain the trespasser and to collect damages.

The doctrine originated prior to the days of air travel and never appears to have been applied by a court in a manner to prevent air travel through the space above a man's property. A Federal Circuit Court of Appeals recently had occasion to pass upon the application of this doctrine to airplane travel.

The owner of a strip of real property adjoining an airport brought suit against two airplane transport companies for damages and an injunction, alleging that the companies had trespassed on the owner's property rights by flying airplanes over his property at heights varying from five feet to one hundred feet. The owner contended that he owned the stratum of space overlying his tract of land and that the action of the transport companies in flying their planes over his land interfered with and trespassed upon his rights.

The court rejected the plaintiff's contention and refused to construe the doctrine outlined above in such a manner as to prevent the transport companies from flying their planes over the plaintiff's property. In this connection the court stated that the doctrine merely meant that the owner of the land could use the overlying space to such an extent as he was able and that no one could ever interfere with that use, concluding with the remark:

"We own so much of the space above the ground as we can occupy or make use of in connection with the enjoyment of our land."

This decision would appear to be a practical one as airplane travel necessarily entails flying over the property of many different people. If such travel constituted a trespass on the rights of the owners of the property beneath the line of travel, it would be necessary for the airplane operator to make satisfactory arrangements with all of the property owners, which of course would be a physical impossibility.

Disclose Completely

IF YOU decide to patent an invention, make sure that your patent contains a complete disclosure of the invention.

Occasionally an inventor only partially describes his invention in a patent, retaining the remainder of the invention as a secret, and in that way believes that he has adequate patent protection and also the additional protection afforded by keeping an important portion of his invention in secrecy. Nothing could be further from the truth. In most instances the failure to disclose the invention completely in a patent results in an invalid patent.

The Patent Statute requires that the invention be described "in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which it appertains, or with which it is most nearly connected, to make, construct, compound, and use the same." The reason for this is found in the fundamental theory underlying our patent law.

The government affords to an inventor a monopoly on his invention for a limited period of time in return for a complete disclosure by the inventor to the public so that upon the expiration of the monopoly the public may be sufficiently informed to practice the invention.

An example of results flowing from failure to disclose completely an invention is to found in the recent case decided by a Federal Court, in which the plaintiff brought suit for infringement of a patent on a moving picture screen. Among other things, the patent stated that the screen should be provided with perforations of sufficient size and number to permit passage of sound waves therethrough without blurring, while at the same time preserving the light reflecting properties of the screen so as to make it efficient for the presentation of pictures. The patent did not describe the exact number or size of the apertures, but merely concluded that they should be such "as to yield results of the character demanded by a critical public."

The court found that this did not constitute a complete disclosure and that the public was required to experiment in order to ascertain the nature of the apertures to be provided. It concluded that the patent was invalid, stating that "if the description be so vague and uncertain that no one can tell, except by independent experiments, how to construct the patented device, the patent is void."

An Explosive Problem

THE uninitiated layman may regard toy torpedoes and salutes as very similar forms of fireworks but a federal court recently had occasion to distinguish between them. In a suit for patent infringement brought by one fireworks manufacturer against another, the plaintiff contended, among other things, that a toy salute manufactured and sold by the defendant infringed plaintiff's patent on a toy torpedo.

Each of the claims in the plaintiff's patent related specifically to a torpedo or to a method of making a torpedo. The defendant made a salute in a manner similar to the torpedo described and claimed in the patent. The court, however, held that the salute did not constitute an infringement of the patent on a torpedo. In reaching this conclusion the court pointed out that a torpedo is actuated by impact while, on the other hand, a salute is caused to explode by ignition of a fuse projecting from inside the salute. The decision was based upon the principle of patent law that where a patentee intentionally limits the scope or field of coverage of a claim, he is bound by the limitations in the claim and cannot later attempt to expand the interpretation of the claim beyond the field originally selected. In this connection the court said:

"Here it is too clear for argument that, by both the claims and specifications, the patentee was not claiming an improvement for pyrotechnic devices generally, but was intentionally limiting his improvement to a specific and particular species of minor fireworks, a torpedo."

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Ratings of 1937 Cars

Divided into three price classifications under $1,000, over twenty-five leading models of 1937 automobiles are rated in the current March issue of *Consumers Union Reports.* Some of them are rated as "Best Buys," some as "Not Acceptable," and others as "Also Acceptable" in the estimated order of their merit. Based on such factors as economy, comparative safety of operation, general performance and other engineering features, these ratings were made by competent automotive engineers after thorough examinations and actual performance tests. Such features as hypoid gears, automatic choke, frame durability, driver-visibility, and others are discussed at length. Tables on comparative gas consumption are also given. This report—which should be read by everyone contemplating the purchase of a new car—will be followed in an early issue by ratings of cars in higher-priced groups. Previous issues of the *Reports* (still available) have analyzed and rated tires, gasolines, motor oils, and anti-freeze solutions.

Also discussed in the March issue are the following products: RADIO SETS, FLOUR, SHEETS, CAN OPENERS, BAKED BEANS, CANNED ASPARAGUS AND CHERRIES.

SOME OF THE CARS RATED IN THIS ISSUE

Willys	**Ford**	**Chrysler**
Chevrolet	**Buick**	**Dodge**
Plymouth	**Studebaker**	**DeSoto**

Begin my membership with issue checked.

- ☐ MAY—Toilet Soaps, Breakfast Cereals, Milk.
- ☐ JUNE—Automobiles, Gasolines, Seeds.
- ☐ JULY—Refrigerators, Used Cars, Motor Oils.
- ☐ AUG.—Oil Burners and Stokers, Hosiery, Blacklist of Drugs and Cosmetics, Meat.
- ☐ SEPT.—Shoes, Tires, Whiskies, Women's Coats.
- ☐ OCT.—Men's Shirts, Gins, Electric Razors, Dentifrices, Anti-freeze Solutions.
- ☐ NOV.—Radios, Toasters, Wines, Children's Shoes, Winter Oils.
- ☐ DEC.—Vacuum Cleaners, Fountain Pens, Electric Irons, Blankets, Nose Drops.
- ☐ JAN.-FEB.—Men's Suits, Cold Remedies, Shaving Creams, Children's Undergarments.
- ☐ MAR.—1937 Autos, Radio Sets, Sheets, Flour, Canned Foods.

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