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YEARS OF RESEARCH IN ONE SENTENCE

YEARS of research, knowledge, and experience are often compressed into a single sentence in Scientific American. When a subject is given a full length article, the reader is assured of complete, accurate coverage of a topic of vital interest. When the matter to be presented has many varied phases, and is made the basis of a special issue such as the November Navy Number, Scientific American receives universal attention.

The announcement of our Navy Number attracted attention. Its publication brought an avalanche of requests from publishers here and abroad to reprint much of the material.

This is not surprising, for that material was not available in comprehensive form from any other source. For public service rendered, we wish to express our appreciation for the valuable help of one of our contributing editors, Captain W. D. Puleston, who since 1929 has been a member of that distinguished group whose active co-operation is available to our readers.

PULESTON, W. D., Captain, U. S. Navy: Graduated from Annapolis in 1902. Graduated from the Naval War College in 1915, and from the Army War College in 1925. Served in connection with the Naval College Staff in 1915 and 1916. Spent 17½ years at sea in all naval grades from Midshipman to Captain. In 1917 served on the staff of the Commander in Chief of the Asiatic Fleet as Fleet Gunnery Officer. In 1918 was in command of the destroyer *Cushing* in the war zone. For his war service was honored with the award of the Navy Cross. Author of a number of books. Collaborated in 1916 with Admiral Knight in preparing "A History of the Naval College." In 1926 his "The Dardanelles Expedition" was published. In 1934 "High Command in the World War." Now in Washington at the Naval Bureau, as Director of Naval Intelligence.

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Measured in numbers, the readership of Scientific American is not large, and never will be large. Its editorial standard is too high either to appeal to or to be appreciated and understood by the mass mind, yet the Scientific American readership, in its influence and purchasing power, is an unexploited and unused market for many advertisers desiring to reach those who pioneer in Commerce, Industry, School, and Government.

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NINETY-FIRST YEAR • ORSON D. MUNN, Editor

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COVER

ONE of the towers of the Triborough Bridge (see page 323) stands in bold relief against a background of the sky, as photographed by Jacob Deschin, conductor of our regular monthly department "Camera Angles".

The SCIENTIFIC AMERICAN DIGEST

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50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

IT IS frequently the case that present-day advances in science and industry can be more fully appreciated when there is available some knowledge of what has gone before. The accompanying excerpts from Scientific American for December 1885 were selected from our files for their inherent interest and significance. If you would like to see this page continued as a regular feature of Scientific American, won't you write us a note to that effect?

ORSON D. MUNN, *Editor and Publisher*

PASTEUR—"The entire civilized world has for some time past been watching with intense interest the experiments on the treatment of hydrophobia conducted by the celebrated French scientist, Dr. Louis Pasteur. These researches have now been so far completed that the results have been presented by the investigator to the French Academy of Sciences."

BALLOONS—"At a recent meeting of the Military Service Institution, held at Governor's Island, Gen. Russell Thayer, of Philadelphia, presented in detail his system of independent and dependent dirigible balloons, intended particularly for use in war times. General Thayer has made many experiments in aerial navigation, and has so far been successful that a number of his designs and working models are now under consideration at the British War Office."

ALUMINUM—"According to *La Lumière Electrique* Mr. L. Senet has invented a new process that permits of the manufacture of aluminum, as well as copper, silver, etc., by electrolysis. A current of from 6 to 7 volts and 4 amperes is made to act upon a saturated solution of sulphate of aluminum in the presence of a solution of chloride of sodium, the two solutions being separated by a porous vessel."

ASPHALTED JUTE—"According to the *Journal des Fabricants de Papier,* a material called asphalted jute is being largely employed in Germany for covering roofs, for isolating damp walls and floors, and for preventing bad odors from reaching apartments situated over stables, etc."

ANDROMEDA—"The new star in Andromeda, which was first seen by Ward, at Belfast, on August 19, as a star of the ninth magnitude, and two days later reached its greatest brightness as one of the seventh magnitude, is now fading at the rate of one magnitude in 18 to 21 days, and has reached the lower brilliancy of a star of the eleventh magnitude."

MECHANICAL STAMP SALESMAN—"An English invention is designed to do away with complaints about a want of post office agents for the sale of stamps. The apparatus is a mechanical box which automatically transacts the business of selling stamps, etc., and may be put up on lamp-posts like the letter boxes."

ASPHALT—"French rock asphalt pavement in the city of London still holds its own; and while no asphalt has ever been taken up to replace it with wood, there have been cases where the wood has been taken up and replaced with asphalt."

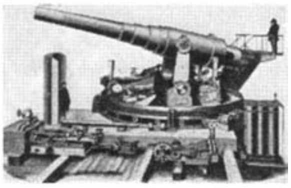
GARNET—"While making the excavations for a sewer on 35th Street between 7th Ave. and Broadway, New York City, the workmen recently uncovered a large garnet which was enclosed in the gneiss about nine feet below the level of the street."

BESSEMER—"A recent improvement in the Bessemer steel process as carried out at the Edgar Thomson Steel Works, near Pittsburgh, will have the effect, it is said, of making Bessemer steel equal in quality to the crucible product, and at only about one-tenth the price."

OBELISK—"The work of preserving the Obelisk at Central Park, New York, has now been completed, and apparently none too soon, as the numerous storms which have since assailed the shaft would have done it material damage had the pores of the stone still remained open. The process employed consisted of treating the heated stone with a mixture of paraffine, creosote, and turpentine."

JEWS—"The *Bulletin* of the Geographical Society of Marseilles estimates the total number of Jews in the world at 6,377,602—that is, 5,407,602 in Europe, 245,000 in Asia, 413,000 in Africa, 300,000 in America, and 12,000 in Oceania."

RUSSIAN CANNON—"Messrs. Easton and Anderson recently issued invitations to officers of Government manufacturing departments and foreign attachés to visit their works at Erith, in order to inspect the Moncrieff gun carriages made by them for the new Russian ironclad *Catherine II.*" The gun mounting was a cast steel platform revolving around a hollow steel pivot on 22 rollers. The gun was of the "disappearing" type and was provided with a clever variable hydraulic recoil mechanism.



DYNAMITE AIR GUN—"Three dynamite projectiles were thrown from Lieut. Zalinski's pneumatic gun, at Fort Lafayette, New York harbor, on the afternoon of Nov. 28. The projectiles were thrown a distance of about two miles, and two of them, one containing 50 and the other 100 lbs. of nitro-glycerine, exploded in a most satisfactory manner, the other one sinking in the water without exploding. . . . The air pressure employed in the new gun was 1000 pounds to the square inch."

NICARAGUA CANAL—"An official report has been submitted recently to the Navy Department by Civil Engineer A. G. Menocal, U. S. N., of the relocation of the Nicaragua Canal made by the government expedition of last winter. The route now given the preference extends from the harbor of San Juan del Norte, or Graytown, on the Caribbean Sea, to the port of Brito, on the Pacific, a total distance of 169.8 miles, of which 40.3 miles are canal proper and 129.5 miles open navigation through Lake Nicaragua, the river San Juan, and the basin of the river San Francisco."

AND NOW FOR THE FUTURE

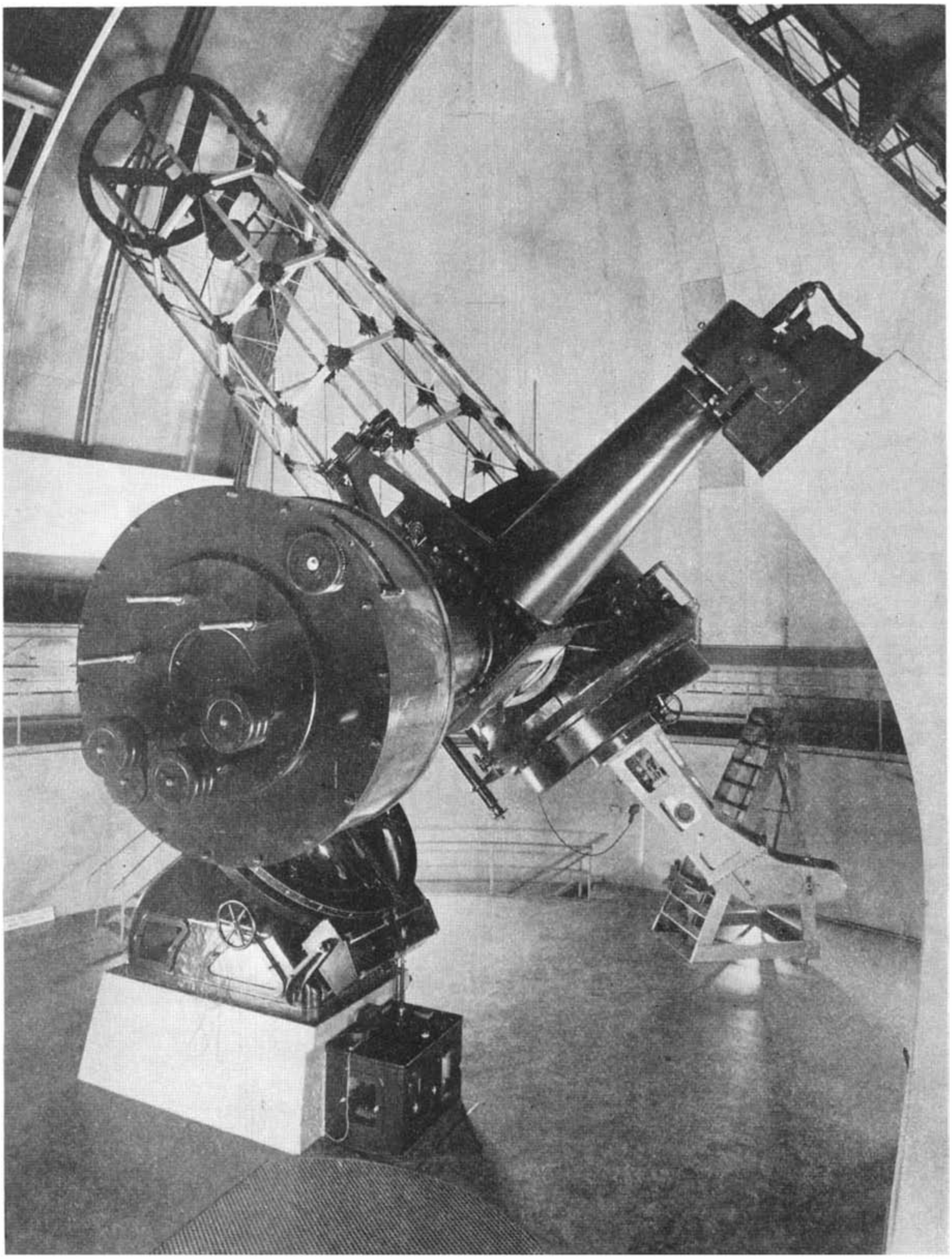
"Making 'Radium' Artificially," by Prof. E. U. Condon. Substances of great therapeutic value.

"Civil Aviation in National Defense," by Reginald M. Cleveland. Can transports be made into bombers?

"The Food of Pekin Man," by Dr. Ralph W. Chaney. Man's first dietetic record discovered.

A study of the possibilities of Diesel engines in battleships, by Capt. A. M. Procter, U.S.N. (Ret.)

"Seeing the Invisible," by de Bary Kerston. Sound waves investigated by photography.



CANADA'S NEWEST AID TO SCIENCE

WITH the 74-inch telescope of the University of Toronto now in use—second largest telescope in the world at present—the center of gravity in regard to things astronomical on the North American continent shifts to the north-eastward, for important research will be done by means of it. The photograph does not well indicate the size of the instrument: the tube is 28 feet long. Attached to it is a spectrograph. The telescope was made in England by Sir Howard Grubb, Parsons and Company. The mirror disk is American Pyrex. It was figured by Grubb.

A military plane lays a dense smoke screen. Instead of this harmless chemical, the plane might use one which would cause heavy casualties in men. *Inset:* A modern service gas mask

No Super War Gas!

Ideal War Gas May Never be Found . . . Requirements and Limitations . . . Nations Still Rely on Wartime Combat Chemicals

By ALDEN H. WAITT

Captain, Chemical Warfare Service, U. S. Army

WAR gas is deadliest in the minds of enterprising newspaper reporters whose imaginations have run riot for years. In fact, so much pure, unadulterated hokum has been written by them since the World War, that it is quite a relief to read Captain Waitt's accompanying article and find that war gas is not, *can not be,* anything like as deadly as most people believe. This author, an authority on chemical warfare, thoroughly de-bunks this subject which has so intrigued the sensation-mongers.—*The Editor.*

OF the many hundreds of poisonous substances known to the chemist, the few that are important as agents of chemical warfare may almost be counted on the fingers. The layman finds this difficult to understand. As a matter of fact, he generally refuses to believe it. Mr. Average Citizen is convinced that there are dozens of new and secret formulas tucked away in the locked files of the war offices of the world ready to be brought out at the first suspicion of war so that fiendish brews may be prepared and used for his destruction.

Mr. Citizen, however, is wrong. It isn't as simple a matter as he thinks to add to our list of chemicals useful as weapons. The difficulty lies in the many essential factors that enter into the problem. The chemical warfare agent not only must have toxic or irritant properties sufficient to cause casualties or disable in extremely low concentrations, but it must possess also suitable physical and chemical characteristics, and meet rigid economic standards. To find a material that will combine enough of the desired properties to be useful is a tremendous task. To find one that will combine all requirements is practically impossible. The ideal chemical combat substance has not yet been found. Probably it never will be found.

From 1915, when the first gas attack took place near Ypres in Belgium, to 1919, when the war-time research establishments were placed on a peace basis, or completely demobilized, over 3000 compounds were carefully investigated. Less than 30 of these were of sufficient value to be used in actual hostilities and only some 10 or 15 were found satisfactory for use on a large scale. The field was covered in those years by the most eminent chemists of the times in the intensive search for something that would surprise and defeat the other fellow. Since then the search has continued, although perhaps less intensively, and in spite of the innumerable reports about a super gas that have appeared in the newspapers of the world, there is no real evidence that such a compound has been discovered. Upon tracing down these reports one finds that the alleged ideal gas has been investigated before and found wanting or that it lacks certain of the qualities absolutely necessary for successful use in war.

Before examining further into the characteristics that the military chemist is seeking in his ideal, let us ascertain just what a war gas is, what it must accomplish, and how.

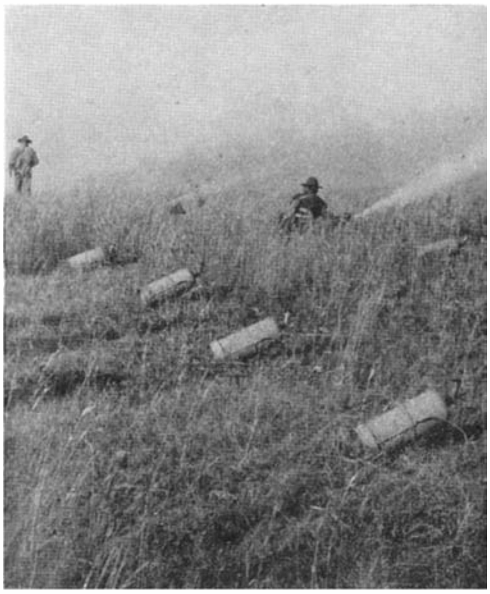
The word poison gas is a misnomer. Most of the chemical combat substances are liquids or solids under normal conditions. They are disseminated in the air by various methods. Some chemicals are contained in artillery shells or bombs which explode and throw the liquid or solid agent into the air in drops or in fine particles. Some solids are volatilized by heat and thus pass into the air as vapor or in a fine particulate cloud. Others are carried in tanks on planes and released into the air so that they fall to the ground in droplets or as a fine mist. These latter are liquids, although the same method might be applicable to finely pulverized solids.

Chemical mortar in action

A few—those which are volatile—which enter the gaseous state readily, can be released directly from cylinders or drums merely by opening a valve. They form a dense cloud which is carried by the wind. Whether we call these materials chemical agents, combat chemicals, or poison gases, the terms all refer to any substance useful in war which, by its normal and direct chemical action produces either a powerful result on the body, a screening smoke, or an incendiary effect.

Obviously, if a search is to be started for a warfare chemical a military requirement for it must exist. There has to be some tactical need for it. Further, it must fulfill that need more effectively and better than something that already is available. Consequently, in examining the combat chemicals we often find it desirable to group them according to their tactical uses. They may be employed tactically to produce casualties, to harass, for screening, or as incendiaries. Many of them fall into more than one class. Casualty agents are those having properties which adapt them primarily to the infliction of casualties; their purpose is to put the individual exposed to them in the hospital or cause his death. Harassing agents are used to reduce the effectiveness of troops by compelling them to wear the gas mask. Screening agents form an obscuring smoke and interfere with observation, while incendiary agents cause destruction of material.

THE tactical purposes are accomplished by their action on the body and perhaps the most convenient classification of the war gases for the purposes of this discussion is according to their physiological effect. The lung irritants are those which attack the breathing apparatus only. They are essentially casualty agents. Phosgene (CG) is typical of this class. The skin irritants or vesicants (blistering agents), typified by mustard gas (HS), affect all parts of the body, cause inflammation and blistering of the skin, acute inflammation of the eyes and respiratory tract. The skin irritants are principally for casualty action, but also are valuable for harassing and for making ground untenable by unprotected troops. The eye irritants or lacrimators (tear gases), valuable only for harassing, produce, in extremely low concentrations, an intense irritant effect on the eyes so that vision becomes impossible. CN (chloracetophenone) is the type agent of this class. The nose irritants or sneezing agents, sometimes called sternutators, cause sneezing, nausea, and extreme mental depression. DM (diphenylaminechlorarsine) is typical of this class which, like tear gas, is for harassing purposes but to a greater degree. The nose irritants produce only temporary casualties and do not cause death. Finally there are the paralysants, or nerve poisons, such as hydrocyanic acid gas, which act directly on the nervous system, causing stoppage of heart action, and the poisons such as carbon monoxide, which act upon the blood to upset its function of supplying oxygen to the tissues. No practical method has yet been discovered of utilizing either the nerve or blood poisons as war gases because of their physical and chemical deficiences. Carbon monoxide, generated by the bursting of high explosive shells, has claimed many victims, but these casualties may not be considered as due to chemical warfare.



Gas cylinder attack: chlorine and

Qualities of the chemical agent which give it tremendous value are its ability to shoot around corners and the fact that it is continuous in time and space. The bullet or high explosive shell speeds on its way or bursts and immediately the effect is over. If anyone gets in the way a casualty is caused; if not, no result is obtained. The gas, however, diffuses in the air so that it is effective over a greater area than the explosive or bullet, and for longer periods of time. It sinks into low places and penetrates crevices.

THIS does not mean that gas cannot be controlled or that once released from bomb or shell a chemical agent may be carried for miles to destroy those whose destruction is not contemplated. On the contrary, it can be controlled to a greater extent than any other weapons except those of the thrusting type. It is a very flexible agency in that it can be designed to cause severe casualties or merely to harass and cause delays. It can be controlled definitely in time and space. It can be used to cover a relatively large area or a small area. It can be placed on the ground where its effect under average weather conditions will be exerted for several hours or days, or it can be disseminated in such a way that the effect is over in a few minutes. This is governed by the method of dispersal and by the persistency of the gas. A gas is called non-persistent if, when dispersed in the field, it is dissipated rapidly, say in 10 minutes, under the influence of a low velocity wind. A gas is considered persistent if it remains effective for longer periods —say several hours. Phosgene (CG) is a non-persistent gas and when dispersed in the field will become a vapor and be

spouting from ground cylinders

blown away rapidly. Mustard gas (HS) is a persistent gas which, when dispersed in the field, may be effective for several hours or several days. Persistency is extremely important in its relation to the tactical uses of an agent.

The search for the ideal war gas, then, is governed by tactics, physiology, physics, and chemistry. In addition, since we fight with dollars as well as with men, the procurement agencies demand that careful attention be paid to economics. Obviously, then, a compromise is necessary since the ideal probably cannot actually be realized. We can set up the ideal, however, even if it may never be attained. It gives the military chemist an aiming point.

IN the first place a chemical combat substance must be effective in small concentrations. Let there be no confusion here as to what is meant by the term small. It is a matter not of a few parts of the substance to 100 or 1000 parts of air, but rather of a relatively few parts of the combat substance to a million parts of air. Unless the gas can do its work in these almost infinitesimal quantities it has no value in warfare. The number of shells or containers that can be brought up to the forward areas and fired is limited. Moreover, the amount of substance the air will take up is comparatively small. The chemical must be so powerful that the few pounds of it that reach the enemy positions are able to accomplish the tactical mission set for it—that is, to produce casualties, to harass, or to deny ground.

Phosgene, according to Dr. Rudolph Hanslian[1], the German authority on chemical warfare, will cause severe irritation of the respiratory organs and eyes immediately in a concentration of .04 of an ounce per thousand cubic feet of air. That is about one part in 100,000. In very much smaller quantities, if inhaled for a few minutes, this gas may lead to fatal cases of poisoning.

The tear gas, CN (chloracetophenone), produces its effects in much smaller concentrations. Hanslian states that the minimum concentration necessary for irritating the eyes is .0003 of an ounce per thousand cubic feet of air. CA (brombenzylcyanide) produces an intolerable effect on the eyes after three minutes exposure to a concentration of .0008 of an ounce per thousand cubic feet of air. Let your mind play with a conception of this small weight of substance for a moment. Just imagine that an ounce of this chemical is divided into 10,000 parts, and that eight of these parts are disseminated evenly in the air contained in a box ten feet on a side. The average man could stand the effect of the tear gas in the box for three minutes; then the irritation on his eyes would be so great that he would be compelled to close them. That is why the tear gases may be so valuable in war. Although they do not cause serious or permanent casualties, it only requires a little bit to make a man put on his gas mask, with the loss in his efficiency that wearing the mask entails. It may be cheaper to use them for certain purposes than to use a more toxic gas which has to be employed in much larger quantities. If the tactical need is to delay, harass, or hamper the enemy's operations, one shell filled with a powerful tear gas will do the work of at least ten mustard gas shells. Some nations realize this and are planning to combine small amounts of a solid tear gas in their high explosive shells. The Russians suggest the use of a splinter chemical shell which bursts to give the explosive effect without appreciable loss in efficiency and at the same time sets up a tear gas concentration in the air.

MUSTARD gas is another that the ideal gas must compete with in effectiveness. The fatal dose to the lungs is between .006 and .2 of an ounce per thousand cubic feet of air, depending on the time the victim is exposed. The eyes may be injured by concentrations as weak as 1 part in 14,000,000, but this, of course, is on long exposure. The odor of mustard gas is perceptible in concentrations as low as one part of the agent in 10,000,000 parts of air, and yet burns on the body have been caused by sitting on ground contaminated with traces of the substance where no odor was observed.

It should be noted in connection with the foregoing that the concentration is only one factor that influences the production of a casualty. The length of time of exposure is also of prime importance.

The effectiveness of the compound in small concentrations, however, is only the first of our requirements for an ideal war gas. There is still a long way to go. Our ideal agent must next be difficult to protect against. It should be able to penetrate the enemy's protective equipment or at least tax it severely.

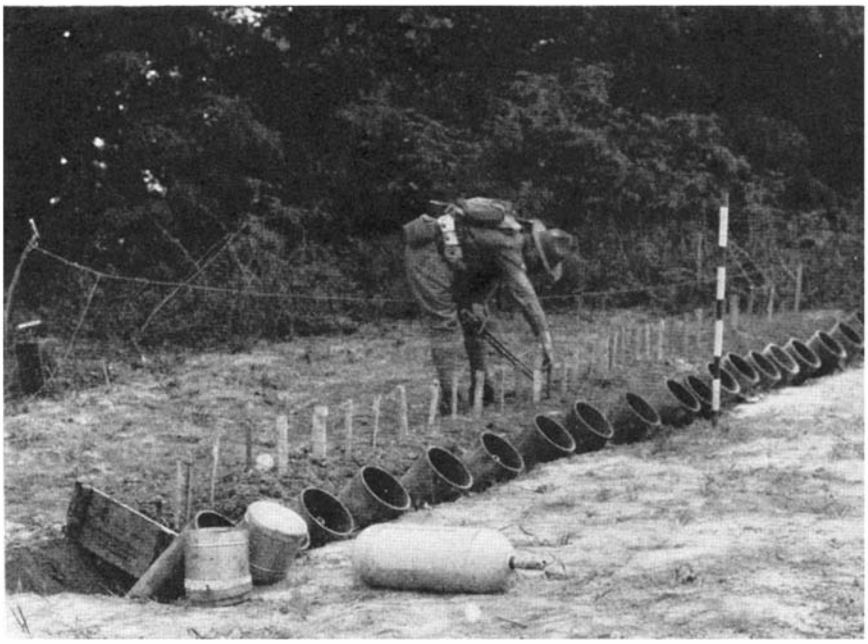
Every modern nation now has developed first-class protection against gas. If the hypothetical new gas cannot penetrate this protection, it is valueless unless surprise can be effected and the soldier caught without his anti-gas equipment completely adjusted. This is not going to be an easy matter in the future, considering the great lengths to which the nations of the world are going in their training of men in defense against gas. True, there is a definite advantage in forcing the other fellow to mask, but already we have plenty of agents that will accomplish that purpose cheaply and well.

THE new gas must do more than cause masking. It should attack all parts of the body—that is, it should be a combination lung, eye, skin, and nose irritant. Here again it must compete with mustard gas which, in both the vapor and liquid state, affects the lungs, eyes, and skin. The property of vesicant action on the skin was one of the principal reasons that mustard gas came into use. Practical protection from head to feet is not easy to obtain. In order that a soldier be safe against a spray of liquid mustard gas from the air he must be encased in some sort of impermeable garment which, of course, would be uncomfortable to wear and impossible to fight in for more than a few minutes.

If the new gas does not affect all parts of the body, it should be able to break through the mask. To do this, it must be unreactive. In other words, it should not combine readily with other materials. Moreover, it should not be adsorb-

Mechanized chemical mortar unit

[1]"Der Chemische Krieg"—by Rudolph Hanslian—Berlin, 1927.



Livens gas projector emplacement

ed easily by activated charcoal, the important material of the gas mask canister, and should not be held back by the smoke filter that removes small solid or liquid particles. The more unreactive a gas, the more difficult it is to find something to prevent it from passing through the gas mask canister. Although chlorine, the classical war gas, is highly toxic, it is an extremely active chemical and combines readily with many other chemicals. Consequently, it has always been an easy matter to protect against it. A cloth pad saturated with washing soda will filter it out of the air. Chlorpicrin (PS), another war-time agent, will remain a threat in war because it taxes protective equipment. Only the best gas mask will remove high concentrations of chlorpicrin, which is a comparatively unreactive chemical. The ideal gas, therefore, must be unreactive and should affect all parts of the body. Thus, to be completely protected, the man would have to wear a mask that would keep out the gas and provide oxygen to sustain life, and impermeable garments that would encase him from head to foot.

PERHAPS in some test tube such a material exists, but the jump from the test tube to large-scale production is a hurdle that has thrown a number of chemicals. Your war gas must be easily manufactured in large quantities. Although it may take only three drops of a substance to kill a man, it may be necessary to use a ton in order to assure that the three drops reach the victim.

The sensationalists delight in describing how a few airplanes equipped with chemical bombs or spray could wipe out cities. Of course, it is absurd. A plane might carry enough poison in one tank to kill every individual in a city if each molecule of the poison could reach its target—but that's the rub. Most of it will never reach a human being. It's like putting salt on a bird's tail. Therefore, to assure that enough of an agent reaches a target, hundreds of pounds of it must be used just as hundreds or thousands of H. E. shells must be fired to cause a few casualties; although pound for pound the gas has a wide advantage over the high explosive in putting men out of action.

In any event, no matter how powerful the gas, great quantities of it must be available. The fact that the chemist is able to produce a few pounds in the laboratory does not mean that the chemical engineer can turn the substance out by the ton. It is a long and laborious task to find a reliable and practical method for manufacturing some chemicals in quantity. During the World War the Germans manufactured about 5000 tons of mustard gas and toward the end of the war were turning it out at a rate of over 66,000 pounds per day.[2] The Allies knew how to make mustard gas in the laboratory long before the Germans used it. In fact, it has been reported that the British had considered it as a war gas in 1916. It was nearly a year after the Germans first used it, however, that the Allies were able to reply in kind with mustard gas of their own manufacture.[3]

A complicated process of manufacture means generally an expensive process. Special equipment is costly. One of the requirements of a war material is that is shall be cheap. This applies to all munitions. If the explosive or the gas is too expensive, something else must take its place. Expense is no small factor. Money is one of the important sinews of war; it may flow like water in war time, but there is a limit to spending even then. Given two agents reasonably close to each other in performance, the less expensive of the two will be used. The Germans had an excellent gas in superpalite, a compound having about the same toxicity as phosgene. During the war we were unable to make it in quantity so that it could compete in price with what we already had, so we never used it, although in many ways it was superior to phosgene.[3] Our ideal gas will not be of much use to us if it proves to be too costly. It is a cold-blooded fact, but none the less true that creating casualties is a dollars-and-cents proposition.

Regardless of expense, however, the military chemist, in constructing a new compound, is limited also to raw materials that are easily procurable in the homeland. Strategic materials—those that come from overseas and the supply of which depends upon transport facilities and the ability of the Navy to keep the sea lanes open—are barred as building blocks. Similarly, critical materials for which there is a big demand in the manufacture of other essential war products, should not be used as raw materials for the ideal war gas. We are especially fortunate in this country in our raw materials, for there are very few that enter into war-gas manufacture that we do not have immediately available. Some few, not important at present, are limited in amount. If, for example, by some stretch of the imagination, it should be found that nickel carbonyl has some use as a war gas because of the fact that it will decompose to produce carbon monoxide, we would have difficulty in getting enough nickel, which is not obtained in quantity within the United States. We would, perhaps, avoid iodine compounds since large amounts of the raw material, iodine, are not immediately available.

England had trouble in getting bromine to use in making tear gas, so instead adopted an iodine compound, ethyl iodoacetate. At the time her supply of iodine was greater than that of bromine. Since the war, processes of making bromine from sea water have increased the availability of that element.

WITH our tremendous natural resources, we are not likely to be restricted materially by raw materials in our choice of a combat chemical, but we cannot overlook the requirement of availability in making that choice. It would be very sad to base plans upon a compound only to find that a component needed in the manufacture was missing at a critical moment.

Besides the essential requirements already discussed, all of which must be

[2] "Die Chemische Waffe in Weltkrieg" by Dr. Ulrich Mueller—Berlin, 1932.
[3] "Chemical Warfare"—Fries and West, N. Y., 1921.

met by any chemical agent, there are several more which are highly desirable, and in which the *ideal* agent certainly must qualify. The war gas should be easy to transport. If a true gas, for example, it should be easily liquefiable. If the gas cannot be reduced to the liquid state readily, it would be well nigh impossible to transport enough up to the point of discharge to make an attack worth while. Enough chlorine never could have been brought up to the trenches to produce the great cloud gas attacks that were made on the Western Front by both Allies and Central Powers if it were not possible to reduce it to the liquid state and confine it as a liquid in metal cylinders. Carbon monoxide has many qualities which would make it an ideal war gas, but it is practically impossible to liquefy. It would tax the transport facilities of an army to the breaking point to get enough carbon monoxide forward. It cannot be carried in light balloons. It must be confined in heavy metal containers and these represent dead weight ineffective in the attack.

The transportation problem is a hard one in war and anything that complicates it is serious. The war gas not only should be compact, but it should be safe to transport. Anything that is difficult to confine, that leaks, that corrodes the container, is undesirable, although these defects do not necessarily rule an agent out of consideration. Corrosion, however, is a factor which limits the value of a material. Some chemicals cannot be confined in metal since they react to destroy the metal and in so doing are changed themselves. Brombenzylcyanide (CA) is an example of such a chemical. Since it corrodes steel and iron and thus loses its effect, it cannot be filled into ordinary shells as is possible with mustard gas, but must be contained in special glass or enamel-lined shells. The German T-stoff had similar properties and was placed in lead containers which fitted into the shells. This, of course, is undesirable since shell manufacture is complicated, expense is greater, and the weight of shell is increased.

STABILITY is another requirement that must be taken into account. A combat chemical is valueless if it breaks down into harmless or less effective compounds from the shock of explosion when fired, or if it will not stand up unchanged upon long storage. National defense requires that stocks of war materials be held in war reserve so that they may be immediately available in an emergency. There should be enough munitions on hand when a war starts to take up the slack before manufacturing production can meet the demands of the armed services.

The nation that has adequate war stocks is not likely to have to fight. A good war reserve is excellent peace insurance in spite of all that our pacifist friends may say to the contrary. A chemical war reserve, however, demands very stable chemical agents. Hydrogen cyanide often has been suggested as a war gas. One of the objections has been that it is not stable enough. Again, the ideal competes with mustard gas, which is highly stable. I have seen cylinders of war-time mustard gas opened recently; the agent was found to be unchanged since being placed in the cylinder in 1919.

Both hydrogen cyanide and carbon monoxide fail to meet ideal requirements in another respect. They are not heavier than air. A war gas must stay close to the ground when fired. Gases that are lighter than air are likely to be dissipated before they can accomplish their mission. True, the two cited are not much lighter than air, and if they met all other specifications would still be useful although they do fall short of the ideal in not being heavier than air.

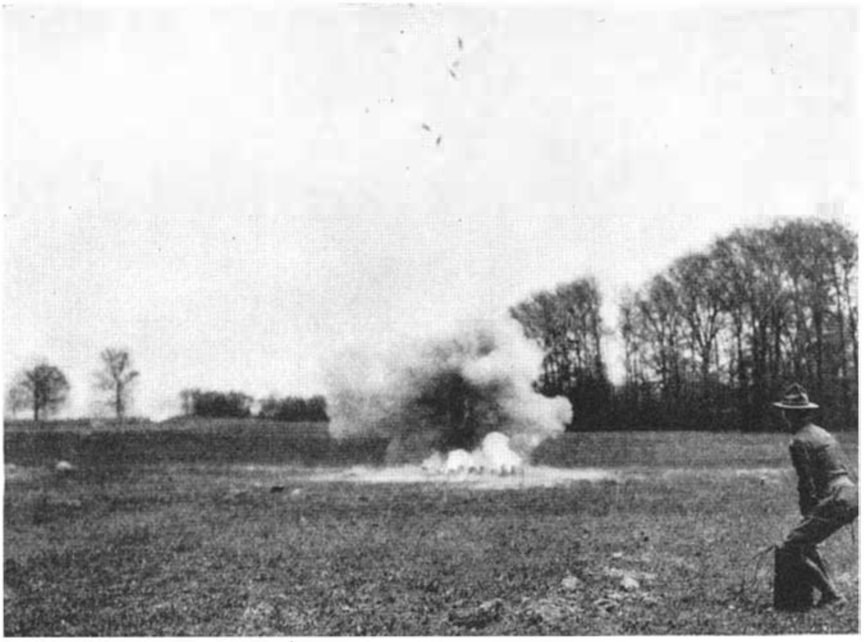
So, finally, we are approaching the end of our requirements. If a chemical agent is found that combines all of the qualities enumerated, it will be extremely useful in war, useful enough perhaps to decide the issue for us; but for it to be perfect, there is one more hurdle. The ideal war gas should be difficult to detect. It should be colorless, odorless, and tasteless. I can think of only one substance that might possibly be used in war that meets this last requirement. That is carbon monoxide, which has no odor, no color, and no taste. Here again mustard gas makes a plea for attainment of the ideal. It cannot be detected by color in the vapor state, and in spite of its strong odor, it has the property when breathed for a minute or so of destroying temporarily the sense of smell. The smell organs become fatigued and the odor is no longer detected after a few breaths. We can't quite accept that as meeting specifications, but it is a good try. Mustard gas will continue to be used.

The quest for a perfect chemical combat substance, however, is only one of the many problems confronting the chemical warfare research establishments. The development of adequate protective equipment and the development of suitable munitions and weapons for the dispersal of the war chemicals are equally important. All these researches go hand in hand. The field is a large one, yet it represents only a part of a much larger field—the maintenance and development of the entire system of national defense. No nation may neglect any part of its scheme of defense without endangering the whole. The military problems are so many and so varied that the quest for the perfect gas may only receive its proportionate share of attention as determined by supreme military authority.

The specifications for the perfect war gas should convince us that perfection is the unattainable ideal. Progress will be made, and new and more effective compounds doubtless will be discovered, but, considering the many requirements that have been enumerated, we need not be alarmed at sensational reports of a new gas that will blot out civilization.

●

Can battleships be driven by gangs of Diesel engines of the size used in motor trucks or buses? A discussion, scheduled for January, says yes—provocatively!—The Editor.



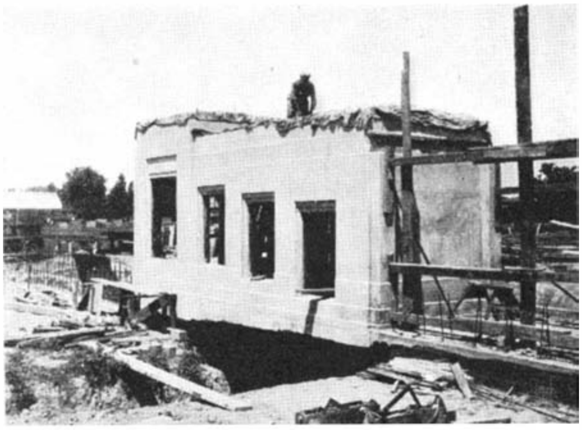
Firing a battery of gas projectors. Note cylinders in air

Another Step Toward

HIGHWAY SAFETY

A Planned Express-Way . . . Overhead Crossings . . . Pedestrian Subways and Overpasses . . . An Example Worthy of Attention by City Planners Elsewhere

By EARLE DUFFY



Left: **One of the entrances to a pedestrian subway along the new express highway.** ***Below:*** **Two miles of the highway have been cut through a city park. The sloping banks will be landscaped.** ***Lower right:*** **A highway grade separation that is typical of the structures which will carry cross streets safely over the new express-way**

IT is to be just one street with five traffic lanes, yet St. Louis' new express-way will carry two and a quarter times as many vehicles as the ordinary wide boulevard. The new artery, a part of a super-highway 38 miles long, will demonstrate, claim its builders, that motor travel can be made safe as well as rapid. The project is being watched with interest by other cities, cursed, like St. Louis, with traffic troubles.

Three and a half miles of this new highway leading to downtown St. Louis is within the city limits. One mile of the artery is to be depressed, with cross streets carried overhead. Not a single street intersection at grade level will be encountered in the section within the city. Four special pedestrian subways and overpasses and one equestrian subway are the finishing touches that make this a roadway really designed for the automobile. The project is well under way, and work will continue throughout the winter.

The wide right-of-way for the depressed section, cut right through where homes, apartment buildings, and shops once stood, will permit of gently sloping banks along the highway, which are to be sodded and landscaped.

The entire project is called Traffic Relief 40 which extends westward 38 miles from downtown St. Louis, to connect with U. S. 40 and U. S. 61. At the edge of the city two miles of an existing five-lane highway will be utilized. Then comes 13 miles of four-lane concrete and six miles of three-lane pavement, all over new right-of-way.

This carries the road to the Missouri River where a new bridge will be built. The road then continues three lanes wide to Wentzville. All busy intersections will have highway grade separations.

The express-way crosses Missouri 77, a wide belt-line highway that encircles the city five miles out from the city limits. Consequently the express-way will be of great utility to tourists and through travelers. They may approach the city on any one of the several roads, strike the belt road and follow it to the express-way. This will carry them to downtown St. Louis in a few minutes, as against the 45 minutes now required over the devious routes that must be followed.

The express highway is the only one of its kind outside the New York City area. There, a depressed highway leads from the Holland Tunnel through Jersey City. However, that a city of the size of St. Louis, less than a million population, should build such a modern artery leads to the conjecture that other cities, both larger and smaller, may soon embark on projects of a similar nature. St. Louis engineers have expressed the opinion that only through the construction of elevated or depressed roadways can real driving comfort and safety replace the widespread congestion with its attendant dangers which are so characteristic of many of the so-called "super" highways that have been built during the past few years, and are still being built.

OUR POINT OF VIEW

The Trade Mark Scarecrow

NOT all pirates are on the high seas. Not all the racketeers are to be found in the kidnapping and bootlegging business. In fact, the once infant racket has grown to such a stature in our modern commercial world and has raised such a family of not-so-little brothers that today rackets are to be found in the most unexpected places.

One of these big brother rackets now stalks the halls of our various State Legislatures. It has been aptly named "The Registration Racket."

For the trade-mark owner engaged in interstate commerce, Federal registration of trade marks is desirable. Registration, particularly under our Federal Trade Mark Act of 1905, is highly advisable. Such registration has many benefits. A certificate of registration under the Law of 1905 is prima facie evidence of ownership. It gives the registrant the rights to sue in Federal Courts regardless of diversity of citizenship. By taking advantage of the provisions of the Law of 1905 a registrant may prevent the importation of goods bearing infringing marks. Other procedural advantages are likewise to be gained by Federal registration.

What is not realized, however, and at times only vaguely understood, is that ownership of a trade mark in this country arises *out of use* and not out of registration. In South America and some of the European countries, the so-called Continental system is in effect which makes registration a prerequisite to ownership and results in a race for registration and permits piracy of trade marks by unscrupulous competitors and others who register marks in the expectation that the otherwise rightful owner will be forced to buy them off by purchasing the registration.

The trade-mark racketeer favors some such system. He is not interested in advocating Federal registration. That means but one registration. He would like to multiply his "service" by forty-eight. So he advises registration in all of the States—he, of course, to handle the business of securing registrations. Owners of trade marks are approached and advised that they will lose their rights to others unless they register in the individual states.

The self-styled trade-mark service specialist is rarely ever a lawyer or patent attorney. He comes as close, however, as he can to the unlawful practice of the law, trying always to keep within bounds but frequently overstepping the legal limits. He sometimes conducts an advertising campaign filled with misleading statements. He usually begins by falsely representing that trade-mark ownership may be *created* under existing state statutes by *state registration.* He frequently resorts to intimidation—the usual weapon of the racketeer. He advises as to the legal effects of statutes and decisions—perhaps "misleads" would be a more accurate word. Many good and valid trade marks have been registered, of course, in the various states but their validity is predicated upon wholly collateral facts.

The trade-mark owner is becoming educated. Much has been written recently on this subject. The Association of the Bar of the City of New York, as early as 1929, published a bulletin prepared by the Association's then Committee on Trade Marks and Unfair Competition entitled "Warning against misleading advertisements of Trade Mark Specialists." As late as December of 1934, the current Committee of the Association republished this bulletin.

Recognizing that trade-mark owners are gradually coming to the realization that existing state statutes do not support the extravagant claims made for them, our self-styled specialists determined upon a bold move and almost carried it out. In certain states they have fostered and vigorously supported proposed new trade-mark legislation which had been recently introduced as revenue measures. These proposed bills would make registration in a given state the sole determinant of ownership in trade marks. Consequently, the first to register would become the owner of the mark within the state in question regardless of whatever might be the property rights of others in the next state or elsewhere.

These bills propose to set up elaborate machinery comparable to the procedure followed in connection with the registration of trade marks in the United States Patent Office. In these times of financial stress, frantic law makers seeking to add to the states' revenues have listened attentively to any means which will provide additional and sorely needed funds. However, as this is being written the jokers in the deck have been discovered and Maryland, Nevada, New Jersey and New York have apparently rejected bills of this nature which had been proposed.

It is to be hoped that the legislatures of other states, in addition to those named, will take similar action in refusing to enact such vicious legislation and that trade-mark owners will not permit themselves to be unduly alarmed by those who advocate this bugbear of state registration.

Agricultural Imports

A STRANGE thing has been happening to our foreign trade. While the United States has been recapturing certain markets abroad—notably in Pan-America, as discussed some months ago in these columns—we, too, have been captured. With our backs against our tariff wall which functions to restrain much of the trade that is most proper for us, we have been content to sit and smugly contemplate the operation of experiments which seem but to encourage "improper" trade. The results are startling.

For the first eight months of 1935, the excess of exports over imports was 27,277,000 dollars as compared with 259,124,000 dollars in the same period of 1934. But that is not the worst. Imports of food products, of which there should be adequate supplies from our own vast farms, have risen at a shocking rate while exports of the same commodities have fallen. Here are a few samples:

IMPORTS	1935	1934
Wheat (bu.)	*9,801,715*	*557,603*
Lard (etc.)	*10,758,779*	*147,361*
Butter (lbs.)	*21,826,263*	*436,695*
Corn (bu.)	*31,822,886*	*371,731*
Canned Meat	*49,770,402*	*26,215,757*
EXPORTS	**1935**	**1934**
Wheat (bu.)	*142,173*	*16,618,769*
Lard (etc.)	*86,235,889*	*369,604,047*
Butter (lbs.)	*500,881*	*965,776*
Corn (bu.)	*154,307*	*2,122,114*
Canned Meat	*9,115,899*	*11,049,454*

Of course we have done somewhat better with other commodities but the above figures tell a significant story. Most people believe there should be a natural exchange of goods between nations—each nation exporting what it can best produce and importing those products it lacks or cannot make. In the United States, there should be no dearth of agricultural and dairy products. The reader may, therefore, draw his own conclusions from the figures quoted above. It would, indeed, be bitter irony if the farmers, traditionally inimical to the protective tariff, should suddenly raise a howl for a tariff to protect their farm products so they can continue cutting production and raising prices!

ENERGY FROM MATTER

By E. U. CONDON
Associate Professor of Physics, Princeton University

THAT the readers of this magazine desire the inclusion of at least some stiffer, less elementary articles than those which have appeared in the past few years was clearly indicated by the enthusiastic response to our "feeler" for reader reaction which accompanied Professor Condon's article in the August number. Except for two negative votes—one from a Missourian who said it was then too hot to think very hard, and one from a man who asked us, instead of articles on physics, to publish articles by G. B. Shaw (!)—every letter contained highly favorable reaction to the inclusion of harder articles in the magazine, and we take this opportunity to thank the writers of many valued and detailed comments on the magazine's policies for their letters. Next month there will be a third article by Professor Condon.
—The Editor

THIRTY years ago Einstein announced the principle that mass and energy are equivalent. That is, the more energy a body contains, the greater its mass or inertia. The amount of energy equivalent to a given mass, he said, is obtained by multiplying the mass by the square of the velocity of light. This means, since that velocity is 3×10^{10} centimeters per second, that one gram of matter is equivalent to 9×10^{20} ergs of energy.

On this view matter is a latent or "frozen" form of energy. If we could convert the energy into a useful form like kinetic energy or heat energy or electrical energy, enormous quantities would be available from small amounts of matter. All this has been the object of much speculative peering into the future, sometimes with pretty fantastic results. Instead of doing that, let us review carefully just what sort of evidence has recently come to light showing that Einstein's principle is correct.

Before doing so, however, let us first get a better idea of the amount of energy frozen in matter in terms of more familiar units than the gram and the erg. There are 453 grams in a pound, so conversion of a pound of matter into energy would give 4.07×10^{23} ergs of energy. The erg is a very small unit: there are 3.6×10^{13} ergs in one kilowatt-hour. Dividing out we find that the energy latent in matter is *11.3 billion kilowatt-hours per pound.* This is more than a billion times greater than the energy made available by the burning of fuels. A typical value of the heat available in burning petroleum products is only 6 kilowatt-hours per pound.

The relative smallness of the energy change in combustion, and other chemical reactions, accounts for the negative result of all experiments in which attempts were made to detect a change in weight of the substances transformed in a chemical reaction. As the energy change on combustion is only about a billionth of the whole latent energy, the change in weight in going, say from gasoline plus oxygen to the combustion products carbon dioxide and water, will amount to only about one part in a billion. No known methods of weighing can be carried out to this precision, so it is hopeless to try to check Einstein's principle in this way.

FROZEN or unavailable energy always excites popular imagination, since the unavailability is a challenge to everyone to make it available. It is easy to think of other vast quantities of unavailable energy, but these are not in such a concentrated form as that latent in a mass of matter. For example, if one could slow down the earth's rotation on its axis so that the day became only one-billionth of a second longer than it now is, the energy would be diminished by 1,240,000,000 kilowatt-hours. This is comparable with the energy latent in an ounce of matter, but this energy is spread out over the whole mass of the earth: it is an attribute of 6×10^{21} tons of matter instead of one or two ounces. Think of the difference in concentration!

Such playing around with the conversion factor between mass and energy may provide striking examples of the vastness of the energy content of matter, but it tells us nothing about how to release that energy. What we have now to consider is the experimental evidence for the reality of the conversion. As yet there is no recorded instance in which the whole mass of an atom was converted into energy of motion or of radiation. The amount of energy associated with the motion of individual cosmic ray particles is about right to correspond to such processes, however. This naturally gives rise to the speculation that cosmic rays originate in this way, and stimulates investigation concerning cosmic rays. But, so far, nothing is known about how they originate.

The kind of evidence we have for mass-energy conversion is based on the energy changes involved in the atomic transformations studied in nuclear physics. In these the total mass of the products may fail to check with the total mass of the initial atoms by about one part in a thousand. These very small mass changes have then to be correlated with the energy changes occurring, to see whether a diminution in mass means a gain in energy and vice versa—and, of course, to see whether

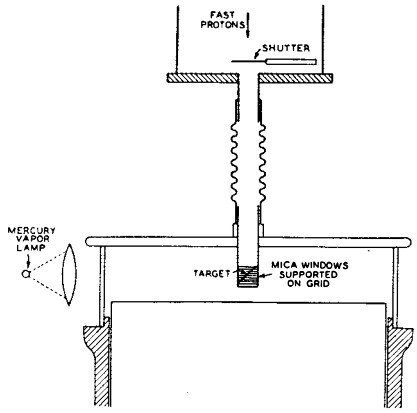


Figure 1. **Arrangement by which Dee and Walton used a cloud chamber to photograph tracks made by high energy alpha particles produced when a lithium target is bombarded by protons. The protons are produced in a discharge tube, only the lower end of which is shown in the diagram. They pass down the flexible sylphon tube and strike the target inside the cloud chamber. There protons and lithium nuclei combine to form two helium nuclei which rush out through the mica windows into the cloud chamber. The bottom of the chamber is a piston which can be suddenly expanded, causing the moist air in the chamber to cool. This makes water droplets form on the ions formed in the moist air by the fast helium nuclei, thus rendering their tracks visible. The top of the chamber is of glass and the tracks are photographed from above**

How Einstein's Principle is Verified . . . Stupendous Energy Revealed . . . But Unavailable Because of Low Efficiency of Transmutation

the conversion factor between mass and energy is that given by Einstein.

Evidently this calls for very precise measurement of the atomic masses and a close analysis of the energy changes involved. Although recent research has provided numerous examples in which these mass-energy conversions are studied, let us confine our attention to one specific case in the interests of clarity. We consider the atomic transmutation that is symbolized in the equation $Li_3^7 + H_1^1 \rightarrow He_2^4 + He_2^4 +$ kinetic energy. This has recently been studied very carefully by Oliphant, Kempton, and Rutherford in the Cavendish Laboratory at Cambridge University in England.

THIS abstract equation refers to what happens in an experiment of the following sort: A vacuum discharge tube is arranged which contains an electric arc burning in hydrogen at one end. In this arc hydrogen molecules are dissociated into electrons and protons. The proton is symbolized by H_1^1 in the equation, H being the chemist's symbol for hydrogen, the subscript 1 meaning that the particle has unit electric charge (same as that of an electron) and the superscript 1 meaning that its mass is *approximately* 1. (We shall have to speak of the exact mass later.) The end of the tube containing the arc is put at a positive potential of several hundred thousand volts with the aid of an auxiliary power supply. The other end of the tube is placed at ground potential and in it is placed a small target of lithium, atoms of which are symbolized in the equation by Li_3^7, since the lithium nucleus has three positive charges and a mass *approximately* 7.

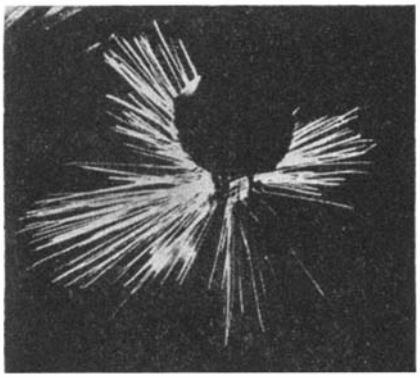


***Figure 2.* A large number of the tracks of fast alpha particles as obtained with the apparatus diagrammed in Figure 1. The black area in the center from which the tracks radiate is the end of the discharge tube which contains the target**

Under the influence of the electric field applied to the tube a current of the positive hydrogen ions is drawn out of the arc and accelerated down the tube. With suitable design the ions of hydrogen will be kept focused in a narrow beam and can be made to strike a target less than a quarter of an inch in diameter. The energy of motion acquired by the ions can be simply calculated from the known voltage used to accelerate them and their charge.

Striking the target, most of the hydrogen ions go into the lithium and lose their energy in encounters with the electrons in it without getting close enough to the nucleus of a lithium atom to have any effect. This is because the distance apart of the nuclei is some 10,000 times their size, so the chances of a direct hit are very small. This accounts for the low efficiency of the process being studied—if a way could be found to take aim at individual nuclei instead of firing at random, the study of these processes would be greatly simplified.

WE are interested only in the small number of the high speed protons which do make direct hits. They mix intimately with the internal structure of the lithium nucleus for a time estimated at 10^{-21} second (since they move with a speed of 10^9 centimeters per second and the nucleus is only 10^{-12} centimeters in diameter). The stuff is there to make a nucleus having a charge of 4, so it would be beryllium, having a mass approximately 8. But this kind of beryllium atom is unknown—the kind occurring in nature is of mass 9. So, instead, the intimate mixture of Li_3^7 and H_1^1 stuff falls apart, giving two nuclei of helium of charge 2 and mass approximately 4 each. Being both positively charged they repel each other, are set in rapid motion, and so rush apart with kinetic energy.

How do we know this? In several ways. The high speed helium nuclei, commonly known as alpha particles, have enough energy to penetrate thin windows of mica placed near the target in the discharge tube. If the windows are surrounded by a Wilson cloud chamber then photographs may be made of the ionization tracks made by the alpha particles as they go through the chamber. This was done in Cambridge by Dee and Walton. Figure 1 is a line drawing of the apparatus near the target end of the discharge tube and Figure 2 is a beautiful example of a photograph obtained in this way. Here we see many tracks produced by the alpha particles which have started at the target and passed out into the chamber through the thin mica windows. In Figure 3 we see another photograph of the same kind with but two tracks. These are due to two alpha particles which undoubtedly were formed in the same disintegration process and rushed out simultaneously in opposite directions. Actually this second picture was taken with the new heavy hydrogen supplying the ions for bombardment of lithium, and corresponds to transformation of the lighter isotope of lithium of mass approximately 6 by the reaction $Li_3^6 + H_1^2 \rightarrow He_2^4 + He_2^4 +$ kinetic energy. The alpha particles formed this way have considerably more energy than those formed in the reaction we have been considering—that the tracks are shorter in Figure 3 than Figure 2 is due to the fact that in making Figure 3 thicker windows were deliberately used to slow down the particles and keep their whole path within the camera's field of view.

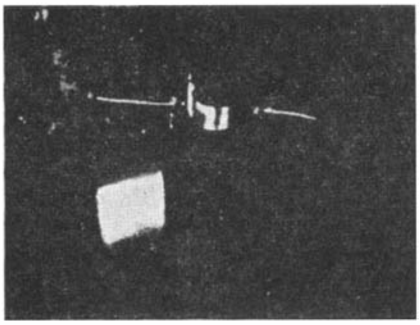


***Figure 3.* This is a photograph similar to Figure 2 except that the proton current was made much weaker to avoid getting a large number of tracks in one picture. In this way it is found that the tracks always come in pairs going in opposite directions from the source, corresponding to the formation of two fast moving helium nuclei when lithium is bombarded with hydrogen ions of high energy**

FROM the length of the track the kinetic energy of the alpha particles is obtainable, allowance being made for the stopping power of the thin windows. The relation between track length or *range* and energy is known from other experiments made with alpha particles from naturally radio-active substances. There are other, more accurate, ways of measuring the range than from the cloud chamber photographs, and with one of these Oliphant, Kempton, and Rutherford found the range of the alpha particles to be 8.29 ± 0.03 centimeters in air, which corresponds to an energy of 13.7 microergs (millionths of

(Please turn to page 339)

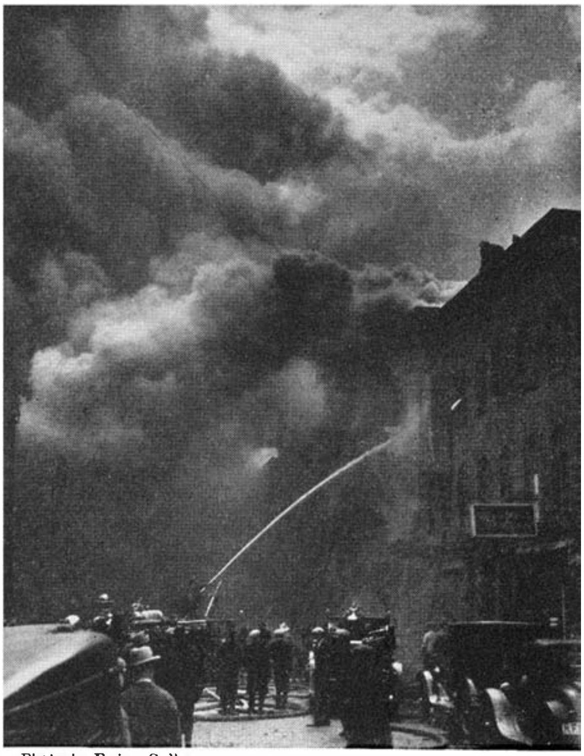


Photo by Ewing Galloway

Smoke is poisonous, but firemen can't keep away from it. Hundreds are felled by smoke each year

THE BREATH

By WILLIAM H. EASTON, Ph.D.

WITH siren screaming, a red fire department automobile dashed up the street and came to a sudden stop before a small apartment house. Two husky firemen, bearing something that looked like a suitcase, sprang from the car and disappeared into the doorway.

A crowd collected at once and, gazing excitedly at the windows of the house, waited for the crash of glass and the tell-tale streamers of smoke.

But nothing happened. No smoke, no fire, no further excitement. Presently the firemen reappeared, and their car bore them out of sight.

"False alarm!" muttered the crowd. disappointed.

But it wasn't a false alarm.

In one of the apartments of the house which the firemen entered, a young man had been sitting beside a closed door, listening, with nerves strained to the utmost, for the thin, high-pitched wail that announces a new life.

Unexpectedly, the door was flung open, and a man thrust his head out.

"Call Greenwood 6-4322, quick!" he commanded. "Tell them to hurry here —baby case!"

"But doctor—" said the young man.

"Step on it!" shouted the doctor and slammed the door behind him.

It was that call that had sent the red car flying through the streets and brought the firemen pounding up the stairs.

Without a word, the physician motioned to the newcomers. Without a word, they entered the bedroom.

For a moment, the bewildered young man could not see what was going on. Then someone moved aside, and he caught sight of a tiny form lying on the bed with a little mask on its miniature face. One of the firemen was working over it, and the other was beside the bed, busy with the apparatus they had brought. The doctor, catching sight of the young man, closed the door.

Five minutes—ten minutes—passed in silence. Then the listener heard the doctor's voice. "Okay, boys," he said, "that's done it."

The door opened, and the doctor called, "Come in, Mr. Brown, and thank these men. They have saved your son's life."

JOBS like this are all in the day's work of every well-organized fire department. Daily, all over the country, specially trained firemen are answering just such calls—calls for the breath of life. Sometimes it is to help a new-born baby start breathing properly. Sometimes it is to revive victims of illuminating gas, drowning, or electric shock. Sometimes it is to ease the distress of those suffering from pneumonia, asthma, and other suffocating diseases. These men of the rescue companies of the Fire Departments have the breath of life, and it is freely at the service of anyone needing it.

Many others are now also rendering this service. Every modern hospital has the necessary apparatus. In most of the larger cities, including New York, the police departments take care of the majority of calls of this nature. Everywhere, electric light, gas, oil, and other industrial companies have trained and equipped rescue squads which are ready to serve the public in case of need. But for the country as a whole, reliance is placed chiefly on the fire departments for the equipment, the trained personnel, and—perhaps most important of all—the rapidity of action that is vital when someone is dying for lack of air.

Statistics for the country as a whole are lacking, but a medical official of the New York Police Department has estimated that about 12,000 die annually in the United States from suffocation due to drowning, gas poisoning, electric shock, and so on, and that from 40,000 to 50,000 are rescued from a similar fate by the prompt application of remedial measures.

In fact, if there is a spark of life left in a victim of asphyxia, and he is not otherwise seriously injured, the chances are better than 10 to 1 that a trained rescue squad will bring him around.

Smoke, to the average citizen, is one thing; to the fireman, it is something quite different. The layman, thinking of smoke in terms of his experience, considers it, in itself, relatively harmless; the fireman, as the result of his experience, knows that any kind of smoke may carry a deadly menace.

A boy, rescued from the burning steamship, *Morro Castle*, thought there was something very strange about the "bitter, black smoke" that rolled down upon him from an upper deck, and he is reported as testifying on the witness stand that this smoke "did not smell like ordinary smoke, not like wood smoke at all, but had a peculiar biting quality."

But the evidence presented at this inquiry goes to show that this smoke was the result of the burning of such ordinary materials as woodwork, rugs, draperies, furniture, and bed clothes, so there was nothing unusual about it at all. The lad was in direct contact with *real* smoke for the first time in his life, and it surprised him.

AS a matter of fact, smoke consists of two parts—visible and invisible. The visible part of smoke consists of exceedingly fine particles of carbon, or soot, together with certain tarry and oily substances. These particles, suspended in pure air, form what the average person regards as smoke. When breathed into the lungs, they are somewhat irritating but are not asphyxiating to any considerable degree. Hence the general impression that smoke is not particularly harmful.

But smoke of the kind that rolled down upon the boy on the *Morro Castle*, and fills burning buildings, contains invisible gases as well as visible particles —and these gases the fireman has good reason to dread. Strangely enough, it is

OF LIFE—AT YOUR SERVICE

Smoke, to You, is One Thing — to the Fireman Quite Another...He Takes It Seriously... Knows Its Dangers . . . A Pleasant Death, Anyway

only in the past year or two that we have gained a clear conception of the composition of the gases in smoke.

On May 15, 1929, a fire broke out in a Cleveland hospital where 8500 pounds of X-ray films were stored. One hundred and twenty-four people died in this disaster, of whom the great majority were killed by smoke and not by heat or flames. This led to an investigation of the kind of gases given off by burning film, and this, in turn, led to a study of the gases given off by the combustion of a variety of common materials. This work was carried out by Dr. John C. Olsen and associates, of the Polytechnic Institute of Brooklyn.

In conducting these experiments, Dr. Olsen used a small building consisting of a single, asbestos-lined room equipped with facilities for drawing off gases. In this room he burned newspapers, wood, excelsior, gasoline, rubber insulation, woolen goods, and natural silk. The gases formed by both the slow (or smoldering) combustion and the rapid burning of each of these materials were drawn off and analyzed.

When all of these substances were burned, Dr. Olsen found that the resulting smoke contained irritants such as acids or ammonia, volatile organic compounds, many of which act as anesthetics, the comparatively harmless carbon dioxide, and the deadly carbon monoxide. In addition, he found in the smoke given off by burning rubber, woolen goods, and natural silk, surprisingly large amounts of the most poisonous gases known to man—hydrocyanic, or prussic acid, and hydrogen sulfide.

As a killer of man, carbon monoxide stands at the head of the list of these smoke gases. Formed by the *incomplete* oxidation of carbonaceous material (carbon dioxide is the *complete* oxidation product), it is present in the smoke of practically all fires. It is also found in artificial illuminating gas, in the "coal gas" that issues from coal stoves and furnaces, and in the exhaust of automobiles, and it is often given off by improperly regulated gas and oil stoves.

It is difficult to conceive of a more insidious enemy than carbon monoxide. It poisons us, states Dr. Yandell Henderson, of Yale University, in a report to the Committee on Poisonous Gases of the American Medical Association, because it combines over 200 times more readily with the red coloring matter of our blood than does the life-giving oxygen. Hence, when we breathe air containing only a few tenths of one percent of carbon monoxide, our blood absorbs it eagerly and becomes charged with it. Oxygen is then excluded, and we die of what may be called "internal suffocation."

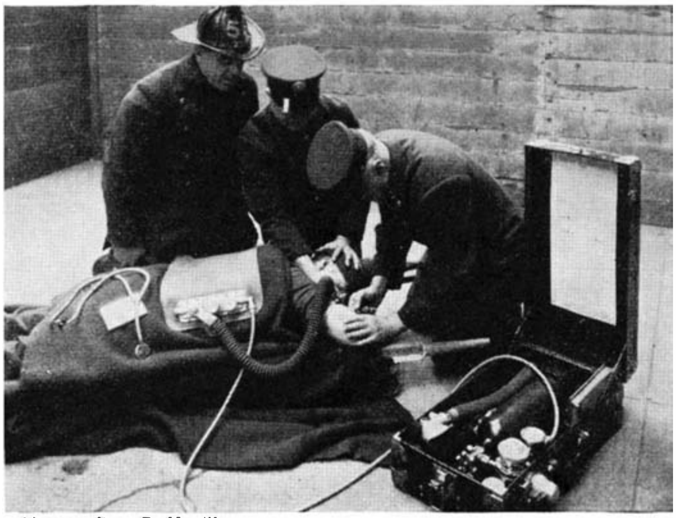


Photo by Dana B. Merrill

The inhalator supplies a mixture of oxygen and carbon dioxide for use in the treatment of cases of asphyxiation

Carbon monoxide is tasteless, odorless, and colorless; we breathe it without knowing it. And usually "carbon monoxide gives no warning," says Dr. Henderson. "The first effect is often a sudden muscular weakness which causes the victim to fall to the floor and renders him helpless. Unless he is discovered in time, unconsciousness soon follows and then death."

This, then, is the gas to which firemen are constantly exposed. But hydrocyanic acid and hydrogen sulfide—the other two highly toxic gases found by Dr. Olsen in the smoke from the burning of certain common materials—are even more poisonous than carbon monoxide. Death may result from a few breaths of either.

In fact, such quantities of hydrocyanic acid and other poisons are produced by burning silk and wool that Dr. Olsen emphasizes the special danger of inhaling smoke from burning garments. Many persons, he points out, undoubtedly lose their lives at fires because their clothes ignite and they are then enveloped in toxic gases.

THE moral is—Beware of smoke! If, for example, you find smoke pouring out from behind the door of a clothes closet, *don't open that door.* Clear the house of people, and call the fire department, if possible. If there is no fire station in the vicinity, don't attack the fire yourself until you have provided yourself with plenty of fresh air by opening doors and windows, are assured of a ready retreat (and preferably by more than one route), and have at hand ample facilities for extinguishing the blaze. Be especially careful not to let the smoke envelope you when you then open the closet door.

Also, if it is humanly possible to avoid doing so, never rush out into a smoke-filled hallway. Everyone should know that the safest plan to follow when caught in a burning building is to close the door of the room you are in and *get out by the window.* If escape this way is impracticable, throw the window open and make as much noise as possible.

"Most people who perish in burning buildings die from smoke rather than flame," an officer of the New York Fire Department told the writer.

There is beneficence in this: Death by smoke is quick, and, according to Dr. Henderson, painless.

"Of course, firemen understand the dangers of smoke and know how to protect themselves," said the writer, somewhat naïvely.

"Protect themselves!" was the answer. "Say, listen! When those boys are ordered into a burning building they go in, and they stay in until they are ordered out—or are carried out. There's only one way to protect yourself from smoke, and that's something a fireman can't do—stay away from it."

No serious and avoidable risks are taken, however. Where the atmosphere is known to be too "thick" for human safety, trained men with gas masks are sent in.

But firemen do not wear gas masks regularly, and a hundred or more are overcome by smoke in every large city every year. The treatment of these cases is one of the routine jobs of the fire department rescue companies, so they have become extraordinarily efficient in this service, to the benefit of their public as well as their fellows.

To aid them in this work, modern science has developed an ingenious instrument known as an "inhalator." This device administers copious supplies of oxygen to the victim of suffocation. Some years ago dependence was largely placed on mechanical breathing devices which pumped oxygen in and out of the lungs by applying positive pressure and a vacuum alternately. In unskilled hands, however, devices of this kind may injure the lungs or force fluid into them, thereby increasing the chances of pneumonia, and their use by laymen is not recommended by medical authorities. The inhalator, on the other hand, accomplishes the desired results without the use of moving parts and without forcing gas mechanically into the lungs. It is accepted for rescue work by such bodies as the Accident Prevention Committee of the American Gas Association and the Council on Physical Therapy of the American Medical Association.

THE inhalator as now used is due to the work of Drs. Henderson and H. W. Haggard, of Yale University. These investigators knew that carbon dioxide is one of the regulators of our rate of breathing. As they point out in their book, "Noxious Gases," we breathe more rapidly whenever carbon dioxide tends to accumulate in our lungs, thereby getting rid of the excess, and we breathe more slowly when the carbon dioxide content of our lungs tends to go below normal, thereby permitting a normal amount to collect. That is why we breathe more rapidly after physical exertion; we are getting rid of the excess of carbon dioxide formed in our bodies as the result of our efforts.

In studying various methods for the treatment of suffocation, Henderson and Haggard decided to make use of this principle and tried the experiment of administering oxygen gas containing about 7½ percent of carbon dioxide to carbon monoxide victims. As soon as the gas mixture containing carbon dioxide enters the lungs, breathing is immediately stimulated. A patient, who may be just drawing feeble breaths, begins at once to breathe more rapidly and deeply, and thus inhales large quantities of the life-giving oxygen.

This mixture of oxygen and carbon dioxide is now universally used in the treatment of asphyxia. The inhalator, by means of which the gas mixture is administered, is a very simple piece of apparatus. Its most important part is a cylinder containing "carbogen" under 2100 pounds pressure and equipped with a reducing valve and two pressure gages. Rubber tubing connects the reducing valve with a collapsible "breathing" bag, and a length of flexible hose connects the bag with a face-piece which can be fastened over the victim's nose and mouth. The whole is contained in a small case and is readily portable. The equipment is ready for instant use, it is easily operated, and it is safe in the hands of those without medical training.

When anyone is overcome by smoke or gas, he is carried out into the open air and wrapped in blankets. The application of artificial heat is very desirable, and many rescue squads make a standard practice of filling hot-water bags from the radiators of their cars for this purpose. The face-piece of the inhalator is attached to the victim, and the gas mixture turned on.

If the victim is still breathing, the stimulating effects of the gas mixture are evident at once. He takes deep breaths of the gas and, under favorable circumstances, soon regains consciousness. If breathing has ceased, artificial respiration is immediately employed, which draws the gases into the lungs and stimulates natural inhalation.

Similar treatment is employed for practically all cases of suffocation for, in all, resuscitation depends upon providing the body with an adequate supply of oxygen. In cases of drowning, suffocation by certain gases, and electric shock, where the nerve centers controlling the breathing muscles have been paralyzed, success is usually attained when the victim starts breathing. But with carbon monoxide poisoning, the blood is literally saturated with the poison, and this must be removed in order to insure recovery. Fortunately oxygen will displace carbon monoxide in the blood stream if it is supplied copiously. Hence in such cases, treatment is continued until the blood stream is brought back to normal.

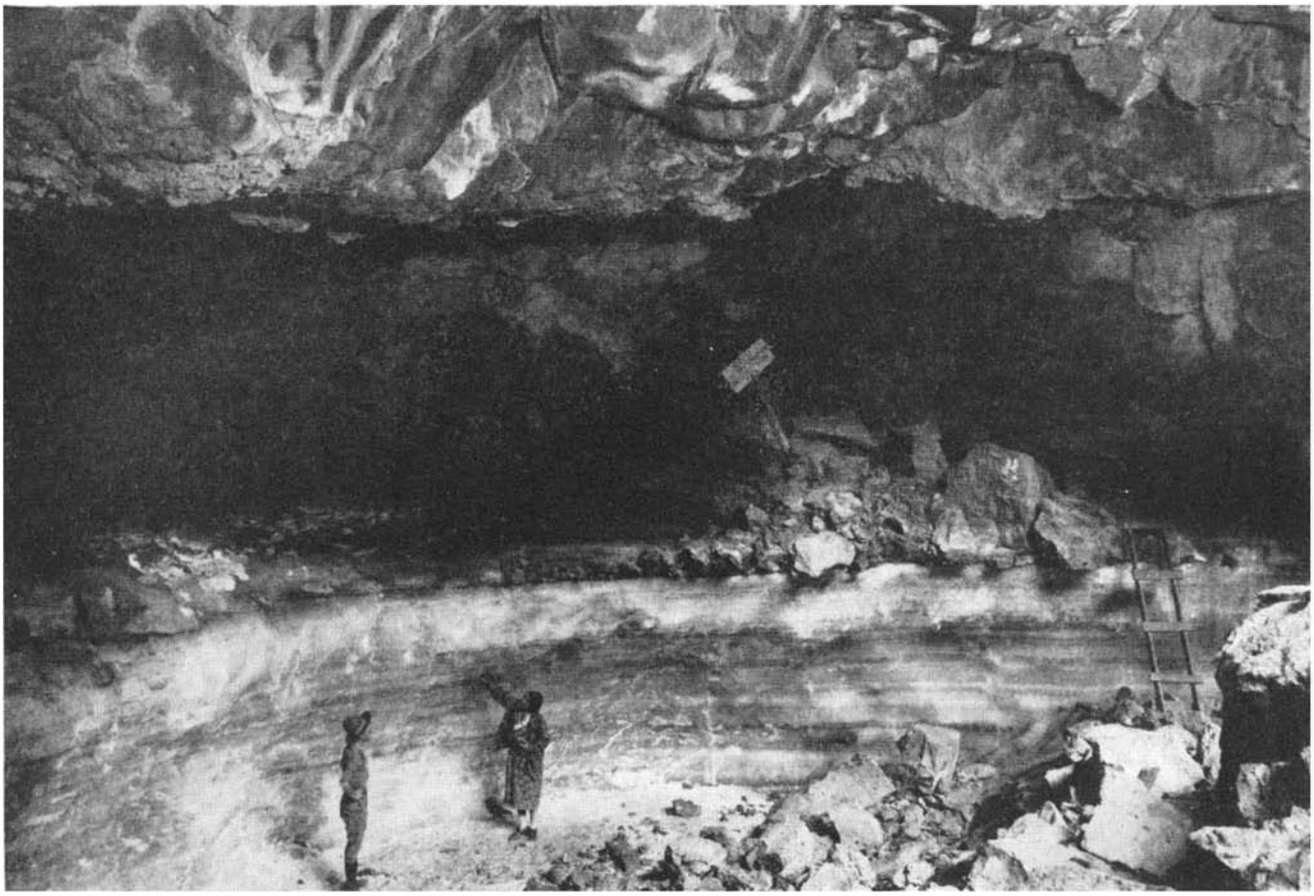
OUR first line of defense against carbon monoxide poisoning, and other forms of suffocation, is to teach as many people as possible how to apply artificial respiration. Experts, naturally, are not apt to be around when cases of suffocation are discovered, and, quick as firemen, police, and physicians are to respond to emergency calls, they may arrive just too late. A few minutes of artificial respiration in the interval before competent help appears may make all the difference between life and death. As a matter of fact, many people today owe their lives to the training in this method given to Boy Scouts and others.

Our second line of defense is the inhalator. The number of these efficient and easily operated devices available to the public is rapidly increasing, not only through regularly organized rescue squads but also through industries. An ever growing number of industrial companies are standardizing on inhalators as part of their "safety-first" equipment.

Behind all, of course, stands the physician. Mobilized in time, these three defenses are sufficient. Therefore, everyone should know where, in his community, he can look for first aid to the suffocating—whether to fire department, police department, public utility, or industrial company. Then, in need, he should summon that aid first, and then call a doctor.

Photo by Dana B. Merrill

Saved by "The Breath of Life"—firemen revived by the inhalator



PERPETUAL ICE IN A LAVA BED

By A. P. PECK

ONE of the outstanding curiosities of the western United States is the Perpetual Ice Cave of New Mexico, located in a lava bed. The well-known fact that lava begins its existence as a molten mass lends a hint of the mysterious to the 25,000 cubic feet of solid ice some 60 feet below the surface of a geologically recent extrusion of lava. Furthermore, the gross volume of the ice is apparently the same throughout the changing seasons.

For an explanation of the existence of this bank of ice, it is necessary to go back to the formation of the lava, and to keep in mind the natural laws of insulating materials and circulation of air.

Basaltic lava, after it is ejected from a volcano, cools and solidifies. The cooling of the surface exerts great pressure on the still molten lava below, and the gases expelled from the slowly hardening stone make the mass as porous as a sponge. Also, tunnels or "volcanic tubes" are formed below the surface, the roofs of which frequently collapse forming a volcanic "sink." It is in such a "sink" that the Perpetual Ice Cave formed. Fallen stone and rubble effectively choked the tube except for a single vent which permits circulation of air from subterranean areas of the lava bed.

THE porous mass of the lava serves as an excellent insulator and, accordingly, when the great mass of lava has once been thoroughly chilled—to a point perhaps many degrees below zero, Fahrenheit—variations in surface temperatures can have little effect on the bulk of the stone. The lowest temperature reached in the most severe winter in the history of this region probably yet lurks in the remote depths of the lava deposit.

Circulation of air, warmed by the sun at the surface of the lava bed, will draw chilled air from the frigid depths through cracks and faults in the basaltic mass. Since the air thus drawn from below is considerably lower than freezing temperature, moisture seeping downward from the surface of the bed becomes ice when it encounters the cold draft. The deposit of ice thus formed blocks the passage of the cold air until sufficient melting temporarily reopens the flue. Thus the principles of insulation and circulation combine to create perpetual ice at a point where, lacking the presence of moisture, a constant blast of cold air would certainly issue from the depths of the lava bed.

The bank of ice in the cave is of aquamarine color, banded with dark horizontal stripes. It is believed that the greenish-blue coloring is attributable to pollen from nearby forests of yellow pine, which is blown by the wind to the depths of the cave with the surface water. The dark lines were formed by similarly deposited layers of dust and volcanic ash.

That the cave has been known to man for centuries is evidenced by the presence of the ruins of prehistoric Indian dwellings, as yet unclassified, on the surface of the lava flow.

The Perpetual Ice Cave is located in western New Mexico, about 25 miles from the town of Grants. It is reached by means of an improved road through El Morro National Monument and the Indian town of Zuni to the city of Gallup.

WIDE SPECTRUM LINES AND

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

THERE are two stages of success in the solution of a scientific problem. Success in the first means that, knowing the facts by observation, we are able to interpret and explain them upon general principles. Success in the second would signify that, starting with the general principles alone, we could predict the facts themselves. Perfect success of the latter sort is hardly attainable. We are sometimes in a position to say: "If there are any objects of this sort, they will have such and such properties." But to say: "There actually will be so many objects of the kind in such and such positions," is too much to expect.

With this limitation, it may fairly be claimed that astrophysics is now advancing to the second stage of success.

We can not only explain the major properties of the stars in terms of those of atoms: Starting with the general properties of atoms, and the law of gravitation, we can now say: "If there are masses of matter scattered through space, only the large ones (say 100,000 times as massive as the earth or more) will be hot enough, inside and outside, to be visible at the distances measured in light years"—and, following Eddington, we can predict about how bright a star of given mass will be. To be sure, our success is incomplete—given the mass, we can predict how bright it will be, but not how big. But it is very probable that, when we know more than we do now about atoms, we will be able to predict this too.

But how will these hot luminous bodies *look?* If we mean only their appearance to the eye, the answer is trivial—like mere points of light. But if we extend our meaning to inquire how the stars' light will appear when analyzed by a spectroscope, we really have something to answer.

ELEMENTARY theory shows that the spectra will be continuous and crossed by dark lines, revealing the composition of the stars' atmospheres. Going a little further, we find that the metals will show up in the cooler stars, and the permanent gases in the hotter ones—which is an old story now.

What of two stars of the same temperature, but differing in real brightness? Can we distinguish their spectra, and if so, how and why?

How this can be done was determined 20 years ago by Adams and his colleagues at Mt. Wilson, by studying the spectra themselves. Certain lines were stronger in the very luminous giants, others in the faint dwarfs, and we all know how this discovery has been utilized to find the distance of thousands of stars. Why the lines behaved as they did was a harder problem; but, thanks to years of co-operative investigation, this, too, is substantially solved.

If we set side by side the spectra of the sun and of a giant star like Gamma Cygni, which gives out more than a thousand times the sun's light but is of substantially the same color and temperature, we will find that many of the lines are stronger in the spectrum of the latter, while others are nearly equal in the two. The star, being so much brighter than the sun, and yet no hotter, must be much larger—probably 40 times the sun's diameter. It may have a dozen times the sun's mass but the force of gravity at its surface can hardly be 1 percent as great as the sun's.

IN consequence, its atmosphere must be far more extended than the sun's. At a depth where the same quantity of matter lies above a square mile, the pressure will be only 1 percent as great. This low pressure will have two consequences. First, it will increase the proportion of atoms which have lost an electron and become ionized—another well-known effect. Secondly, it will make the gas more transparent.

This may seem strange, when it is recalled that the haziness in a star's atmosphere, which limits the depth down to which we can see—or from which we can directly receive the outcoming light—is produced almost entirely in the presence of electrons and charged atoms (ions). Should not the percentage of these make the atmosphere hazier? But this elusive fog depends not on the mere presence of these electrified particles, but upon their interaction with one another—upon the number of times per second that an electron hits an atom or comes close to it. The more rarefied the gas, the less likely this is to happen, and hence a column of gas containing a given number of ions and electrons will be more hazy, the more it is compressed (bringing the particles together), and conversely, clearer, the more it is expanded.

At the low atmospheric pressure in the giant star, we can therefore see much deeper—through layers containing far more tons of material per square mile (and, of course, *à fortiori*, to a very much greater depth in miles). Since there are more metallic atoms in the path of an equal beam of escaping light, the lines ought to be stronger. So they are, in the case of the ionized atoms, which are in the majority, even in the sun. But the low pressure in the star leads to the break-up of so large a fraction of the neutral atoms that those which are left are no more numerous than in the sun. This accounts fully for the behavior of both the sets of line described above. But when we come to the white stars, like Sirius, and to the lines of hydrogen which are the strongest of all, we find a contradiction. These lines are strong in the less luminous and smaller stars, and much narrower and weaker in huge super-giant stars like Alpha Cygni. There is no theoretical reason to suppose that at this higher temperature the laws which govern the atmospheric haze are reversed. Indeed, we have evidence that they are not, for the lines of the metals are much stronger in Alpha Cygni than in Sirius—indicating a thicker atmosphere. Granted this, we are faced with the anomaly that a smaller quantity of hydrogen, in the denser star, produces stronger lines than a much larger quantity in the rarefied atmosphere. The solution of the particular puzzle lies in certain peculiar properties of the hydrogen atom and its spectrum.

IF hydrogen is stirred up to shine in a tube within which there prevails a powerful electric field—a gradient of thousands of volts per centimeter—its spectral lines, originally single except when observed with very high power, break up into complete groups of equally spaced lines. The stronger the electric field, the wider is the pattern, and as we pass from the red line $H\alpha$, to the blue $H\beta$, and the violet $H\gamma$ and $H\delta$, the number of components, and the width of the pattern, rapidly increase. This "Stark effect"—named, like many others, from its discoverer—is far greater for hydrogen than for any other element. Helium shows it faintly, and the heavier atoms to but a small extent.

In a star's atmosphere—which must be a good conductor of electricity—there can be no perceptible *general* voltage-gradient. But, since it is full of electrified particles, any given atom

Small Stars

within it will be exposed to the electrostatic attractions (another name for electric fields) of the neighboring charges. These will never exactly balance one another, and will sometimes be very much unbalanced, when one charged particle is much nearer than the other. Calculation shows that the average electric field acting on an atom will be powerful enough to split up the hydrogen lines widely. If this effect was the same for all the atoms, we would see these lines split up into complex groups: but as it varies very greatly from one to another, patterns of quite different scales will be superposed, and the net effect will be to smear the hydrogen lines out into wide, structureless affairs fading out gradually from center to edge, but with no definite boundary.

It has long been believed, with good reason, that this actually happens. Now the matter has been put to the test of precise calculation by Professor Pannekoek—one of the most distinguished astronomers of the Netherlands—and his associate at Amsterdam, De Verwey.

The calculations must have been very laborious. Starting with a formula showing what proportion of the atoms in a gas of given density would be exposed to electric fields of a certain magnitude, they computed the smearing effect upon the various hydrogen lines. Next, assuming an actual atmosphere composed mainly of hydrogen, they determined the haziness at different depths, and worked out the combined effect of the absorption by layers at all levels, thus finding at last what the stellar line should look like. Separate computations had to be made for each of the four principal hydrogen lines, for different values of the star's temperature, and for several values of the surface gravity. The results justified the heavy work: they brought a complete explanation of things that had previously been puzzling.

For example, it is known from atomic theory that the number of hydrogen atoms which are at work absorbing the red line is much greater than for the blue, while for the violet lines it is smaller still. We might therefore expect that the red line would be the strongest and widest, and the others steadily weaker. But the Stark effect widening is much greater for the blue and violet lines, and the net result turns out to be that these two influences balance one another almost completely, so that all four lines should be of almost equal width—which measures of the spectra show that they actually are.

At very high temperatures, when almost all the hydrogen is ionized, all four lines are weak. Taking everything into account (including the influence of the metallic atoms which are present) Pannekoek finds that, for such a value of gravity as exists in Sirius or Vega, the lines should be widest at a temperature of about 8500 degrees (which is probably not far from that of such stars). His curves, showing the theoretical width of the lines and the way in which the intensity should change from the center toward the edge, agree with actual measures of the lines in Sirius and Vega with remarkable clearness. Now the calculations were made on a basis of pure atomic theory, making not the slightest use of any observed property of the stars (except that their atmospheres were composed mainly of hydrogen). The agreement with observation is therefore an example of the second and higher degree of success in the interpretation of nature. The theory predicts precisely what the hydrogen lines in Sirius are like—and could have been worked out in the laboratory by men who had never seen a star.

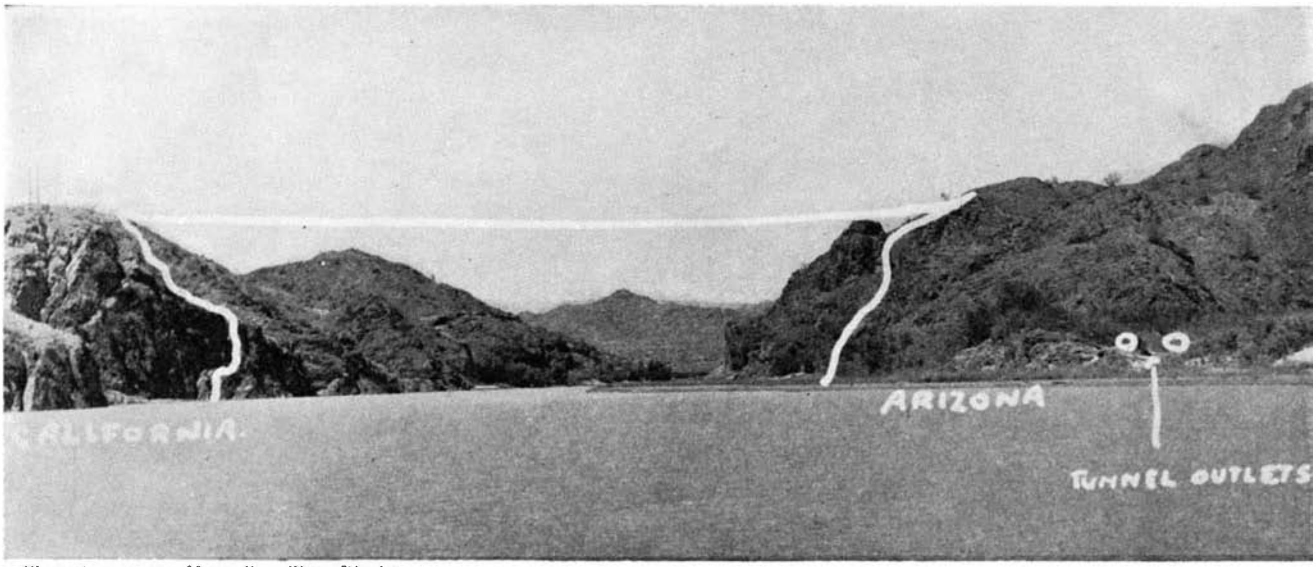
An equally satisfactory result is the full explanation of the abnormal behavior of the hydrogen lines in stars of different brightness. If the force of gravity is a hundredfold greater on one star than on another of the same temperature, the new formulas show that the atmosphere of the first star will be so much hazier that the actual quantity of gas (per square mile) above the level to which we can see will be only one tenth as great as in the second. But the greater Stark effect in the first star will broaden the lines so much that they will be two and one half times as wide as in the other.

By far the greatest known force of gravity is found at the surfaces of the white dwarf stars. On the companion of Sirius it is about a thousand times as great as on the sun or on Sirius. We might therefore expect that the hydrogen lines would be correspondingly widened—and so indeed they are. At the same time, the atmospheres of the white dwarfs should be thin, containing much less material per square mile, and this accords with the fact that the lines of the metals—such as the great magnesium line at 4481—are hardly to be seen at all in their spectra.

Pannekoek concludes that, when the width of these lines has been accurately measured, we may be able to calculate from this alone the force of gravity at the surface of a white dwarf, and so to get an independent estimate of its mass, even if it is not double.

Only those who have engaged in similar calculations can realize how much work lies behind the pages which tell this new story, but the remarkable success which has repaid it may, it is hoped, be intelligible to a larger circle of readers.—*Princeton University Observatory, October 3, 1935.*

At the left is the 61-foot dome which houses the new 74-inch reflector (see page 292) at the observatory of the University of Toronto, 15 miles north of the city. At the right is the new administration building with three smaller domes on top. Of these the nearest houses a 19-inch reflector built at the University by Prof. R. K. Young, assistant to the Director, Prof. C. A. Chant. Prof. Young is not only an astronomer but a telescope maker and mirror maker in his own right. The two other domes are later to house other telescopes. The big telescope is to be used mainly for spectrographic purposes, including radial velocities and physical constitution of stars fainter than sixth magnitude. It will be reserved for public use on Saturday nights. The observatory buildings will be open for inspection on certain afternoons. The administration building is made of white stone and contains offices, a library, a machine shop, several laboratories, and a lecture room



Illustrations courtesy Metropolitan Water District

A view of the valley of the Colorado River, showing the location of Parker Dam and the diversion tunnels

COLORADO RIVER'S NEWEST DAM

Will Divert Water for California . . . Gates to Control Severest Floods . . . Concrete Arch Type

By ANDREW R. BOONE

PARKER Diversion Dam, now under construction on the Colorado River 150 miles downstream from Boulder Dam, will perform the very useful function of storing water in a reservoir 100 miles long from which the Metropolitan Water District will draw ultimately a billion gallons of water daily for use in Southern California. [See September and November, 1934, Scientific American for details of the Colorado River Aqueduct.—*Ed.*]

The diversion dam will raise the water about 72 feet from present river level to an elevation of 450 feet above sea-level, thus providing a 717,000 acre-foot storage basin for regulating and clarifying the water. The dam will be of the concrete arch type and will contain a total of 7,479,000 cubic feet of concrete in the dam proper, the spillways and piers, and so on. Five 50-foot by 50-foot roller-bearing gates on the crest will provide for the passage of floods.

The large gates can be lifted bodily to relieve the pressure built up by a possible flood sending down the canyon the staggering total of 500,000 second-feet, or 326 billion gallons of water every second. This figure tops the biggest flood recorded on the Colorado in 50 years, and includes both the maximum capacity of Boulder Dam's spillways (400,000 second-feet) and 100,000 second-feet of inflow along the river below Boulder. Thus there will be no danger of flooding the Mojave Valley, including the city of Needles, 100 miles upstream. These five gates will occupy openings within the concrete superstructure. Normally, all gates will occupy the closed position, during which time water will pour down through the power plant, which, when built, will develop 80,000 horsepower.

Parker Dam will cost 8,000,000 dollars—only one sixth the cost of Boulder Dam. Pumping station and power line will bring the total construction charges to 28,000,000 dollars. This figure would have been much higher were not construction proceeding at a time when the Boulder Dam reservoir is filling, thus diminishing materially the need for more and larger diversion tunnels at Parker.

Designed and constructed by the United States Government through the agency of the Bureau of Reclamation, with funds furnished by the Metropolitan Water District, the dam and reservoir will be owned by the Government and will be operated by it. The United States retains one half the power privilege at the dam and a limited right to regulate the top 10 feet of storage in the reservoir. The remaining half of the power privilege belongs to the District. A contract for construction of the dam has been let by the Bureau of Reclamation to the Six Companies, Inc., and construction activities have been started.

The actual diversion of water to the aqueduct is to be made by two pumping plants, the first with a lift of 290 feet, and the second of 302 feet.

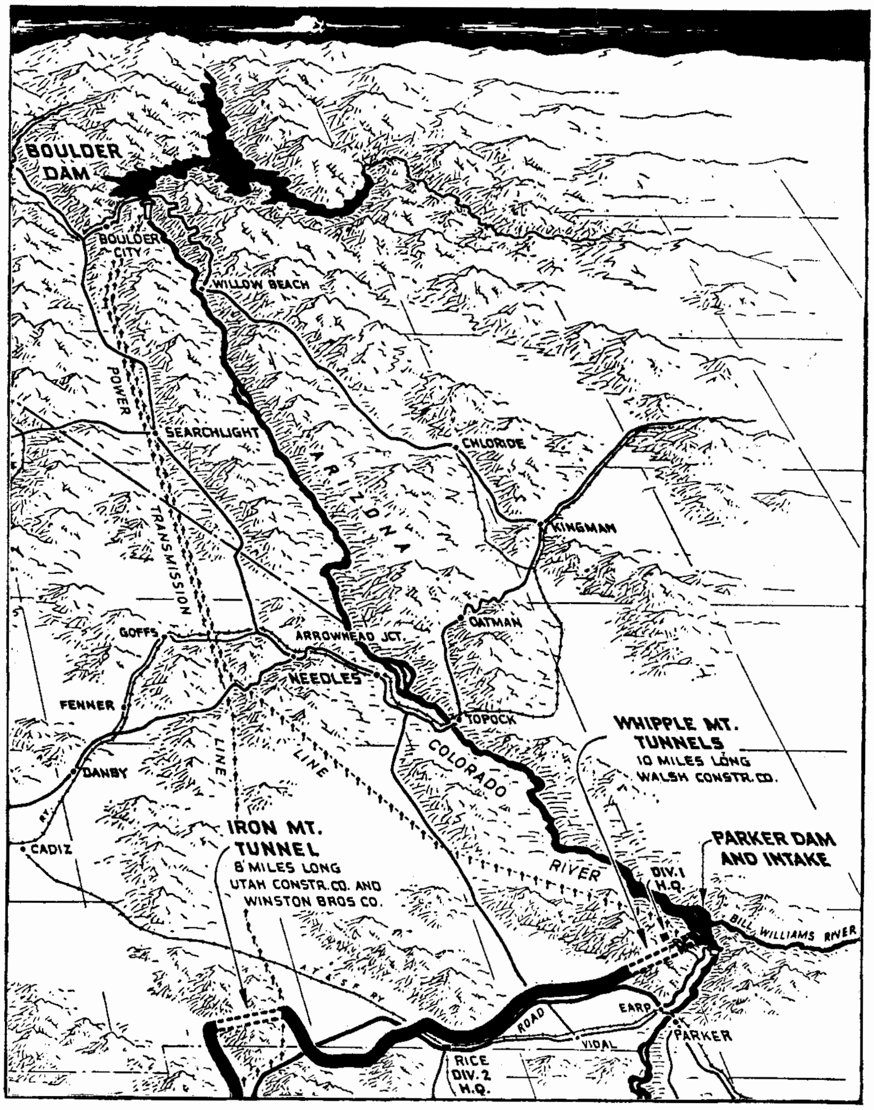
Although nine pumps—eight operating, one standby—eventually will lift a billion gallons daily 1700 feet in five stages from the river through the aqueduct over the mountains, only three will be installed initially. The pumping

Ends of the two 29-foot horse-shoe type diversion tunnels built at Parker Dam

problems are being studied now by the engineering department at the California Institute of Technology. "When all pumps are in operation and delivering the full 1600 cubic feet per second," explained Prof. R. L. Daugherty, "there will be required about 350,000 horsepower for the entire system. The power required for a single pump will range from 4000 horsepower in the lowest head plant (160 feet) to 12,000 horsepower for the highest head (480 feet)."

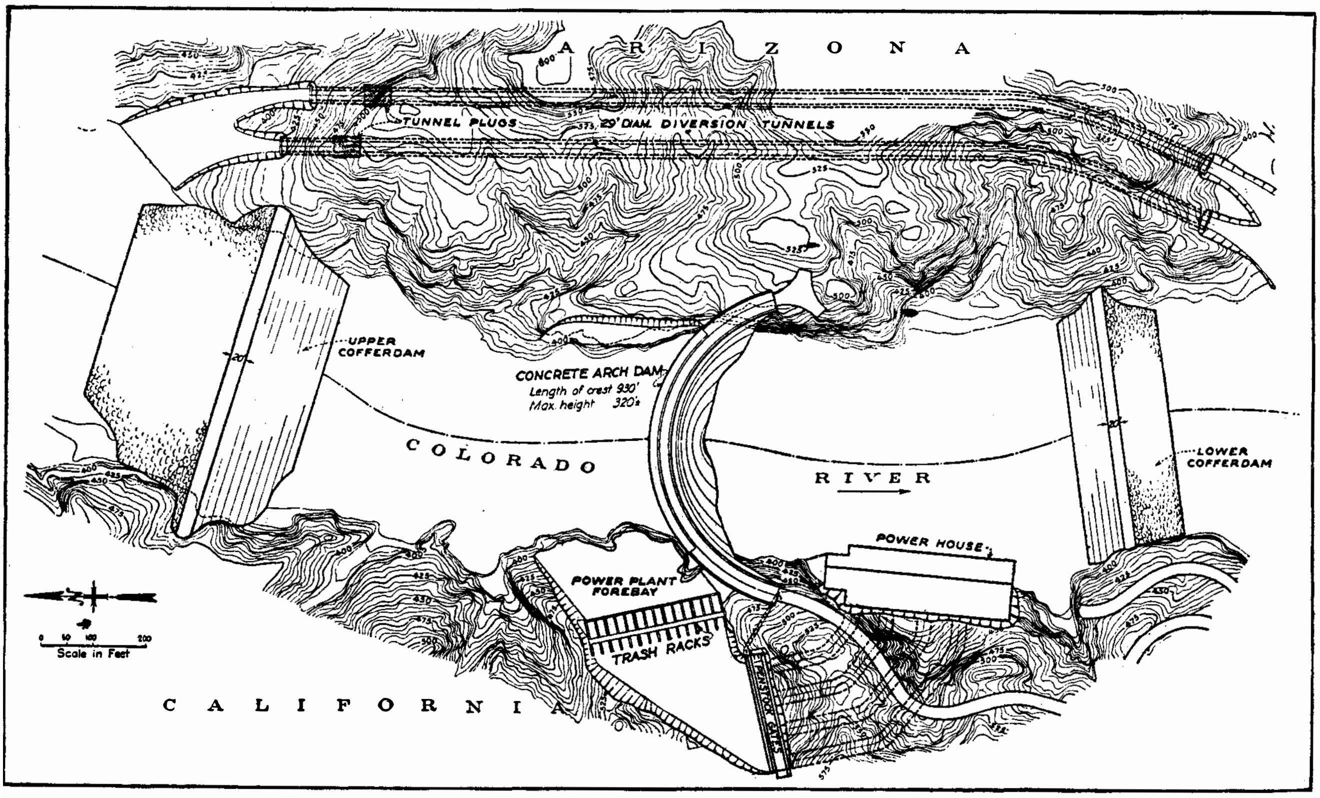
During early years of operation energy for lifting some 300,000,000 gallons daily will be supplied by power from Boulder Dam. The aqueduct is being financed with proceeds from 50-year bonds, and its full capacity of one billion gallons daily will be reached sometime before the half-century period has run. It is anticipated the dam will be completed sometime in 1938, coincident with completion of 13-mile San Jacinto tunnel, final unit of the aqueduct.

Careful study of all possible routes led to the final selection of the diversion site, 16 miles up the river from Parker, Arizona. This selection was influenced by a combination of economic, topographic, and geologic factors. It is considered the safest route to build and to maintain; it requires less gross pump lift than any other feasible route; the river is confined at the point of diversion in a narrow rock canyon.



Right: **Map showing the location of Parker Dam and near-by projects**

Below: **Plan of Parker Dam, giving pertinent dimensions and other data**



PREHISTORIC BURIALS OF TEPE GAWRA

By CHARLES BACHE
Field Director, Joint Assyrian Expedition of the University Museum, Philadelphia, and The American School of Oriental Research, Baghdad.

THE tombs under discussion in this article were found intrusive in Levels 9, 10 and 11 of the great city mound at Tepe Gawra, described in an article in the October number of Scientific American. The contents of the tombs indicated a culture quite unlike the culture of the occupational levels immediately below or above the levels of the tombs. Objects found in the tombs, with the exception of a very common type of bead, are never duplicated by objects found outside, but within the same strata. One would naturally expect the dead to be equipped with the best of their possessions, but even in the rare instances where we found ordinary every-day objects, such as pottery vessels, they were also dissimilar from objects used by those who *lived* on Gawra.

Despite the fact that there is no difference in the culture of Levels 8 and 9, we are forced to the conclusion that at the end of the occupation of 9 and before the beginning of 8 there was a break in the continuity of the occupation of Tepe Gawra. For some reason—invasion, disease, fire; exactly what we cannot tell—the Gawrans deserted their mound, and some other people who may have lived nearby used Tepe Gawra as a necropolis. Not only did they bury their dead on Gawra, but they even robbed the ruined temple of Level 9 of its sun-dried brick for the construction of their tomb walls.

Today there is nothing that indicates where the village or town of these people was. Perhaps they lived close to Jebel Badhiqa, where there was an excellent water-supply, about a mile from Tepe Gawra. Perhaps they built their houses at the base of Gawra. Wherever their abode was, we have yet to find it. That it was not on Gawra, we may be sure.

In all, 23 *libn*[1] tomb burials were excavated in the last two campaigns: 14 in the campaign of 1932-33, 9 in 1934-35. Exactly one half of those found in the earlier campaign had been robbed. None of the more recently discovered burials, all in Levels 10 and 11, was disturbed before we came upon them. For this reason we were able to obtain structural details which had been lacking until the last few months. It can be stated with almost certainty that the same method of construction was followed in every one of the tombs, with a single exception.

THE general method is as follows (See Figure 1): a hole, generally about four feet deep, eight feet long and five feet wide, was dug in the debris of the *tell* (hill). All sides of this pit were lined to the top with walls of *libn*. The size of each *libn* is approximately 3 by 8 by 16 inches. Usually the walls of the tombs are but one *libn* in thickness, although occasionally we have found tombs where all walls are of double thickness. and we have one or two instances in which the long walls are double, the end walls single.

Beyond leveling it off, there was no especial preparation of the floor of the tomb. Over it, the construction of the walls being finished, there was placed a reed mat on which the body of the lamented one was placed. The body was always in a contracted position—knees drawn up so that the thighs were at right angles to the trunk, legs placed as close to the thighs as possible, so that the angle of the knees was very acute, the body lying on its side (there was no rule for which side) the elbows at the chest, the hands raised to the mouth. In the hands were then placed the funerary objects. In one tomb only did we find a deviation from this rule.

Then the body was covered with another reed-mat, or the mat that already was beneath it was wrapped around the body. Over the body was then built a small wooden structure (See Figure 2). That it had a gabled roof, we know. We have found traces of the ridge poles in several of the tombs, as well as the remains of the corner posts, their tops somewhat lower than the ridge poles. While we have found the remains of the boards that formed the roof, we have no evidence for assuming that the structure had board walls as well. It is possible that it did. The roof of this added protection was somewhat lower than the tops of the walls of

Figure 1: **Four *libn* tombs, Numbers 109, 110, 111, 114. *Libn* is much like adobe**

[1]A sun-dried mud brick, similar to adobe.

libn. Therefore, the intervening space was filled with dirt to the upper level of the walls. Covering the whole structure and extending to the outside of the walls was placed another reed mat, held in place by two additional courses of *libn,* placed on top of the walls. This mat was then well plastered over with mud, and the burial was finished.

In almost every excavated tomb, objects and skeletons were in badly damaged condition. Very frequently substantial things, such as stone vessels, were shattered. Until recently we suspected that these had been intentionally "killed," but we now know that our assumption was incorrect. It is almost certain that in the course of the years after the burials the posts that supported the wooden roofs rotted away, allowing the tons of accumulated earth above to fall in the tombs, crushing the skeleton from which the flesh had already decayed, smashing any brittle object that offered resistance, and bending and twisting gold ornaments that formed decorations on the bodies.

While there was no definite practice in the orientation of the bodies themselves, very definite rules for the orientation of the tombs obtained. Their corners were *always* at the cardinal points of the compass, the longitudinal axis northwest-southeast. No exception to this rule was found. In connection with this, it is interesting that in all buildings of Levels 9, 10, 11, and 12 the same rule also held true. Corners of rooms, and corners of the buildings, were at the same cardinal points. In the case of buildings, however, the longitudinal axes are northeast-southwest.

As stated above, 23 tombs were excavated, of which a number merit description here. The others had been robbed, or else had originally contained no objects.

In Tomb No. 24, the skeleton lay on the left side, its skull at the southeast end of the tomb. Held in the hands, which were raised to the face, or near the skull, were two interesting objects: a comb and the hair ornament shown in Figure 3. Both are of bone. The hair ornament is a striking work of art, with four bands of gold around it, both for decoration and reinforcement of the fragile bone needle. The central portion is inlaid with lozenges of turquoise and lapis-lazuli, in alternate spiral rows. It must have been worn so that the points were thrust in the hair, leaving the colorful center exposed. I believe I am safe in saying that this piece is quite without parallel.

Tomb No. 25 contained a double burial. It was built in connection with No. 24. Skeletons lay on their sides in the usual sharply contracted position, facing

Twenty-three Tomb Burials Excavated . . . Apex of Stone Craftsmanship and Goldsmith's Art . . . Over 5000 Years Old . . . Who Were the Gawrans?

each other, their knees touching, their heads at the northeast side of the grave. The tomb contained no funerary objects beyond a stone amulet and a gold ear-pendant. This instance of double interment will be discussed below under No. 111.

Tomb No. 30, which measures about 82 by 60 inches, is also a double burial,

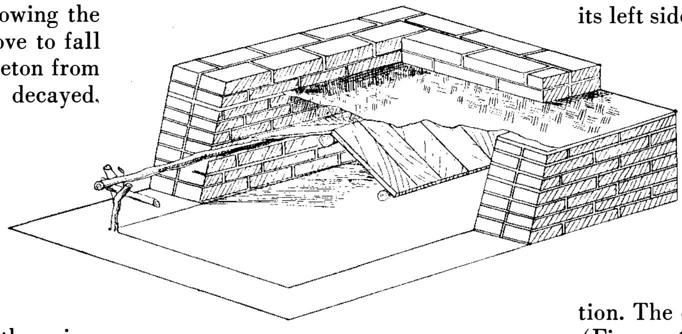


Figure 2: **Reconstruction of a *libn* tomb, showing walls, mat, and roof**

but in character dissimilar from No. 25. One skeleton lay on its left side, head at the northeast end of the grave. The other—smaller—lay at the feet of the larger, its head almost in the south corner of the tomb, the body parallel to the southeast wall, on its right side. It will be of interest for the reader to contrast this burial with Nos. 25 and 111. No objects were found in the tomb.

Tomb No. 31 is one of the richest burials we have found in Gawra. All objects were found close to the face, as if they had been placed in the hands of the corpse at time of burial. Besides a string of 512 beads of shell, carnelian, lapis-lazuli, turquoise, crystal, and gold, there were four stone vessels, two stone objects of uncertain function or purpose (Figure 4), a seal-plaque, two combs, and a hair-ornament, all of bone. Gold in the form of hemispherical studs and a rosette with a gold dangling ribbon was also found. The studs had been filled with bitumen and affixed with this adhesive to cloth, the imprint of which still remained. Very likely these latter formed a fillet that was worn around the head.

A seal-plaque found in the same tomb shows a man driving before him an ox or bull, and over the bull is the "star" sign, later to become the "ilu"—symbol of divinity, probably Enkidu. Incidentally, this is the first indication of any attempt at writing that has ever been found on Gawra—even in the later levels in which times writing is known to have existed.

Four vessels also were found. A tiny alabaster jar, not two inches high; an unusual object consisting of two bowls carved out of one piece of "Mosul" marble; a small incomplete bowl, 1½″ in diameter of oölitic limestone and lastly a beautiful handled bowl of steatite (Figure 5). The last is translucent and highly polished.

In Tomb No. 34 the skeleton lay on its left side, its head at the southeast end of the tomb. This is the largest tomb of Gawra, and is also one of the poorest. I believe, however, that it had been robbed in ancient times, as the skeleton was not complete—all of the body above the pelvis was missing, only the skull remaining of the upper portion. The only object was a large comb (Figure 6) of the "Spanish" type—curved to fit the back of the head. Most of its teeth were gone.

No. 102: While this is not intrinsically the richest tomb, archeologically its contents are the most important that we have. In their order of importance, they are: a pottery dish of coarse redware; a pear-shaped mace-head of oölitic limestone; 28 stones, a few unshaped, a few roughly cubical, the majority spheres, all intended as ballistas; 260 large beads of white shell and carnelian, worn as a necklace; over 25,000 small beads, all discoid, of which all but 1100 were white shell. The 1100 were made of obsidian and, on account of their size and number, are quite unusual. Judging from their position in the tomb, they formed, it is likely, a bead jacket. Strung together, the strand is over 145 feet in length.

The two most distinguished objects may be seen in Figure 7. Made of obsidian, these spouted vessels represent the apex of stone craftsmanship. Anyone who has ever attempted to work flint or obsidian can appreciate the skill and labor that was put into the manufacture of these finds. In the Iraq Museum in Baghdad the visitor may see a silver ewer recently discovered at Warka (Erech) in southern Babylonia. If one were to place this ewer beside the obsidian ewer at the right in the illustration, it would be almost impossible to distinguish them, if material be disregarded, so alike are they in size and shape. It is a parallel such as this that makes a find of importance. A unique object may be of interest, but in archeology the old adage that "comparisons are odious" collapses loudly.

No. 107: Skeleton on the left side, its skull at the center of the southeast wall. The only objects were a half-dozen ballistas of alabaster.

No. 109: For the purpose of museum display, and in actual *intrinsic* value, this is the richest tomb on Gawra to date. Here I will not attempt to describe all the gold objects—some may be seen in Figure 9. A total of 410 was found—falling into 12 separate categories: 235 beads of gold and electrum; 90 "bangles" shaped very much like a tennis-racquet (apparently these bangles were part of a necklace which was also comprised of pearls); eye-shaped ornaments, use or purpose unknown; flat crescents, pierced at each end for stringing; a ferrule (for a sceptre?); six clam-shell-shaped ornaments; 50 hemispherical studs, similar to those of tomb No. 31 and rosettes, both plain and with dangling ribbon.

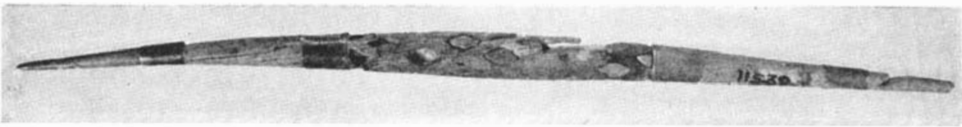


***Figure 3:* The hair ornament found in Tomb No. 24. It is made of bone, with four gold bands around it, and inlaid with both turquoise and lapis-lazuli**

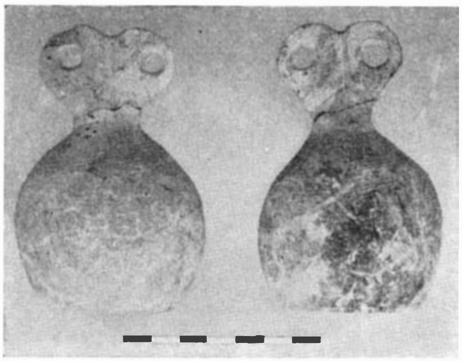
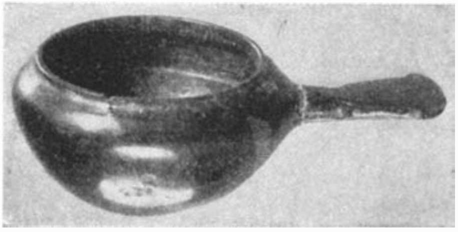


***Figure 4:* Two stone objects of uncertain purpose, found in Tomb No. 31**

***Figure 5:* A beautiful, handled bowl of steatite,—translucent. From Tomb 31**



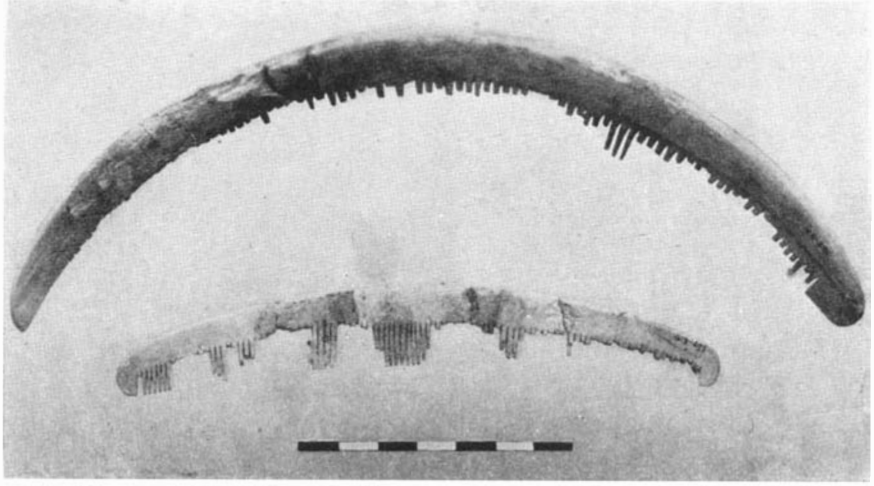


***Figure 6:* A large comb antedating the Spanish type; also a straight comb**

QUANTITIES of beads were also found—lapis-lazuli, turquoise, carnelian, and white limestone. The majority were of lapis-lazuli, and some of these were carved in unusual shapes. An amusing and interesting object is a representation of a flying-ant; its globular body is lapis-lazuli, its wing and head in electrum. Two splendid obsidian razors and a bone comb were found underneath the hands. The comb was 8¼ inches long, with a very massive grip. It could not have been worn, as it was straight, and must have been used in caring for the hair.

The small black and white marble jar shown in Figure 8 is one of the daintiest of stone vessels that has come from Gawra burials. It is absolutely undamaged and is perfectly executed throughout. Two other bowls of stone, one of alabaster and one of oölitic limestone, complete the list of furnishings for this tomb. These last two are the exceptions to the rule that all objects are placed at the head of the skeleton in its hands—both were found, inverted, at the feet. The oölite bowl (Figure 11) is an excellent piece, with a decorative notched molding near the outer rim, on the almost flat shoulder. It, too, is undamaged. The alabaster bowl mentioned a few lines above is dull and uninteresting. Hemispherical, it bears no ornamentation, and the soft alabaster was badly crumbled on the bottom and around the rim.

No. 111 contained three skeletons. It was built in direct association with No. 109, the northwest wall of the latter being the southeast wall of the former. This same condition obtained in Nos. 24 and 25. Except for No. 25 being double, and 111 being triple burials, they are strikingly similar. Each joins a rich single burial. Each in itself was woefully poor in tomb furniture. Each is northwest of its rich companion tomb. In all probability each of them was built at the same time that the richer burial was made. In each case, the multiple burial lay at the *feet* of the skeleton in the richer tomb.

Of the three skeletons in No. 111, only one had with it anything in the sense of ornament—an inconspicuous string of 71 beads and pendants, seven of which were of gold, the rest of the usual semi-precious stones—lapis-lazuli, carnelian, and so on. Each skeleton was provided with a plain earthenware pot. Contrast this with the marvelous stone vessels in No. 109, 102 and 110. In view of these circumstances, is it unreasonable to assume that here we have examples of human sacrifice to a dead chieftain? In a somewhat later period at Ur, in the Royal Cemetery, there are examples of this same sacrifice on a much larger and more impressive scale.[2] It seems to me that more than likely either slaves, followers, wives, or concubines of nobles were slain and buried with them to minister to them in after life, as they had done in this world.

No. 110: The tomb was quite a rich one but it presents no feature of extraordinary interest. It contained the usual type of gold ornaments—rosettes and eye-shaped. For the first time we found the extruding nipple of stone in the center of the larger rosettes (Figure 9). One was of lapis-lazuli, the other of a green stone which we have not yet had identified. Also of interest is that here we found the original order of stringing beads of carnelian and gold: that is, the ten carnelian discoids, one gold cylinder and so forth. Two rotting maceheads of limestone, and six ballistas of alabaster were also found. A curved bone comb and a seal stamp of lapis-lazuli almost complete the roster of objects.

The two finest things are the steatite cups shown on either end of Figure 8. Absolutely symmetrical, elliptical in plan at their rims, of extreme thinnesses as to ware, their very shape precludes the use of the wheel, which at this time was not in use on Gawra. While steatite is an infinitely more tractable material in the hands of an artisan than is obsidian, these cups, by their shape and

[2] C. L. Wooley, "Ur Excavations, II," The Royal Cemetery, p. 73.

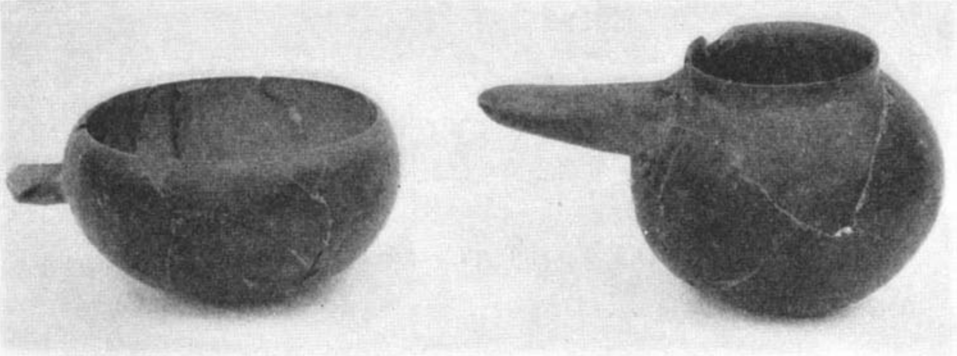
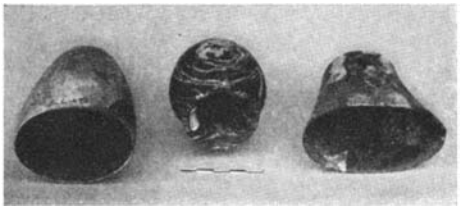


Figure 7: **Spouted vessels representing the very height of craftsmanship. They were made of obsidian, a very hard stone**

Figure 8: Center: **Black and white marble jar. Cups from Tomb No. 110**



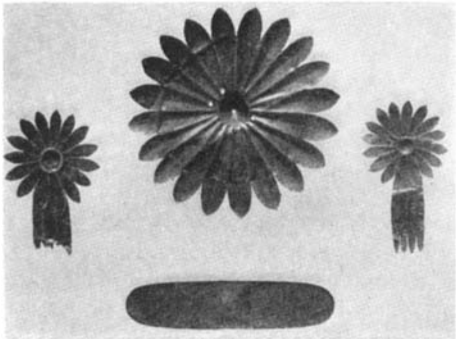


Figure 9: **Gold ornaments from various tombs, as well as the hone from No. 114**

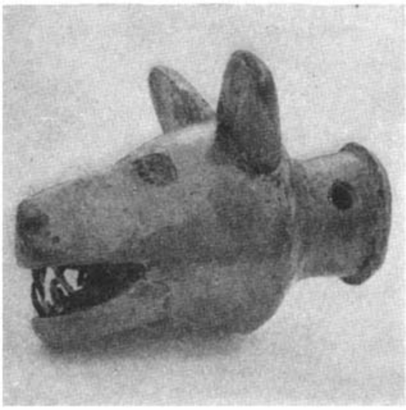


Figure 10: **Gold-silver alloy wolf's head, Tomb 114—"most beautiful"**

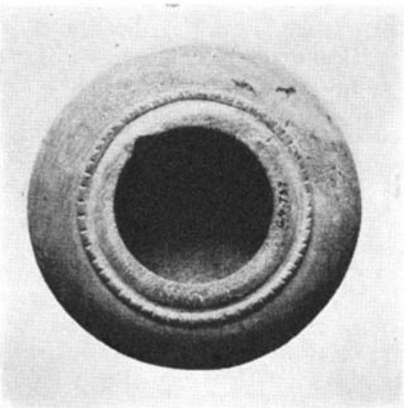


Figure 11: **The oölitic limestone bowl from Tomb 109—undamaged**

workmanship, are impressive monuments to the exceptional stone work of the Gawrans.

No. 114: If No. 102 is archeologically the most important tomb, then, esthetically, 114 is the most important. Had we excavated but these two burials and found nothing else, we could still count our results as being more than worth the expenditure of effort and money in obtaining them. In Tomb 114, the skeleton lay on the left side, the skull to the southeast end of the tomb.

The wolf-head shown in Figure 10 is unquestionably the most beautiful object that has come from Gawra's tombs. So realistic as to be almost breath-taking, it is the zenith of the goldsmith's art in these early times, and will compare more than favorably with the finest metal work of any time. It is made of electrum, a natural alloy of varying proportions of gold and silver, much in use among the ancients, and is beaten around a core of bitumen (asphalt). The lower part of the mouth is removable, being attached to the main part of the head by means of a prong that penetrates to the outside of the under-jaw, and is bent upward to hold it in position. The ears, which had fallen off, are attached by means of copper pins, their only trace being the dust of the green oxide. Doubtless the eyes, which are missing, were of glowing carnelian, or some colorful stone. The teeth are also made of electrum, drawn into wire, the points sharpened to needle-sharpness. Probably this head was fixed to the end of a wand—perhaps as a symbol of authority wielded by some high official of the ancient city mound of Tepe Gawra.

Another fine object, beautiful for its very simplicity, is the hone shown at the bottom of Figure 9. It is made of hard, green stone with a plain band of gold about its middle. An unusual pear-shaped mace-head of hematite, with three projecting knobs on the heavier end, and three simple bone hair ornaments with gold bands, finish the list of unique objects from this fascinating burial. Besides these things, there were many other objects which add to the wealth of the tomb. A seal stamp of lapis-lazuli, depicting a leaping gazelle; a gold rosette, large and with a nipple of stone; many hundreds of beads—gold, carnelian, and so on; six ballistas made of a marbled red stone, and an alabaster mace-head, bring the list of objects to an end.

This was the last tomb of importance that was excavated in these two seasons. At the beginning of this article, I mentioned the fact that there was but a single exception to the rule in the construction of the tombs. This was one that contained no objects, but is of interest since, inside the *libn* walls, it was lined with large stone slabs, with a slab floor and a slab cover.

TO set an exact date for these burials is difficult. It is doubtful that it will ever be done with certainty, since there are no historical data nor written evidence for it. At this time, a conservative estimate will suggest that 3500 B.C. is a reasonable date. They cannot be more than a few years later than this, and it is very possible that they are considerably earlier. The levels in which they are found are 20 feet below the level contemporary with the First Dynasty of Ur—beginning 3100 B.C. Between this level (6) and the tombs, there was a long occupation, marked by constant building and re-building in all the phases of stratum 8, and at the conclusion of 8 there was yet another long period before the building of 6 started. The date 3500 B.C., while only a hazard, is certainly not a reckless one.

IT is interesting to note that the walls of Level 8 were built over some of the tombs discussed in this article and that in some few instances the builders of Level 8 must have broken into and robbed them. We found, in tearing down this stratum, a fragment of a stone vessel, the rest of which was later discovered on the floor of one of the pilfered tombs.

In the 9th and 10th levels, tombs were confined to the north and west sections of the *tell*. Since only the north and east sections of Level 11 have so far been excavated, we cannot yet say definitely whether or not their location is similarly restricted in this level. However, none was found in the excavated east section of Level 11—only in the north. All the tombs of Level 11, being buried in débris far deeper than those that were found in Levels 9 and 10, were unrobbed by the builders of stratum 8.

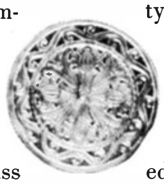
...NOT JUST GLASS

Glass Age is 6000 Years . . . Last 20 Have Seen Most Progress . . . Important New Uses . . . Architectural, Industrial, Scientific Types of Glass

By PHILIP H. SMITH

YOU can now build a house of glass and live comfortably—and privately—within it. What is more, you can throw all the stones you wish with impunity, for glass research has outmoded the old adage.

If you think of glass only as a brittle, transparent material which must be protected from shock, then you are sadly uninformed. This clear, fragile material has been worked over until established definitions for it are inadequate. The commonplace glass which you purchase for window panes must still be protected from baseballs, but there are types which will withstand terrific impact. And there are types which transmit the infra-red rays, or ultra-violet rays; X-ray protective glass which is equal in effectiveness to one third its thickness of lead; and bullet-proof glass made of laminations of plate glass and plastic. Glass is no longer just glass.



Students of glass history give it an age of 6000 years, but aside from advances in the technique of making art objects, very little progress was made for a long span of years. More progress has been made within the past 20 years to determine just what glass is, what can be done with it and how to do it, than was accomplished in all the previous 5980 years. That is why when you examine glass manufacture today, you find a backward industry moving forward at astonishing speed.

RESEARCH has made possible the enormous strides, and research is guiding the industry today. Manufacturers will admit this even in plants where research facilities are slim. And with all that has been accomplished we are admittedly only on the threshold of developments. It has taken years to attain a scientific understanding of the commonplace practices of centuries and this had to be acquired before departures could be made. Now, with better foundations laid, developments should come thick and fast; indeed, they are already crowding upon the stage.

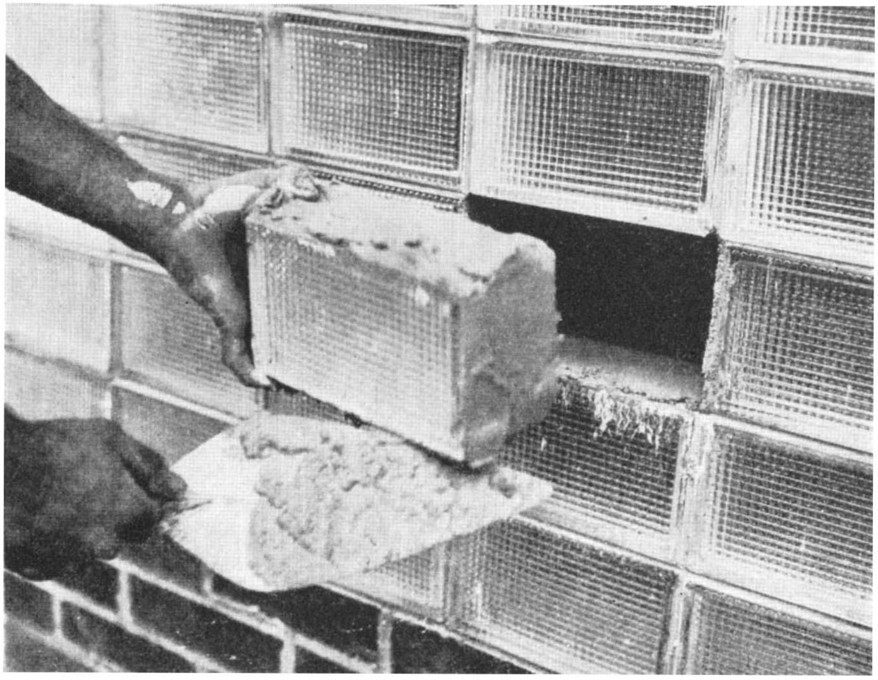
Let us look at glass as a building material. In this form it touches the greatest number of people. By the time this article reaches your hand you will be able to order a house built of glass and get prompt delivery, and you can be assured that nothing of privacy will be lost. There will be no particular problem in heating it or keeping it in repair. Glass building blocks have made this possible.

There are going to be several types of glass building blocks available, variously called structural units, bricks, masonry, or tile, but a description of one type will come very close to describing them all as regards fundamentals of design. The unit is made by taking two box-shaped pieces, or a box and a lid, and fusing them together on their edges to form a hollow block. There are various sizes and several methods devised for cementing the blocks into place in a wall. The inside faces of the block are fluted in such a manner as to break the light rays and destroy all images—hence your privacy.

The hollow, fused construction has very distinct advantages. With the cooling of the block, following the heat of fusing, a partial vacuum is created. This insures that there will be no frosting of the glass due to moisture within the void. By using a glass having a very low coefficient of expansion, wide variations in temperature can be withstood and a large number of units can be assembled to form a wall surface with safety.

One might question why such blocks have not been available in the past, since the glass house isn't a brand new idea. There have been houses erected with glass walls all over the world, particularly public buildings, and they have withstood the ravages of the elements. Perhaps the best explanation for delayed use lies in architectural style. Glass walls envisage "modern" architecture and the public was not ready for it. Before there could be this radical departure in materials there had to be a like departure in public taste.

Can you now vision this glass house? It will have perfectly smooth interior and exterior walls which can be easily washed. The fluted interior of the blocks will give a diffused light throughout the



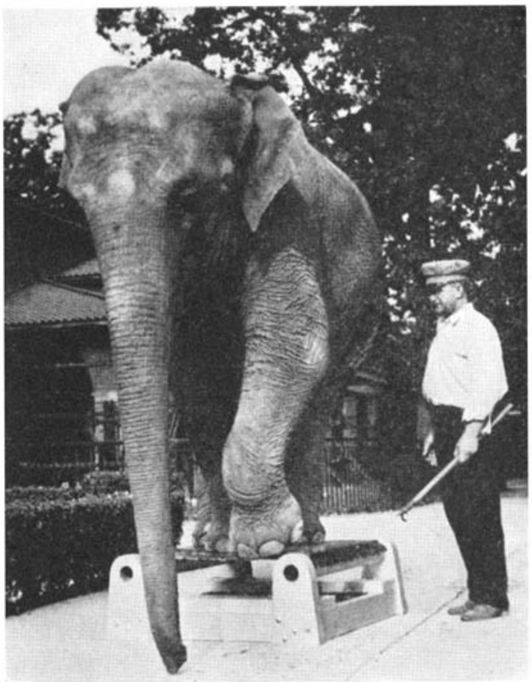
Are we to have a "glass masonry" age? Some people predict it. Here we see how easily a glass brick in a house wall may be replaced. Note the prismatic surface

house, no matter how strong the sunlight. And in cost it will be comparable to brick.

While glass building blocks are a distinct departure, their development followed quite naturally upon the advances which have been made in architectural glass. Manufacturers have learned how to make special glasses to render particular services and they have established a control in manufacture which assures getting the uniform result they want.

WITHIN recent years, given the new types of glass, the idea has grown among architects and builders that here was a material which not only transmitted light rays, but could be made to contribute a superior decorative effect if given the proper treatment. In the effort to accomplish this, many other fields were drawn upon to yield their best of recent advances. For example, illuminating technique was brought to bear on the problem of handling light within buildings and we have what is commonly termed "indirect lighting." Instead of a concentrated light source for the illumination of a room, which is nothing more nor less than the modern version of the candle, there came diffusion of the rays through the use of fluted glass, so that today an illuminated frieze or pilaster is quite commonly used in large buildings as a light source. Color effects, too, have been obtained by utilizing colored (neon) lights and filters to the end that great panels and columns of color replace orthodox lighting.

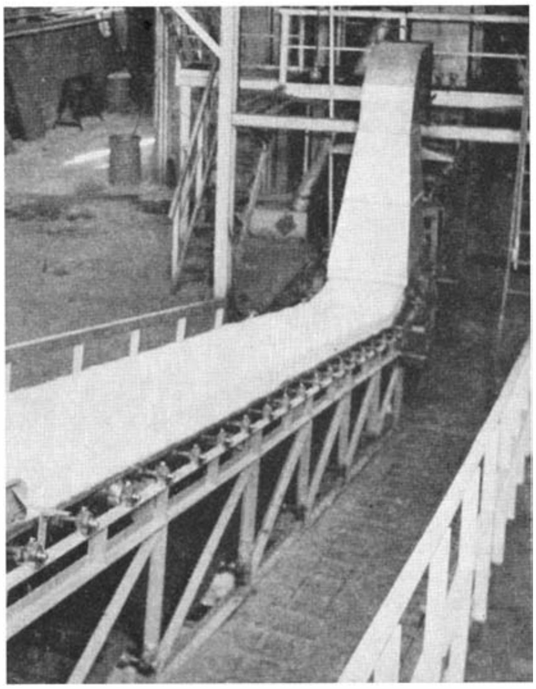
The advent of glass having a low coefficient of expansion promptly increased the potentialities of glass as an exterior wall material. Actually this type has less movement under temperature changes than most of the metals and can be used without hazard of breaking. For the sake of appearance, such glass is joined with opaque cement or a synthetic resin. The chemist has made a definite contribution to glass by providing a transparent binder, having a high light transmission factor and a bending quality that surpasses the opaque cements.



Glass is certainly "not just glass" when it is tempered and strong enough to support tons

Among the special glasses contributing to the field of architecture is a type which transmits both visible and ultra-violet rays. A small percentage of the ultra-violet transmission is lost after the glass is first put into use, but from then on the transmission is nearly constant. The principal use of this glass is in sanatoria and hospitals, but now that costs have been lowered it is beginning to replace ordinary window glass in homes. Then there is glass which absorbs a large part of the heat or infra-red rays while transmitting most of the visible rays. This type is eminently suitable where it is desired to keep out the sun's heat, as in air-conditioning where inside control of heat is sought.

More recently, double-glazing has been launched. This development for windows was mentioned in a previous article[1], but some of the technical problems involved are significant of the research conducted to get a satisfactory product.



Like "taffy" on the production line: glass "wool" batts made by patented steam process

Double-glazing is much more than a sash carrying two panes of spaced window glass. Maximum insulation demands a certain dead air area between the panes and the air must be free from moisture, otherwise the glass will "steam" over and vision will be obscured. The seal must be such that no air can enter and yet be flexible enough to permit expansion under temperature changes. Finally, the glass itself should be of a sufficiently stable type so that it will not ultimately develop a cloudy surface.

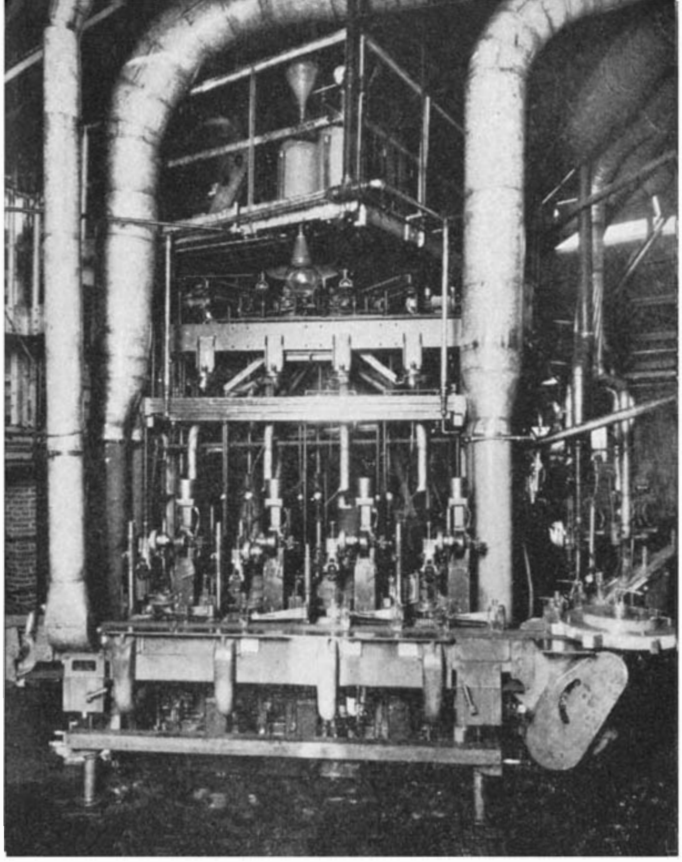
Light transmission and decorative effects are not the only qualities which recommend glass to the construction industry. Glass can boast insulating properties when made in the form of a wool. The appearance of glass wool is similar to mineral wool. It is simply a batt composed of very fine filaments. Placed in the wall of a house it provides a blanket of stagnant air pockets and it is, of course, very resistant to fire. Glass filaments also serve as filters. For air-conditioning equipment countless numbers of these little strands are laid down in crisscross fashion within a box-like structure. On one side—the outside when installed—the strands are coarse to corral the larger impurities in the air, while on the inside the strands are very fine to remove the smallest particles. Here again resistance to fire is an attribute.

TEMPERED glass, too, will have household uses. Since this remarkable glass was described in these pages,[2] several new uses have been developed. In keeping with the modern trend in interior decoration, this glass has been brought forward as a component material in furniture; and, because it will withstand great heat, it is to be used for firescreens and skylights. In Navy homes—the battleships and cruisers—it serves excellently for portholes. It brings about a great saving in weight because the thickness of the glass can be reduced from 1½ to one half inch with no loss of strength.

Laminated safety glass for windshields has undergone notable improvement under the guidance of research. You may recall the yellowing and fogging of the early types after months

[1]Scientific American, September, 1935, page 137.

[2]Scientific American, September, 1935, page 127.



Amazing versatility: the only gob-fed machine making both small and large bottles—one dram to one gallon capacity

of use. The yellowing was due to the action of ultra-violet rays upon the cellulose nitrate binder of the laminations, while the fogging came from the penetration of moisture between the laminations. Cellulose acetate has replaced the nitrate to provide a much more permanent product and even the glass itself has been improved. For many years safety glass came only in flat form; now it can be had in curved surfaces. It requires more labor to produce the curved type because the two pieces of glass must be heated and bent with very careful indexing so that when they are assembled with the plastic between there will be no distortion of vision.

The answer to the beer can challenge

Quite recently a new type of safety glass was developed which employs another synthetic resin binder. This resin is claimed to have an index of refraction almost identical to glass, hence increasing the transmission of light where it strikes through the inner glass surfaces. The development is significant as indicating the trend of safety glass—better transmission of light and greater clarity of vision. The problem of fogging due to moisture penetration has been solved by proper sealing of all types of safety glass, and the new glass claims to go one step further by using a binder which itself repels moisture.

The advent of glass as an industrial material really dates back to the discovery of boro-silicate, heat-resisting glasses. They were products of research and immediately opened up fields for glass where it had never before been practical. They are highly resistant to heat, have very hard surfaces and great chemical stability. Acids, with the exception of hydrofluoric and glacial phosphoric, show little effect on them and they are unusually stable in the presence of alkalies. Most householders have used boro-silicate glass in the form of cooking utensils, the scientific world has employed it in the laboratory, and industry knows it in the form of insulators or containers for chemicals. Some of the food industries are taking to glass piping because it can be sterilized easily, permits visual inspection, is free from corrosion and resists thermal changes. However, recent advances in the use of glass piping can be attributed not to sudden discovery of these good qualities but rather to better methods of coupling and to lower costs due to machine manufacture.

Use of glass tubing in beer manufacture is an innovation; bottling the product in glass is old, so old in fact that it bred the belief that beer would always come in bottles. Imagine the rude shock when the can manufacturers announced that they were going to supply cans for beer. It was a threat of no mean proportion and the glass makers accepted the challenge. The champion evolved for the competitive bout is new in shape. It is lighter in weight, nearly a third lower in height and planned as a one-way bottle. Redesigning permits substantially faster production. So the fight is on.

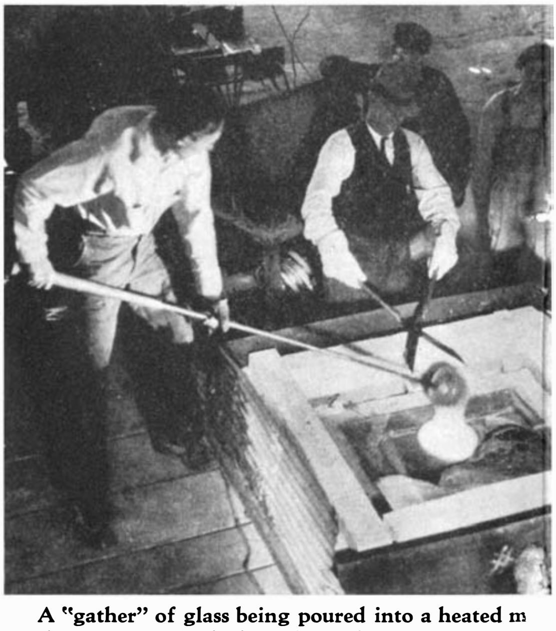
If it is research which has made possible the recent advances in glass as a material, it is the same persistent study applied to the technique of manufacture which has enabled the many and diverse products to be placed at the service of the consumer, at a cost the consumer can pay. Until quite recently, glass making was a hand craft. Glass blowing was an art; the product almost a luxury. Then, only a quarter of a century ago, innovations began and automatic machinery became a reality. Sheet glass, bottles, bulbs, and tubing underwent a process revolution. Let us see what happened to sheet glass.

Sheet glass was originally made by blowing a cylinder which had to be slit, re-heated and flattened. Today it is drawn in sheets vertically from the molten mass. The early process involved the operations of blowing, cutting, flattening, annealing, and cutting, whereas now it involves only drawing and cutting for the annealing is done in the drawing process. Plate glass, likewise, underwent a drastic change in process. It was cast and rolled on an iron table until technicians found a way of rolling continuously as the glass flowed from a tank furnace. The process of grinding and polishing of the surfaces was an intermittent one until the continuous process was perfected in recent years to raise the production rate from 600 square feet in eight hours to 500 square feet in one hour.

THE first fully automatic bottle making machine was developed about 30 years ago and was responsible for showing that mechanization of the industry was not impossible. Today's bottle making machine is far removed from the first conception. Molten glass exudes from an orifice of the forehearth where it is sheared and dropped, a lump at a time, into a mold for shaping. It is then transferred automatically to the blowing mechanism and as quickly expelled as a finished bottle. Were it not for the advent of this machine which can produce bottles as fast as you can count, bottles could never have been produced at a cost which would permit their becoming a universal container.

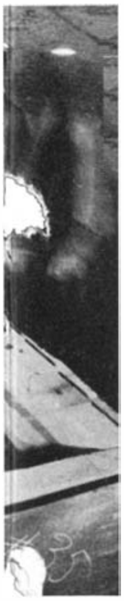
Electric light bulbs are also made by machine, the most recent development being a mechanism which can produce over a half million of them in a day, and

Grind
fit wh



A "gather" of glass being poured into a heated m
the glass panel which is shown being ground at top

ing a section of decorative glass panel to insure a close
en finally installed at Rockefeller Center, New York



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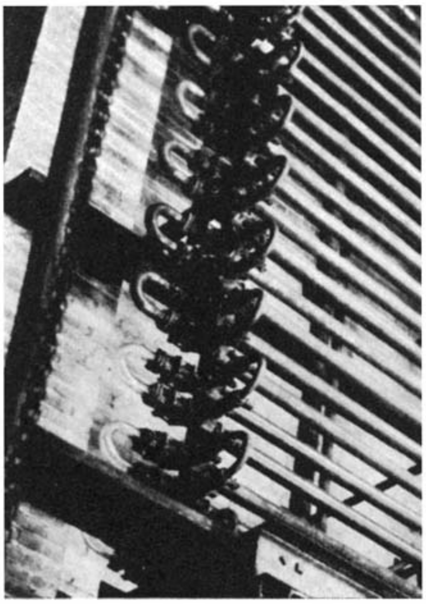
that means bulbs for all at a moderate price. The process works automatically, beginning with the flowing of molten glass like a ribbon onto a chain having equally spaced orifices. The molten glass sags through the orifices and immediately another chain overhead causes "blowheads" to register with the orifices, and elongated blanks are blown. At this stage a third chain carrying molds rises underneath, the molds surrounding the blanks, and the blowing is continued until the bulb is formed. As soon as the bulb is shaped, top and bottom chains fall away and the chain bearing the suspended bulbs moves on to where the bulbs are ejected.

The fourth machine in this group which revolutionized the making of glass is one for drawing tubes. The tubing is drawn from a rotating mandrel which is fed with molten glass in a continuous stream and the machine also cuts the tubing into proper lengths. Once made and cut, it is mechanically gaged for diameter, but if a higher degree of accuracy is demanded, an automatic weigher sorts the sticks to closer dimensions. Tubing of small diameter can be produced at the rate of 100 to 150 miles per day.

OCCASIONALLY, one finds that machine operations are combined with a certain amount of skilled hand work. Thermometer tubing is a case in point. The blank is formed by hand and consists of an elongated lump of molten glass backed by a strip of opal glass, carefully formed with a hole in the center. And to provide the necessary magnifying power in the finished tube, one side of the blank is formed V-shape. Following this hand work, which skilfully creates a condensed form of what is wanted, the blank is drawn upward 125 to 150 feet into a tower where, after cooling, it is cut into desired lengths. This, in short, is the machine which has placed accurate thermometers within the buying reach of millions.

The art of glass blowing is not lost and, in fact, still holds its place for certain types of quality products, but it is machine development of recent years which has made glass in its best form an everyday utility. Perhaps the best example of this is to be found in an insulin bottle. Here medical science, glass research, and machine technology have combined to bring relief to mankind. Insulin requires that a glass container be used which is stable in the presence of alkalies, hence a boro-silicate glass is used and small bottles are produced on a machine with an economy



. . . and in industry: glass pipes, couplings, bends, size reductions

that makes them a negligible cost factor in the distribution of this medical aid.

Presumably everyone has heard by now of the 200-inch glass reflector cast[3] for celestial observation, and of the plan to use chromium and aluminum to give it its final reflecting surface. Previously mirrors had been coated with silver, and silver was not wholly effective in reflecting the ultra-violet rays; then, too, it tarnished easily and had to be replaced. Small mirrors coated with chromium and aluminum can be used for microscopes, and at a cost of a few dollars they replace very expensive quartz reflectors, while for studying ultra-violet stellar spectra, mirrors with this new surface promise to open wider the secrets of the heavens for scientists.

For thousands of years, glass had a reason for being in that it served man as a light-transmitting material. That was enough to warrant the creation of a large productive industry. But that quality of light transmission is not the one that is sending it forward today. There are other qualities that are recommending glass and new qualities will undoubtedly be imparted to it through the agency of research.

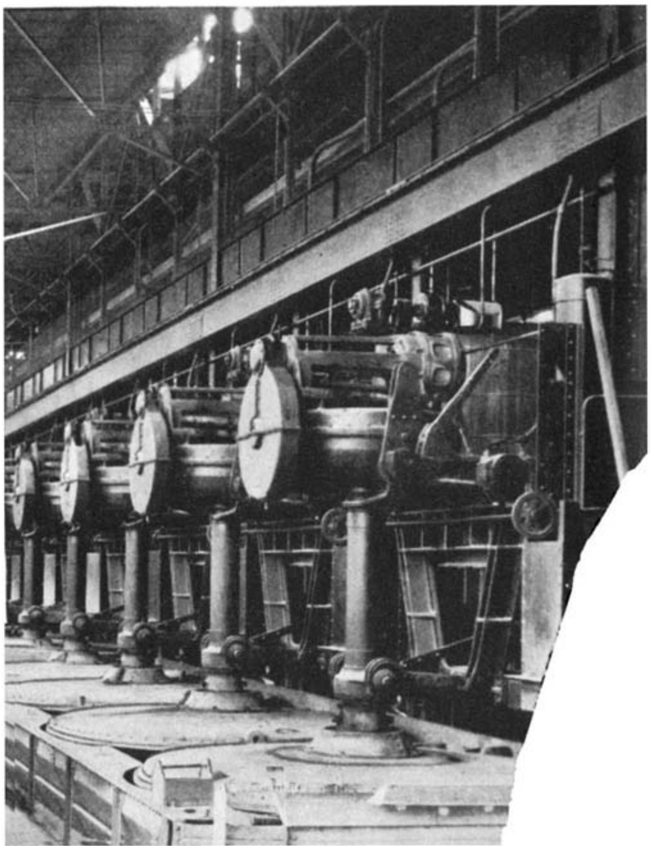
Much remains to be done. Though more types of glass and better glass are being made, the field of silica chemistry is awaiting further exploration. Even its physical nature remains in part a secret. Actually, glass is still an unpredictable material, not yet lending itself to precise measurement.

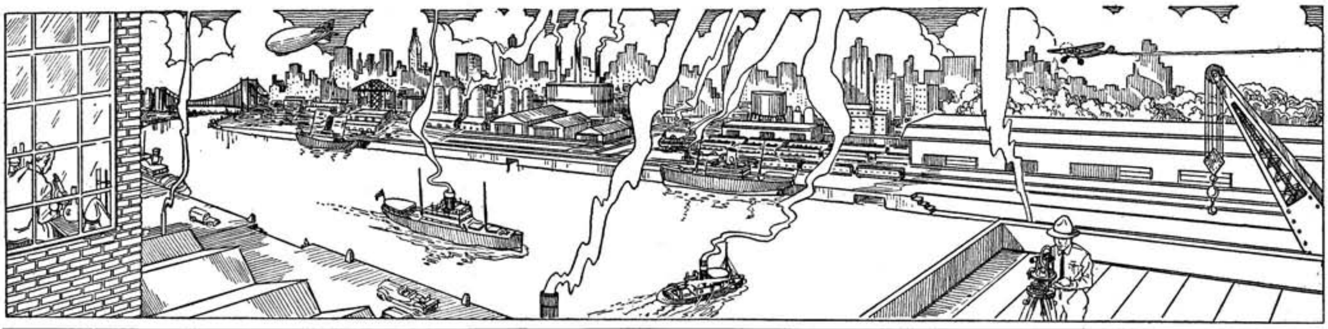
It is reasonable to believe that where there is so much research smoke there must be some development fires. One cannot witness glass withstanding hammer blows without realizing that its potentialities are great, nor can one see long flexible strands of the material without thinking that somehow, sometime, it will be treated like any other thread to fashion new fabrics with new uses. Let us not overlook the fact that glass is a modern material despite its long history. It is a material unique in combining all those qualities—clean and attractive appearance, durability, fire-resistance, and transparency—which are so eagerly sought in other materials. We need to alter our conception of it. Then things will happen faster.

Photographs courtesy: Owens Illinois Glass Company; Libby-Owens-Ford Glass Company; Corning Glass Company; Hartford-Empire Company; and Pittsburgh Plate Glass Company.

[3]Scientific American, July, 1935, page 3.

Plate glass being ground and polished in the modern manner, under a battery of rotating disks





THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

Contributing Editors

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

A. E. BUCHANAN, Jr.
Lehigh University

Dr. Clyde Fisher, the many-sided curator (botanist, astronomer) of the new Hayden Planetarium in New York, with the lecture staff of the institution. Left to right: Miss Dorothy Bennett, Mr. Arthur L. Draper, Miss Marion Lockwood, Mr. William H. Barton, associate curator. Above is represented the constellation, not of Cupid, but Sagittarius, on the planetarium dome

Auto Parts from Soy Beans

ONE of Henry Ford's dreams—that of raising the raw materials for automobile manufacture on the farm—takes a step toward actuality with the construction of a huge mill for making molded automobile parts from soy-bean plastics, now nearing completion at the Ford River-Rouge plant. The completed mill fully equipped has a projected cost of approximately 5,000,000 dollars.

The first machine units, including storage tanks, giant mixers, and presses, are now in place and are turning out test parts. Actual production of parts will be started as soon as the necessary machinery can be installed.

The molding plant will require 86,000 quare feet of floor space. It will be housed a steel structure two city blocks in length 1 containing several balconies as well as a long open area for molding presses. Mixing of the plastic material will be carried out in the balcony structure through a series of 26 mixers. The parts will then be turned out from the long battery of presses. It is estimated that the completed factory will have a capacity of more than 100,000 parts a day.

When completed, the plastic mill will be the largest factory in the world devoted to processing farm products for industrial use.—*A. E. B.*

Photo-Cell Output

IN response to queries by several readers, Mr. John H. Radu, author of the article "Make Your Own Light-Sensitive Cells" which appeared in our October number, writes us that tests of the type of cell described show that a current output of approximately two milliamperes per square inch of cuprous oxide plate may be expected.

FINGERPRINTS

THE largest collection of fingerprint data in the world now reposes in the Federal Bureau of Identification of the Department of Justice in Washington. The fingerprint records of 5,154,254 persons were on file there July 31, 1935.

Measles and Whooping Cough Decrease

MEASLES and whooping-cough, both serious diseases of childhood, are on the decrease, it appears from figures reported by Dr. Haven Emerson, of Columbia University, to the American Public Health Association.

The decrease has been particularly marked during the past five years, Dr. Emerson found. Deaths from both diseases and the number of cases of measles have been much fewer.

This is not because of any improvement in measures to control the diseases, Dr. Emerson indicated. Instead, the decrease appears to be the result of a change in the age distribution of the population. Fewer children and more adults in the United States within the past decade is reflected in the decline of these childhood diseases.—*Science Service.*

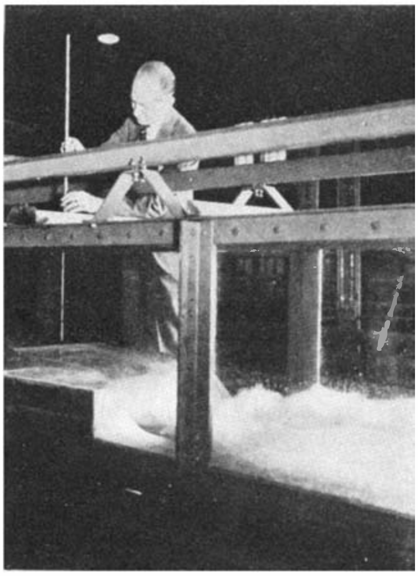
Canal System on Upper Mississippi Studied

WATER flowing through glass-walled channels in the hydraulic laboratories of the University of Minnesota, at Minneapolis, is aiding engineers to determine the stability of sand dams being constructed in connection with the canalization for navigation of the upper Mississippi River.

The 60-foot long experimental flume has glass on the sides and bottom through which hydraulic engineers observe swirls, eddies and flow conditions with a wide range of water velocities and depths.

High water and flood conditions can be simulated by the equipment, according to Prof. L. G. Straub of the engineering experiment laboratories, under whose direction much of the hydraulic research is being carried out.

"Instantaneous closing gates as well as



A laboratory set-up that aids in studying the stability of sand dams

head-regulating gates are arranged at both ends of the channel, thus providing the possibility of studying a large variety of flow phenomena. The arrangement allows for the simulation of flow conditions in canals and rivers, the effect of abrupt or gradual gate opening at ship locks, and the like.

"The introduction of coloring matter into the water at various points along the stream assists materially in studying flow conditions.

"The channel is provided with a sediment-intercepting basin at the discharge end so as to allow for observations of the erosion, transportation, and deposition of sediment by flowing water.

"Although the apparatus is quite new, a number of investigations have been made therein which indicate the variety of tests which are possible. These include studies of the stability of the sand dams being constructed in connection with the canalization for navigation of the upper Mississippi River, the design of flood regulating works for various hydroelectric developments, and the like."—*Science Service.*

Windowless Building

THE photograph of the windowless office building of the Hershey Chocolate Corporation on page 270 of our November issue was made especially for us by the York Ice Machinery Corporation whose air conditioning system has been installed in this building. We regret the oversight which caused omission of the credit line.

Mightiest Diesel Locomotive

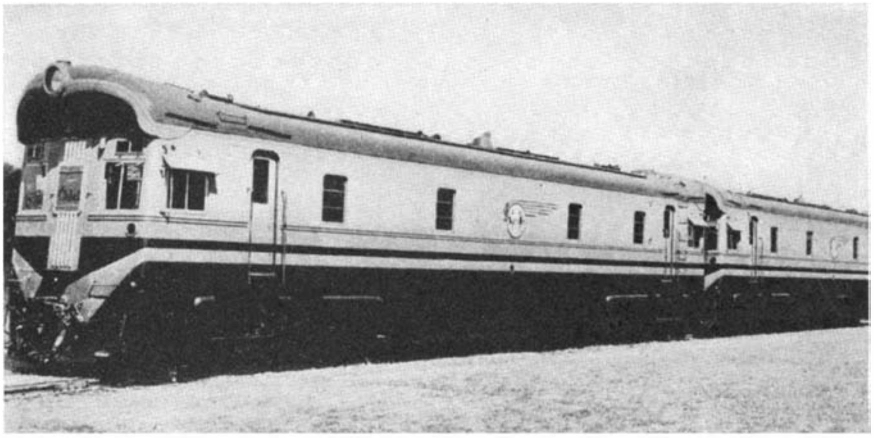
ANNOUNCEMENT by the Santa Fe that it has just taken delivery from the Electro-Motive Corporation of the most powerful Diesel locomotive ever placed in service—and that the new giant, if exhaustive tests prove successful, will haul the road's crack flier, *The Chief*, between Chicago and California, on a faster schedule than at present—marks another dramatic milestone in the spectacular drive by the management of major American lines to regain for the rails their old place in the sun with the traveling public.

With a conservative rating of 3600 horsepower, a weight of 240 tons, and approximate over-all length of 127 feet, the Santa Fe's new "power house on wheels" overshadows any previous application of Diesel power to light streamlined trains, to rail cars, or to relatively light switching locomotives. Actually it is a multiple unit of two identical sections which can be operated singly or together, or coupled to any desired number of similar units, all of which can be controlled by a single operator. It thus marks the longest step that has yet been taken in exploring the possibilities of applying the flexible and economical power of Diesels to any kind of train on main line service. The units are arranged for double-end operation, with an operator's cab and control station at each end. From these control stations the driver is afforded a clear view ahead and of both sides of the track.

Motive power of each unit of the locomotive is supplied by two Winton V-type, 12-cylinder, high compression, two-cycle oil engines. Since each engine is conservatively rated at 900 horsepower, the two units provide a total of 3600 horsepower, all available for traction purposes.

These engines are extremely light in weight, weighing less than 20 pounds per horsepower, a remarkable weight-saving over the usual type of Diesel engine that has been obtained by incorporating newly designed principles of engineering and construction. The fuel used is a comparatively inexpensive Diesel fuel oil, 1600 gallons of which can be carried.

Among the many new features developed especially for this modern type of locomotive is the steam generating unit for heating and air-conditioning the cars of the train. This is a light weight, compact, automatic unit, drawing its fuel from the same storage tanks that supply the main power plant, and having an evaporation capacity of 2000 pounds of water per hour at a working pressure of 200 pounds. The twin locomotive boiler water capacity is 2500 gallons.



The multiple-unit Diesel locomotive described above

PROGRESS In This Age Of Science
As Told to SCIENTIFIC AMERICAN

By WILLIAM B. STOUT
President, Stout Engineering Laboratories, Inc.

WHEN we finally "unhitch 'Old Dobbin'" from the automobile we are going to make some giant strides in automotive transportation. It may have been all wrong as far as the horse-drawn vehicle is concerned to have the "cart before the horse," but it will not be long before it is proved to be equally wrong to have the car behind the horsepower. When the day of the rear-engine car arrives, the driver will have infinitely better vision from all angles. The automobile will be lighter and more efficient and yet safer, the ride will be easier, and the body will be more roomy without sacrificing maneuverability. In fact, there will be a large gain in this respect as well as in comfort.

Along with the horse-drawn vehicle tradition we have such things as the uncomfortable transverse seat for passengers and driver. The automobile today is the only long-distance vehicle in which passengers are compelled to sit bolt upright in a strained position hour after hour whether they like it or not. The rear-engine car will change all of this. The strange part of it is that we have had to suffer many inconveniences because we have insisted on placing the engine in front. The break is beginning to come, however, and it will not be long before the current type of automobile will be just as obsolete from a transportation standpoint as the horse-drawn vehicle which it has so faithfully followed in many respects over the last 25 years.

Ethiopian the Oldest Language

ETHIOPIAN is the oldest language in that it has departed the least in its form from the original proto-Semitic, according to Dr. John P. Harrington, ethnologist of the Smithsonian Institution. Even the Hebrew in which the Bible is written has gone a long road of development beyond the modern Ethiopian. Hidden away in the African Alps, this old language still survives, uncorrupted by the centuries.

Let us take for instance the name of the

Cessna high-wing monoplane, winner of the Private Owner's Race

letter "a." This letter in its capital form still preserves today very much of its original pattern, which was that of a crude figure of the head of the ox. The descending strokes at the bottom of capital "A" are the horns of the head of the ox. Ancient Egyptian has a very similar symbol. The natives of central Celebes have similar carvings of the head of the water buffalo on the beams of their houses. Now the name of this letter and of the ox in the primitive Semite, spoken 5000 B.C., is "alf." In ancient and modern Ethiopian the name "alf," ox, is still on the tongues of the people. But in the Hebrew of the Bible it is already "aalef," ox, the word having been distorted into two syllables and starting with a lengthened vowel.

Ethiopia is the oldest Christian country, having been completely converted to Christianity at a date somewhere after 200 A.D. The Ethiopians were a thoroughly Christian country under a heavy priesthood at the time when Italy was persecuting Christians under the Roman emperors.

A Race for Private Owner Planes

WHILE no speed records were established at the Cleveland Air Races, the introduction of a special race for private owner planes—stock models—had real significance. The National Aeronautic Committee, in inviting manufacturers to participate in this new type of race, pointed out quite correctly that the American market for private planes was opening up, and that the contest was very timely.

There were five tests, four of which were run about a week before the races. The rules for these tests were as follows:

1. Obstacle Take-off and Landing.

Take-off and landings over a light 50-foot barrier. Points allowed, 1 point each for each 5 feet less than 1000 feet.

2. Maximum Speed.

Tests over 3-kilometer course. Points allowed, 2 points for each mile above 70 miles per hour.

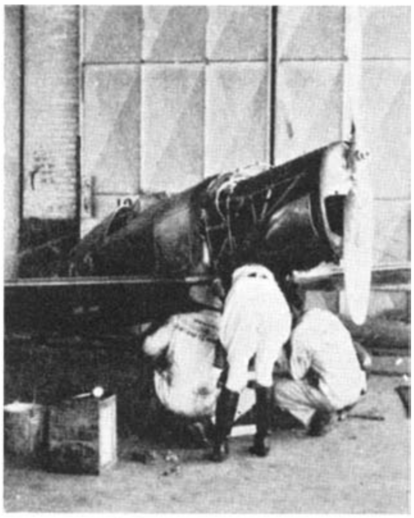
3. Speed-Economy Run.

Closed 150 mile circuit, with at least two turning points and stops. Points allowed in accordance with the following formula:

$$\frac{(\textit{Useful Load})\quad(\textit{Miles per gal.})\quad\dfrac{\textit{Average Speed}}{\textit{Maximum Speed}}}{70}$$

4. Closed Course Speed Sprint

Five laps around a 5-mile closed course, take-off and landing over a 10-foot barrier in a lane 100 feet wide. Points allowed: Take-off and landing, 1 point for each 100 feet from 1000 foot mark. Speed 1 point for each five miles per hour.



Tuning up a fast racing plane just before the Thomson Trophy Race

5. Private Owner Features

Points allowed for field of view; additional passengers beside pilot; side by side seating; enclosure of cabin; starter; baggage; dual control; adjustable trim; landing lights; heating; ventilation; tail wheel; adjustable seats.

The winner of the race was the Cessna which is illustrated in our photograph. The Cessna is a remarkably clean high-wing cabin monoplane, with both wings and landing gear entirely of the cantilever type. It is a four-place machine, with a wing area of 180 square feet. Its gross weight is 2200 pounds, and it is powered with a Warner Super-Scarab engine of 145 horsepower. Maximum speed is 162 miles an hour. In the fuel economy race, the Cessna made 13.2 miles to the gallon of gas, and it landed over a 50-foot barrier and came to a full stop in only 658 feet. It made a take-off of 910 feet over the same barrier.

The Cessna scored 62 points out of a possible 80 on the private owner features.

The reason we are dwelling at such length on the achievements in the private owner race is because the points were allotted by impartial and capable judges. Their findings indicate that American aviation already has to offer the public a plane of high performance, good fuel economy, and excellent private owner characteristics.

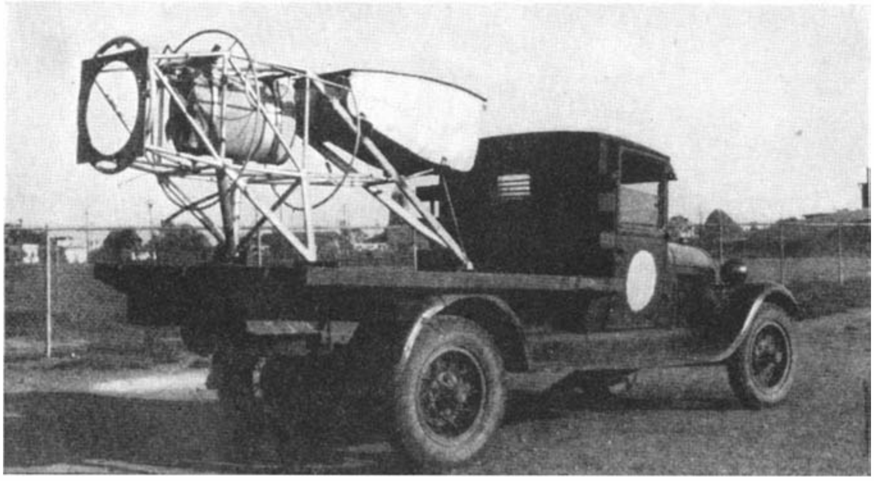
—*A. K.*

A Social Register of Flying

WE welcome the appearance of the "Air Pilots Register," probably the first work of its kind that has appeared anywhere in the world. It contains a list of American War Aces, the holders of the Distinguished Flying Cross, a Roster of the Caterpillar Club, a complete directory of airports in various states with adequate descriptions of each, a complete registration of private flying insignia, and other material of interest to those engaged in flying either professionally or from an owner's point of view. Some of the insignia which are carried on their planes by private owners are really beautiful. The publication is another evidence of the fact that private flying is definitely here.—*A. K.*

A Portable Aircraft Engine Test Stand

THE public, flying at three times the speed of a railway train and with equal regularity, does not realize the growth in airplane maintenance and servicing that has made such operation possible. Airline operators and manufacturers are constantly finding new wrinkles. Thus, General Airmotive Corporation has introduced a portable test stand for aircraft engines, which is of real utility in the field. This comprises a one-ton truck on which an engine test stand is mounted. The stand itself is constructed of obsolete airplane parts, can be removed from the truck in a few minutes, and is



Portable engine test stand, mounted on a light truck

capable of taking any engine from a large Wasp down to a small Velie engine, merely by changing the plate on the motor mount. This is a simple device, but one for which many aviation people working under pressure of time in the field will be thankful.
—*A. K.*

The World's Fastest Landplane

IT was a great disappointment, at the Cleveland Air Races, that the Hughes racer was not finished in time to compete. The fast racing planes were the same that had entered the classic speed contests in 1934, and as a result no records were broken and speeds attained were even a trifle lower than in previous years. The Hughes racer, had it participated, would have undoubtedly "walked away" from the field.

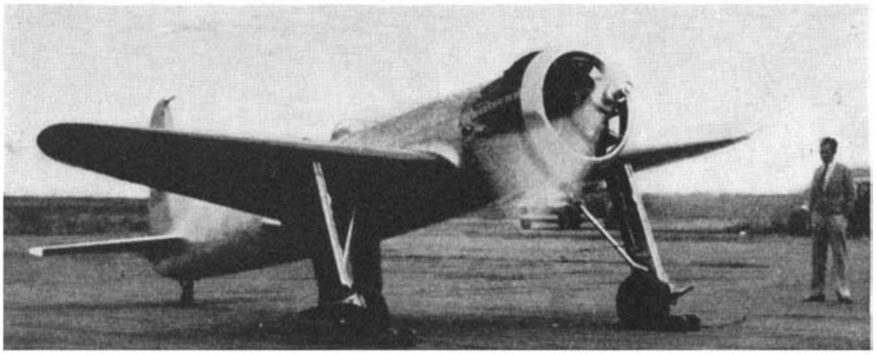
The world's landplane record was established at 314.319 miles per hour by the French pilot Raymond Delmotte, on December 26, 1934. Lieutenant Francisco Agello, piloting a Fiat motored Schneider Cup racer established the world's seaplane record of 440.2 miles per hour on Lake Garda on October 23, 1934. Soon after the Cleveland races, Mr. Howard Hughes, backer of the new design, himself piloted his craft to a new world's record of 353 miles an hour. This figure, while not yet confirmed by the Féderation Aéronautique Internationale, is nevertheless perfectly reliable.

Mr. Hughes is a young man, who received a technical education at Rice Institute, Texas, succeeded his father in the oil tool business and amassed a large fortune. He was afterwards equally successful in moving picture production at Hollywood. It is a fortunate thing for American aviation that a man of his enthusiasm and means has taken up airplane racing as the latest of his hobbies

It may be asked: Why does the landplane record stand so much lower than the seaplane record? The first reason is that the seaplanes were developed for the Schneider Cup by governments, with no practical limitation on cost and power, and were powered with engines turning up 2500 horsepower or more. The second is that seaplanes alight on water and can stand more landing speed and less wing area; the smaller the over-all dimensions, for a given power, the greater the speed of an aircraft.

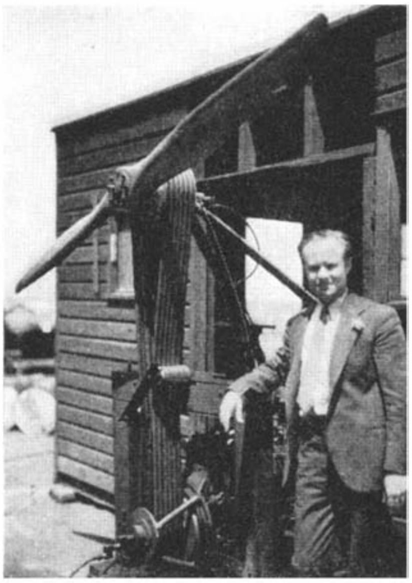
At the same time, the Hughes monoplane is fast enough. It is a single seater, open cockpit, low wing monoplane. The power plant is a Pratt & Whitney twin row Wasp, capable of delivering 1000 horsepower for racing purposes. This tremendous power is employed for a machine only 27 feet in span, and 140 square feet in wing area. To absorb the high power, a large diameter Hamilton-Standard controllable pitch propeller is used, and this explains the somewhat stilt-like appearance of the machine. The wheels retract into wells on the under side of the wing.

The Hughes monoplane is quite a rugged craft. On its last run over the speed course in Los Angeles, a long streak of black smoke indicated engine trouble and the plane reeled off its course. One gasoline tank had been exhausted and another failed to feed the motor. In the ensuing forced landing, the retractible landing gear was only half-way down, yet the damage was restricted to a bent propeller and a torn fuselage. Mr. Hughes suffered no injury.
—*A. K.*



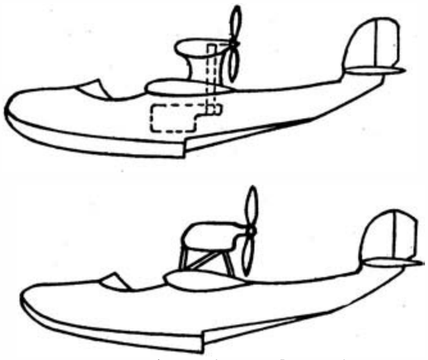
The high-speed Hughes monoplane—world's fastest landplane

Belt Drives for Flying Boats?



A practical aircraft belt drive

IN a flying boat of the private owner type and of small dimensions, the problem of propeller clearance necessitates the placing of the engine well above the hull. In a typical arrangement, the engine is mounted on a strut framework and the propeller is of the pusher type. Even though the clearance between the propeller and the top of the hull is kept at a minimum, the motor is bound to be high above the hull itself. The private owner flying boat is apt to be expensive, and the Air Commerce Bureau (still actively concerned with the cheapening of flying equipment) conceived the two following ideas: 1. Use an automobile engine of relatively high weight, but low price. 2. Place the engine within the hull (with obvious advantages in accessibility and maintenance) and drive the airscrew by means of some type of transmission.



***Top:* Belt drive for a flying boat, with engine in hull. *Below:* Standard practice; the engine on struts**

As a preliminary to putting these two ideas into practice, it was necessary to design a suitable drive and speed reduction between the motor and the airscrew. The use of gearing and shafting did not look promising, because of weight and mechanical difficulties. Then the Casey Jones School of Aeronautics hit on the expedient of a belt drive. Under the auspices of the Department of Commerce, and with the cooperation of a belt manufacturer, the Casey Jones School has completed a successful 300-hour run of a belt-drive installation, which is illustrated in our photograph. The experiment was conducted under operating conditions, since the tests were made out-of-doors, and the installation was subjected to dirt, dust, and varying weather conditions.

An ordinary automobile engine, developing 88 horsepower at 3800 revolutions per minute, was used continuously in conjunction with a belt driven airscrew, and the cost of replacement of engine parts after the 300-hour test was only about 50 dollars.

To reduce belt slippage to about 3 percent at full engine speed, six belts were employed. With a single belt, slippage was prohibitive. At the engine, the pulley was bolted directly to the flywheel; above, the six-grooved pulley was mounted in simple bearings. Duralumin pulleys were used at first, but it is apparently better to resort to steel pulleys.

The belt must have special characteristics. A belt never fails because it lacks mere strength. It fails because the flexing over the pulleys introduces high stretch and tension at the outer side, high compression and shortening at the inner side. Therefore the way to design a belt for these severe conditions is to place the main strength in the center portion of the belt, and to have the outer portions made of a flexible material capable of being stretched or compressed indefinitely without much wear.

Whether the experiment will be continued by actual embodiment in a flying boat has not yet been determined, but it certainly opens up interesting possibilities.—*A. K.*

Waterproof Glue Film

AN important new development in the manufacture of veneers and plywood which has recently achieved success consists in the replacement of the water-soluble glue heretofore used by a synthetic resin which gives a waterproof and mold-resistant

Making a mold of a delicate art object, using crisscrossed strips of ordinary gummed paper. See the text

bond of enormously increased strength, says *Industrial and Engineering Chemistry*.

The idea of using phenol-formaldehyde resins as the adhesive bond in plywood is not new, but previous attempts to apply the idea have met with limited success. The problem has been solved by preparing a special type of resin in the form of a thin sheet. This product, known commercially as Tego glue film, has been developed by the Resinous Products and Chemical Company of Philadelphia, in conjunction with the Theo. Goldschmidt A.-G., Essen, Germany, and is being manufactured and used in this country on a large scale.

The new type of plywood veneer is being specified by manufacturers of furniture, radio cabinets, airplanes, and so on, and not only will replace the older type in many cases, but is expected to open up important new uses for plywood. Its use in the manufacture of pre-fabricated houses is engaging serious interest, and is of great importance to the immense fir plywood industry of the Pacific Coast. This new resinous glue in sheet form is also finding application in such products as the bonding of laminated phenol-formaldehyde panels to wood, and of thin wood veneer to fireproof asbestos board.—*A. E. B.*

CANNED BEER

ONE can company, it is reported, has installed facilities for turning out 50,000,000 beer cans monthly by the end of this year. The canned beer idea seems to be catching on at a tremendous rate.

Delicate Art Works Copied by Four Cent Process

BEAUTIFUL sculptured art works, that never before could be reproduced for fear of damaging the delicate surface, can be copied safely by an ingenious and inexpensive new process. The process, devised by Lamont Moore—of the Newark Museum (New Jersey) staff, shown in the illustration—has been successfully tried first in making a cast of a famous ancient Indian sculpture, the head of a Mayan corn god belonging to Peabody Museum, Cambridge, Massachusetts.

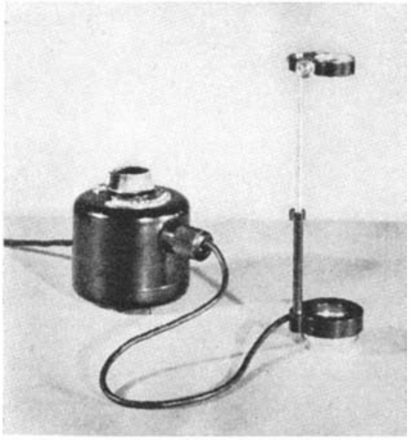
Knowing that beautiful colors painted on the corn god's image would be ruined if oil or grease were applied, as is necessary in making an ordinary plaster of Paris mold, Mr. Moore determined to find a way to produce the copy that his museum wanted for exhibit.

His process, evolved after many experiments, is to stretch several layers of ordinary paper handkerchiefs over the surface to be copied. Over this soft layer which protects and fits to the sculptured contours, he crisscrosses narrow gummed paper until three layers of the gummed strips have been built up over the features, forming a perfect mask. The mask is lifted from the sculpture, and greased, shellacked, and plastered in preparation for use as a mold.

Cost of making such a mold, Mr. Moore finds, is only about four cents, and some 15 reproductions can be cast from it. An experienced worker can make a mold by this process in eight hours or less.—*Science Service.*

Surface Illuminator Aids Microscopists

WORKERS on opaque materials under the microscope have been complaining for a long time about the difficulty of evenly lighting their specimens without a battery of lamps distributed around the stage.



Better light for the microscopist

The accompanying illustration shows a new surface illuminator, developed by Bausch and Lomb, which supplies a well-balanced annular cone of light. It can be varied in both intensity and incident angle. It will reveal details in irregular surfaces as no previous illuminating source has.

The little instrument is simply a ring holding six bulbs spaced equally around the inside of the ring with individual reflecting surfaces back of each bulb. The ring slips over the microscope objective and is held in position by an extension rod suspended from a clamp attached to the eyepiece adapter, which may be either vertical or inclined.

The small bulbs are 2.5-volt, 0.3 amperes and are made in either clear or daylight glass. The light may be dimmed to any degree of intensity by means of a transformer with variable resistance and switch for 110-volt, 50- or 60-cycle, A. C. For direct current a converter is supplied.

At present the illuminator is made only for 48-mm, 32-mm, and 16-mm microscope objectives. It is particularly useful with any conventional monocular laboratory microscope whose body tube is 35- or 39-mm in diameter, or with the Toolmaker's Microscope.

Little Girls Turn Blue

FOR the rest of their lives 10 little girls will face the world with blue or slate-gray complexions. Within the last year these girls, as well as five boys, have developed argyria, a discoloration of the skin or tissues resulting from the free use of silver preparations. At present, no treatment for the condition is known.

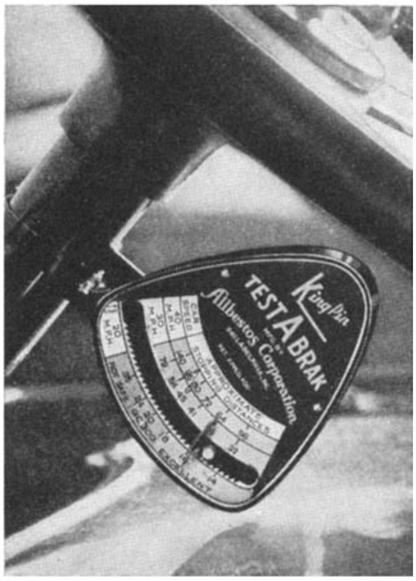
Dr. L. Edward Gaul and A. H. Staud, New York City, discuss the alarming increase in argyria in the *Journal of the American Medical Association.* Seventy cases of this permanent discoloration of the skin have been reported. The number of cases has increased more than 100 percent in the last five years, these medical workers state.

The disfigurement of the 15 children mentioned, all of whom are under 10 years of age, followed the use in the nose and throat of solutions containing silver for the treatment of colds and allied conditions. Argyrol, collargol, and neo-silvol are the silver compounds involved, according to the report of these two scientists, both of whom are connected with the New York Post Graduate Medical School and Hospital, Columbia University. The human body, state Dr. Gaul and Mr. Staud, can retain only so much silver—an equivalent of eight grams of silver arsphenamine. If more than seven grams from this or any source is taken in argyria develops.

The discoloration first appears on the face, neck, hands and the half-moons of the finger nails, as a result of the chemical action of the light on the retained silver.—*Science Service.*

New Brake Tester for Car Owners

THE King Pin Test-A-Brak is the newest recording device for testing the condition of an automobile's brakes. Its operation is so simple that any automobile owner can make his own recordings. The new device indicates whether brakes are in a safe, doubtful, or dangerous condition.



Test your own brakes

It records the approximate distance required to stop a car at a speed of 20, 30, and 40 miles per hour. There are no bulbs, wires or cables to get out of order. The unit is self-contained in a Bakelite molded case. It is manufactured by the Allbestos Corporation.

Insulating Cement

ON page 206 of our October number was described an insulating cement, Sonittep, and the statement was made that 1000 pounds of this cement will cover 50 square feet to a depth of one inch. This was a typographical error; the statement should have been that 100 pounds of the cement will cover 50 square feet to a depth of one inch.

Why?

WITHIN the past few years some men of science have endeavored to understand the ultimate nature of things, and some of them their meaning. Thus, what is spoken of as the "philosophy of science" has attracted widespread attention, rather more without scientific circles than within —possibly because of the linkage of these thoughts with faith. Most scientists intuitively feel that the search for truth—final, ultimate truth—by means of the methods of the scientist is either far beyond our present reach or forever unattainable. Therefore they do not try to find out *why* things in Nature work or why they exist, feeling that these questions are beyond the province of science. Their first aim is to find out *how* all things work. A similar thought of defeatism in the solution of the problems of the philosophy of science is expressed in the following verse written by a reader of this magazine, Anna Ball, of Colton, California:

THE QUESTIONNAIRE

By Anna Ball

"What is this, Mother?" "The rain, my child."
The desert lupin looked up and smiled.
"Mother, there shoots a strange, sweet thrill along my roots.
What is 'rain,' Mother? How is it made?
Mother, the dim sky makes me afraid.
Mother, why is it I feel so glad
When all the wide world's dim and sad?"
The mother answered: "Because of the rain."
"What is 'rain,' Mother? Tell me plain."
The mother answered: "*This* is the rain."
"But what *is* it, Mother? I have to know."
The Mother answered: "H_2O, hydrogen, oxygen—H_2O."
"But Mother, that's no *plainer*, you know."
"You be satisfied because it's *so*."

Triborough Bridge

BRIDGES have played a tremendous part in the march of progress. Today their significance is greater than ever before due to the serious traffic problems brought about by the steady increase in the use of automobiles. In thickly populated sections where traffic congestion is an accepted thing, each new bridge is welcomed by motorists with a sigh of relief. This has been the case with all bridges around New York City, but the Triborough Bridge, across the East River, has particular value because of its strategic position at the focal point of three boroughs.

This bridge will be a new arterial highway for vehicular and pedestrian traffic between the boroughs of Queens, Manhattan, and the Bronx, connecting as well with Randall's and Ward's Islands over which it passes. The Queens to Bronx branch of the bridge will form a junction with the Manhattan branch on Randall's Island.

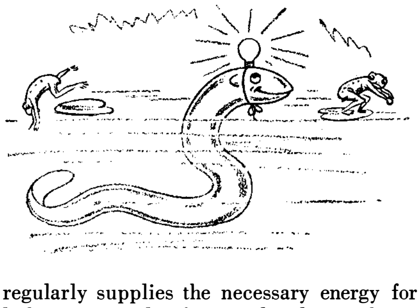
The bridge structure will consist of a suspension bridge over the East River, a vertical lift bridge over the Harlem River, through truss spans over the Bronx Kills and adjacent railroad yard, together with plate girder viaduct structures on the Queens and Manhattan approaches, over Ward's and Randall's Islands and Little Hell Gate. These structures, comprising the bridge proper, will aggregate a total length of three and one half miles. Also included in the project are highway connections in the three boroughs totalling 14 miles of modern highway construction.

The bridge between Queens and the Bronx will provide for two roadways, each 43 feet 6 inches wide, on a single deck, for a total of eight lanes of traffic. The Manhattan branch will provide two three-lane roadways, 33 feet 6 inches wide for a total of six lanes of traffic. Sidewalks for pedestrians will be provided throughout. The suspension bridge over the East River will have a main span of 1380 feet and side spans of 705 feet. The deck will be suspended at a clear height of 135 feet above the water level from two parallel wire cables of 20¾ inches diameter. The cables are to be spaced 98 feet apart and will pass over the tops of two 300-foot towers. The anchorages contain a total of 140,000 cubic yards of concrete. A total of approximately 62,000 tons of structural steel will be required for the entire bridge structure, including the viaducts and truss spans.

Concrete piers have been completed on the Queens Approach and the steel viaduct structure has been erected. The piers and viaduct structure are also in place on Ward's Island. The remaining work to complete the project is being prosecuted vigorously and it is anticipated that the bridge will be open for traffic in the summer of 1936.

EELECTRICITY

ELECTRICITY can be ichthyologically produced, whereupon it might be considered as eelectricity. In the Aquarium in New York, for example, there is a six-foot length of *Electrophorus electricus*, or electric eel. This swimming central station



regularly supplies the necessary energy for lighting a couple of neon glow lamps thrice daily, says the *General Electric Review*.

The two two-watt neon lamps are attached in parallel to antenna loops atop two aluminum wires submerged at the ends of the eel's 10-foot tank. At first the eel kept the lamps glowing much of the time, but then he became temperamental. Now he works only when tickled with a copper wire; and the tickling procedure is conducted at 11:30, 2:00, and 4:00 o'clock in the presence of spectators.

Only one side of the neon bulb is illuminated, showing the discharge to be direct current. Experiments have indicated the voltage to be from 125 to 200 volts.

SOLAR VARIATION

OBSERVERS of the Astrophysical Observatory of the Smithsonian Institution have finally proved that the sun is a variable star, that its heat varies from day to day and from month to month.

Reviving Oil Wells With Chemicals

CHEMISTRY has come to the aid of the oil industry since it was discovered that a dormant or exhausted oil-well may be revived by pumping hydrochloric acid down the pipes to the floor of the oil pocket. The acid attacks the calcareous formations developing considerable gas pressure and ejecting oil not readily obtained by pumping.

But here the chemist is called upon to perform another bit of legerdemain—the acid must not attack the iron of the downpipe or the pressure pumps, but must act upon the calcite rock. To obtain this discriminatory action, the chemist uses substances that he calls inhibitors. Just as there are catalysts which accelerate certain chemical reactions, so these substances retard the action on the metal. In this case, however, the selective action is of great importance, as it is not desired to retard the action on non-metallic substances.—*A. E. B.*

Were Our Ancestors "Magnificent Savages?"

A SURVEY by Prof. A. V. Vallois of present knowledge relating to the diseases of prehistoric man, communicated to the Institut de Paléontologie Humaine, appears in *La Révue Scientifique*, Oct. 27, 1934. The general conclusion is that it is an error to suppose that our ancestors, living a wild and savage life, had acquired a greater resistance to disease than ourselves. There is, however, a difference in the diseases which were most prevalent, and this distinction is to be observed not only as between modern man and neolithic man, but also as between neolithic man and paleolithic man. Rickets does not appear to be present in paleolithic man, but there is abundant evidence of rheumatoid arthritis, attacking the vertebrae as well as the limbs. It becomes increasingly common in the neolithic and bronze ages.

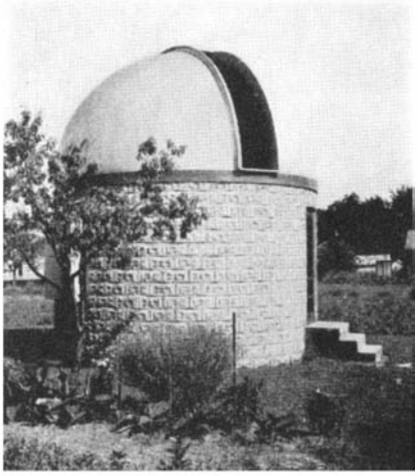
Evidences of wounds are not very common in the paleolithic period. In the neolithic age they become more frequent and are found in all the bones. Two facts are noticed —the presence of flint arrowheads in the injuries, especially in the dorsal vertebrae,

(*Please turn to page* 335)

THE AMATEUR TELESCOPE MAKER

Conducted by ALBERT G. INGALLS

O. R. YOUNG and Son are machinists at Roanoke Avenue and Fifth Streets, Riverhead, N. Y., their letterhead indicating that they do welding, sheet metal work and so on, and they have made a pretty swanky observatory for their own use. We show two pictures of it. "The observatory," O. R. Young writes in answer to our bid for more information, "is 16 feet in diameter on the inside and is made of building blocks. The dome has a wooden frame covered with Sislecraft paper and 20-gage galvanized sheet, soldered. The dome turns on an angle-iron circular track on ten 8″ flanged wheels. It is turned by hand with a crank mounted on the side wall with a pair of bevel gears and a shaft and pinion which meshes in the circular rack fastened to the bottom of the dome. The hatch slides on a circular angle-iron frame, and is worked by a hand chain with worm and gear connected to the rack on the hatch by three lengths of shaft with universal joints between each piece.



The Young Observatory

"We did not make the objective lens. The objective is of 8″ aperture with a focal length of 130″. The tube is seamless and made of a magnesium aluminum alloy ⅛″ thick, which makes it light and rigid. The fittings are of bronze.

"The equatorial is made of steel, fabricated by the electric arc. Both the declination and polar axis shafts are carried on Timken precision bearings. The circles are bronze, 16″ in diameter. The hour circle is graduated to 1^m and the vernier reads to 5^s. The declination circle is graduated to 15′ and the vernier reads to 1′.

"The equatorial is mounted on a 10″ extra heavy pipe which goes into the ground about five feet in about four yards of concrete. There are provisions in the head for adjustment both ways for setting the polar axis.

"The electric drive, which is of our own design, consists of a box made of 1″ cold drawn steel 7″ by 7″ by 15″, with two partitions, making three compartments in which are mounted in a series three 40-to-1 worm drives, and one variable speed friction disk, which are mounted on Timken bearings.

"The power is a ⅛ h.p., 1800 r.p.m., 1-phase synchronous motor driving the first worm reduction. There is then interposed the variable speed friction disk. The driver is a steel disk held in contact with the edge of the driven Formica disks by spring tension. The driven disk slides on its shaft to give the variation in speed, and is controlled by a graduated dial on the outside of the box. All the gears run in oil.

"On the last worm gear shaft, which extends out through the end of the drive, is a bronze drum with a half round thread cut on it of the same pitch as the diameter of the Monel cable, which runs up over a grooved sheave on the worm shaft on the equatorial, and then down through the column, with a weight on it. The drum has a ratchet for winding the cable on it, and holds enough cable for about 4 hours' running.

"You will note from the photograph that we have a polarizing eyepiece for solar observation. This screws in place of the regular eyepiece holder. This we made from aluminum castings, mounting four black glass flats inside on a 57° angle.

"Another thing is a sidereal clock which we made, a picture of which I am enclosing. We bought a No. 68 Seth Thomas movement, took off the train of gears which moves the hour and minute hands, and cut another set of gears with a compound gear 1-to-2 for the hour hand drive. These we mounted on a brass plate which we screwed to the front frame of the movement and which gave us a 24-hour clock. The face is aluminum and the figures and graduations are filled with black Duco. The case is arc welded steel sheet with screwed bronze doors, which makes it practically dust or air tight."

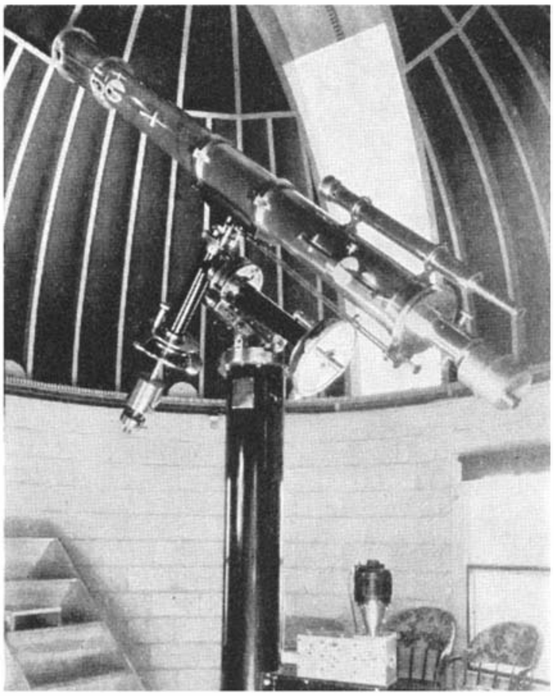
JUDGING from letters received, also from your scribe's own recollection, most beginners find that the knife-edge test leaves them with severe headaches from eye strain. For the first year or so this test is generally nerve-wracking, after which it seems to flatten out so that looking at the shadows as long as one wishes to do so is no harder on the eyes than looking at the scenery at a bathing beach or at a pound of butter. Perhaps the following hints will help:

The first thing is to place one's self in a completely comfortable, relaxed position, and get into a placid, limp, easy-going frame of mind. To make physical relaxation better possible, find out the height of your eye when sitting in a slouched position in a chair, and then place the test stand at the same height. Sprawl out your feet and arms when testing, and have your head well back, with no knots tied in your neck—relax. If possible, rig something for your left elbow to rest on, while manipulating the knife-edge, and have it at "just right" height, but this rest ought not to be on the same base as the knife-edge. Adjust the mirror so that the cone of returning rays is high enough above the table or board on which the knife-edge rests to permit you to get your chin on top, or else have the knife-edge come so near the edge of the table that your chin is not a factor.

The worst source of headache and nervous tension is trying to close the other eye when making the test, just as it is when using a telescope or microscope. Leave the other eye entirely open, as all microscopists and astronomers do; you will soon learn to forget or ignore the extraneous image on its retina—it is on the eye but not in the brain, as it were. Don't squint or screw up the eye you look with—just look with it as you would look off down the street, wide open, easy and naturally.

A third factor is psychological: At first you do not seem to see all you had hoped to see and, thinking that all others see everything, you become irritated at yourself and thus waste nervous energy—like a bunkered golfer. It may, therefore, help if you are told that no one sees everything in the test at first and, in fact, mighty few ever do become well enough trained to extract all the juice from it. Insight comes gradually, hence you should not expect to pick it all up, or even a quarter of it, within a month or so. You will see enough to work with, after playing with the test for a few sessions, but the education of eye and brain goes on practically forever.

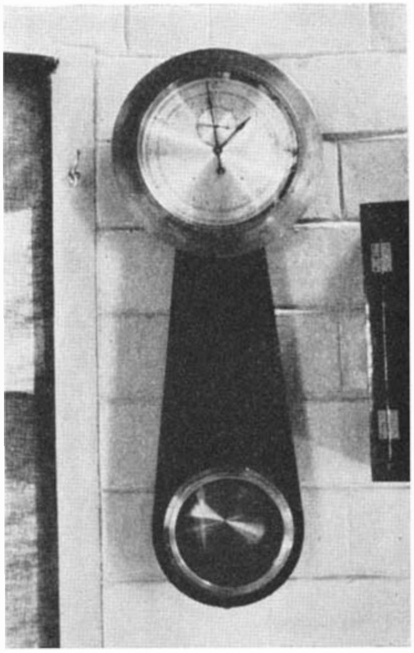
If you are still doubtful about all that



The Young refractor. Note motor drive

has just been written, as applied to your own case, perhaps it will encourage you to hear that the writer had all of these troubles for months, and then none of them.

A YEAR or so ago we decided to find out, if possible, about the matter of alleged local figuring of optical surfaces by means of the heel of the hand, the thumbs, or the fingers, which some said was a myth and others said was a recognized method of the oldtimers. We referred the question to a professional, and he told us the tradition



Sidereal clock, Young Observatory

was based on a myth, and we believed him, stating that belief in this department. Pretty soon, however, we began receiving reports from various amateurs who were actually doing it. First it was Clyde Tombaugh, who has his name "writ large" on Pluto. He wrote, "One's thumb is an excellent tool to rub glass. The method is supreme for central hills." Then came S. H. Sheib of Richmond, telling us he used the middle finger of his hand and that the method worked well—too well, in fact, until he found that a little of it went quite a way. Next, Wallie Everest said he used the method regularly—fingertips, in his case; following which J. H. White of Cranford, N. J., mentioned his recollection of many years ago watching Alvin Clark working on a lens with a very broad thumb.

It began to look as though the ayes had it, and so we tried the method on a mirror which had a raised ring in the outer zone: mirror inverted, thumbs dipped in rouge mixture, and worked on the zone with short strokes as the pedestal was circumnavigated, knuckles used as a gage and control of distance in from edge. The zone came down and the method proved to be capital. Thus another fine theory is blown to ribbons by a mere fact; it may be true that a live meat local polisher ought not to work, but apparently it does. One thing to remember is that a little of this method goes a long way—otherwise your raised zone becomes a valley and your central hill a well. A little preliminary practice and gradual "feeling out" of the method will reveal its safe limits before any serious damage is done.

Horace E. Dall, 166 Stockingstone Road, Luton, Beds., England, submits the following suggestion for a direct method of measuring the angular diameter and physical appearance of certain stars. "So far as the writer is aware," he points out, "the following suggested method has not been put forward before and, although limited in application to about 10 percent of the sky, it may prove to be capable of giving information concerning the diameter and distribution of light on star disks unobtainable by any other known means.

"It is of course well known that the stars occulted by the moon apparently disappear instantaneously, due to their exceedingly small angular diameter. Actually, in the case of a certain number of stars, the time interval of occultation is by no means beyond the powers of modern electrical methods of recording. The method proposed is to direct the light from the star approaching the dark limb on to a sensitive photo-electric cell of the type which responds practically instantaneously to light variations. The small electromotive force generated would be conveyed to an amplifying unit employing thermionic valves, and the current from these would in turn be conveyed to a cathode-ray deflector and recording device similar to those employed for measuring and recording explosion pressures in guns. Alternately the current from the amplifier could be recorded photographically by an Einthoven string galvanometer having an extremely short vibration period or by an electro-magnetically operated vibrating mirror.

"The interpretation of the photographic record of an occultation (or reappearance) so obtained should present no special difficulty. Due allowance having been made for the inertia of the photo-electric cell and recording device, and for the eclipse of the aperture of the telescope, the remaining time interval and light curve will give a measure of the diameter and light distribution curve of the stellar disk.

"From a study of the theoretical occultation curve it does not seem unreasonable to assume that the method is capable of measuring stars down to an angular diameter of 0.0001″, *i.e.*, 100 times smaller than the limit of the 50-foot interferometer. This corresponds to the size of our sun at a distance of 93 parsecs (at which distance it would appear 9.7 mag.) or to a star of Aldebaran's size at a distance of 7500 parsecs. It may be contended that irregularity of the lunar horizon will introduce errors; this is certainly true—but the probability of steep slopes is not great, and several occultations can be observed of each star. Furthermore, an analysis of the shape of the occultation curve may reveal slight irregularities of the lunar limb which can be allowed for. Another problematic point is the effect of our own atmospheric tremors; but the writer would suggest that this may not be a serious factor unless the *total* light received from the star is *very rapidly* and irregularly fluctuating.

"The possibility of causing artificial terrestrial occultations (from mountains and so on) is probably ruled out because of atmospheric tremors on *both* sides of the occulting plate. Although other planetary bodies would not be suitable for measuring star disks, owing to the nature of their surfaces, the method may be inverted and be made to supply information regarding the surface, or, for example, in the case of Saturn, the nature of the rings."

Here, then, is another chance for someone who is interested in electronics to work out something that will make him famous as a contributor to science. Three of our amateur fraternity are working on a similar problem in photo-electric telescope guiding—something which, if satisfactorily solved, will amount to a whole lot.

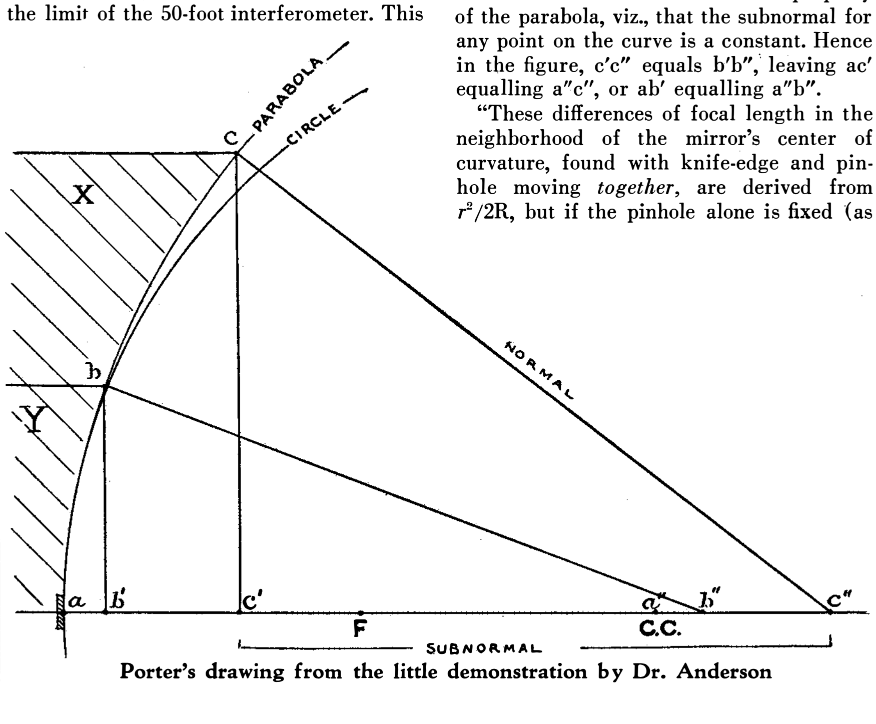
HERE is a note R. W. Porter recently sent in:

"Dr. Anderson called my attention today to the fact that the depth of a telescope mirror is *always equal* to the distance between the foci of the mirror's central and marginal zones.

"For instance (in the figure) if knife-edge and pinhole are together at a″ for an even cut-off of light reflected from around a, and are at c″ for light reflected from c, then a″c″ is equal to the mirror's sagitta ac′. This applies to all apertures or focal ratios.

"It arises from a fundamental property of the parabola, viz., that the subnormal for any point on the curve is a constant. Hence in the figure, c′c″ equals b′b″, leaving ac′ equalling a″c″, or ab′ equalling a″b″.

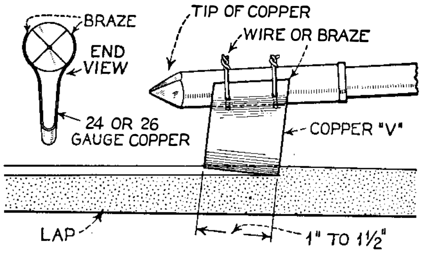
"These differences of focal length in the neighborhood of the mirror's center of curvature, found with knife-edge and pinhole moving *together*, are derived from $r^2/2R$, but if the pinhole alone is fixed (as



Porter's drawing from the little demonstration by Dr. Anderson is customary among amateurs) r^2/R is used, giving twice these amounts.

"It had never occurred to me that a fellow could find this quantity quite independent of the formula, by simply laying a straightedge on his mirror and measuring its depth. I had never seen the point alluded to in any book on applied optics."

THANKS to Yankee ingenuity there are something under 1,000,000 ways to cut out the facets on pitch laps. The one in the

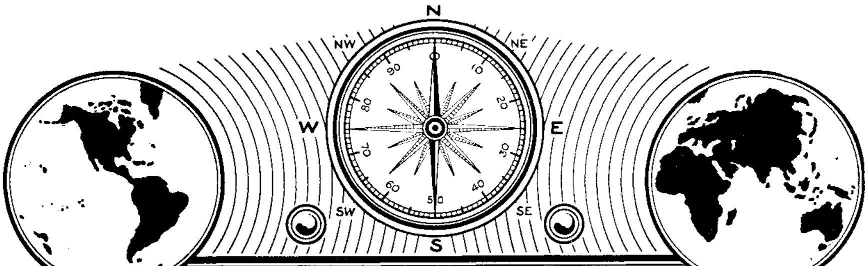


Mason's hot plow for pitch laps

accompanying drawing is by William A. Mason, 1303 Lakeview Ave., Lorain, Ohio. He says, "Do not try to make the groove full depth at the first stroke. Pull this tool through the pitch rather than push it. Do it slowly. With this tool there will be no chips or flakes." In the redrawn sketch the lap thickness was inadvertently exaggerated.

ABOUT once a month, for years, we have received letters much like the following: "Will you kindly advise me the names of books or publications containing data on the theory and construction of spectroscopes, also on their operation." So far as is known, there is no such book, and we wish somebody would write one covering just that ground in an all-around manner. Physicists pick up their knowledge of the use of spectroscopes by word of mouth, from older physicists, not from anything in print. Of course, it may be that such a book would not pay its way, unless a very high price were charged for it, but we believe many an amateur would lay down five simoleons for one if it were practical, understandable and interesting. A physicist we recently spoke to about the matter stated his belief that it would be possible to drop out the deep stuff (higher physics) which is so closely hooked up with spectroscopy, and still write a good book, but he was too busy to do so. The fact probably is that few who understand the use of spectroscopes (except manufacturers) could tell us how to make them. Maybe it would best be a two-man book, then, but we don't know the names of the logical candidates to write it.

LAST month we gave you a little advance dope on the forthcoming fourth edition of A.T.M. Various things, including our annual vacation and a little attack of the tummyache, have held us up and, at present writing (Oct. 14), the second proofs have just been returned to printer. So it looks as if the book ought to be ready by another month. It will be no larger but certain out-of-date parts have been replaced by what we think is better stuff, a lot of small corrections have been made, and quite a few new notes substituted for older ones.



WORLD-WIDE RADIO

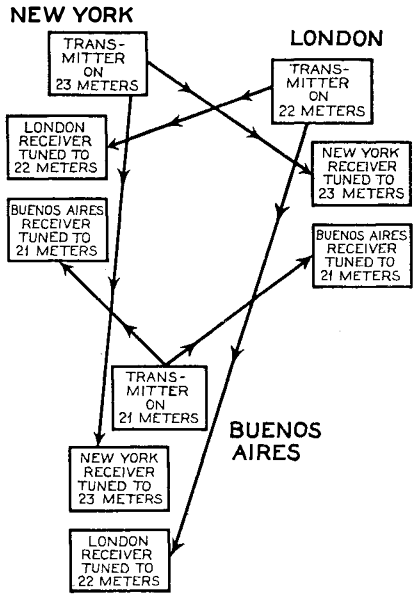
Conducted by M. L. MUHLEMAN*

Radio Telegraph Stations

THERE are literally hundreds of commercial radio telegraph stations operating in the short-wave bands. A large portion of the world's communication takes place "in the spaces on your receiver dial" between the short-wave broadcast bands.

No doubt you have heard the rhythmic sounds of these transmitting stations and have had cause to wonder just what all the noise may amount to.

Communication links normally go into action only when there is traffic to be handled. Not so with the powerful radio telegraph transmitters; they pound away hour after hour irrespective of whether or not there are messages to be sent. The reasons for this continuous operation are many: For one thing, it costs more to shut down and start up a powerful transmitter than it does to keep it idling on the air. Moreover, when "cold," the frequency or wavelength of a transmitter is apt to shift; it is necessary, therefore, to keep the transmitter warmed up for instant use when traffic comes through over the land lines for overseas transmission. Furthermore, the receiving station in each country of the world maintaining service with the transmitter must be kept properly tuned to the station at all times. So long as the transmitter is in operation, the operator at each receiving position can keep a constant check on the signal.



Showing how constant radio telegraph communication is maintained

This rather peculiar manner of operation serves to maintain an almost foolproof service, ready for instant use at any time of day or night.

Of course, a single radio transmitter maintains schedules with a number of countries. A New York station may clear traffic with London one moment and with Buenos Aires the next moment. At the same time the transmitters at London and Buenos Aires may be clearing traffic with New York.

This form of operation is made possible through the use of separate transmitting wavelengths and separate receivers, one receiver for each transmitter in the link. Thus, as shown in the accompanying sketch, New York transmits to London and Buenos Aires on, say, 23 meters; London transmits to New York and Buenos Aires on 22 meters, and Buenos Aires transmits to London and New York on 21 meters. Furthermore, New York has receivers constantly tuned to London and Buenos Aires, and so on, with the result that, with no change whatsoever in wavelength, New York can cut short transmissions with London and immediately commence the transmission of traffic to Buenos Aires. At the same time, both London and Buenos Aires can be clearing traffic with New York.

Actual traffic is handled at high speed, and is entirely automatic. During intervals of no traffic, the automatic sending device sends out a continuous series of dots, or the device is made to repeat over and over again the call letters of the station preceded by the letters "abc" or the letter "v". It is quite impossible, therefore, for the London operator to tune his New York receiver by mistake to the signals from Buenos Aires—not that it would be apt to happen anyway.

Transmission Line Extension

MANY listeners seem to believe that the radio receiver should be placed as close to the aerial and ground connections as possible, but quite often such a location is inconvenient. There may have been some excuse for this assumption in the past, when long lead wires through rooms increased noise pick-up, but with the advent of the noise-reducing antenna system using a transmission line, the assumption is invalid.

There is no reason why you shouldn't

*Editor, Communication and Broadcast Engineering; Radio Engineering; (Radio) Service.

place your radio receiver where it will be convenient to tune. A slightly longer transmission line will not reduce signal strength or increase noise pick-up. For that matter, efficiency will not be reduced if the line is brought in through, say, a window, and run along the baseboards to the receiver in some other room.

Metal Tubes

THERE have been some nasty rumors relative to metal tubes, most of which hinged upon production difficulties which are now fairly well ironed out. With the exception of the 5Z4, which has been redesigned, and the 6A8, a few of which have developed trouble in service, the metal tubes are good.

Courtesy RCA Manufacturing Co., Inc.

Welding metal tube parts. In this powerful machine, Thyratron-timed currents on the order of 75,000 amperes weld the parts to form the air-tight containers for the units

Three metal-tube receivers have been put through their paces. On the broadcast band, these sets are the equal of receivers using the glass tubes; on the short-wave bands the metal-tube receivers certainly appear superior. In any event, the metal tube is not to be sneezed at. It is here to stay.

Brute-Force Experiment

A NEW approach to the transmission of short-wave radio telegraph signals over long distances will be tried by RCA on the completion of a new 200-kilowatt short-wave transmitter now under construction at the company's station at Rocky Point, Long Island.

By means of this tremendous short-wave power, which is 5 to 10 times the intensity usually employed by international communication, it is proposed to "battle the ionosphere with kilowatts" and over-ride certain natural obstacles which to date have limited the signal strength under abnormal conditions.

As explained in previous notes in this column, the ionosphere, or Kennelly-Heaviside layer, is an electrified region in the earth's outer atmosphere. Short-wave radio signals are reflected or refracted back and forth between this region and the earth in their passage around the globe. There are cycles in the daily conditions of the ionosphere which make it necessary to use several wavelengths for long-distance radio communication. There are also times of magnetic disturbances, when the turbulent condition of the ionosphere causes absorption and dispersion of the radio signals and consequently reduced signal strength at the receiver. It is then that even highly concentrated beams become least effective.

What the engineers expect to determine by means of the new 200-kilowatt transmitter is whether the hours of usefulness of one or more of the wave-bands used in long-range communication may not be lengthened and the effects of magnetic storms minimized by the use of increased power.

The new transmitter will be operated at first only on one wavelength, in the neighborhood of 28 meters, which is between two of the present international short-wave broadcast bands. This wave has been selected as the trial one which promises the greatest general serviceability. It is expected that when radio signals from this transmitter are hurled against the ionosphere the greater power will cause them to be reflected back even during less favorable hours of operation for that particular wavelength. Present-day commercial radio practice has been brought to a high degree of reliability by directive transmission. This new step by RCA looks toward further conquests of the ether by enabling transmission through severely disturbed periods.

Ultra-Short-Wave Riddles

NUMEROUS theories have been advanced with regard to the nature and the behavior of radio signals below five meters. It is assumed that signals of such high frequency behave much in the same manner as light waves, yet full proof of this assumption has not been obtained.

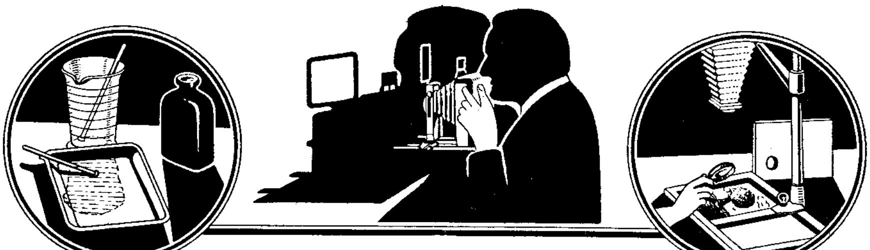
There is the supposition that the high-angle waves—those which are radiated upwards—are not sufficiently bent by the layers of the ionosphere to permit them to again return to earth. Presumably these waves are dissipated in outer space.

There are left the low-angle waves which, because of their similarity to light waves, are not perceptible beyond the optical horizon—at least presumably so.

In contradiction of the scant theories on the subject, signals transmitted on five meters are now consistently received over distances far beyond the optical horizon. Moreover, it cannot be said that there are definite limits to the distance an ultra-short-wave signal can cover.

It would seem that reception of these signals beyond the optical horizon is due to wave diffusion—after all, it is possible to see the beam of a powerful searchlight directed into the sky from a long distance off, because of light diffusion. But wave diffusion will not account for the reception of ultra-short-wave signals from a point hundreds of miles distant. In this case it would seem that some portion of the wave is reflected back to earth.

Once the nature of ultra-short radio waves is clearly understood, and more is known of their behavior, it may be possible to control them to a degree sufficient to permit their use for numerous services so far excluded from our over-crowded channels.



CAMERA ANGLES

Conducted by JACOB DESCHIN

Prints in Color

AND now prints in color—three colors, at that. The ingenuity of the men who burn the midnight oil to light the path to new discoveries in the photographic science has long been well known. But in view of the growing interest in color photography, few of these discoveries can equal the welcome accorded the advent of a new method by which any amateur may produce a three-color print from color-separation negatives within a half hour after fixing the three positives required for completion of a finished print.

This method is known as Chromatone, the discovery of two young New York chemists, Francis H. Snyder and Henry W. Rimbach, who developed it while hunting for a suitable way to produce color in photomicrographic work.

Success in turning out a color print by the Chromatone method depends entirely on the worker's fidelity to instructions furnished by the distributors, reasonable care in executing the various steps in the process, and thorough washing. That isn't asking any more than the cautious worker already gives his darkroom activities. Furthermore, there is nothing essentially new in the various steps of the Chromatone method; it is only the correlation of several known methods into an ingenious synthesis that is new.

The basis of the Chromatone process is the same as that which serves for three-color photography; namely, three color-separation negatives are taken, respectively, through blue, green, and red light filters. These negatives are used to make three contact or enlarged black and white positives on a special stripping film known as Chromatone Print Paper (a "double-weight" paper support for a collodion gelatine layer coated with an emulsion having approximately the speed of Azo No. 2). The collodion gelatine layers are "peeled" off while in the hypo and the three total in thickness, when dry, about 0.001 of an inch.

Each of these positives is then toned to its proper color—yellow, magenta and blue-green—and, while they are still wet, are superimposed in sharp register one over the other on a white paper base, using a rubber squeegee to force out the excess water. This constitutes the print and when dry it is trimmed to the size desired and mounted by the dry-mounting process.

Complete instructions for processing as well as a full discussion of color photography, illustrated with charts in color, are contained in a very comprehensive treatise which is furnished with a "kit" containing all the necessities for making Chromatone prints, as well as solutions and positive material for turning out eight 5 by 7 three-color prints. The booklet may also be purchased separately for a nominal sum so that the photographer who wishes to investigate the possibilities more thoroughly before making an investment may do so.

An advantage of the new color process lies in the fact that the original three color-separation negatives may be exposed in any camera and not necessarily, as hitherto, in the expensive "one-shot" professional outfits that cost as high as 1000 dollars and more. The only special equipment needed for taking the picture is three color filters, which are obtainable for as little as one dollar for the set. Another feature of the cost angle is that whereas hitherto a three-color job could be had for not less than 100 dollars and as high as several hundred dollars, the Chromatone process makes it possible to produce a three-color print in spectroscopically correct colors for from 60 cents to less than two dollars, depending on the size.

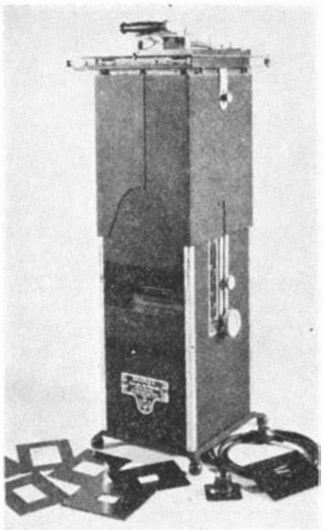
It seems fairly obvious that when taking a three-color picture in a camera other than the "one-shot" type, which exposes three negatives at once, persons as subjects are definitely "out" because of the danger that the subject may move slightly during the interval it takes to place another filter over the lens and bring a new film into place. Even so slight a movement as "a hair's breadth" would be enough to throw the thing off, since all three must be in perfect register if they are to line up in the final printing.

However, pending the appearance on the market of a reasonably inexpensive "one-shot" outfit selling for the price of a good ordinary camera, which, at the time of this writing, was already in the offing, pictures of persons as well as other subjects in which the probability of movement is a factor to be considered, are not necessarily "out of the picture." Of course, there is Dufaycolor or similar film, but their use as a medium for the Chromatone process involves an intermediate step. This lies in the photographing of the original in the usual way and then making three color-separation negatives of the projected transparent color positive. Messrs. Snyder and Rimbach suggest that three color-separation negatives of live models may easily be made on the miniature type of camera in less than five seconds for the complete set. Very nearly flat lighting is recommended for color photography.

If there were any doubts before, it is certainly safe to say now that color photography is here to stay. Nor is it, henceforth, to be the exclusive province of the few. It is not hard to foresee picture albums filled with color and when baby next appears in print her red dress will be red, not a shade of gray, and her eyes sparkling the blue that Dad saw as he tripped the shutter.

Versatile Enlarger

A NEW accessory for the advanced amateur's darkroom, just announced, offers many desirable features in one complete and compact unit. Called the Enlarg-or-Printer, the device offers the photographer facilities for rapidly making enlargements or contact prints from negatives up to 2¼ by 3¼ or from sections of that size from



You can enlarge, print, or retouch with this new equipment

negatives up to four by five. Strip film can also be used, suitable adapters being provided. The device also can be converted into a retouching desk.

The accompanying illustration shows the Enlarg-or-Printer, together with its lens and a selection of negative masks. The light source is located in the base of the unit, and projects upward to the platen top which is of the automatic printer type. A Photo-flood bulb, in series with a ruby lamp, is automatically operated by the platen and a toggle switch provides a choice of two light intensities for varying requirements.

With this unit it is possible to turn out contact prints up to eight by ten at the usual speed. What is more important, however, from the standpoint of utility, it will turn out enlargements up to eight by ten just as fast and just as simply as it produces contact prints. With a wall easel it is possible to make enlargements of a size limited only by the quality of the negative.

The compactness of the equipment is remarkable, taking up a space only 11½ by 13¼ inches, and standing 26⅜ inches high overall. It weighs 21⅗ pounds.

Amateurs Score "Beats"

INSTANCES of amateur photographers who cash in on their hobby by being "on the spot" and getting the pictures before news-cameramen reach the scene come up often enough to make it worth the amateur's while to be always on the lookout for such opportunities. The recent tragic Will Rogers-Wiley Post crash in the Alaskan wilds provided such an opportunity for Dr. Henry Greist, missionary physician. Using a 3A Kodak with ordinary roll film and despite fog and rain he succeeded in making a series of exposures of the tragic scene long before professional photographers could reach the place. The films were flown via four changes of planes to San Francisco, where they were developed in the Associated Press darkrooms and then sent broadcast by the Wirephoto system.

Another case of a live-wire camera amateur was that of Ivan Dmitri, of New York City, one of the best known of the miniature camera enthusiasts, who made some shots of a big fire sometime ago and sold them to two metropolitan morning newspapers before their own men could get on the job. The pictures appeared on the front pages of the two newspapers the next morning.

The lesson to be learned here is that news cameramen cannot be everywhere and a picture "on the spot," even if made by a small box camera, is worth any number of the most excellent pictures taken after the event. Newspaper editors are always eager for this type of picture and will show their appreciation by paying well for your trouble.

Stick to One Clerk

THE advice often given to beginners in stamp collecting to cultivate some particular dealer because his fund of knowledge will save them from many pitfalls, is just as applicable in the case of the camera enthusiast. If the store is a large one and employs several clerks, pick one clerk and go to him for all your purchases. Dealer or clerk, either can be of tremendous help when it comes to solving some knotty picture-taking or darkroom problem, or when about to purchase additional equipment. The honest dealer or clerk, and most of them are that, is always ready to listen to your tale and give you sound advice, whether it means a sale or not. After all, he has everything to gain if you are successful and happy in your hobby, and certainly much to lose if you are not.

New 35-mm Film

THE Cappelli 35-mm film is now available in the United States after having achieved a reputation for speed and fine-grain excellence abroad. Packed in a daylight spool of 36 exposures, it has a Scheiner rating of 26° and is fully panchromatic.

Low-Priced Reflex

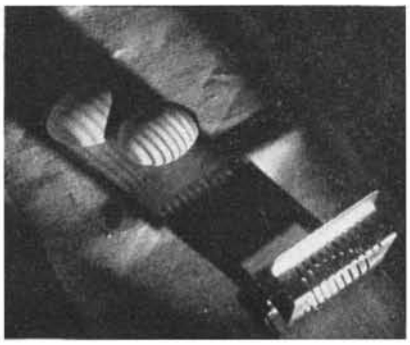
THE K. W. Reflex-Box, taking 2¼ by 3¼-inch roll-film, is the most recent addition to the reflex field. Not the least attractive of its features is the fact that it sells for an unusually low price for a type of camera whose cost has hitherto made it prohibitive to modest purses. The self-erecting hood containing the focusing screen of ground glass, on which the subject is viewed as it will appear in the negative, is part of this equipment as it is of the more expensive ones in its field. Focusing is done by rotating the lens.

An all-metal slit shutter provides speeds of 1/25th, 1/50th and 1/100th second and for brief and long-time exposures. The camera weighs but two pounds and measures

4⅞ by 3⅛ by 4½ inches. There are two models, one equipped with an f/6.3 anastigmat lens, the other equipped with a Steinheil Actinar f/4.5 anastigmat, iris diaphragm, level, carrying strap, and cable release.

Shadow Patterns

PROJECTING a design in shadow on either subject or background is a popular method of gaining effects for unusual photographic interpretations. Two eggs become dramatic entities when a spotlight throws over them long shadows cast by a simple egg slicer; the netting in a tennis racket held over the face of a fair lady at high noon gives a beautiful effect. The most interesting results are to be had indoors with the use of a spotlight to throw the shadow of the design or object, although many odd and often startling impressions are frequently found outdoors under brilliant sunlight.



Light and shadow

Shadow patterns are created by interposing an irregular object or cardboard cutout between the light source, whether solar or artificial light, and the area on which the shadows are to fall. The irregular object might be a vase, a pair of shears, a leaf, or it might be composed of lines, curves, or circles or other forms strung within a frame. Allowing of still wider manipulation is the projection cutout made of cardboard. Here the opportunities are unlimited, since the designer may even simulate a street scene within his home studio merely by making a cutout and projecting its shadow upon a light background.

Observation has taught that the nearer an object to the area on which its shadow is thrown the smaller will the shadow be, and the sharper its edges; the farther away, the bigger the shadow and less sharp. A spotlight, because of its concentrated power, will give a sharp edge, but a diffused light will not. For shadow patterns, therefore, particularly where objects are simulated by means of the projection cutout, the spotlight is preferable and in some cases indispensable.

35-mm Reversible Superpan

FOR users of cameras taking 35-mm film, an emulsion for getting direct positives which are developed by the reversal process (Agfa Reversible Superpan) may offer opportunities for new adventures. This film, which has a Scheiner rating of 20° in daylight, is suitable for viewing by transmitted light, for the making of paper negatives, or making larger negatives by direct projection.

THE SCIENTIFIC AMERICAN DIGEST

(*Continued from page* 325)

and the high proportion of cases in which the fracture heals with a good join.

The observations of tuberculosis and syphilis are subject to the fact that no soft parts are available for examination; but otherwise there is no appearance of tuberculosis in the paleolithic period, while in the neolithic, bronze, and iron ages cases are few. To a certain extent, there is uncertainty in the identification of the lesions of syphilis, but it would appear that there is no case of syphilis in paleolithic man, and in the later prehistoric periods only a very few cases from France and one from Russia appear certain.

Dental caries is not found in paleolithic man in Europe, but appears in Africa in men of (probably) late paleolithic age.—Adapted from *Nature* (London).

Cellophane Soda Straws

STRAWS of Cellophane in various colors, called Glassips, are the latest supplement to the current fashion of serving cool drinks in different colored glasses for parties and outings. Since they do not disintegrate in alcohol, they may be used for both hard and soft drinks. Absolutely tasteless and shape-retaining, they are ideal for the sick room. Children are delighted with them and find that drinking milk can be a pleasure.

VACATIONS

ACCORDING to a recent estimate, the American people spend 5,000,000,000 dollars in a normal year on holiday and vacation travel.

Gelatin Noses and Ears

NOSES, ears, or other facial features made of gelatin and applied with a mastic cement were described recently by Dr. Oscar V. Batson of Philadelphia at a meeting of the American Academy of Ophthalmology and Otolaryngology.

When the features have been destroyed by disease, accident, or curative measures to such a degree that the patient feels himself disfigured, it is the duty of the physician to remove if possible the stigma, fancied or real, Dr. Batson declared. Plastic surgical measures should be considered first in such cases, but if the vitality of the skin has been lowered, they may not succeed.

For such cases Dr. Batson advised the use of artificial features or prostheses, to use the medical term. He considers gelatin the most satisfactory substance because it is flexible, moves with the changing expression and can be attached without mechanical support. In a suitable patient, Dr. Batson said, the gelatin prostheses are not obvious to the observer at conversational distance.

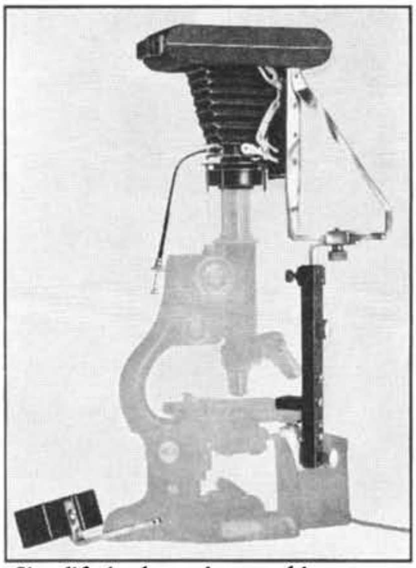
The gelatin artificial features are made by pouring gelatin, colored to match the skin, into molds made from wax models of the feature to be restored. They are held in place on the face with a mastic cement. The gelatin artificial features are of course temporary. Depending on the time of year and the character of the patient's skin, they last from one to ten days. However, the patient may be supplied with molds, suitably colored gelatin and cement, and can learn to make and apply his own feature as needed.—*Science Service.*

ROSIN

ROSIN production is said to be increased 100 percent by treating the wounds of the tapped trees with a solution of 25 percent hydrochloric acid. The balsam is not affected by the treatment.

Photomicrography Simplified by New Device

HERE'S news that should be welcome to every microscopist who takes his work seriously. A new device called the Microdak, makes it possible for any user of a microscope to make photographic records of his work without more than a casual knowledge of amateur photography. Microdak is an Eastman development.



Simplified photomicrographic set-up

It is only necessary to focus the subject under the microscope properly, to place the Microdak in position, and to operate the shutter. Because the camera uses roll film, no darkroom is required, so photomicrographs can be made in any schoolroom or office. After exposure in the Microdak, the film can be developed and printed by any regular photo finisher or by the microscopist himself.

The Microdak is not a toy. It consists of a camera using 2¼ x3¼ roll film, and having a fixed focus lens and a shutter with provisions for bulb and time exposures; a light-lock to shield the microscope eyepiece and camera lens; a bracket for holding the camera, a support for the camera and bracket, which fastens to the stage of the microscope; and a counterweight that attaches to the microscope base. The phantom picture shows the Microdak attached to the microscope, ready for operation.

Etching Stainless Steel

A NEW method for etching stainless steel, prior to microscopic study of the grain structure, has been developed by the National Bureau of Standards.

All metals are composed of small, imperfect crystals known as grains, the size, shape, and structure of which are of great importance in the study of any metal and its application in service. To reveal this grain structure it is necessary to etch the metal with a chemical reagent. The appearance is then studied under the metallurgical microscope at suitable magnifications.

Certain metals are difficult to etch satisfactorily because of their compositions. Stainless steels are among the most troublesome, since they resist all ordinary reagents. In the past it has been necessary to use strong, mixed acids to reveal the structures of stainless steels, and these mixtures require great care in handling and in disposing of them afterwards.

The new method was worked out in connection with a study of the changes induced in stainless steels by welding. The stainless steel is etched electrolytically in oxalic acid (10 grams dissolved in 100 milliliters of water), the specimen being the anode and a piece of platinum the cathode. Current is supplied from four dry cells in series or from a 6-volt storage battery. The carbides are revealed in from 15 to 30 seconds' etching time, while an additional 30 to 45 seconds will reveal the grain boundaries of the "18-8" (18 percent chromium, 8 percent nickel) type of stainless steel. The solution is relatively rapid in etching action and does not stain the specimen.—*A. E. B.*

Transparent Operating Masks

NUMEROUS movies and stage productions have made everyone familiar with every detail of hospital operating rooms. It now appears that we will have to be re-educated, for the newest type of mask for operators is made of Plastacele—transparent and impermeable shields over the nose, mouth, and chin. These deflect the operator's breath backward and away from the patient and serve to protect the wearer against possible infection.

Among the advantages of these Maskons, as they are called, are feather-weight construction, quick adjustment, freedom from gagging, and easy cleaning, says the *Du Pont Magazine.* To put one on, the wearer simply adjusts the ear-loops or tapes and then presses the flexible aluminum rim at the top to fit the face. If the operator wears glasses, the snug fit on the upper part of the face keeps his breath from fogging them. This device also permits free breathing and speaking and eliminates nose and mouth pressure.

LAMPS

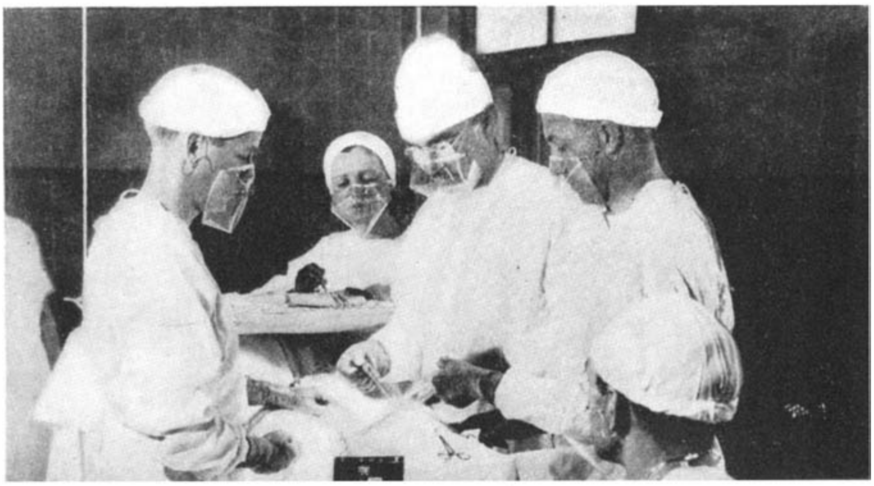
AS an index of lighting progress, the American citizen consumes slightly more than five lamp bulbs per year. The next nation in the order of lamp usage is Denmark with about 1.75 lamp bulbs per person per year. Most European countries use about 1.5 lamps per person.

Egyptian Tomb Paintings

THE tombs of Egypt are a veritable encyclopaedia of the manners and customs of the ancient Egyptians. For many years Joseph Lindon Smith has spent part of each winter in Egypt where he has made paintings of details from the ancient tombs along the Nile. Karnak, Luxor, Sakkara, Thebes, and Giza, among other ancient sites, have provided material for his brush. Nor has he neglected the Nile landscape from the Sudan to Cairo.

The Boston Museum of Fine Arts, of which Mr. Smith is Honorary Curator of Egyptian Art, has acquired over a period of years through the generosity of an anonymous friend, more than a hundred of his works. Seventy-eight of these are now in the Special Exhibition Galleries of the Museum. They are grouped according to source and arranged chronologically.

The paintings create an astonishing illusion of reality. One wishes to be reassured again and again that one is looking at a canvas and not a sculptured relief, notably in the group from the tomb of

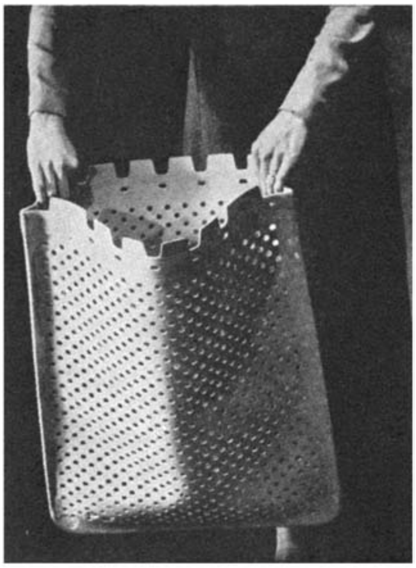


The latest in operating masks—made of Plastacele

Meresankh III. Figures in high relief represent various members of the family of Meresankh who accompany her through eternal life. Among them is her mother, the fair haired Hetep Heres, who appears to wear a smart gown with pointed shoulders. Other details indicate the food, clothing, and furniture used at the time, and the social customs prevailing.

Rubber Laundry Net

A RUBBER laundry net which is said to solve several of the more pressing problems of the industry has been produced by United States Rubber Products, Inc., after 18 months of experimental work in conjunction with the American Institute of



To save your clothes . . .

Laundering and with a further six months' collaboration with some 20 commercial laundries.

Laundry patrons have probably ruminated at one time or another on the problem a laundry faces in retaining the identity of the numerous shirts and pajamas dumped into its tubs in the course of a day's work. The secret of course is that they are not dumped into the tubs *en masse* but are placed in nets and washed in units.

This procedure has, in the past, given rise to a problem—each time the contents are washed the net is washed too. Laundry statisticians have figured that in the course of a year's time the average size laundry wastes seven or eight weeks washing and rewashing the old style nets. This problem has been solved by the development of a rubber net that will not wash with the clothes it holds.

Two other outstanding advantages of the rubber net are: (1) rubber nets do not burst and mix your clothes with those of your tub mates and, (2) the danger of tearing clothes while washing is considerably reduced.

Water-Soluble Resin

COMMERCIAL production has just been started on a new water-soluble "resin," Abopon. It is an odorless water-white liquid "resin" soluble in water but not soluble in any other liquid. It is a pure complex chemical compound and not a mixture. Abopon forms smooth, non-tacky, flexible, glossy films. It is neutral and non-hygroscopic, spreads readily, and is more viscous and denser than glycerine. It is entirely inorganic, non-combustible, and is not affected by moderate amounts of strong acids or alkalies. It possesses strong adhesive properties.

Its indicated uses are as a suspending medium for pigments and abrasives and as a grinding medium for colors and pigments. As a wetting medium for pectin, gum tragacanth, gum karaya, and other water swelling materials, it prevents lumping and hastens dispersion. It serves as a sealer for surfaces which are to be lacquered or painted, and as a temporary coating for wares on display, to prevent soiling. This coating is washed off by the consumer, exposing a clean surface for use.

NEPTUNE'S METHANE

CALCULATIONS completed at the University of Michigan show that the outer layers alone of the atmosphere of Neptune contain six billion million tons of methane gas, which also forms a large portion of the natural gas found in the earth.

PROGRESS OF A FIVE-YEAR-OLD DISCOVERY

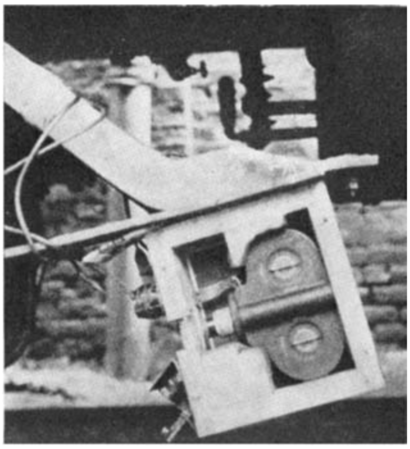
ABOUT five years ago, Scientific American reported the discovery of new non-toxic refrigerants, di- and tri-chlorodifluoromethane, by Thomas Midgley, of the General Motors Research Laboratories, and quoted the inventor's prediction that the application of these compounds to air-conditioning would result in greatly broadening the scope of this industry. Today that prediction has been verified. The total air-conditioning in use in the United States is now more than 16 times what it was in 1930.

Over 85 percent of all the mechanical refrigeration installed for air-conditioning since 1931 (when organic fluorides were first made commercially available) is operating on either dichlorodifluoromethane or trichlorodifluoromethane. At the present time 95 percent of all such new installations being made use one or the other of these refrigerants. Over 99 percent of all mechanical refrigeration in use on Pullman cars for air-conditioning employs dichlorodifluoromethane as the refrigerant.—*A. E. B.*

SLOW-MOTION PICTURES CHECK "ROUGH RIDING" OF TRAINS

ABOUT a year ago, the Chicago, North Shore & Milwaukee Railroad, the high-speed electric line running between Chicago and Milwaukee, decided to conduct an investigation of truck oscillation or "nosing"—a transportation factor which, because of the resulting uncomfortable riding, has become increasingly objectionable on all railroads as speed has been increased.

A slow-motion 16-millimeter Bell & Howell motion picture camera was mounted in a box on a bracket on one corner of a truck which was guilty of nosing. Solenoid control started the camera after the car had reached a speed above 60 miles an hour, when noticeable nosing commences. The camera was focused on the lower part of the wheel where it contacts the rail, and pictures were taken of a worn wheel as found in service and then of a new replacement wheel. When the films were projected both the worn and the new wheel were seen to oscillate with a regular and continuous motion. The only difference noticeable in the movies of the two wheels was the less violent action of the new wheel due to the fact that this wheel had less clearance between flange and rail than did the worn one. This led to the belief that the oscillation was caused by the taper of one inch in 20 which has been a part of the standard design for railroad wheels.


The camera checks train riding

On this belief, a set of wheels was turned without any taper but with the flange kept the same shape and size as formerly. Slow-motion pictures taken of these wheels showed no regular oscillation at all; in fact, the flange seldom impinged upon the rail on a straight track. The riding of the car was greatly improved, as there was no more nosing. The test car was put into regular service and watched as to wear of wheels and riding quality. The wheels wore with some taper due to the rails' being worn that way by the standard wheels, but slow-motion pictures taken after 30,000 miles showed only a slight tendency toward oscillation. This car is still in service and is being carefully watched, but the results of the test have been so conclusive that all new wheels and those re-turned are of the new type without a taper.

Says a Chicago, North Shore & Milwaukee Railroad official: "A number of railroad men from other lines have viewed the slow-motion pictures and have applied the principle to their equipment, especially in the case of the new streamlined trains, and greatly improved riding has resulted."

PLATINUM THERMOMETERS

PLATINUM is extensively used in the chemical laboratory and is gradually finding new applications in the chemical factory. One of the interesting uses of platinum for measuring temperatures was described by F. E. Carter in *Industrial and Engineering Chemistry.*

"Chemical processes have usually to be carefully controlled as to temperature," says Mr. Carter, "and the platinum metals are much used in the indicating devices. In resistance thermometers, temperature is obtained by measuring the resistance changes of the wire with the temperature. Pure platinum wire is generally used because of its stability and of its high temperature coefficient of resistance. The material must be of the highest purity, in which condition the coefficient is about 0.0039 per degree, Centigrade. Such thermometers are exceedingly accurate up to about 900 degrees, Centigrade, (1652 degrees, Fahrenheit). Above this temperature thermocouples must be used. Base-metal thermocouples have a high thermo-electromotive force but cannot be used satisfactorily much above 1000 degrees, Centigrade. For higher temperatures platinum metals are used. The negative element is pure platinum and the positive element is practically always an alloy of platinum and rhodium."—*A. E. B.*

SHRINKAGE FACTS

"WILL it shrink?" Most people want assurance when they buy a garment of any description, that it will still fit after it has been laundered or dry cleaned. Many manufacturers are trying to meet this demand for information by some sort of statement on the label attached to the garment. Unfortunately, many of the statements thus made are indefinite and almost worthless to the consumers, says the Federal Bureau of Home Economics.

What does "Preshrunk" or "Supershrunk" really tell you. Merely that the fabric has been subjected to a shrinking process. Will it shrink any more? You do not know. "Will not shrink out of fit" is a statement you sometimes find. It sounds more promising, but what does "out-of-fit" mean? Opinions vary. If it does shrink, the merchant's idea as to what constitutes "fit" is just as good as yours. "Fully shrunk" or "Will not shrink" can be rightly interpreted to mean that the garment will show no noticeable shrinkage when laundered.

The New York Board of Trade would go even farther. It recently initiated a project on shrinkage under the sponsorship of the American Standards Association. The committee working on the subject recommends that no woven fabric be labeled "Preshrunk" if it will shrink more than 3 percent when subjected to a standard washing procedure. In addition it recommends that the probable percentage of shrinkage be definitely given on the label, as "Preshrunk, will not shrink more than 2 percent." At present these recommendations have not been adopted by fabric finishers.

MAN, EXTINCT BISON, CO-EXISTENT IN AMERICA

NO doubt about it—there were hunters roaming the American wilderness so long ago that they slew animals unknown today.

A hand-made stone dart point has been discovered where it dealt its death blow—fixed in the vertebra of an extinct form of bison. The find clinches in the affirmative arguments that man inhabited America in those early days, perhaps 10,000 or 20,000 years ago.

The shot that paralyzed the hapless bison was discovered by Dr. Frank H. H. Roberts, Jr., of the Bureau of American Ethnology during recent excavations in northern Colorado. Dr. Roberts found the vertebra in an assortment of bison bones at a place where the ancient hunters butchered their game.—*Science Service.*

ENERGY FROM MATTER

(*Continued from page 301*)

an erg). The total energy released in the reaction in the motion of the two alpha particles is therefore twice this, or 27.4 microergs.

The energy put in as kinetic energy of the bombarding hydrogen ion is much smaller. The experiments can easily be done with voltages below 400,000, which means an energy of the bombarding ions of

$$\frac{400.000 \times 4.77 \times 10^{-10}}{300} \text{ ergs, or 0.64 microergs.}$$

(The rule is: voltage times charge divided by 300 gives energy in ergs, and the charge, 4.77×10^{-10} is the same as for an electron.) Thus there is a *clear violation of conservation of energy*, for about 27.4 — 0.6 microergs of energy are gained for every transmutation taking place.

This may seem trivial when expressed per atom, but in view of the enormous number of lithium atoms in a pound (3.9×10^{25}) it is easily calculated that the conversion of a pound of lithium this way would give about 30,000,000 kilowatt-hours of energy, which is several million times the fuel value of petroleum. But the research of the type done so far is far from converting an appreciable quantity of material and, in view of the large energy used for protons which do not make a proper hit, the apparatus consumes vastly more energy than is released by atomic disintegration.

Now let us consider the exact masses. The precision measurements of these we owe to Aston of Cambridge, England, and to Bainbridge, now of Cambridge, Massachusetts. It is too long a story to describe here the details of the mass spectrographs in which a beam of ions is deflected in electric and magnetic fields to supply data from which the masses may be obtained. Suffice it to say that with this method the precise values of the masses involved in our discussion are found to be

H^1	1.0078
He^4	4.0022
Li^7	7.0146

Using these masses we find that the total mass of Li^7 and H^1 is 8.0224, whereas the mass of the two alpha particles given out by the reaction is 8.0044, so the *mass of the products is less than the mass of the atoms used by 0.0180 units.* The unit of mass here is such that the mass of the lighter oxygen isotope is taken to be exactly 16. It is known that unit mass on this scale is equal to 1.65×10^{-24} grams.

Therefore we are dealing in these experiments with a transformation in which the *total mass decreases by 2.97×10^{-26} grams and kinetic energy is gained by 26.8 microergs for every pair of alpha particles produced.* According to Einstein's principle this mass loss ought to correspond to 26.7 microergs, which is a perfect check.

As mentioned earlier, there are a number of nuclear transmutations whose energies have been measured and found to involve mass changes accompanied by the equivalent energy changes. Neither the total mass nor the total energy is the same before and after the transmutation, but the sum of energy plus mass, multiplied by the square of the speed of light, remains unchanged. This we interpret as meaning that we have true conservation of energy if we count the mass changes as being equivalent to energy changes by the Einstein principle.

In a recent paper by Oliphant, Kempton and Rutherford, 15 different reactions are given, in which a quantitative correlation is established between the mass change and the energy change. So the validity of mass and energy equivalence is now fully established experimentally. But there is no hope of getting at this latent form of energy that is locked in matter until some more efficient way is found of stimulating the nuclear reactions by which it is released.

CURRENT BULLETIN BRIEFS

WOOD HANDBOOK is a well printed, 326-page book, paper covers, in which wood is defined in technical properties and behavior. The publication is of interest to wood users generally, embodying the results of 25 years of research by the Forest Products Laboratory. It treats of all practical uses of wood and is thoroughly illustrated with drawings and photographs. *Superintendent of Documents, Government Printing Office, Washington, D. C.—25 cents (coin).*

BLUE BOOK OF THERMOMETALS is a 32-page loose-leaf bulletin which gives a comprehensive review of specifications, properties, and methods of application of modern thermostatic bi-metals. Ten full-page charts show flexion and force characteristics together with appropriate design formulas. *Write for Bulletin 1235A to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

A COMPREHENSIVE CATALOG of radio parts of particular interest to set constructors and service men is now available in a 40-page pamphlet which lists particularly molded and other types of insulating forms and panels. Specialized tools are also included. *Write for Bulletin 1235B to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

SCHNEIDER LENSES FOR PHOTOGRAPHY AND CINEMA WORK is an informative pamphlet, beautifully illustrated with photographs showing the type of work done with these particular lenses, and especially valuable to the advanced amateur photographer. *Write for Bulletin 1235C to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

SKEET HANDBOOK describes briefly the increasingly popular sport of skeet, shows how to lay out skeet fields, and gives valuable hints about skeet shooting. Thoroughly illustrated with excellent photographs and helpful drawings. Also included is "Macnab on Skeet," a little pamphlet which gives specific hints about shooting at the various positions, as well as generalized information. Both booklets will be sent upon request for *Bulletin 1235D to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

PRACTICALLY EVERYTHING in the way of radio supplies, ranging from soldering lugs all the way up to a 24-tube all-wave receiver, is included in a new 196-page radio catalog now available. *Write for Bulletin 1235E to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

NICKEL CAST IRON, THEORY AND PRACTICE, is a small, well illustrated pamphlet with a unique presentation of 10 studies. On each page is given the theory of some phase of cast-iron usage and immediately beside the theory are given practical applications. *Write for Bulletin 1235F to Scientific American, 24 West 40th Street, New York City.—3-cent Stamp.*

CASTINGS deals with problems encountered in various industries where metal articles are used. It gives specific advice regarding particular applications of cast alloys, and is thoroughly illustrated. Tables give properties of the alloys discussed. *Write for Bulletin 1235G to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

SPHERICAL ROLLER BEARINGS tells of the theory underlying the design of this type of roller bearing, illustrates many of its uses in diversified industries, and devotes several tables to the selection of spherical roller bearings for various purposes. *Write for Bulletin 1235H to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

FACTS ABOUT WELDED PIPING deals with the advantages of this type of installation for industrial and home use. A complete illustrated section is devoted to pipe welding specifications for heating, plumbing, refrigeration, and power piping installations. *Write for Bulletin 1235K to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

MICRODAK BOOKLET describes in detail a simple camera and stand for taking photomicrographs with any microscope. It also gives complete instructions for use. *Write for Bulletin 1235J to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

ZEOLITES: MINING, PROCESSING, MANUFACTURE AND USES deals with these phases of the zeolites which are coming into extensive use in water softening systems. Text and 84 photographs tell the whole story in detail. *Write for Bulletin 1235L to Scientific American, 24 West 40th Street, New York City.—3-cent stamp.*

A SECOND PRIMER, by Samuel Crowther, is a broad discussion of economics as they pertain to the present situation in the United States and particularly in relationship to trade and tariffs. *The Chemical Foundation Incorporated, 654 Madison Avenue, New York City.—Gratis.*

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By Alexis Carrel

IN this rather lengthy but readable book the famous French surgeon and biologist of the Rockefeller Institute sets down an immense amount of fact and philosophy regarding our bodies and minds and the activities of each. But his book is far from a mere catalog of physiological facts—it is mainly philosophical and is provocative. Dr. Carrel is a mystic—he also believes in telepathy and clairvoyance and this book presents his metaphysical leanings in general.—$3.65 postpaid.—*A. G. I.*

YOUR INVENTION

By Elmore B. Lyford

IF an invention is to be properly protected and then exploited to greatest advantage, there are a multitude of details which must be properly attended to. The author of the present book makes an effort to outline these details in simple yet concise language and to provide for the reader a definite guide to the correct procedure of handling his invention. No matter how small or trifling an invention may be, the inventor of it will do well to peruse the pages of this book and thus provide himself with a background which will enable him to avoid many of the pitfalls that might otherwise cause him to lose the benefit of his conception. A full page chart reduces to graphic form the steps which must be taken between the inception of an idea and the issuing of a patent.—$1.65 postpaid.—*A. P. P.*

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By Cassius Jackson Keyser

THREE essays on mathematics; its meaning, relation to human society, and bearing on the thesis that our universe is a manifestation of mind; also two allied discourses and a biographical sketch.—85c postpaid.—*C. E.*

THE EMPEROR OF THE ANTS

By Vamba (Luigi Bertelli), Translated by Nicola Di Pietro

THIS is a book of fiction but nevertheless a highly instructive story for children around the age of ten. A clue as to the theme of the story is given in the titles of the first, second, and third chapters which read: "How Too Little Desire to Study Caused Three Children to Wish to Change into Dumb Animals"; "Gigino Becomes an Egg"; and, "What a Boy, Who Doesn't Like to Study, Must Learn on Being Reborn as an Ant." From the third chapter on, Gigino learns all there is to know about ants while living among them. The volume is well illustrated throughout. Drawings show all stages of ant life, activities, and interests. Any child with the slightest flair for Nature study will take great delight in this volume.—$1.65 postpaid.—*F. D. M.*

THE FLYING FAMILY IN GREENLAND

By Lieut. Col. George R. Hutchinson

THIS is a story of the four Hutchinsons—father, mother, and little Janet Lee and Kathryn—whose flight to Greenland a year or two ago attracted so much attention. It tells the intimate story of their airplane journey while attempting to make a trip across the Atlantic, of their disappearance, and of their final rescue. It is as much a story of adventure as it is an epic in the annals of aviation progress. Written for youths and grown-ups alike.—$2.15 postpaid. —*F. D. M.*

PREHISTORIC ARCHAEOLOGY AND SIR RAY LANKESTER

By J. Reid Moir

THIS is the story, rather vivid and racy, of a fight to vindicate a new idea in science. About 25 years ago the author (who has often written for Scientific American and is an amateur archeologist) made notable discoveries of ancient man in England, which did not fit in with the established doctrines of an older generation of anthropologists, for they showed man to be very much more ancient than was then believed. The dynamic Sir Ray Lankester, head of the British Museum of Natural History, sided with him and helped him win through to final full recognition by science. Some of Sir Ray's methods were startling and the narrative is a running record of the fight, with a chuckle in every episode.—$3.00 postpaid.—*A. G. I.*

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