POWER FROM BACTERIA

SCIENTIFIC AMERICAN

April · 1938 ★ 35c a Copy

TEST-TUBE BABIES

FROM the test tubes of industry have come many of the jobs that keep America busy. Fifteen million American men and women are at work today in jobs that did not exist in 1900. These jobs do exist today because, through research, industry has been able to develop hundreds of new products. And it has been able to make them so inexpensive that millions of people have been able to buy them.

These jobs are "test-tube babies," created in the modern research laboratories of industry. As a result, millions of people are employed today in welding, in making and selling radios, electric refrigerators, lamp bulbs, automobiles, and hundreds of other manufactured products invented within the memory of many now living.

General Electric engineers and research scientists have contributed greatly to this progress. From the G-E Research Laboratory, in Schenectady, has come the modern electric lamp, which uses less electricity and gives more light, thereby saving the public $5,000,000 a night. From it have come the modern x-ray tube which is helping the physician save lives, and conquer disease and suffering; the high-vacuum tube which makes radiobroadcasting possible; and many other developments which have created new jobs.

G-E research and engineering have saved the public from ten to one hundred dollars for every dollar they have earned for General Electric

GENERAL ELECTRIC

1938 — OUR SIXTIETH YEAR OF ELECTRICAL PROGRESS — 1938

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NINETY-FOURTH YEAR • ORSON D. MUNN, Editor

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"FROM Steel to Streamliner," page 210, tells the story of the construction of a stainless-steel streamlined train, fabricated through the use of the Budd "Shotweld" process. Our cover illustration shows a workman using the Shotweld machine which might be said to bear the same relationship to ordinary welding as a needle and thread bear to a modern high-speed sewing machine. With the equipment illustrated, the expert welder controls each weld perfectly, creating a structure with maximum strength and minimum weight.

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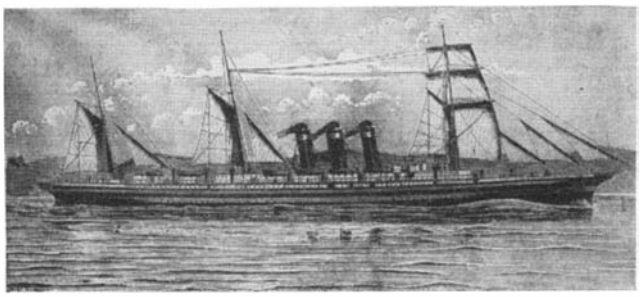
50 YEARS AGO IN . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of April, 1888)

SEA SERPENT—"The schooner Coral, Captain Sherman, is now at the port. Captain Sherman reported that recently, when his vessel was in the vicinity of Cornfield Lightship, there suddenly appeared astern and not two hundred feet away an immense sea monster that fully answered the description previously given of sea serpents. Captain Sherman says he had a perfect view of the monster. He described it as being over one hundred feet in length, and in some portions its body was as large around as a flour barrel. The head of the serpent resembled that of an alligator."

TRANSATLANTIC—"On March 15, there was launched, on the Clyde, the splendid twin-screw steamship *City of New York*, the first of the two liners now being built by Messrs. James and George



Thomson for the Inman and International Company, plying between New York and Liverpool. The Inman Company is well known to Atlantic travelers as providing in their floating 'cities' a safe and comfortable means of transit across the Atlantic. . . . It is expected that the speed of these vessels will be at least as great as the fastest liners now afloat, but at the same time speed is by no means the first consideration which the directors of the company have kept before them, the two paramount considerations being the safety and comfort of the traveling public."

BIG GUNS—"No less than ten of the large 9.2 guns made for the British government have recently failed at test, the inner tubes of nine having been split and the outer casing of the other fractured. This, we believe, is the style of gun that has of late been so urgently advocated by certain of our army and naval officers as necessary for adoption in this country, to the exclusion of all other kinds of ordnance. In the opinion of these wise men, all people who hinted at anything else were behind the age."

POSTAGE—"The New York *Journal of Commerce* and a great many other influential newspapers, we are glad to see, are advocating the proposed measure for reducing letter postage to one cent. They justly take the ground that, with the large surplus in our treasury, the post office business of the country need not be made self-supporting. . . . A great deal might be said in favor of free postage, as an educational factor, but what the public will be satisfied with for the present is a reduction of letter postage."

KNOWLEDGE—"Nothing could well be more forcible than Sir James Paget's exposition of the advantages of the study of science, and his vindication of even 'a little knowledge,' so that it be real and true as far as it goes, and has been made the property of the mind by a process of self-verification."

VENTILATION—"One of the great evils of civilization lies in the crowding together of large numbers of persons in confined spaces. This is especially the case with schools and with factories, but is not limited to those instances. . . . The only remedy lies in effectual ventilation, and there can be no doubt that in factories, schools, and all other places in which many persons live and work or study in confined space, the ventilation should be much better than it is."

TELEPHONE—"Taken up in the beginning as an incomplete experiment, a wonderful toy, the telephone has developed into an indispensable adjunct of commercial business. No city or town of prominence is now without its telephone exchange, furnishing a quick and certain means of intercommunication to the business community, and its radial system of suburban lines connecting the surrounding territory with the commercial centers."

ARMY SIGNALS—"With the very extensive fronts of the large armies of the present day, it is not always possible to communicate by telegraph, specially when two divisions are separated by marshy ground. In such cases the field signaling apparatus can be used to advantage. This is an optical telegraph which consists essentially of a triangular and a hexagonal piece of linen, which can be so arranged in different positions in relation to each other that full dispatches can be transmitted very quickly."

WHEAT—"The Texas wheat-growing counties report the increase of acreage this season at from 10 to 100 percent. The world's annual consumption of wheat is estimated at 2,165,000,000 bushels."

STRIKES—"Striking was one of the principal occupations of the laborers of the United States in 1887. According to an estimate in Bradstreet's, the total number of strikes for the year was 858, involving 340,854 workers."

MINE SAFETY—"A perfectly efficient and safe miner's lamp has yet to be provided, and colliery managers are still far from unanimous in their approval of an effective and at the same time harmless substitute for gunpowder and dynamite as explosive forces."

HOT WATER—"A system of hot water distribution is being introduced in Boston. . . . Hot water under a pressure of about 300 pounds to the square inch and heated to 350 degrees to 400 degrees is used. . . . It is proposed to use this system for steam heating, making use of reducing valves to diminish the pressure from the water pressure of 300 pounds to the square inch, allowing it to expand into steam."

AND NOW FOR THE FUTURE

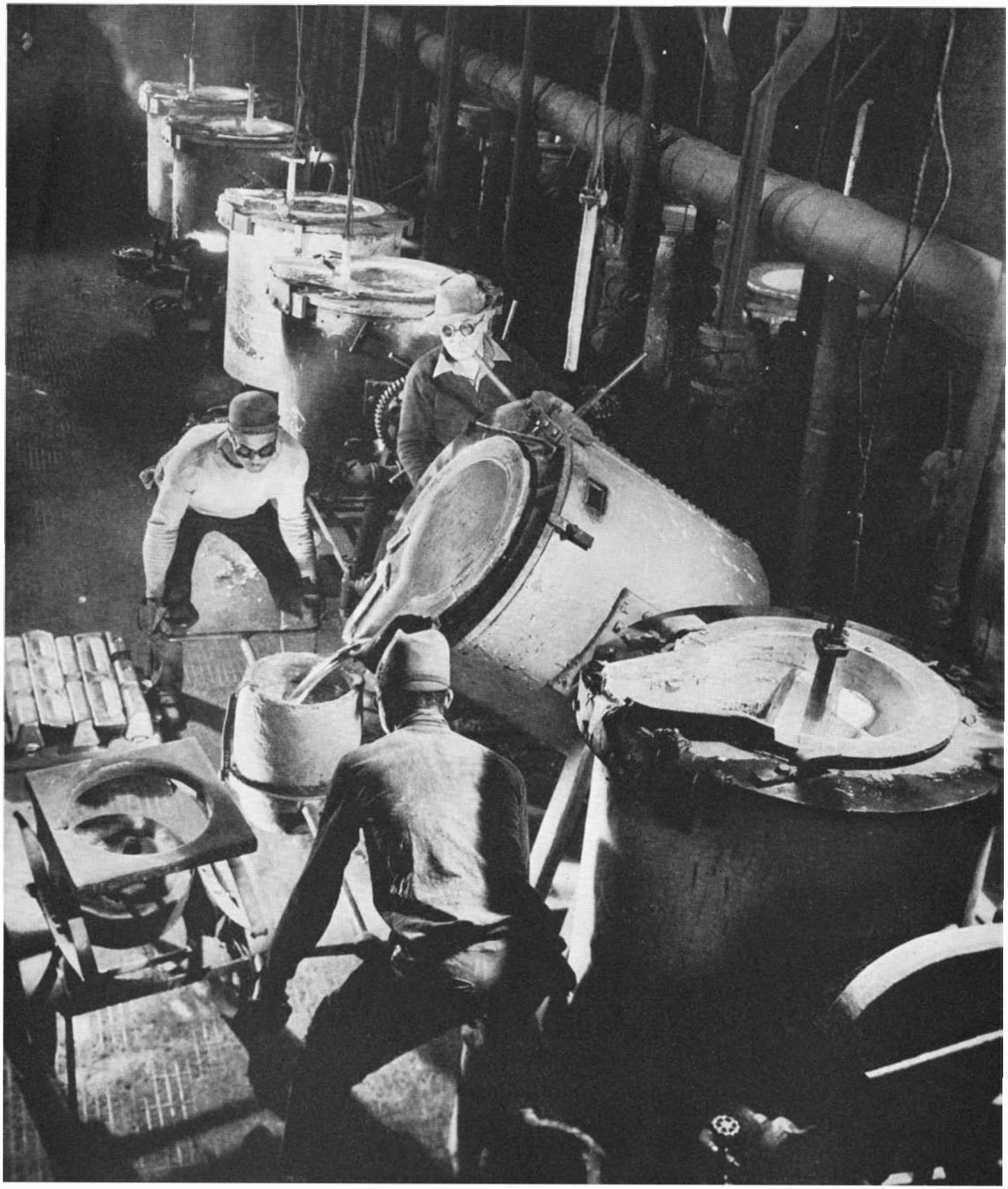
¶How climate and weather rule human affairs, by Clarence A. Mills, M.D., Ph.D.

¶Dr. Robert Hutchings Goddard, Number One Rocket Man, by G. Edward Pendray.

¶How the problem of naming colors is being solved, by John H. Crider.

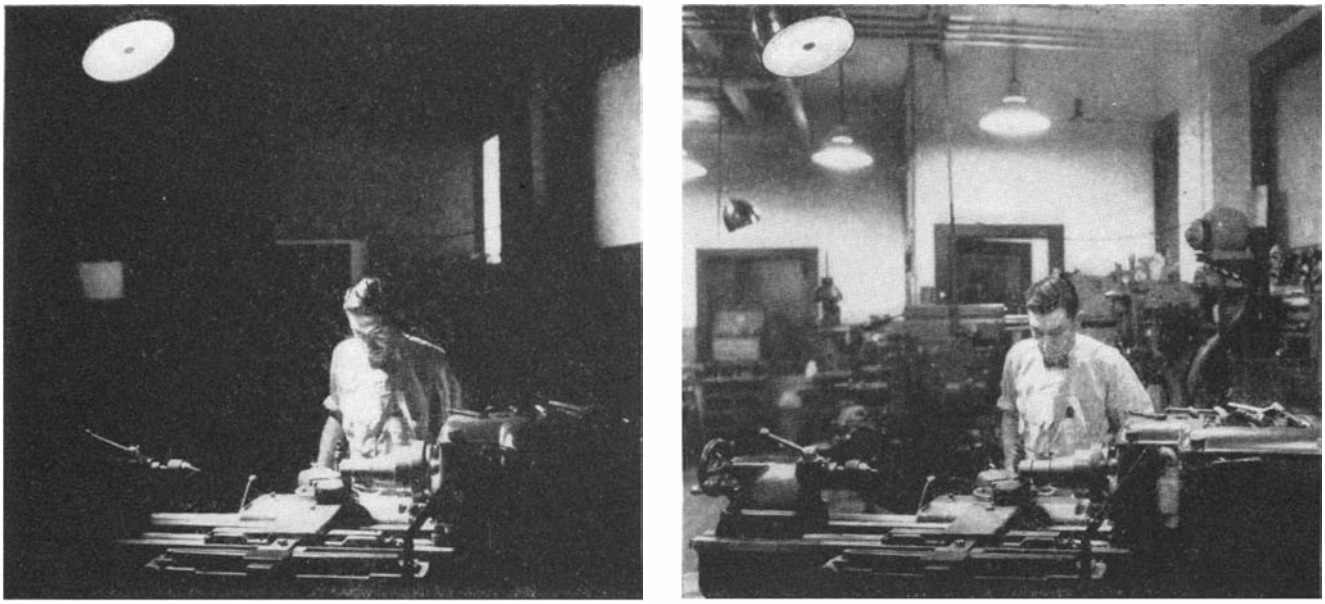
¶Flood forecasting in the Tennessee Valley, by Herbert F. Gough.

¶Micro-chemical analysis and what it does, by A. L. White.



MOLTEN STRENGTH AND LIGHT WEIGHT

FEW metals have a brighter incandescent whiteness when molten than aluminum, which is here shown being poured into graphite crucibles, or ladles, from which it will be poured, in turn, into prepared molds to make sand castings. Many oil-fired, tilting furnaces such as these are in the Cleveland works of the Aluminum Company of America, producing liquid metal from aluminum ingots. Thermocouples are suspended in the liquid mass of each furnace to determine pouring temperature.



Striking difference between local, or spot, and general lighting of work. Contrasts are so severe in the scene at left that seeing is hindered rather than helped by the single bright light. The vast improvement with general lighting is shown at right

INDUSTRY NEEDS MORE LIGHT

Plant Lighting Lags Behind Engineers' Knowledge . . . Designed Systems Speed Production, Decrease Spoilage and Accidents . . . Inexpensive

By A. K. GAETJENS
Nela Park Engineering Department, General Electric Company

IT is absurd to imagine men working in complete darkness, yet in a great number of industrial establishments employees do work under starvation levels of illumination that are little better than darkness when considered from a safety angle or from the standpoint of quick, comfortable, and accurate seeing.

The tremendous change in our living conditions which has been caused by the rapid increase in industrial occupations has not been accompanied by a corresponding ability of the eye to adapt itself to new conditions. Nature works slowly in adjusting mankind to his environment. For countless generations men lived by hunting or fishing and, later, by farming. These were outdoor occupations performed where daylight illumination ranges from 500 footcandles* in the shade of a tree to 8000 footcandles in the bright midsummer sunshine. Seeing was casual the greater part of the time; the objects to be seen, such as game, were at a comparatively long distance from the eyes; it was seldom necessary to employ the close coordination of eyes and hands to concentrate on fine detail which is so essential in many of our industrial operations today. When night came, man put away his weapons and slept. These are the circumstances for which the eyes were conditioned. Even with the advent of civilization there was little change in this mode of living until the end of the 18th Century.

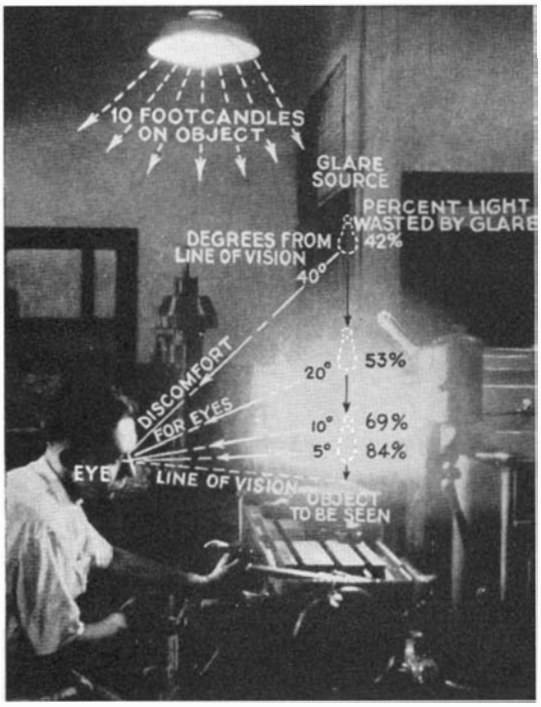
Today, however, industry has brought a great number of workers indoors where the demands upon their eyes are vastly different from the above conditions. From the extreme precision of interchangeable parts, even in heavy goods manufacture, to the fine delicacy of watches, modern methods demand that the eyes accurately coördinate with the hands much of the time. The eyes must also quickly and accurately discriminate fine detail. The work is usually within arm's length. The hours of concentrated attention are long. Most serious of all is the necessity of doing these difficult visual tasks under lighting that is negligible compared with outdoor light.

THE enormous development of the electrical industry in the past 50 years has given us a means of obtaining good artificial lighting. The illuminating engineer now has at his disposal light sources and equipment which enable him to plan a lighting installation which will aid the eye to see comfortably, efficiently, and easily. Fundamental laboratory research in conjunction with practical field studies is leading the way toward this desired goal.

Laboratory researches already completed in the science of seeing have led to methods whereby the illumination for any particular seeing task can be specified by quantitative measurements. The new Luckiesh-Moss Visibility Meter which is used for this purpose, for example, is an instrument which indicates how much light is necessary to see any particular object, based upon the factors of visibility which are involved. It is an extremely versatile instrument in the hands of a lighting specialist.

Few laymen realize the great differences in the ease of seeing common objects. They can be made to realize this in extreme cases such as reading a well-printed book, compared with the task of reading a 64th-inch scale, but under usual and less extreme circumstances these differences are not recognized. The accompanying chart indicates a number of work-world seeing tasks which have been evaluated to as-

*A footcandle is a standard unit of light measurement—approximately the quantity of light upon a surface one foot away from a sperm candle.



More general knowledge of the figures shown would prevent many abuses prevalent today

certain the quantity of light necessary for all of them to be seen with equal ease.

Although progressive manufacturers have realized the benefits of good lighting and are taking advantage of the studies of the Illuminating Engineering Society, it is unfortunately true that the great majority of American industries are still woefully underlighted. The cost of this neglect in the form of slowed production, excessive spoilage, poor and uncertain inspection, and industrial accidents is staggering. The fact that poor lighting is the cause of these difficulties frequently is not realized because the eye is so highly adaptable to many conditions. Secondary effects frequently are the only tangible results of the poor lighting except that, over a period of years, the eyes weaken and need correction. One of the illustrations shows the direct relationship between occupations and eye defects.

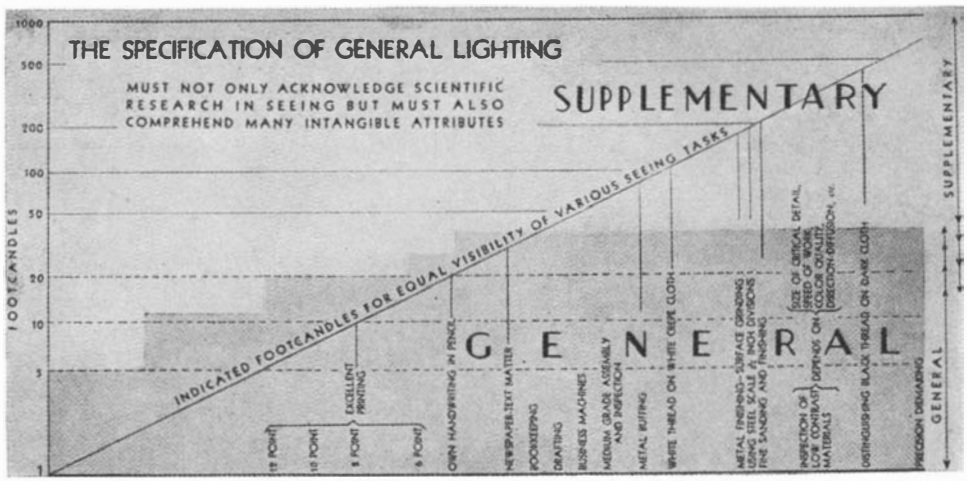
In the field of industrial accidents alone, Mr. W. Dean Keefer, Director of the Industrial Division of the National Safety Council, has estimated that poor lighting is probably the direct cause in 5 percent and a contributing cause in 20 percent of all industrial accidents, the annual cost of which is estimated to be 1,500,000,000 dollars. In 1936, according to the National Safety Council estimates, there were 18,000 fatal accidents, 70,000 permanent disabilities, and 1,460,000 temporary disabilities arising from gainful employment. Records of industrial accidents show that the average disability costs the employer 200 dollars in compensation, doctor bills, and hospital fees. In addition, there are added costs covering the value of lost production, labor turnover, damaged machinery and material, and other items which total about four times the direct cost. Thus, the average disabling injury suffered by a worker will cost the employee's company 1000 dollars. The prevention of one such accident would pay for the installation of good lighting over several thousand square feet.

Where good lighting has been installed, it is frequently found that the intangible benefits were fully as numerous and important as were those for which an accurate check could be made. Good lighting is the most natural of all aids to improve work because its assistance is not apparent. By making it easier to see, it helps the workmen to help themselves. The attitude of many employers who were visited in a recent survey of comparatively new lighting installations is typified by the following statement. Mr. F. A. McDermott, Factory Superintendent of Bastian Brothers Company, Rochester, New York, has this to say in regard to the unmeasured benefits of a good lighting installation.

"About six months ago we began to install improved lighting in our plant. Since we had decided to do the job right, complete rewiring was necessary, and for this reason the work of installing the new lighting covered a period of several months and, in fact, is still going on. . . . One thing has been evident from the day the first section of the factory was relighted: the men appreciate the difference between adequate and inadequate lighting. Those who already have the improved lighting have expressed their satisfaction with it, and those who are still working under the old lighting system are highly impatient to have their section of the plant relighted. This reaction on the part of the factory personnel is highly gratifying to the management—so much so that even if the improved lighting should bring us no other tangible benefits, its installation will be considered well worth while because of the improved morale of our employees."

In planning a lighting system, it is desirable, first of all, to provide a substantially uniform level of illumination throughout the room. This eliminates shadows in dark corners and makes the entire work area equally suitable for any desired arrangement of machinery and benches. Lighting units are spaced relative to their height above the surface to be illuminated. As this surface is usually a work level from 2½ to 3½ feet above the floor, it is permissible to plan the spacing of the units proportionate to their mounting height above the floor. Usually, a spacing distance which does not substantially exceed the mounting height from the floor will result in reasonably uniform illumination.

WHERE the lighting is very non-uniform, with extreme contrasts between bright and dim areas, the eyes continually try to adapt themselves to the various lighting conditions in the field of vision. Eyestrain usually results, and continued vision becomes difficult. Spotty illumination may be caused by one or more of the following conditions: Incorrect spacing of lighting units, the use of the wrong type of lighting equipment, or the use of localized lighting with no general illumination. This last factor is becoming more and more important as general lighting is being sup-



Seeing tasks evaluated by the Luckiesh-Moss Visibility Meter on the basis of footcandles needed, general and supplementary, to obtain equal ease of seeing in a wide variety of tasks

plemented with a considerably higher level of light at the work plane for tasks where seeing is difficult. Where this work is confined to small areas, the most practical way to provide for the increased footcandles is by supplementing the general illumination by a unit which gives additional light directly to the area in question. Where such lighting is employed, care must always be taken to provide sufficient general illumination so that the proper contrast conditions for visual comfort will not be exceeded. This can usually be accomplished by providing at least one footcandle of general illumination for every 10 footcandles of supplementary, or direct job-lighting.

The proper solution to the problem of supplying this special lighting involves not only the actual footcandles to be provided but also the proper method to employ, the equipment to use, and the location of this equipment with respect to the specific task. A well balanced combination is shown in an accompanying illustration.

Recommended Footcandles for Representative Industrial Operations

(These footcandle values represent order of magnitude rather than exact levels of illumination)

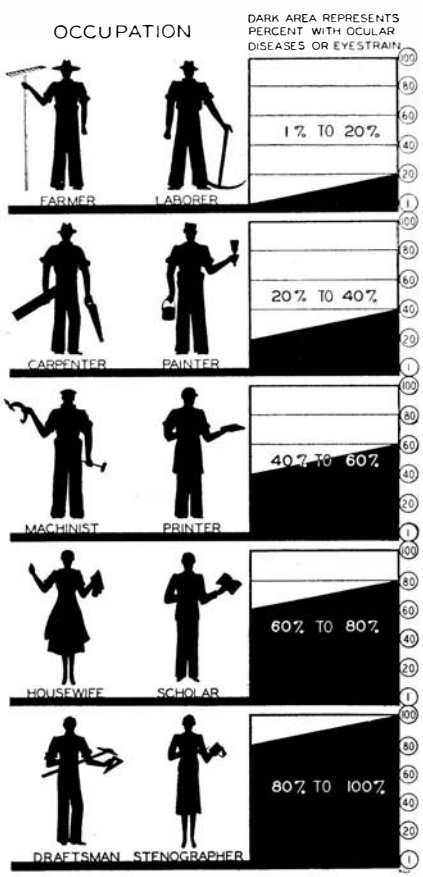
Operation	Recommended Footcandles
Assembling	
Rough	10
Medium	20
Fine	50-100
Extra Fine	100 or more
Inspection	
Rough	10
Medium	20
Fine	50-100
Extra Fine	100 or more
Machine Shops	
Rough Bench and Machine Work	10
Medium Bench and Machine Work, Ordinary Automatic Machine with Rough Grinding, Medium Buffing and Polishing	20
Fine Bench and Machine Work, Fine Automatic Machines, Medium Grinding, Fine Buffing and Polishing	50-100
Extra Fine Bench and Machine Work, Grinding—Fine Work	100 or more
Steel and Iron Mills, Bar, Sheet and Wire Products	
Soaking Pits and Reheating Furnaces	5
Charging and Casting Floors	10
Muck and Heavy Rolling, Shearing, Rough by Gage	10
Plate Inspection, Chipping	30-50
Automatic Machines, Light and Cold Rolling, Wire Drawing, Shearing, Fine by Line	15

Glare is one of the most detrimental factors encountered in the industrial work-world today, for a glaring bare lamp will decrease the effectiveness of any lighting system. In a broad sense, we are familiar with these facts. It is not comfortable to look at the sun when it is high in the heavens, neither is it comfortable to look at a sheet of water glistening in the bright sunshine. In looking at the sun, direct glare is encountered. The sheet of water in the bright sunlight is an example of reflected glare. Both are uncomfortable, and one instinctively turns away. But the industrial worker cannot look away from his task; he must keep his eyes upon it even though the bare lamp in his field of vision is uncomfortably bright and may also be reflected to his eyes, for example, by the polished metal upon which he may be working.

THESE factors are some which are collectively termed the quality of illumination or the quality of lighting. They are considerations that must be observed in order to obtain a good installation. However, in order that the light may aid productive effort most efficiently, it has been found that certain definite footcandle levels should be considered a minimum for the best lighting effect. Tables of recommended footcandles of illumination for various tasks have been made and are generally accepted as a guide to current practice. These tables are based upon practical experience and economic justification. A few excerpts are presented in the accompanying tabulation to indicate the range of footcandle levels now recommended in industrial lighting practice.

After a lighting system has been installed, it can be maintained at high efficiency only by a well-planned cleaning schedule. Dust and dirt inevitably collect upon the reflecting surfaces of the equipment and unless they are cleaned periodically the result will be an extremely inefficient installation. Even a barely discernible layer of dust frequently decreases the light output as much as 30 percent. For this reason, a schedule of cleaning the units with soap and warm water at intervals not greater than six to eight weeks in the average plant is highly recommended.

The lighting equipment serves to re-



An extensive survey revealed a significant relationship between occupations and eye defects which are in higher proportion in the vocations which involve difficult seeing tasks

Excellent visual conditions with 20 footcandles diffused general lighting plus supplementary lighting

Using the Luckiesh-Moss Visibility Meter to determine amount of light

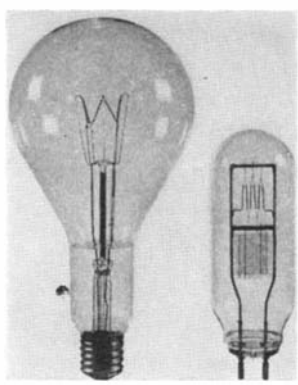
direct the light generated by the lamp filament. The filament itself can transform electrical energy into light efficiently only when the voltage upon it is equal to the voltage for which the lamp was designed. The economical production of light, therefore, requires wiring of sufficient capacity to carry electrical energy from the distribution panelboard to the lamp socket without excessive voltage-drop and power loss in the wiring. The importance of this step is shown by the fact that a 1 percent drop in voltage reduces the light output of an incandescent lamp about 3 percent and a 5-volt drop lowers it about 16 percent.

The difference between the initial cost of an undersized wiring job and one of thoroughly adequate capacity is not as a rule very great, and the subsequent saving is sufficient to make it profitable in industry. In general, wiring to carry double the indicated load can be installed initially at about one third extra cost.

AN entirely new technique has been developed to manufacture the 1000-watt, 750-watt, and 500-watt medium bipost lamps which have been announced recently. The 1000-watt lamp has a decided advantage over the older type of lamp from the standpoint of physical size. Its other advantages are equally outstanding. The hard glass bulb will withstand water drops and juicy insects better than the older lamp. The use of a screen in the new lamp reduces blackening on the sides of the bulb to a great extent. This is so effective that the overall maintenance of illumination at the end of the life of the new bulb is appreciably better than that of the former lamps at 50 percent life. The small-size bulb permits the use of smaller and less expensive reflectors to obtain the same distribution of light.

In addition to the bipost lamp development, the past three years have seen a remarkable acceptance of the new mercury lamps. When equipped with the proper transformer or reactor auxiliary, this type of lamp can be used on either 115- or 230-volt alternating current circuits. The initial efficiency is approximately twice that of comparable wattage incandescent lamps, while the rated life is 2000 hours. The lamps are tubular in shape.

The light emitted by these lamps has the characteristic line spectrum of mercury, in contrast to the continuous spectrum of the incandescent lamp. This means that all of the light is represented by only a few lines which produce yellow, green, and blue light. Although the light from the lamp appears blue, it also is very rich in the yellow-green lines. This attribute makes it a very good source to use in combination with incandescent lamps. The mixed light appears similar to daylight although it will accentuate certain colors and is, therefore, not suitable for critical color discrimination.



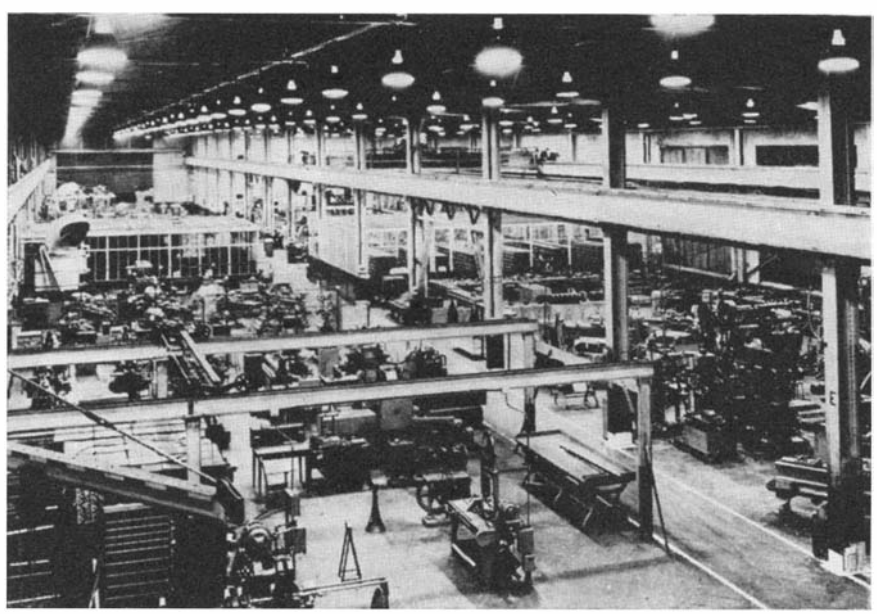
Old type 1000-watt lamp and new 1000-watt bipost lamp

The leading lighting equipment manufacturers have developed direct and indirect, distributing and concentrating types of units for use with the mercury lamp or combinations of mercury and incandescent lamps.

The cost of both lamps and equipment has been constantly decreasing while their efficiencies have been increased materially. The cost of electrical energy also has consistently shown a downward trend. As a result, the lighting dollar now purchases 10 times as much light as it did 25 years ago and twice as much as it did only 10 years ago. In addition to this marked improvement, newly developed methods of applying light most effectively for visual well-being still further increase the actual value of light.

IN order to have a sound basis on which lighting costs and economics may be studied, the following analysis of manufacturing costs is presented. These are average figures for all types of industries, and any one industry or any one plant may vary somewhat from these quotations. The major accounting items of the total production cost are distributed as follows: Salaries, 5.9 percent; labor, 16.5 percent; raw materials, 52 percent; fuel, light, and power, 2.7 percent; miscellaneous (including such items as advertising and sales cost, insurance, taxes, interest, depreciation, workmen's compensation, and profits), 22.9 percent. If the percentage representing the lighting alone is separated from the fuel and power cost item, it appears as only 0.3 percent of the value of the manufactured product. This means that for every three dollars' worth of goods sold, one cent is paid to enable the worker to see what he is doing.

From such a cost analysis, it is apparent that while good lighting can effect a valuable improvement in working conditions which benefits every phase of plant operation, actually it represents a very minor part of the operating costs of the business.



Modern high-level illumination. Between the old 1000-watt lamps, 400-watt mercury lamps were interspaced. Result: 40 footcandles of white light on the work

OUR POINT OF VIEW

Research

MORE than passing strange, we continue to hear indictments of the machine as the true cause of all our economic woes. This fiction, this hallucination, will not down. It is worse than futile to counter with figures definitely proving that this is not the case or to ask for proof of the accusation; the shades of the Technocrats still clank their chains and continue to frighten timid souls. And as that fright may be measured, by so much is real progress retarded.

Now, on the other hand, a member of Congress states, in effect, that two to three million men would be given jobs if 200 scientists and engineers would each create an invention in 1938 that would start a 40,000,000-dollar industry. It sounds exciting. And it is—all of that and more! But—who is to supply the formulas for the inventions? Who will select the 200 most-likely-to-succeed heroes? Who will guarantee their year's work to be worth, industrially, 40 million or 40 thousand or 40 cents? And how shall we be sure that, like a division of soldiers, they won't all shoot at the same target?

Perhaps, however, the thought was that all research men, all engineers, should work hard and purposefully toward creating industries, and maybe 200 would succeed. If this be so, one can criticize this Congressman for nothing more than repeating a truism, for superfluity of language. For, if some people are not already aware of the fact, there are in this country numerous industrial and institutional research organizations humming with the intense activities of many thousands of "professional inventors" whose one aim is to improve industry. They do not say, each to himself: "I am going to invent one thing before the end of the year which will found a 40,000,000-dollar industry." Instead, each drives ahead, solving some part of an industrial problem on which others may also be working; and in the end a new product is born, an old one is vastly improved, or a better, more efficient way of producing it is worked out. The result of the work of this mighty army of superior thinkers is improvement all along the line and a steady, if slow, growth of business and employment figures. Besides this group there are, of course, numerous free-lances in this business of developing new products and improving the old; and though their work is more casual, they make many outstanding inventions each year, some of which establish great industries.

We don't believe that research men have envisioned more than a fraction of the work that is to be done. Still, if they, trained specialists, need a formula, then it is they who will supply it; certainly no layman can have more than a smattering of knowledge of their problems, the things they should do. It is in a sympathetic understanding of the enormous benefits of scientific research that the layman can shine. The above-mentioned Congressman can best do his share for the well-being of the country at large by fighting for an expansion of governmental scientific research which has been badly curtailed these past few years.

Reassurance

DEADLY and horrible as it will be when—and if?—the next world war comes, there is some consolation to be derived from facts learned from certain military failures in Ethiopia, China, and Spain. In these three brutal reversions to savagery, science, as expressed in the newer machines of war, has not always shown up so efficiently as a maker of military advantage. Some of these facts will bear repetition.

In Ethiopia, optimistic predictions of attacking commanders put the invading army in Ethiopia's capital in little more than marching time. Months later, despite vastly superior equipment, airplanes, tanks, guns, and even war gas, the invaders were still fighting bloody infantry battles far from their goal.

It is in Spain, however, that the calculations of the strategists have suffered their most serious upset. Both sides in this fraternal strife have been well supplied with tanks and the most modern fighting and bombing planes. Yet neither of these devices has proved as successful as was to be expected. As pointed out in *Army Ordnance* by Captain Liddel Hart, the great speed of the planes has militated against their efficiency, and mud has proved the nemesis of the tanks. Planes bombing bridges, rail-heads, and other important military objectives have failed generally to accomplish their destructive purpose; their very speed has made their marksmanship poor and their bombs have fallen far from their targets. Their real effectiveness has been as frightful *strafers* of civilian populations and as a means of lowering the morale of troops. As for tanks, it appears that they have licked the problem of mud no better than those dozen or so we saw bogged down in the shell-churned mud opposite Verdun in 1918.

In China, poorly equipped and poorly trained Chinese held off the Japanese at Shanghai for weeks although the latter used every modern device of warfare including the big guns of naval vessels firing at point-blank range. Superior equipment and training of the Japanese finally pushed back the Chinese, but very slowly indeed, and at what a terrific cost to the invaders in men, munitions, and planes! In the beginning, conquest seemed an easy matter, yet it begins to look as though mere men and rifles of the Chinese may hold off the Japanese until they are worn out and decide to quit.

No matter how one looks at it, these three wars are horrible to consider. Yet in no one of them has the promise of a civilization being wiped out by machines shown any evidence of fulfillment nor even has there been evidence of the irresistible march to victory that one who has listened to the scare-mongers would expect. True, the use of gas has been avoided—for fear that such use would alienate world friendship irrevocably for the offending user—but gas is not so deadly as some people think. There is in existence no gas, usable in warfare, that will wipe out cities; in fact, the military gases used 20 years ago in No-Man's Land are still the best for their horrendous purpose.

Yet if all this is reassuring as to the relative inefficacy of the machines of war, there remains to be considered the human factor, the woeful savagery of the military mind. This has shown itself in the lowest form of bestiality in all three of these bloody affrays in a total disregard for the humanities. Prisoners of war have been murdered in cold blood; thousands of civilians have been destroyed, principally by airplane bombs, for no military purpose; and all manner of un-military cruelties have been perpetrated in the name of national honor, national face-saving, and furtherance of megalomaniac ideologies.

At this point in civilization's retrogression, the democracies of the world seem to be the last hope for the preservation of some semblance of "humanitarian" warfare. Already powerful voices are being raised for that purpose. We hope they will wax more powerful. Whatever the final result will be—whether an agreement among the nations or the not-to-be-disregarded pressure of mass opinion—some progressive step, some definite action against further destruction of noncombatants must be taken soon lest civilization perish in the ashes of its own consuming fires of fury.

New Light on the Sumerians

Though Science Remains Ignorant of Their Origin, Recent Archeological Discoveries Have Increased Our Knowledge of this Mysterious Ancient People

By E. A. SPEISER

Professor in the University of Pennsylvania and Director of the American School of Oriental Research in Baghdad

THE Sumerians have long been the problem child of Oriental archeology. Unlike the Hittites or the Horites, they were not foreshadowed in the Bible. Their appearance on the scientific stage was not linked with the discovery of lost empires, for it was neither sudden nor dramatic. They insinuated themselves, so to speak. It was years before the very existence of the Sumerian language and a Sumerian people was definitely established. Today Sumerian records can be read with comparative ease. The known cultural achievements of the Sumerians are numerous and of fundamental importance to civilization. But the list is as yet far from complete. We are still in the process of discovering the people.

Figure 1: **The altar of the shrine, dedicated to Abu, god of fertility**

Ancient Mesopotamia used to be regarded as the private and exclusive battleground of the Babylonians and Assyrians. Increasing knowledge of the available evidence showed that the Biblical estimate of the country accords better with the facts, for the Land of the Two Rivers has never ceased to justify its description as a Tower of Babel. The oldest historic times already yield a picture of many languages and many races. The Semitic Babylonians were but one group out of many. By 2000 B.C. their language was the official tongue because its speakers ruled the land, but for scientific and religious purposes another language was commonly employed, much in the manner of Latin in the Middle Ages. That language was Sumerian. It had become a "dead language" 4000 years ago because the Sumerians themselves had disappeared by then as a political power, and evidently also as a race. But their influence persisted. In the Orient it has continued ever since, and in some respects it has pervaded even the western civilizations of today.

AT all events, Sumerian political history is not later than the third millennium B.C. Indeed it is from that period that we get our fullest information about the Sumerians. We see them as founders of city states and as capable civil and military organizers. They were efficient farmers and accomplished craftsmen. They had evolved an elaborate and humane code of law, and religion had come to play a vital part in the lives of kings and subjects alike. Above all, the Sumerians were a highly literate people. Writing on stone and on clay tablets was used to commemorate important political events, the erection of public buildings, the closing of a business transaction; many inscriptions bear a religious character. To this literary activity of the Sumerians we owe our knowledge of contemporary history and institutions. We know the names of the various rulers and frequently their dates, and we have a fairly clear picture of a number of peoples with whom the Sumerians lived and fought and traded. Naturally, we now have a satisfactory understanding of the Sumerian language. That language is neither Semitic nor Indo-European. All attempts at connecting it with other known languages have proved futile. For this very reason we are in the dark in regard to the background of the Sumerians. The statements that are occasionally made in writings of a popular character, that the Sumerians were Semites, Aryans, or a mixture of both, are absolutely without foundation. The origin of the people remains a mystery.

The problem is twofold: When did the Sumerians arrive in Mesopotamia and from where did they come? On the latter point we are no better informed now than we were ten years ago. But recent archeological discoveries have shed fresh light on the antiquity of the people. First came the justly famous Royal Tombs from Ur. They were unquestionably Sumerian and they date from shortly after 3000 B.C. To be sure, it has been known for some time that the Sumerians were at least as early as that. But the high level of their civilization as revealed by the Royal Tombs was certainly unexpected. There is nothing nearly as early that equals those grave furnishings in wealth, variety, and sophistication. The jewelry is remarkable and the carving on cylinder seals unexcelled. Most impressive, however, is the metal work. Egypt had to try for centuries before she could produce objects in gold, silver, and bronze comparable with the handiwork of the Sumerian smiths from Ur.

But 3000 B.C. is a comparatively late date in our recently reconstructed picture of the ancient Near East. At Tepe Gawra, in the north, that date is represented by Level 7. Below it there are at

Figure 2: **Statue of a bearded dignitary, with eyes of lapis lazuli**

least 16 earlier strata. The Sumerians may have settled on the alluvial plain of Southern Mesopotamia at any time in the fourth millennium without becoming thereby the earliest population of the country. All we can say with certainty today is that they must have come in by the middle of the fourth millennium, for it is at approximately that time that we get in Uruk, the Biblical Erech, the earliest written records known to man, and these records have turned out to be Sumerian. It is a fair and logical assumption that the Sumerians were responsible for the invention of writing, perhaps the greatest single contribution to human progress. All remains preceding the invention of writing must necessarily be anonymous. And so the question as to the exact date of the arrival of the Sumerians remains unsolved, for the time being at least.

Figure 3: **A nude which anticipates the classical statues of Hercules**

Our present approach to the problem of the Sumerians concerns itself not so much with the question of their origin as with the sum of their achievements. The list of these, it appears, is not likely to be exhausted for a long time to come. Each season brings its own quota of contributions. The latest have come from a group of mounds to the northeast of Baghdad, close to the Diyala River. The new material introduces the Sumerians as expert sculptors at the very beginning of recorded history. It gives us also a new insight into the part which athletic contests played in the religious practices of 5000 years ago.

Until last year the excavations in the Diyala area were conducted by the Oriental Institute of the University of Chicago. Under the direction of Dr. Henri Frankfort, one of the leading archeologists of our day, the mounds of that region, including Tell Asmar,

Figure 4: **A curious case. Why was this man's beard chiseled away?**

Khafaje, Ishchali, and Tell Agrab helped to add several centuries to the known history of the Sumerians. The dating of the whole period around the turn of the fourth millennium B.C. was placed on a sound basis, the age in question having proved to be Early Dynastic; that is, the time of the first known dynasties in the land. It coincides, interestingly enough, with the first Egyptian dynasties. Three definite stages of Early Dynastic were established by the work of Dr. Frankfort and his staff, each stage requiring not only several building levels of its own but disclosing also internal changes in art and architecture. The Royal Tombs of Ur fall within the third and latest phase. The bulk of the material is earlier, about 3000 B.C. in round figures.

THROUGH Dr. Frankfort we were invited to take over the concession. We were engaged, however, at the time, in the excavation of Tepe Gawra, nearly 300 miles away from the Diyala concession. At length the invitation was accepted and the Joint Expedition of the American School of Oriental Research in Baghdad and the University Museum devoted a month to the excavation of Khafaje, one of the principal mounds on the Diyala. The success of that venture is due in a large measure to the fullest possible co-operation on the part of the Oriental Institute and the Iraq Department of Antiquities.

The principal group of finds is composed of sculptures in the round. Most of the sculptures discovered by us came up in a small shrine dedicated to the god of fertility. This identification is supported by a pair of animal horns carefully embedded in bitumen before a sacrificial podium. Since horns are known to have been symbols of strength and fecundity, there can be little doubt that the Sumerian god of fertility, called Abu, presided over this particular shrine. Similar shrines were discovered by Dr. Frankfort at Tell Asmar, where they were identified by inscriptions as belonging to the god Abu.

The sculptures were concentrated in two places. One of these was the altar of the shrine (Figure 1), the sides of which were regarded by the devotees as convenient repositories. The other was a shallow pit in front of the altar. The statue was the representative of the donor, calculated to remind the deity of the suppliant's presence. This is obviously the reason why so many of these statues have been preserved; they were treated with reverence and thus escaped the fate of so many other types of objects. A later generation might bury them in order to remove them from

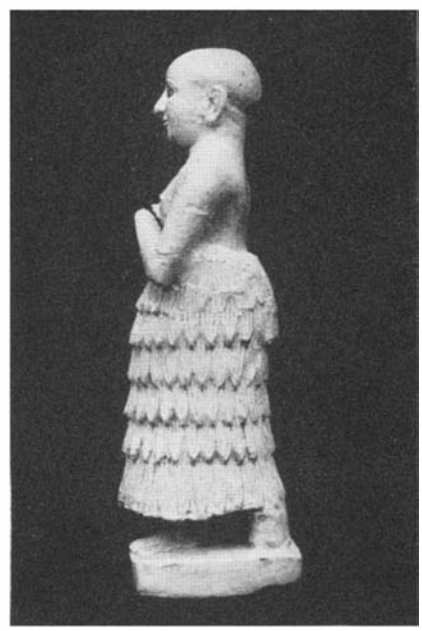


Figure 5: **A beardless statue that may represent some high official**

sight, but they were not destroyed or reused for other purposes.

The statues portray both bearded and beardless men. The commonest specimens would show a portrait in grey marble of a bearded dignitary wearing a flounced skirt, with hands clasped in front and eyes made of inlaid shell and lapis lazuli (Figure 2). The presence or absence of beards was not merely a matter of fashion. The occurrence of the two types side by side has a deeper underlying significance. Years ago, when the available material was scanty, it used to be held that the bearded figures represented the Semites, the beardless ones the Sumerians. But when a number of ancient gentlemen with unimpeachable Sumerian antecedents began to sport beards, it became clear that the reason for the custom was religious. Priests, and kings who combined secular and religious authority, wore beards as the

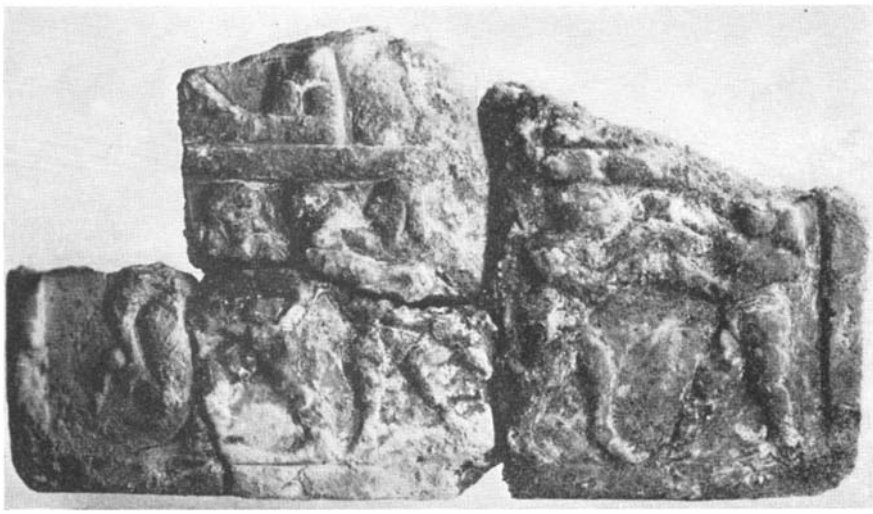


Figure 6: **A bout that took place 5000 years before the days of Joe Louis. The three boxing scenes shown should be read from right to left, not left to right**

prerogative of their office. This interpretation is borne out by the present material. For, in addition to ordinary portraits, we have also interesting nude figures (Figure 3) which could scarcely be representative of average citizens or even of officials. They belong clearly in the temple, and they are just as clearly bearded.

One statuette (Figure 4) resembles the other members of the bearded clan save in one respect: of the original beard only the sidelocks have remained. The rest was cut off as is shown clearly by the none too delicate chisel marks. Had the man lost his priestly office after sitting for the sculptor, so that the beard too had to go? This seems improbable because priestly offices were usually hereditary. Or do we have here an instance of domestic difficulties? The wife may have objected to the apparition so strenuously that the poor wretch had to resort to a compromise for the sake of peace. Who knows?

THE beardless statuettes are made of marble or of alabaster. In all likelihood they represent high officials. They differ from the foregoing also in one other respect. The workmanship is here plainly superior, the likeness less conventionalized. An excellent example of this naturalistic style is furnished by a small statue of grey marble (Figure 5). The man is dressed in an elaborate flounced skirt although he is nude from the waist up. The hands, which are now partly broken, were once clasped in the manner customary to worshippers, but the left foot is moved slightly forward; our friend seems somewhat impatient with the whole ceremony. The back is beautifully modeled. The head is a little masterpiece of naturalistic portraiture. The mouth attempts a smile, but the expression is arrogant rather than kind. The left eyebrow is raised quizzically, accentuating the suggestion of superciliousness. Although the figure is almost

Figure 7: **Why did these two wrestle with immense vases on their heads?**

slender there is a distinct double chin, and a fold of fat on the neck, just below the skull, conveys an impression of stubbornness if not cruelty. Large ears round out the picture. It is not a pretty one. All the more credit, therefore, to the nameless sculptor who succeeded in pleasing the vain and self-satisfied subject, while laying bare before us his character in all its nakedness. In a work of 5000 years ago this is certainly a revelation.

Two other objects from our last season's work at Khafaje cannot be left out of this account. The first is a limestone relief which has not come down to us in the best possible state of preservation. It consisted originally of more than one register, with several scenes depicted on each panel. What we have now (Figure 6) is the lowest register alone, and even this is partly damaged. It consists of three scenes. Viewed from right to left, the first scene shows two men in what is unmistakably a boxing match. The men are sparring, their outstretched arms keeping each other at a healthy distance. The hands are bandaged, but in the present condition of the relief further details cannot be discerned. So far everything seems to be going according to the approved modern rules of the game. The situation changes, however, in the middle scene. Here one of the contestants has been lifted off his feet and his defeat appears to be not far away. In the third scene the action is even more violent. Some kind of ankle-hold is plainly visible to us, and it could hardly have escaped the referee. It must have been legal in ancient Sumer. How the match ended is anybody's guess, because the rest of the relief is broken, thus sparing us the final details, perhaps mercifully.

The ankle-hold may have put us in a mood for wrestling. We do not have far to go, for a legitimate wrestling bout is suggested by another object, this time of bronze (Figure 7). The two opponents are nude except for the scantiest belts. Each tries to secure a hold without losing his own footing. The leg muscles betray the strain which the expressionless faces attempt to conceal. The huge vases on the heads of the wrestlers are a puzzling feature. The only excuse for these staggering appendages is that the bout was part of a religious ceremony. The same is true, of course, of the boxing scenes, inasmuch as both objects were recovered in a shrine. The precise implication of the vases is open to speculation.

ONE feature of this wrestling group is of considerable technical interest. The bodies were cast in a mold, but the hands had to be added afterwards, since no ancient mold known to us could produce the whole group as it stands. Nonetheless, this composite work did not impair in the least the effectiveness of the tableau.

Our brief excursion into ancient Sumer, away from the immemorial past of Tepe Gawra, thus produced results of more than usual interest. The numerous statuettes recovered add greatly to our knowledge and appreciation of early Sumerian sculpture. The naturalistic examples are especially significant, both because a short time ago sculptures in the round were not thought to exist as far back as the turn of the fourth millennium, and also because for sheer frankness these statuettes would be difficult to excel. The athletic specimens push back the history of such contests to an equally remote age and give an entirely new meaning to the term "ancient" when applied to sports.

And so we keep on finding out new things about that remarkable people known as Sumerians. But the answers to two questions still elude us: Where was the original home of the Sumerians, and when did they first appear in Mesopotamia?

Trees On a Salty Isle

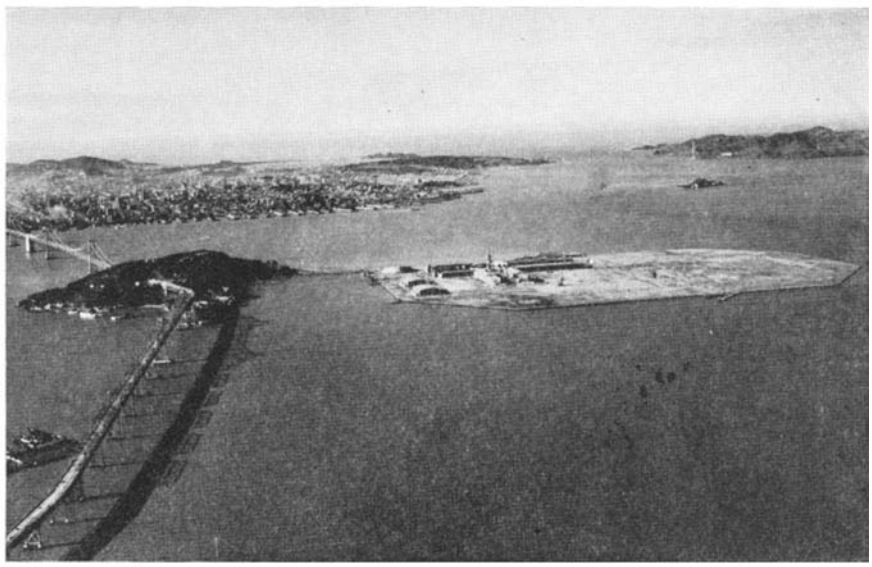
IN February, trees were planted upon a 400-acre rectangle of black sand that lay, less than two years ago, on the bottom of San Francisco Bay, which is as salty and unfriendly to delicate vegetation as any harbor bottom in the world.

By February of 1939, this man-made island, site of the Golden Gate International Exposition, will be a lush garden of sub-tropical plantings, the roots of which will never suspect that they are in an environment that would have been sure death a little earlier. Then by February of 1940, the trees will be gone; this 400-acre island in the center of San Francisco's harbor will be barren again, for it will be an airport, and no transport plane ever took off from a forest, or landed in one with any success.

Behind this unnatural life cycle of 1,500,000 dollars' worth of vegetation is the story of science, once again taking Mother Nature to the cleaners; and in this case-history, Mother Nature will help to defeat her own laws. For the "leaching" of the World's Fair island will in all probability be accomplished entirely by natural rainfall during the California winter rainy season of 1937-38.

Exploratory drillings on Treasure Island, which was dredged up by United States Army Engineers to a height of 13 feet above mean low water, disclosed that a "dome" of salt water remained in the saturated fill. Around the edge of the island, rapid drainage had drawn the salt water nearly down to the tide level, but in the center, where drainage is slower, the water-table was at a higher elevation.

Late in 1937 began the installation of 200 well-points, jetted down 20 feet into the sand. Salt water, gathered through slotted screens, was to be pumped to the surface for some 60 days and shot back into the harbor through the island drainage system, more than six miles of redwood stave pipelines.



San Francisco and the Golden Gate serve as the back-drop for man-made Treasure Isle, in the middle distance, which must be de-salted before vegetation will grow

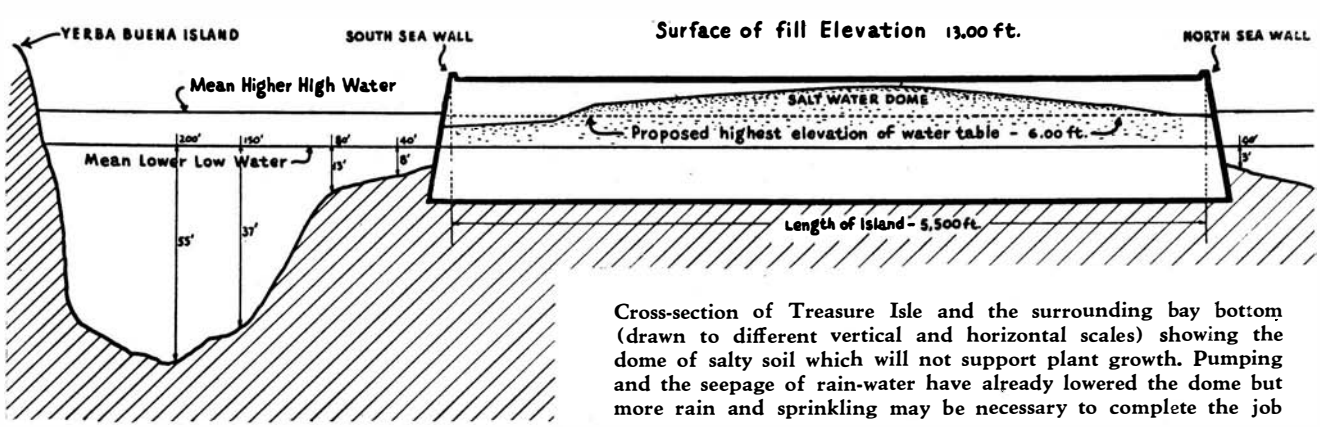
Laboratory tests have proved that this lowering of the salty water-table reduces the salt content of the sub-surface water from its original 5000 parts per million, down to 1000 parts. Natural seasonal rainfall, applying from six to nine inches of fresh water, further reduces this salt content from 1000 to 100 parts per million, other tests have shown, by washing residual mineral salts deep into the fill.

MORE than 90 percent of the trees, plants, and shrubs to be installed on Treasure Island have a saline tolerance greater than 100 parts per million. Areas in which the delicate 10 percent of the planting will be made are to be treated with commercial fertilizer, reducing the salt content to 50 parts per million.

During the winter rains, this process of pumping the salt water to flatten the "dome" continued, with frequent tests to determine the salinity of the sub-surface fill. If rainfall fails to provide sufficient water for leaching, fresh water may be applied by sprinkler systems to complete the cleansing.

Late in January, according to the schedule worked out by W. P. Day, Vice President and Director of Works for the Exposition company, barge delivery of 80,000 cubic yards of rich topsoil began. This loam will be spread from nine to twelve inches deep over the planting areas, and will suffice for the roots of all but the larger plants and trees.

Most of the 4000 trees will remain in their boxes during the 288 days of the Western World's Fair, from February 12 to December 2, 1939. The transplanting program began last February around the perimeter of the island where the water-table had already been lowered.



Cross-section of Treasure Isle and the surrounding bay bottom (drawn to different vertical and horizontal scales) showing the dome of salty soil which will not support plant growth. Pumping and the seepage of rain-water have already lowered the dome but more rain and sprinkling may be necessary to complete the job

THE ODD NEW-OLD STAR

The Much-Talked-of Huge Star in Auriga Yields to Astrophysical Interpretation: an Eclipsing Binary With an Almost Grazing Type of Eclipse

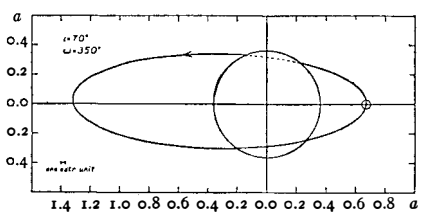
By HENRY NORRIS RUSSELL, Ph. D.

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.

AMONG the reports of astronomical investigations presented at the meeting of which we told last month, one was of such unusual interest that it was reserved until it could be adequately described. Since then, the detailed technical discussion has been published, the daily press has spread the news, and all the world knows that a star of extraordinarily huge dimensions has been discussed by astronomers at the Yerkes Observatory—Kuiper, Struve and Strömgren. These three justly distinguished investigators have done a most interesting piece of work; but when popular report credits them with the "discovery" of this star, it is more than a century behind the times.

Epsilon Aurigae is a star of the third magnitude, easily visible to even a casual looker-on, and very easy to find in the sky. The brilliant star Capella is at one corner of an irregular pentagon—one of the star-figures which any one would notice at a glance. The star we are discussing is next to Capella, at the end of a short side of the polygon. The next corner beyond is formed by a pair of stars of which the outer one, Zeta Aurigae, is another very remarkable system, which we described some time ago. Curiously enough, the star at the corner on the other side of Capella is also an eclipsing variable, Beta Aurigae.

ALL four of these stars are binary systems of unusual interest; but Epsilon Aurigae is the most remarkable and the most puzzling of them. Its variation in brightness was first noticed in 1821 by a German clergyman, Fritsch, who noticed that in the spring of that year it was much fainter than its neighbors at the next corner of the pentagon. Not much came of this for years, but in 1847 Heis observed it faint again, and his observations put its variability beyond doubt. Schmidt—a most devoted observer—made nearly 5000 observations of its brightness between 1843 and 1884; but the real nature of the variations was not discovered till 1902, when Ludendorff showed that the periods of faintness, each lasting more than a year, had come at regular intervals of 27 years, in 1821, 1847-48, 1874-75, and 1901-02, and could be explained by eclipses of a system with this period (then enormously larger than for any other eclipsing pair). The next eclipse, in 1928-29, came off on time, and observations of radial velocity in the interval have shown conclusively that the bright star—which alone shows on the spectrograms—is moving in an ellipse with this period. The latest discussion, by Struve, of observations covering more than the whole period, shows that the eccentricity is 0.33, not large for a double star of this period, and that the bright star is 2,500,000,000 miles closer to us on the near side of its orbit than on the far side. Only the part of the motion which affects the distance from us is revealed by the spectroscope, and, if the orbit is not edgewise toward us, its real diameter must be still greater. From the spectroscopic observations, the time can be computed when the bright star ought to be behind its companion, and this time agreed almost perfectly with the observed time of minimum. These facts (first brought out by Ludendorff in 1924) make it morally certain that the minima of Epsilon Aurigae are really due to eclipses.



The projected orbit of Epsilon Aurigae, showing the smaller, hot star whose orbit passes almost grazingly behind the far larger, dull red, cool star. Reproduced from the paper by Kuiper, Struve and Strömgren, in *The Astrophysical Journal*, December, 1937, pp. 570-612

But these eclipses are very remarkable. It takes the star more than six months (190 days, to be more precise) to fall in brightness. Then it remains constant, and a little less than half as bright as usual, for 330 days (almost a year!) and returns to normal at the same rate as it decreased. The form of the light-curve agrees perfectly well with what would be expected from the total eclipse of one star by another nearly three times as big and not quite so bright. There is no trouble so far, but, as long ago as 1912, Shapley showed that on the eclipse hypothesis the mean density of the larger star, which is in front at the eclipse, must be less than a hundred-millionth part of that of the sun, or less than 1/100,000 that of ordinary air. Nowadays we know of other stars of such low density—though hardly as low as this—so that this result can no longer be raised as a serious objection. But a far more serious difficulty was raised by Ludendorff at the same time. If the eclipse is total, the two stars must be almost equally bright; but the spectra show the lines of only *one* body, and during the "total" eclipse the *same* spectrum continues to be visible. As the eclipsing body is so much larger, it must shine more feebly per square mile—1/10 as much, at best—and we would expect it to be cooler, redder, and show a quite different spectrum. Moreover, the star should appear redder at minimum; but precise observations, made during the last minimum, show that its color does not change.

AS the star begins to lose its light—and even a little before—changes in the spectral lines occur, such as would be anticipated if the big star was surrounded by an extensive and very thin envelope in which additional absorption took place. Similar changes have been observed in Zeta Aurigae, where a small star is eclipsed by a big one, and in this case they are easily explicable. But in Epsilon Aurigae the additional absorptions still show after the light has become constant, and, on the simple eclipse hypothesis, the smaller star is completely out of sight!

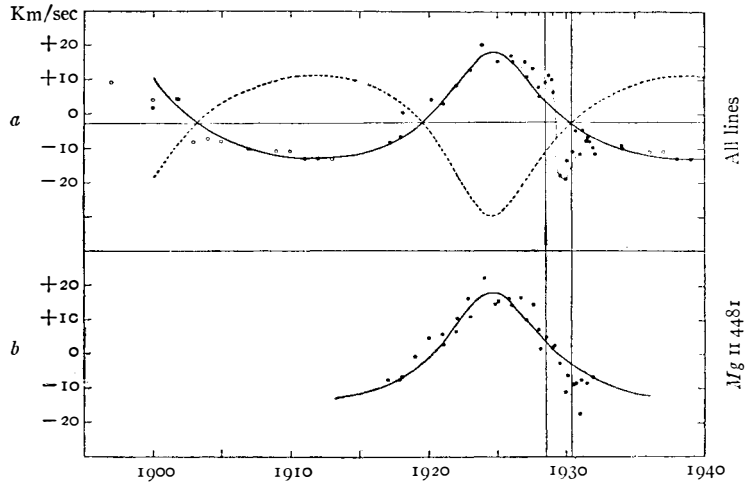
This last set of facts suggests that the larger star does not give out perceptible light of its own, but that its outer parts are partially transparent. As the smaller star goes behind them, its light is gradually weakened—like the sun's as it gets low in the sky and comes through more air—while (as in the case of sunlight) its spectrum remains substantially the same, with the addition of some lines

absorbed by the atmosphere. This hypothesis accounts for the loss of light without much change of spectrum; but any ordinary gas would obstruct blue light more than red, and so lead to conspicuous changes of color—like the setting sun. Even if some sort of "gray" atmosphere could be found, which weakened all colors equally, the more difficult problem remains to explain how this could cut out more and more light as the star sank behind it—and then suddenly stop doing so, and obstruct the same amount of light, even though the rays passed through a greater thickness.

A most ingenious solution of this puzzle is the contribution of the Yerkes team of investigators. Dr. Kuiper leads off by showing that, if we assume that one star goes almost centrally behind the other, we are led to inadmissible conclusions when we calculate the actual size and mass of the bright star. Assuming that the well known relations between mass and luminosity can be extrapolated so far, he finds that a central transit demands that the brighter star shall be 160 times as massive as the sun and 600,000 times as bright. By assuming that the orbit is inclined, so that the smaller star just dips behind the edge of the larger, he gets more credible figures, a mass 20 to 30 times the sun, and a luminosity 10,000 times as great. The latter figure is not alarming, for the star's spectrum shows the characteristics associated with great luminosity, and to a very marked degree. With an inclination of 65 degrees, the mass of the smaller star comes out 24 times the sun's, and that of the large star 21; the radius of the first 120 times the sun's, and of the second 3100 times. The larger star probably radiates almost as much energy into space as the smaller, but, on account of its enormous area, it emits very much less per square mile, so that its calculated temperature is only 1120 degrees K, or 850 degrees, Centigrade, above the ordinary zero. Could we see it close by, and alone, it would appear to shine with a dull red glow; but in comparison with ordinary stars it is practically a dark body. The eclipse is almost grazing—the maximum apparent depth of the outer edge of the smaller star, behind the boundary of the larger, being only one third of the diameter of the former.

The light of the companion thus penetrates only the outermost layers of the big star—the eclipse is by this star's atmosphere, and not by its main body.

Dr. Struve shows that the absorption lines produced by such an atmosphere—taking into account the orbital motions and rotation of the stars—are capable of explaining the peculiar changes in the spectral lines observed during and near the minimum. Dr. Strömgren offers an explanation of the outstanding problem—why the atmosphere cuts off the light of the star behind it almost as if it were



Courtesy *The Astrophysical Journal*

The dots represent measurements of the velocity of the brighter component toward or away from the earth. When above the zero lines the star is moving away from us, when below it approaches us. The two vertical bars near 1930 indicate the first and last contacts of the eclipse

a sharp-edged shade-glass, transmitting about half the incident light. To follow all the details of his reasoning would lead us too far; but the main principle is not hard to understand. The upper atmosphere of a star as cool as the companion appears to be should be composed of gas which, judged by our ordinary standards, would be called almost perfectly transparent. The small scattering by the gas-molecules themselves, which makes the sky above us visible, demands a very much greater amount of gas than is in question here. But, when a gas is ionized, the electrons in it get a far more powerful grip on the light waves than the neutral molecules do and produce a sort of haziness. This electron-scattering affects all wavelengths to the same degree, and so is equivalent to a gray haze.

At the star's low temperature there would be very few free electrons indeed in the atmosphere, and it would be very transparent. But, on the side toward the companion (which has a spectrum of Class F2 and is somewhat hotter than the sun) the ultra-violet light from this would fall on the atmosphere and ionize it. The sun's light does much the same for the earth's atmosphere, producing the ionized "Heaviside layer" which reflects radio waves around to the antipodes; but in this case atmosphere and electron-haze alike are too thin to produce perceptible effects in thicknesses of 100 miles or less.

In the great star we have to deal with distances of hundreds of millions of miles and effects which are imperceptible on earth may mount up to be conspicuous. The ultra-violet light of the companion, which ionizes the atmosphere, is absorbed by the processes involved, and so cannot penetrate to a very great depth. If, therefore, we had a thick layer of gas, of uniform density, exposed to such light, the outer portions would contain electrons and be hazy. Deeper in, as the ultra-violet rays were weakened, the haze would thin out, and, beyond the depth to which these rays could reach, the gas would be clear. For a smaller depth than this the total haze-obstruction to visible light would increase with the depth; but for greater depths it would not, for the deeper portions of the gas would be clear.

This very ingenious suggestion solves the main problem: how the layers of gas, of very different thickness and density, through which the light of the companion passes during the eclipse, can exert almost the same effect in weakening the light that gets through them.

Strömgren goes on to work out the more complicated case of a spherical atmosphere growing denser inwardly, and finds, after pages of mathematics, that the haze-layer should have a practically sharp outer boundary, and that the absorption should actually be a little greater for light which has passed at a grazing angle just inside this boundary than for rays which have gone deeper, but less obliquely at the start. The scattering by the gas-molecules or atoms—which is probably not quite negligible for the rays which pass deeper—may balance the effect and give substantially the observed type of light-curve. This analysis, while brilliant, and based on sound physical principles, leaves some minor difficulties. It is hard to see why such an atmosphere as is postulated should not produce some absorption lines of its own, stronger than any that have been observed. Moreover, the amount of ultra-violet light which the smaller star must be assumed to emit is much greater than would be anticipated from its size and "temperature" (estimated in the usual way). There is an increasing quantity of evidence, however, that stars, even down to the sun's temperature, *do* give out more ultra-violet than we had supposed; so this difficulty is not so bad.—*Princeton University Observatory, February 3, 1938.*

POWER FROM BACTERIA

Troublesome Pulp Mill Waste Supplies Gas for Power... Swamp Bacteria Do the Work... Fifty Year Old Problem Solved for the Pulp Wood Industry

By M. K. ELWOOD

THE history of research contains many strange chapters on the resourcefulness of science in utilizing the waste materials of industry. Few of these instances, however, are stranger than the story of two research chemists of the pulpwood industry who have put ordinary bacteria to work producing power from the sulfite waste liquors of pulp mills.

Several years ago these two chemists, Dr. A. M. Partansky and Dr. H. K. Benson, of the University of Washington, were approached by officials of the Puget Sound pulpwood industry.

"We use the sulfite process of manufacturing pulp," said the officials. "For every ton of pulp we produce, we have 10 tons of sulfite liquor left over. The liquor can't be used again so we have to throw it away. If we dump it into rivers and lakes, we poison the water. We can't afford to evaporate it. Will you help us find a practical way to dispose of it?"

Here was a challenge which could not be ignored. In their well-equipped laboratory in the University of Washington at Seattle, Drs. Partansky and Benson started to work. Their first task was to learn all that they could about their subject.

The pulpwood industry, they discovered, has been plagued with the waste-disposal problem ever since 1867, when the sulfite process was first patented by an American engineer. This sulfite process is a method of extracting pure pulp from pulpwood by dissolving in acid all the other ingredients in the wood. It is accomplished, briefly, by saturating chips of pulpwood with a strong solution of sulfurous acid, and then steaming the mixture in huge "digesters" for eight or ten hours. This cooking process dissolves the intercellular portions of the wood, leaving only pure cellulose fiber (pulp) when the acid is drained off.

THE acid which is drained off, the two scientists learned, is the waste liquor which must be disposed of. For the United States pulpwood industry as a whole, it amounts to 15,000,000 tons per year.

There are a number of reasons why the liquor can not simply be dumped into rivers and streams, they found. One of the ingredients of the solution is sugar, which forms a natural food for tiny algae (*Sphaerotilus natans*) that are present in all fresh water. As a result of the sudden increase in food occurring when waste liquors are dumped into the water, the algae multiply at an abnormal rate and soon cover the bottoms and surface of the streams with a dark, ill-smelling scum. So thick do they become under extreme conditions that they completely cover the feeding grounds of fish and shellfish, causing a migration of sub-surface life to clearer waters.

Furthermore, the sulfurous acid in the liquid has a harmful effect. Its rate of absorption of oxygen during oxidation is quite rapid, and, in slower streams, sometimes actually deprives the fish of oxygen for respiration; and the sulfur dioxide, which usually forms, has a "rotten-egg" odor unpleasant to human beings. In very small streams where the solution is strong, the acid has a poisonous effect on the vegetation along the banks.

A third harmful constituent of the sulfite waste liquors is a small quantity of cellulose which is carried off in the solution. These cellulose fibers have the property of collecting and precipitating sewage and other refuse which may be in the river—with obvious unpleasant consequences to persons and cities downstream.

To counteract these detrimental effects, the scientists learned, the pulpwood industry has tried many remedies. Experiments have shown that the harmful algae will not grow as rapidly if their sugar supply is sent to them intermittently instead of in a steady flow. As a result of this discovery, pulpwood mills have adopted the practice of storing the waste sulfite liquors in reservoirs, and then releasing it at intervals of 10 to 20 hours. To counteract the sulfurous acids, some mills dilute the waste liquors with immense quantities of water. And to overcome the precipitating effect of the cellulose, technological processes have been developed to remove a higher percentage of the fibers from the liquors.

Despite these many counteractive measures, however, a certain amount of damaging result seems unavoidable. In the Puget Sound area, for example, despite every precaution taken by the pulp-paper manufacturers, the sulfite liquors have been slowly poisoning fish and oyster feeding grounds. Repeated lawsuits have finally forced the mills to divert their waste liquors into a deserted area known as Dry Lake.

After learning these facts about the sulfite process, the two research men next turned their attention to the history of the many attempts to convert the waste liquors into some useful product—a feat which has been the objective of hundreds of scientists for half a century.

THE majority of experiments directed toward this end, they learned, have been chiefly concerned with utilizing the liquors to manufacture wood-alcohol. In the course of five decades, several distilling processes have been developed, some of which will produce as much as 15 gallons of alcohol from the liquors of a ton of pulp. The demand is so limited for the inferior alcohol produced, however, that few pulp plants have attempted this method of utilization. The conclusion has been generally accepted that this method will become practical for the entire industry only when some tremendous new market is opened for alcohol—as might be the case if alcohol ever replaces gasoline as a motor fuel.

Other experiments in utilizing the liquors have been tried in the field of agriculture. A neutralized solution of sulfite liquor mixed with molasses, it has been found, makes a fairly satisfactory food for cattle. A similar solution, mixed with nitrogen and phosphates, makes an excellent fertilizer for soil poor in humus. Unfortunately, however, both byproducts are too expensive to compete with other commercial cattle fodders and fertilizers.

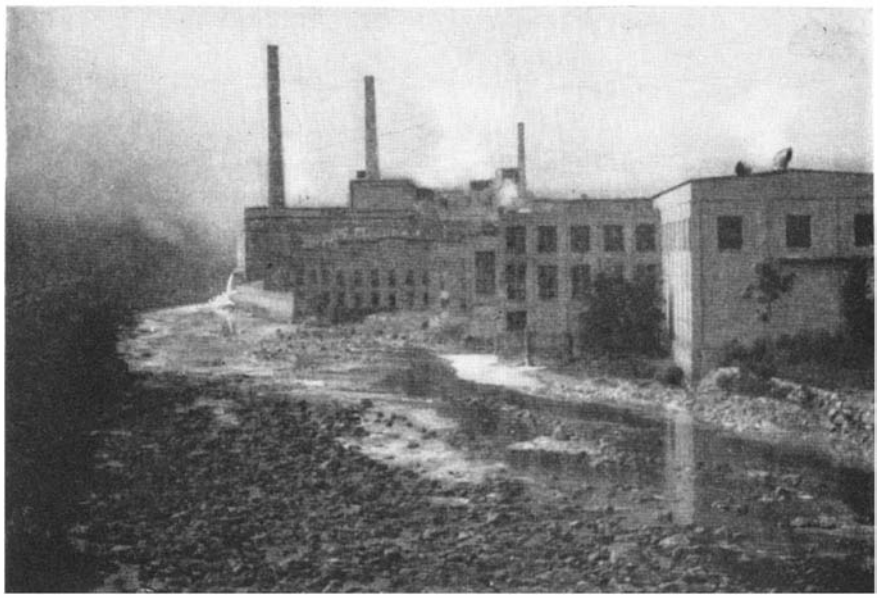
In the field of medicine, sulfite liquors have been found useful in treating hoof and mouth disease and in the treatment of pulmonary diseases. However, here again the recovery process is too costly and the market too limited to answer the question for the pulpwood industry as a whole. Similarly, attempts to utilize

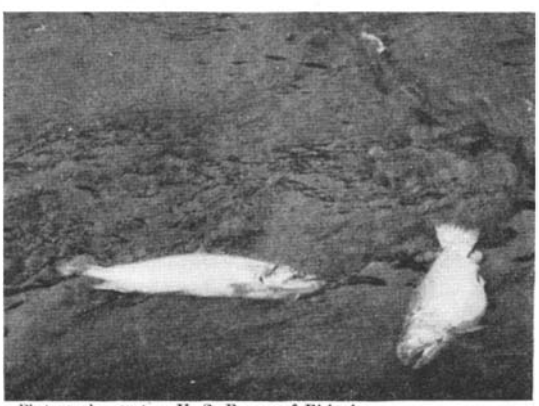
the liquors as a tanning agent, as a preservative, and in making of dyes, have proved impractical in all save a few exceptional cases.

Recently a method has been developed in Europe for making yeast from the sugars contained in the solution, and one such recovery plant has already been built on this continent—at Liverpool, Nova Scotia. This method, while economically practicable, does not completely solve the disposal problem, however, as the bulk of the liquor is not utilized in the process and must still be cast aside.

The nearest to a successful solution that the Washington scientists were able to uncover was a European process of using the liquors as a binder for briquetting powdered fuel (coal, peat, sawdust), for making foundry sand-cores, and for binding road dusts.

It was this latter use which interested them most. Many foreign countries—especially in Scandinavia—have surfaced their roads with concentrated sulfite liquors, and tests have shown that this binder will remain hard and dustless as long as will ordinary road oils. Since there are in the United States approximately 1,413,800 miles of unimproved roads, this means of utilization seemed to offer the pulp industry a wide opportunity.





Photographs courtesy U. S. Bureau of Fisheries

Paper pulp mills use great quantities of water in producing pulp by the sulfite process and discharge sulfite liquors into nearby streams. One of the results of this practice is the destruction of fish and other aquatic life by the contaminated water

The two chemists began experimenting. They first tried the liquor on the cinder athletic track at the University of Washington, where they found it an extremely effective binder. Then, through the co-operation of a Shelton pulp and paper company, they managed to persuade the highway engineers of Mason County, Washington, to try the liquors on a 13-mile stretch of road.

It was at this point in their work that the two chemists had an ingenious idea.

Many years previously it had been definitely proved that the formation of marsh gas (methane) was caused by the action of tiny anerobic (airless) bacteria which fermented the cellulose contained in decaying swamp vegetation. If this was so, reasoned the research men, why couldn't the same bacteria be used to generate methane from the organic material in waste sulfite liquors? The methane produced could then be burned to generate electric power! It was an attractive idea, they decided, and would be well worth investigating.

The two scientists procured a large number of gallon jars. Into each jar they poured 850 cubic centimeters—about one and one-half pints—of neutralized sulfite waste liquor. To this they added two kilograms—about four pounds—of ordinary mud taken from swamplands where anerobic bacteria were active. The remainder of each jar, except for an air space of about 100 cubic centimeters, was filled with water, and the jar was placed in a chamber kept heated to 36 degrees, Centigrade (96.8 degrees, Fahrenheit).

DAY after day, through tubes running from each jar, the scientists measured the amount of gas given off by the mixture. At the end of 340 days—almost a year after the start of the experiment—they added up the total quantity of gas which had been given off.

The average amount of gas which had been produced from each jar, they found, exceeded 18,000 cubic centimeters—more than 20 times the volume of the original sulfite liquor. Seventy-eight percent of this gas was methane, while the remainder consisted of carbon dioxide and a small quantity of hydrogen. Most important of all, they found the heating value of the gases produced to total 134,900 calories per jar—which, translated into large-scale terms, meant that from the liquors of every ton of pulp it would be possible to generate gases with a heating equivalent of nearly 400 pounds of coal! The experiment was decidedly a success! At the generating rate of the first experiment, the total heating value of the gases which can be recovered in the United States will be equal to more than 300,000 tons of coal per year!

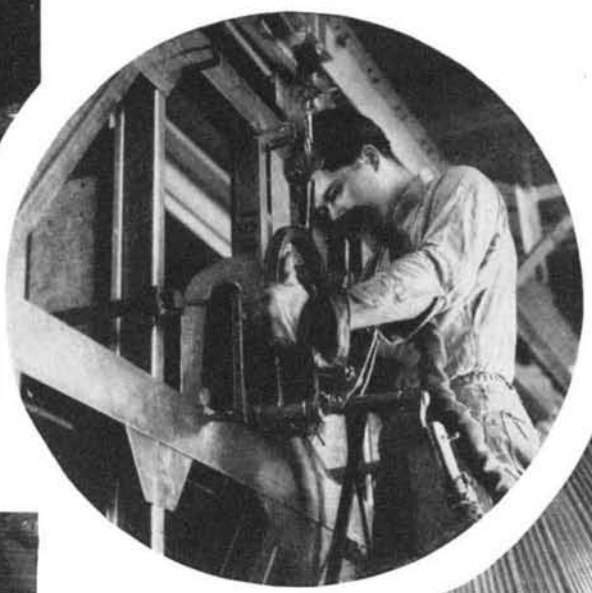
And thus was begun the development of a process for putting the tiny bacteria to work. Since that first experiment, a great deal of additional work has been done. A method of hastening the fermentation by precipitating the lignin in the solution has been discovered. Gas engines capable of efficiently utilizing the fuel have been perfected. Today the process has graduated from the laboratory stage and is now ready for commercial use.

The first fermentation plants are now being planned to utilize the waste liquors in combination with sewage wastes from nearby municipalities (sewage wastes re-act to the Partansky-Benson process in much the same way as the pulp-mill wastes). Later on, disposal plants will probably be built for handling sulfite waste liquors alone.

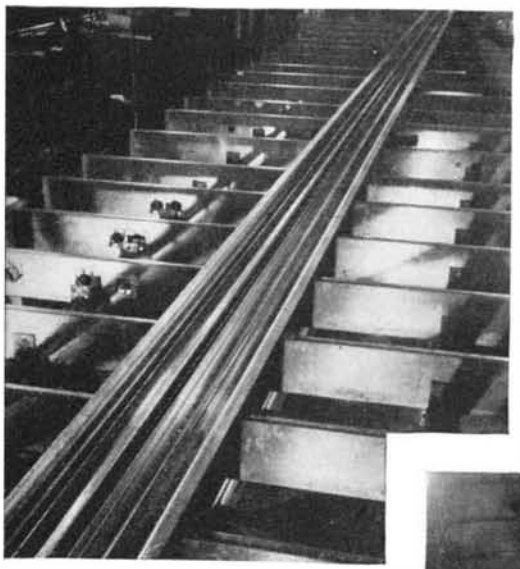
And although other attempts to utilize the sulfite waste liquors have not been entirely discontinued, it is almost certain that the Partansky-Benson process will be adopted by most of the pulpwood industry. Because the recovered methane power can be used right in the pulpwood plants, eliminating the need of developing markets for a new product, the majority of the 181 pulpwood establishments in the United States will probably prefer this method of disposal. It is the perfect answer to their question: "How can we utilize our waste liquors?"

From Steel

1 Light-weight equipment of tremendous strength, capable of high sustained speeds with safety, is the modern demand of the railroads. Streamliners, sheathed in shining metal, are the manufacturer's answer. *Above:* Coils of strip steel are fed through a drawbench, to be formed for use in the construction of a new streamlined railcar

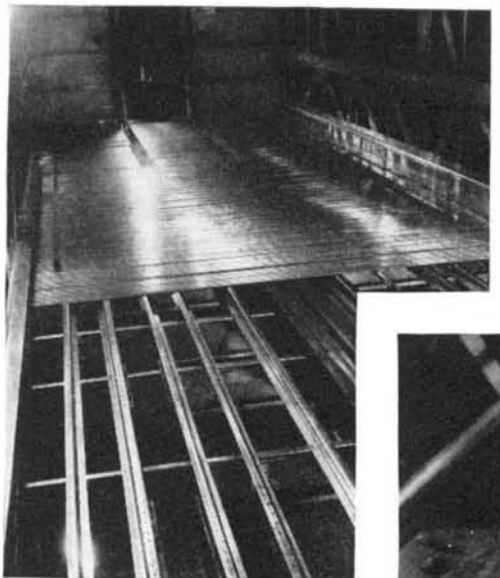


2 Alloy used in the Reading streamliner is stainless steel, cold-rolled to increase strength and elasticity. *Circle:* With a "Shot-weld" machine this expert controls perfectly each weld on a side frame in the first step of assembly. See also illustration on front cover



3 While the side frames of the car are being assembled on one line, the roof is started on another and parallel line. The roof structure will join the side frames after the floor (Photo 5) has been installed. *Right:* Welder putting the final touches on the roof just before it goes into the basic structure of the streamliner

Photographs courtesy Edward G. Budd Manufacturing Company

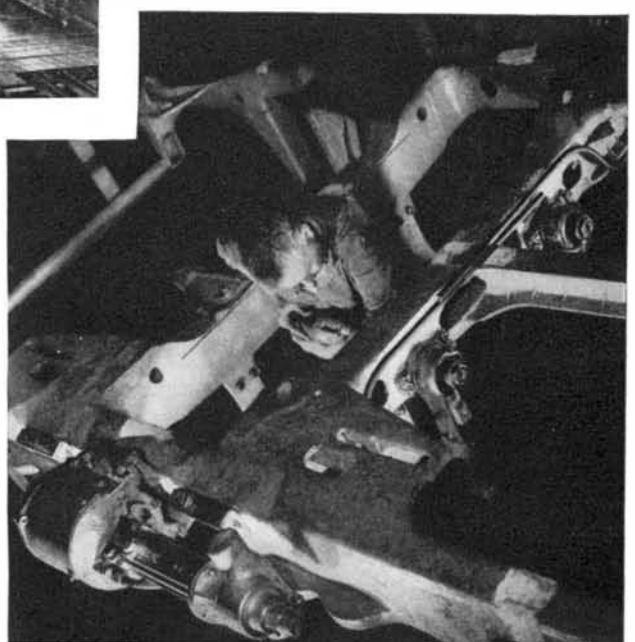


4 Through the utilization of welding and of stainless steel alloys which have approximately four times the tensile strength of ordinary steel, it is now possible to produce railcars in which the weight has been reduced to almost half that of former standard equipment. *Above:* Substructure of a railcar, with center sill and cross members in place, ready for assembly of side walls and floor

■

5 *Above, center:* Part of the first flooring has been welded in place; it is made of corrugated stainless steel similar to that of the roof. The grooves of this first flooring will be filled with a plastic deadener over which will be placed a layer of cork before the floor covering goes on. This construction assists in sound- and thermal-insulation

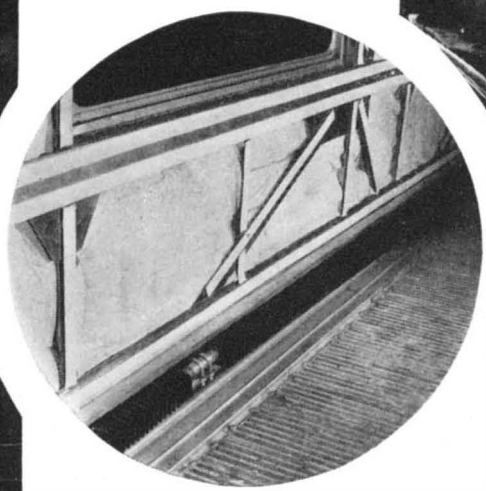
6 Smooth, safe travel in this streamliner is assured by electric pneumatic brakes, side sway eliminators, other developments. *Below:* A workman assembling a truck on a third line. At the same time, other workers are installing exterior flutings and window panels of the car



TO STREAMLINER

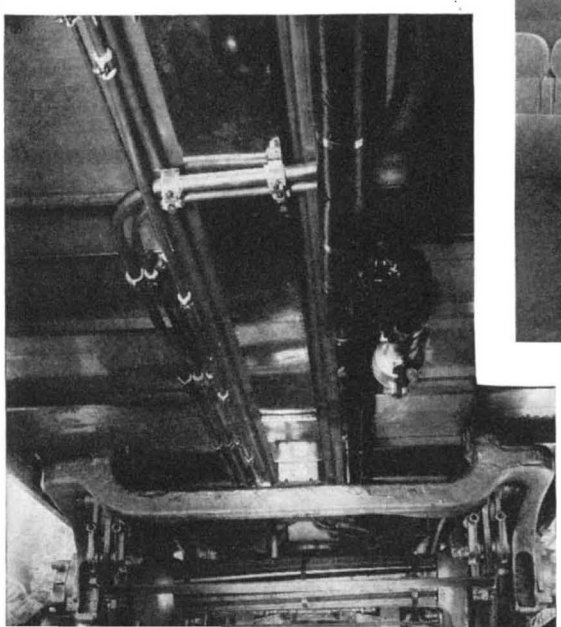
By A. P. PECK

7 Installing the interior trim in the railcar. The thin strips which have been welded to the under side of the roof structure will hold in place the sound deadening and the heat-and-cold insulation material. In one of the tests which these cars undergo during construction, weights are distributed throughout the car to simulate maximum load during operation. An engineer then checks the structure for deflections



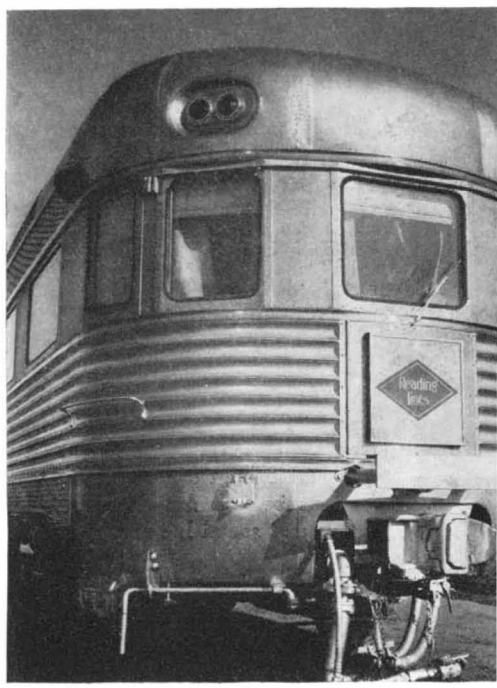
8 The fin-type radiators have been put in place near the floor and insulation has been installed in the side walls. The baggage racks (not shown) have been hung and above them has been placed the heavy roof insulation that protects passengers from extreme temperature changes while traveling

9 The fluted panels on the outside of the car are installed individually so that they may be removed without disturbing the rest of the structure. Following this, the car undergoes a rain test, during which a spray of water under 80 pounds pressure is directed at every joint and seam; if leakage is detected, the defect is remedied immediately



10 How one of the cars of the streamliner looks from underneath. The trucks have been installed and all of the piping insulated to reduce vibration and temperature losses. Final adjustments on the air-conditioning system are made before the car leaves the shop

11 The trimmers and decorators have completed their tasks; the car is ready for the road. Individual chairs revolve and recline for maximum convenience and comfort. The streamliner is complete in every detail—dressing rooms, smoking compartments, lounge, diner, and an observation car



12 The factory's work is done. The train is ready for service on the Philadelphia-New York run, where it is now providing travel comfort unthought of by railroad men only a few short years ago. To metallurgy and welding, working hand in hand, must be given the major portion of the credit for the development of these newest, fastest, safest monarchs of the shining steel tracks of the railroads

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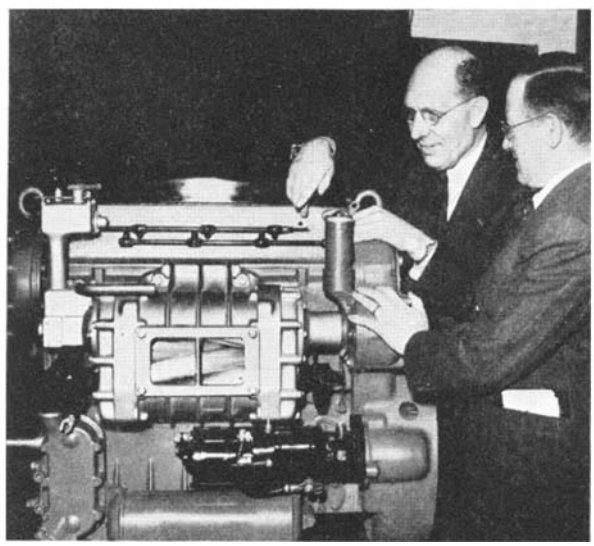
The Diesel Broadens

"Packaged Power" for Many Uses . . . A Complete Power Plant in One Unit . . . How Will Increased Fuel Demand Affect the Market Price?

ABOUT the time this article reaches its readers, it may well be that the owner of a small factory in the deep South, far from a convenient source of cheap electric power, will be unpacking a strong, but compact, case with something of the anticipation of a small boy on Christmas morning. Or that the owner of a large farm somewhere in the northern prairie states will be setting up the contents of a similar crate, rejoicing that for the first time he will be able economically to milk by machinery and to make a dozen different applications of minor power which he knows will lighten his burden and fatten his pocketbook.

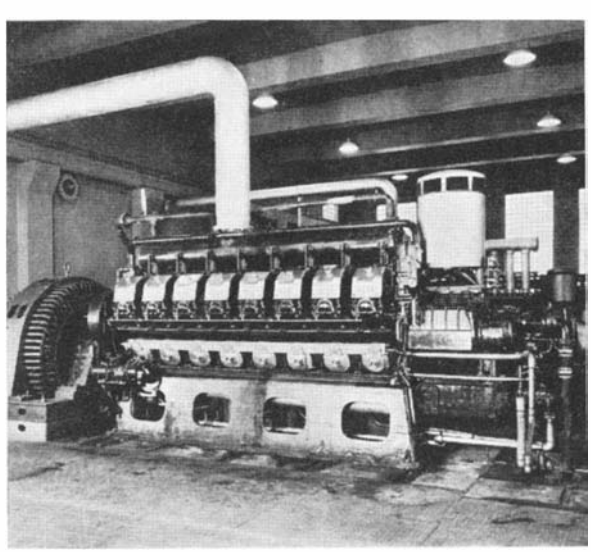
These men will have purchased "packaged power" offered—to a degree not hitherto available—through the fundamental developments which have been made in the Diesel engine field by General Motors Corporation. The significance of these developments has thus far only been hinted at. They would seem to mean—given the maintenance of prices for Diesel fuel at a figure within reason—that the advantages of the oil-burning engine may be extended into a variety of industrial categories not even dreamed of a few months ago. It is perhaps not too much to say that out of the fascinating, extraordinarily sound-proofed, modernistic laboratory in a hardwood grove near Detroit, which is the real seat of the whole undertaking, an effect of major importance on American economic and social life may come.



Charles F. Kettering (left) and R. K. Evans, both active in the General Motors' Diesel development, inspect one of the new medium-size power plants that have been designed for a wide variety of uses

TAKING heart from the immense proved success of the large Diesel-electric applications which power so many of the streamlined trains that have been making railroad history in the last three or four years, the great automotive producer has plainly decided to throw the full weight of its resources and its technical knowledge to a very much broadened field of the whole Diesel undertaking.

The restless, inquisitive genius of Charles F. Kettering, vice-president in charge of research, and of a corps of younger, but no less enthusiastic, engineers, have been making exhaustive study and experiment in the Diesel field for at least a decade. The surface story of what they have accomplished in the design of two-cycle Diesels for railroad use is already familiar; some of the significant facts developed by the operation of these larger Diesel electric units are not so well known. For example, the *Super Chief* of the Santa Fe Railroad — Diesel-powered — has never yet been late at any terminal or intermediate stop. No comparable record has ever been made by a steam-drawn train. Last winter in the Continental Divide the Union Pacific had its usual quota of snow. When a particularly bad storm blocked one of the high passes, a steam train was sent in to clear the track. The train got stuck and had to be pulled out tail first. Then a Diesel-powered train was sent in; it hit the snow at 80 miles an hour and came out on the other side at 50 miles an hour. Thinking the pass was clear, the steam train was sent in again. Again it was stuck and had to be dug out; it was left to the Diesel to do the pass clearing.



A 16-cylinder Diesel and a 1000-kilowatt generator furnish power for the Diesel development laboratory

H. L. Hamilton, president of the Electro-Motive Corporation, a G-M subsidiary, is authority for the statement—and it is backed by railroad operators—that in switching-engine service alone, if the Class 1 railroads were to put into service 3000 Diesel locomotives, this number, about 25 percent of the present locomotive inventory, would cover about 50 percent of the present switching hours and effect a saving of 52,000,000 dollars annually in operating expenses. This saving would be sufficient to liquidate the investment in Diesel locomotives in five years and would allow the retirement of not less than 5000 old and obsolete steamers.

If this prime mover was so eminently an answer to a railroad's prayer, the forward-looking minds in General Motors thought, why not extend its benefits downward so that the small man in almost any field, where more power than that supplied by a single "home-lighting" unit would be useful, could share in oil-burning economies?

This is precisely what has been done in the set-up of the Diesel engine division of the corporation. It involves the new factory at Detroit with its satel-

ITS FIELD

By REGINALD M. CLEVELAND

lite (more important than the planet) the laboratory; the taking over and development of the former Winton Engine Manufacturing Corporation of Cleveland; and the expansion, just now reaching completion, of the locomotive shops of the Electro-Motive Corporation at La Grange, Illinois.

At La Grange, the railroad and large marine units, such as those for the Navy, will be produced. At Detroit will be built the little fellows running down from six to one cylinder and from 160 to 22 horsepower. At Cleveland will be manufactured a full line of medium-size engines, ranging from 200 to 400 horsepower. Here too will be produced the "packaged-power" units which consist of small size Diesel engines and generators, in either stationary or portable models, which can be quickly set up, complete with base, wiring, radiator, and fan, to power small industrial operations, hospitals, theaters, irrigation projects, tractors, pumps, hoists, parking lots, and a score of other enterprises.

NATURALLY, the smaller sizes will be used in extending Diesel truck and motorboat applications. While officials of the corporation say very definitely that no application to passenger car or aircraft use is at present in sight, and refuse even to confirm a guess as to when such development may be expected, it would be foolish to suppose that out of the Detroit laboratory will not come efforts in these fields with their obvious advantages of economy and safety.

In outlining the problem that General Motors has attacked, "Boss Kett" as usual comes down to fundamentals.

"There is no trouble," he says, "about getting engines to work on special fuels today, but we said we didn't want any fuel specifications at all; we want to operate on any standard furnace oil available in the community in which we live. You shouldn't have any special lubricating oils; you should be able to run on any of the standard SAE 30 or 40 oils available in the community in which you operate.

"These engines shouldn't be bigger than the gasoline engines; they shouldn't weigh any more. The smaller engines weigh more than gasoline engines for a good reason; the designers elected to use the standard parts from the big engines for the smaller engines, but still the engines are much smaller and lighter than any competitive engine on the market today.

"There is some correlation between gasoline engines and Diesel engines. Last year, at 50 horsepower per vehicle, we made more than 200,000,000 horsepower of gasoline engines. We made about 1,000,000 horsepower of Diesel engines last year. They were made by 25 or 30 manufacturers. Now, the Diesel manufacturers aren't to be criticized, because they have had to take the job as they could. This is the first attempt we have ever made to try to design a line of engines all the way through, tool-up for it, on the same basis and with the same technique the gasoline engineers use. We have built something like 40,000,000 automobiles in this country, and out of that much experience we have learned to do a pretty good job. We have tried to take that knowledge and apply it to a similar operation.

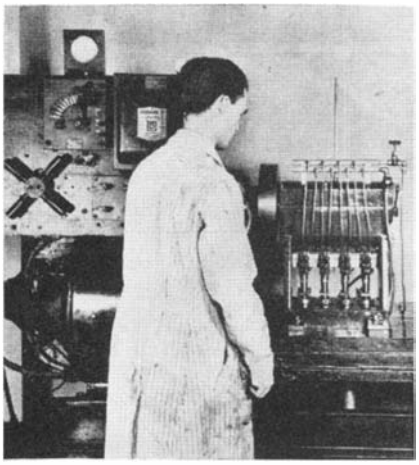
Top to bottom: **Two-cycle Diesels of six, four, three, and one cylinder types. The lower one, a single cylinder model furnishing 22 horsepower, is complete with an electric generator in a "packaged-power" unit**

"FOR the first 20 years—the Diesel engine is about 40 years old, about the same age as the gasoline engine—they had to make Diesel engines like steam engines because they put them in where steam engines came out. The next 20 years they have been trying to make them like gasoline engines. I think this is the first serious attempt that has ever been made to make them like Diesel engines.

"We are introducing a new type of power here; which is a remarkable thing. There is nothing like it in the world. It is very much lighter than any corresponding type of machinery. We have enough faith in it to build these plants and these laboratories."

The engines which have resulted from this formula are compact, smooth-running, and remarkably vibrationless even at 1800 to 2000 revolutions per minute. In the astounding laboratory where the testing is done there is a strange degree of silence. The building was purposely erected on marshy ground, on steel and concrete piles running down about 75 feet. Each test bed in the eight bays opening on a common corridor is also mounted on an independent system of piles, insulating it from the rest of the structure.

Although when the writer was last there Diesel engines were generating at least 10,000 horsepower of energy—



Production and experimental models of Diesel fuel injectors are kept under constant test in machines such as this. The plungers, building up injection pressures of 50,000 pounds, are forced up and down 3,000,000 times a day as engineers check for defects, make plans to remedy them

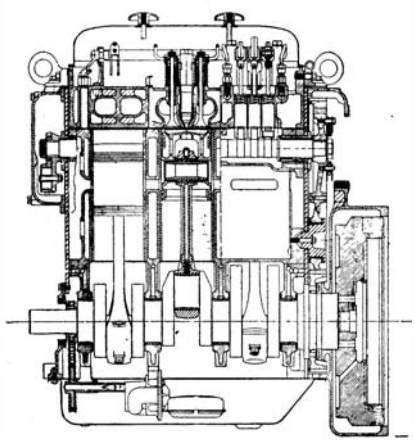
and all this horsepower is used in the form of electricity in the laboratory and adjacent plant—it was quiet enough within the building to talk without marked effort and outside the building there was only a low, droning hum.

The G-M two-cycle Diesels are notable both for compactness and for the interchangeability of parts. Thus, all of the accessories such as exhausts, blowers, auxiliary drives, and so on, can be removed from one side of the engine by the veriest tyro mechanic and attached to the other side. It is not difficult to realize the importance of this feature for boat use or in any place involving cramped quarters. Moreover, the simplest sort of an adjustment makes it possible to reverse the direction of rotation.

APPLICATION of precision standards has been carried out, in the new Detroit plant, to a degree never before applied to mass production—early factory schedules call for 50 engines a day. Some idea of the precision manufacturing involved may be had from the tolerances required in the most exacting parts. For example, maximum clearance between the bore or barrel of the fuel injector and the plunger which moves within it must not exceed 50 millionths of an inch. Maximum clearance at the tip of the injector between the needle valve and the bore within which it moves must be less than one ten-thousandth. The average run of limits of all other parts of the injector assembly is of the order of one ten-thousandth.

These delicate parts are measured by that remarkable instrument, the Electrolimit gauge, which is accurate to the millionth part of an inch, but gives an exact reading on a large calibrated scale. As you watch this scale, you find that one ten-thousandth of an inch, a measurement too small to comprehend, is shown on a scale larger than that of one of the instruments on the dashboard of your automobile.

The hole in the injector nozzle—a very vital consideration in the proper operation of a compression-ignition engine—varies, according to engine size, between six thousandths and fourteen thousandths of an inch in diameter. Drilling is done by the use of special machines, designed at the plant, in which the drill rotates at extremely high speeds by the use of a tiny, air-operated



Longitudinal cross-section of one of the new three-cylinder Diesels

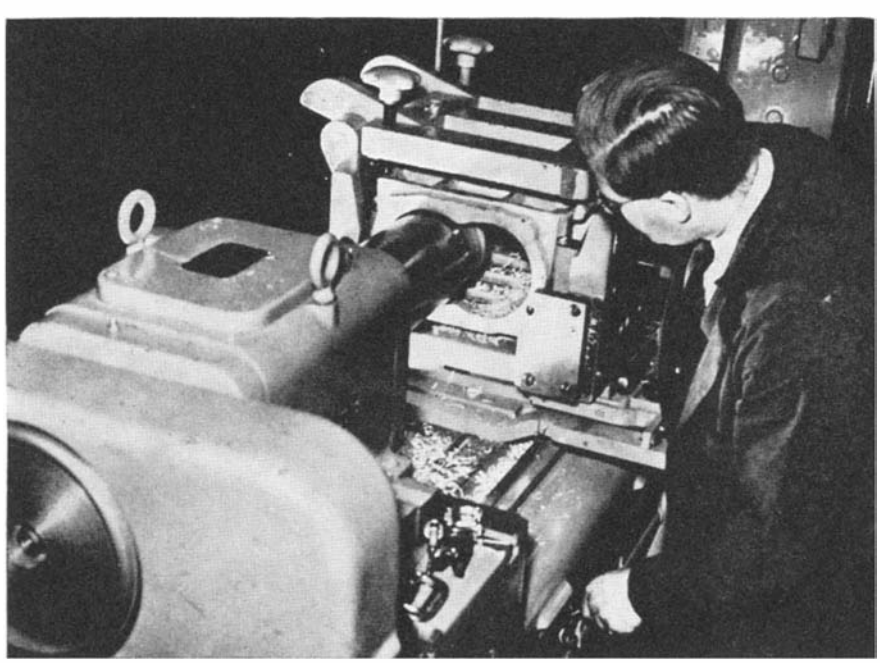
turbine. So sensitive is the drill itself that mechanical means will not suffice to feed it into the work. The spindle floats and is eased into the work by the operator's sensitive fingers as the drill rotates. Each injector is tested on one machine which determines its seal under pressure of 5000 pounds to the square inch and then on another which "pops" the nozzle to insure clear passages.

Dozens of specialized machines make possible the application of watch-making precision to a production operation.

At the present cost of Diesel fuel, it is estimated that the small industrialist and the big farmer, removed from giant sources of power supply like Muscle Shoals or Boulder Dam, can produce his own electricity by means of the new Diesel "packaged power" at a cost not to exceed two cents a kilowatt hour. It is obvious that very broad implications as to decentralization of industry and as to independence of public utility domination, now so liberally castigated in high places, are implicit in such a situation.

There is every reason to believe that a new page has been turned in that story of progress which has marked the patient years since the first application of compression-ignition to power production by the late Rudolph Diesel.

THE fly in the ointment is, of course, the bugaboo of rising Diesel fuel costs, both by reason of price loading by producers and tax pyramiding by legislators. Many oil experts hold, however, that should a demand arrive for Diesel fuel which would supplant a considerable proportion of the gasoline demand, there is nothing in the economics of refining which would justify an untoward rise in the cost of Diesel and domestic oils. It would seem to behoove those who have a real interest in the continued march of technological progress here indicated to keep a careful eye upon this aspect of the situation, and to see to it that the tax gatherer does not unduly hinder a development which is in the broad public interest.



Boring the aluminum blower housing of a Diesel. In the finished engine the blower is a scavenger, forcing burned gases out of the cylinders after each power stroke

THE 'FOURTH TRANSCONTINENTAL'

THERE was a time not so long ago when a single pair of wires would carry all the transcontinental telephone traffic there was, and even then, time hung a bit heavy on its cross-arms. But since that first year the wires have carried a rapidly growing stream of traffic, and one by one, new routes have been carved across the country, new wires added.

Only part of this traffic has been telephone calls. The business of east and west has become so closely interrelated that the old Boston house of Smith & Company must have a branch office in San Francisco to handle its business out there, while the great Los Angeles firm of Jones Brothers must have a sales office in New York—with private telegraph or teletype lines between the two offices. Newspapers on either side of the Rockies exchange news—and pictures—daily, by wire. Finally, the broadcasting stations of the country are welded into great chains by means of wires.

Until recently, three routes across the country were able to handle comfortably the 400 or so daily telephone conversations, the coast-to-coast broadcasts, the telephotographs and the steady stream from hundreds of telegraph keys and teletypes. But studying the growth of these services, engineers realized that before long, more channels must be provided. The result was that the Long Lines department of the American Telephone and Telegraph Company set to work and built the "Fourth Transcontinental," an express telephone highway of large capacity, designed to take over a substantial share of the increasing long-haul traffic. Following the flight of the crow from Oklahoma City to Los Angeles, it cuts square across some of the toughest tracts in the country. Along one section between Amarillo and Albuquerque, some five tons of dynamite were used to blast holes for the telephone poles. All along the route are great furrows in the earth that are now "dry washes," now the beds of seething floods. All of these had to be spanned by some suspension device. Over and over again, the rough terrain presented some problem that had to be solved with an eye on the future and to what changing conditions would do to today's handiwork.

The significant feature of the new line is the equipment now being installed at its terminals—"carrier current" apparatus whereby new voice channels can be superimposed on each pair of wires, at high frequencies, ranging from 36,000 to 140,000 cycles. By combining this system with existing methods, it will be possible for *16 pairs of subscribers* to carry on, simultaneously over a single pair of wires, 16 conversations as neatly and effectively separated from each other as the layers of a club sandwich.

"X" marks the spot for the next pole. Whether there be mud or sand, or rock that must be blasted out, that spot is where the pole must go

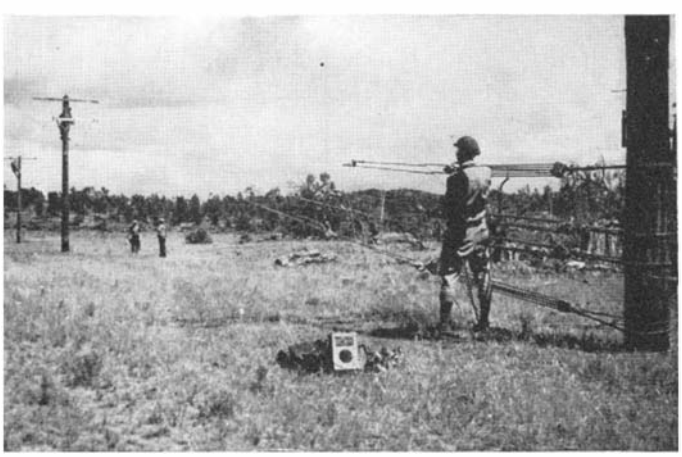
With the installation of the carrier system, more "repeater" stations are being added at numerous points. These repeaters, consisting of vacuum-tube amplifiers that re-energize the voice in its travel over the wires, are usually spaced from 100 to 300 miles apart. Along the carrier channels of the "Fourth Transcontinental" between Oklahoma City and Whitewater, California, a distance of about 1200 miles, there will be 16 or 18 repeater stations—an average spacing of 65 to 75 miles.

Because of the high frequencies to be used, the cross-arms on this line are placed three feet apart, instead of the usual two, as a means of minimizing the "cross-talk" between adjacent wires. It is also necessary to have frequent "transposition" of each pair of wires—the wires crossing each other, in some cases, at every other pole.

ANOTHER requisite of the new system is that poles must be spaced evenly, or very nearly so—not always easy in such terrain—and the sag of the two wires of each pair must be uniform. To produce the desired accuracy, there must be careful adjustment of the wires. In the principal method used, each wire of the pair is plucked in such a way as to cause it to vibrate. The period of oscillation of each wire is compared with that of the other wire of the pair. If these periods are found to be alike, the wires have the same sag.

The new channels on the "Fourth Transcontinental," which enters the Bell System cable network at Oklahoma, will bring the total number of direct circuits from New York to San Francisco and Los Angeles up to 20, while from Chicago there will be nearly 30 direct circuits to West Coast cities.

Since that first tiny filament crept across the Sierras in 1915 there have been notable developments in transcontinental telephony. Some of them interest the scientist, some of them interest the historian. One of them interests everybody, and that is the price of long-distance telephony. In 1915 a three-minute talk between New York and San Francisco cost $20.70. Today, for 30 cents more, one can talk across the Atlantic, while a "station-to-station" talk from New York to San Francisco now costs only $6.50. With this downward movement in cost has come an equally notable upward movement in the quality of transcontinental circuits.

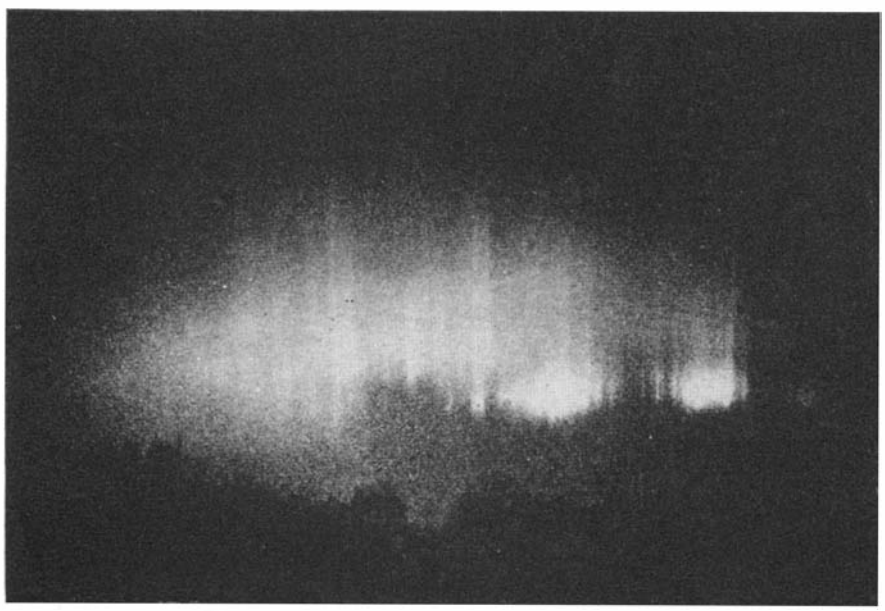


Wires over the cross-arms are pulled taut. On the poles, linemen check the sag of each pair to insure uniformity

NORTHERN LIGHTS

Why the Scientist Studies the Aurora: Research that Is Bound up Closely with a Number of Other Phenomena in the Upper Regions of the Atmosphere

By A. S. EVE, C.B.E., F.R.S.
Emeritus Professor of Physics, McGill University, Montreal



Auroral streamers, photographed at Oslo, Norway, by Prof. Carl Störmer. In the annals of auroral research Professor Störmer's name is extremely prominent

THE appearance of the northern lights has been frequently described, and in any case words are quite inadequate to describe its beauty. The three main forms of display are the arc or arch, the curtains, and the long streamers. The color is commonly greenish white or greenish yellow, sometimes with an admixture of red or violet. The first appearance of the aurora is sometimes a bright quiescent arch with its peak a few degrees west of due north. This may suddenly be followed with a host of streamers, like searchlights, but changing, flickering, and dancing. At other times the display begins with nearly vertical curtains of light, the folds of which keep changing in form. The drapery is usually to the north, spreading from east to westward, but sometimes it appears quite overhead. Even as far south as the state of New York the curtain may sometimes be seen south of the zenith.

The altitudes of these displays have been skilfully measured in Norway by Störmer, with a number of observers connected by telephone, who took photographs at the same instant from different places (Figure 1) at a measured number of miles apart. A simple calculation determines the altitude of the aurora. About 60 miles is the most common result; that is, 60 miles from the surface of the earth, not from the observer. Sometimes the tops of the streamers may be 250 miles above the earth, and I believe that the lowest determination is an altitude of 40 miles. The record height for the top of a streamer is 1000 kilometers, more than 600 miles. Similar measurements were made in Canada by Sir John McLennan and others, and the results there were in excellent agreement with the earlier determinations in Norway.

The spectrum of the aurora has been photographed, and most of the lines, or bands rather, are found to be due to nitrogen, which is the major constituent of the atmosphere (about four fifths) here on the earth, and remains the chief constituent at great elevations. The spectrum of the aurora also includes the famous green line which Sir John McLennan investigated so ably and proved to be due to oxygen in an enhanced or unusually excited state. He and his co-workers actually produced the green line in his laboratory at Toronto by suitable stimulation of oxygen with helium, neon, or argon also present. About 1 percent of the air at ground-level is argon. All the other rare gases are present in much minuter quantities: neon, krypton, xenon, radon. Hydrogen is so light, and the molecular velocity in consequence so large, that the hydrogen overcomes gravity and passes out of the atmosphere.

Some of these gases, notably neon, the ingenious Claude has shown us how to collect, to place in tubes at low pressure, and to ionize with high voltage, so that every city is bespangled with artificial auroras, and decorated with an extraordinary variety of colored signs and vivid advertisements. It may well be that some of the rare gases also play their part in the occasional rich coloring of the genuine northern lights, and Sir John McLennan believed that at high altitudes there is more helium than oxygen! On the other hand Kaplan puts forward evidence that enhanced nitrogen can also excite the green line in oxygen.

EVERYONE today is familiar with a magnetic field, particularly as everyone has lived all his life in a feeble field of that character due to our great magnet—the earth. It is not suggested that we know exactly what magnetism is, but then that is true of everything else. If you shoot electrons at right angles to a uniform magnetic field, the electrons will go around in circles—exact circles. The stronger the field and the slower the electrons, the smaller will be the circles, and the converse is true. The mathematical, electrical, and mechanical principles are simple and certain. If, on the other hand, electrons are projected obliquely to a magnetic field, then the electrons will each one describe a helix or a path with the shape of a corkscrew.

If the electrons are shot earthward from the sun, they will travel through space and become entrapped by the magnetic field of the earth. They will spiral around the lines of force until they meet the upper atmosphere in the regions surrounding either the north or south magnetic poles. The speed of such electrons may be sufficient by their collisions to ionize the molecules; that is, to knock other electrons from them, thus leaving positively charged molecules, or ions. The recombination of electrons with positive ions is attended with radiation,

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as has been amply proved in laboratory experiments. It is generally believed that electrons spiraling around in one direction arrive near the north magnetic pole and give rise by ionization to the *aurora borealis*; while similar electrons spiraling around the lines of magnetic force in the other sense proceed toward the south magnetic pole and occasion the *aurora australis*. This result is well confirmed by experiment. It is not easy to ascertain the extent to which auroras occur together at the same time in both arctic and antarctic regions. There are some theoretical reasons for expecting such coincidence, and some of the major displays such as that of February 4, 1872, have been seen in both northern and southern latitudes.

There are some authorities who declare that light, charged particles, such as electrons, would mutually repel one another on their long journey from the sun, so that they would be scattered far afield, and in that case there should be no auroras at all! Prof. S. Chapman states that there are positive, negative, and neutral particles all coming from the sun. There is also quite a wide choice of possible projectiles—electrons, positrons, protons, neutrons, deutrons, alpha particles, and cosmic rays, besides photons. Therefore it is not wise to be too didactic as to the nature of the bombardment that arrives at the earth's surface, but it is right to insist that only electrically charged particles will show so marked a tendency to proceed toward the two main magnetic poles of the earth.

It may very well be asked why it is claimed that the projectiles come from the sun. The answer is that auroras, sunspots, and magnetic storms all follow, over a long series of years, the same periodic variation of increase and decrease in number and intensity. This is the well-known 11-year cycle. In recent years the variation of the effective frequency required for radio signals across the Atlantic has been found to follow the same cycle.

TODAY there are eight different ways of obtaining information about the nature and properties of the upper air (Figure 2).

Pilot balloons filled with hydrogen can carry up small, light, ingenious recording devices. If the balloon is recovered on its return to earth, there are records of elevation, temperature, and humidity. Such balloons may also be followed with a transit instrument, or theodolite, so that the wind velocity at different levels may be deduced. The greatest elevation attained by a balloon, without recorders, was 23½ miles, at Padua. One of Regener's balloons has ascended 17½ miles and been recovered with its recorders.

In recent years attempts have been made to explore the stratosphere in balloons. The intrepid Piccard constructed a gondola sufficiently strong not to explode, and was himself carried inside it upward by a balloon. The ascent is easy, the place and nature of arrival on the earth are largely fortuitous. He reached an altitude of 10 miles and obtained valuable results on the cosmic rays, which at that height are about 100 times as intense as on the earth's surface. The Soviet gondola crashed to disaster after attaining an altitude of 12 miles. The greatest height so far attained is 13½ miles, achieved by Anderson and Stevens in the United States.

A new method of exploration has been devised by Tuve and others, members of the Department of Terrestrial Magnetism, Carnegie Institution of Washington. A searchlight beam is directed upward to a height of 17 to 40 miles, and the intensity of the light is periodically modulated, or varied, at the source. A large concave mirror collects the scattered light from the upper part of the beam and brings it to a focus on a photocell connected to an amplifier, which is synchronised with the modulation of the searchlight. This apparatus may well give some information on the nature of the molecules in those very regions on which we are least informed, above the range of pilot balloons and below the auroral and ozone layers.

Ozone is produced from oxygen by radiations of a suitable frequency or by electrical discharges. Much of the ultra-violet light from the sun is absorbed or stopped in the ozonosphere about 20 to 40 miles above the earth. The presence of the ozone is revealed by absorption bands in the spectrum of the sun. When the sun is high it passes almost vertically through the ozone layer. When the sun is setting its rays have to pass horizontally through a much greater thickness. Measurements of the intensities of the absorption lines due to ozone, lead to an estimate of the height of the ozone region as being about 25 miles, and therefore lower than the northern lights.

THE barometric disturbance due to the great Krakatoa volcanic explosion traveled four times around the earth, and the actual noise of it was heard 3000 miles away. The sound of big guns or of heavy explosions passes upward into the cool and rarefied air and is then refracted or bent back again to the earth, so that sometimes, like short-wave radio, it cannot be heard or detected at intermediate distances. Newton stood in the gateway of Trinity College, Cambridge, and heard the guns of a naval action between the Dutch and the English. He foretold a British victory, because the noise of battle became gradually fainter as the victors pursued the Dutch. The fact that sounds are bent back again to the earth necessitates a warmer layer above the cold. It seems that with increasing altitude the temperature may gradually decrease down to many degrees below zero, Fahrenheit, but at a height of 30 miles there is an increase up to 80 degrees, Fahrenheit, and the heat to maintain this may be connected with the formation of ozone from oxygen by the sun's ultra-violet light.

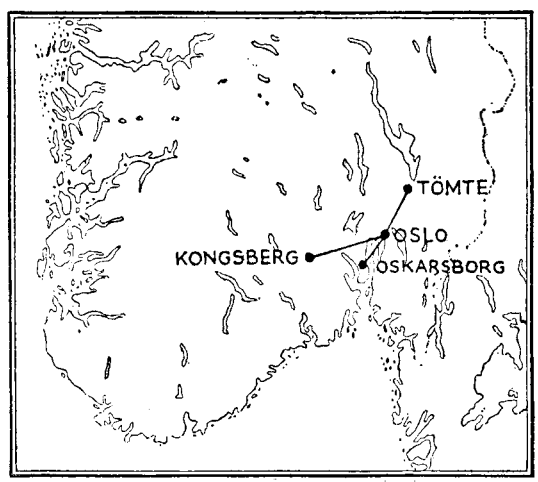

Figure 1: **Störmer's network of observing stations, linked together by a telephone network**

The most important method of throwing light on the nature of the upper regions of the air is by projecting radio waves directly upward, for it is found that with suitable frequencies they will be reflected back to the earth. It will be recalled how puzzling it was, in the early days of wireless, to account for the fact that the electro-magnetic waves, expected to move in a straight line like light, could travel from Ireland to Newfoundland. Today wireless waves, carrying speech, music, or Morse, can be sent completely around the world, so that a man can speak to himself and hear it a fraction of a second later, using waves which have circumnavigated the globe, changing local time in the most remarkable way as they traveled. During a part of the journey it must have been yesterday, or tomorrow, although on return it was the same day and perhaps about a seventh of a second since they started. It was surmised both by Kennelly and by Heaviside, independently, that the possibility of successful long-range wireless signals depended upon reflection or refraction by an electrified or ionized region at a considerable height above the earth. The proof of the existence of such a conducting region was given by Appleton, who also showed that there is another higher region also capable of reflecting radio waves back to the earth.

The lower or E region is at about 100

kilometers from the earth, and it is also called the Kennelly-Heaviside region. The upper or F region is two or three times as high and bears the name of Appleton. It is possible to send a brief signal of suitable frequency which will be reflected back from both the E and F regions, so that both signals may be recorded on a suitable photographic plate by means of the cathode-ray oscillograph. It is possible to measure the very short period of time between the initial and return signals, and as the velocity of such waves is about 186,000 miles a second, it is easy to deduce the height of the reflecting region. For example, if the interval is one thousandth of a second, the reflecting layer would be about 93 miles above the earth. Experiments carried out by Henderson and others, during a total eclipse of the sun in Canada, proved that the E region is made conducting, or is ionized, by the ultraviolet light from the sun, but it is not yet possible to assign a cause to the F region.

It should now be clear that it is necessary to determine in due course the different types of radiation responsible for (a) the ozone layer, (b) the Kennelly-Heaviside layer, (c) the Appleton layer, (d) the more occasional and local auroral displays, all of which are attributable to the sun's activity. There is a yet more difficult problem with respect to the cosmic rays and the bursts or showers of ions to which they give rise. Sometimes 100,000,000 ions occur at a single outburst.

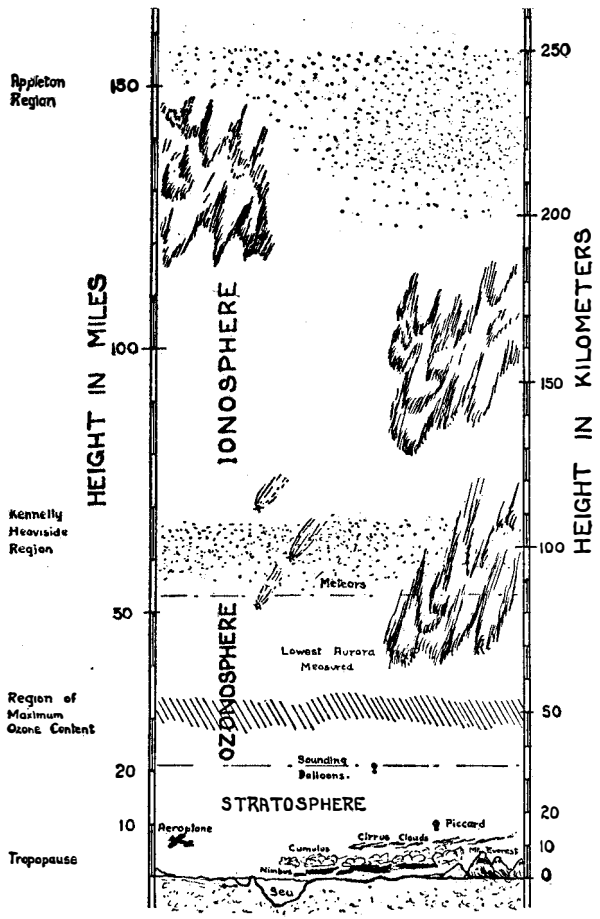

Figure 2: **A scale drawing showing some atmospheric phenomena that take place at different altitudes noted**

IN the upper atmosphere, the pressure is so low that the molecules are quite far apart, and if an electron is detached from a molecule by some type of radiation, it may have to wander a long way before it can find a partner in a positive ion; or it may find a resting place on a neutral molecule, so that the pair become a negative ion. While free, the electrons are so small and light, compared with their electric charge, that they are readily made to oscillate, or dance in rhythm, with any electromagnetic waves that are passing them. Curiously enough, the group of waves travels the *faster* in consequence, so that an electromagnetic wave entering these ionized regions obliquely has the upper part wheeling faster than the lower, until the wave front is turned around and proceeds downward to the earth again. However, much the same sort of thing happens every time you look into an ordinary mirror or looking-glass. There also the free electrons in the mercury at the back of the glass are able by their stimulated motion to return to you a fairly faithful image of your face.

Radio signals will also bounce to and fro between the earth and the reflecting regions, proving that the earth is an admirable radio reflector. The total path for eight such reflections, which have been obtained from the F region, must exceed 2000 miles.

In old days the heavens were deemed to be eternal, changeless and perfect, so that the discovery in the days of Galileo that there were spots on the sun came as a shock to medieval thought.

The face of the sun is a turbulent place at the high temperature of 6000 degrees, Centigrade. Black spots appear on it, sometimes large enough to be seen through a darkened glass with the unaided eye, and broader than the diameter of the earth. The number of these spots follows the same 11-year cycle as the frequency of the aurora. At the beginning of such a period the face of the sun may be practically without spots. In due course a few appear in middle latitudes on both sides of the sun's equator. There is a steady increase in number, the spots become nearer to the equator, and they disappear when at the lowest attained latitudes.

These relatively cool, dark whirlwinds reveal magnetic properties discovered by Hale through the Zeemann effect, and they may perhaps be compared with the "lows" or cyclones which so often bring storm, rain, and flood. The periodicity of sunspots, auroras, magnetic storms on earth, and changing radio phenomena, has been found to hold good for the fluctuations of the white polar caps on the planet Mars, and even for a cycle of ring growths in the great and ancient trees of western America.

MOST people are familiar with shooting stars or meteors, and many have seen in their lives dozens or hundreds of them, yet it always comes as a surprise to learn that no less than 20,000,000 of them every day plunge into our atmosphere with velocities ranging up to 130 miles a second. Sometimes these visitors are but the size of a pin's head, and at other times they are large enough to pierce the atmosphere and reach the earth. The famous Arizona crater may have been formed long ago by a giant meteor; the crater is 1400 yards across and more than 500 feet deep. In 1908, a great meteor, estimated to weigh 130 tons, fell in Siberia and devastated by its great heat hundreds of square miles of country.

The elevation of most frequent meteoric displays is about 40 to 60 miles above the earth. It is somewhere in this region that the temperature rises according to the theory of the reflection of sound waves, to which reference has already been made. Sometimes the meteors are of iron, sometimes of stone, and it is not easy to understand how they become red or white hot when rushing through cool air, how indeed they acquire more heat from the bombardment of molecules than is carried away by them. An experiment in the laboratory of a similar character would be difficult to make, because our projectiles achieve a speed of a few thousand feet a second, as contrasted to meteors having velocities of many miles a second. It must be remembered, however, that meteors are luminous in *rarefied* air at altitudes varying from 100 to 30 miles.

It will be gathered that the study of the Northern Lights is bound up with other physical phenomena in the upper regions of our atmosphere, and that progress can best be made, as in other branches of science, by advance on a broad front.

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Just what is this new science called "rheology"? It is the study of the fact that everything flows. Solid materials slowly flow, as is more and more realized. An early article will explain.

CAN MAN CREATE LIFE?

Important Discoveries... How Disease Viruses May Originate... The Newer Understanding of Viruses and its Significance... Is Life Only a Mechanism?

By BARCLAY MOON NEWMAN

CAN man create life in the test tube? This question has for centuries fascinated men of science and, indeed, all who have given it a moment's thought. Yet the more conservative scientists have always held any hope of success up to ridicule.

Today, ridicule is changing to wonder. Startling new discoveries apparently indicate that man-made life is straight ahead down the path of present research. Two related groups of findings suggest that at least certain simple animate varieties will eventually be manufactured in the test tube. The way toward the ultimate creation of more complex forms seems also to lie open. The view of the world as a vast system of mechanisms gains another triumph, and we may well doubt whether there are limits to the progress of science in such a mechanistic universe.

One line of evidence emerges from the discovery of the nature of the strange germs known as viruses; the other, from the newer understanding of the equally uncanny molecules, the enzymes, which are found as activators and regulators of chemical reactions within the living organization. The two lines of evidence are closely related because both virus and enzyme are not only molecules of tremendous size, but also protein molecules. That is, both are great clusters of atoms, or chemical compounds, similar in construction to hemoglobin (the pigment which makes blood red), to albumin (chief component of egg-white), and to all the innumerable other proteins occurring throughout the world of life and acting as the foundation-stones of animate existence. No organism is possible without protein. Protein is the framework about which the living chemistry is built. Hence, those who would synthesize a live being must first of all learn how to manage proteins.

Typical viruses are the various germs which cause infantile paralysis, smallpox, influenza, and the common cold. Each individual germ turns out to be a big, complex molecule. To the scientist this discovery is startling—but why? A molecule is a fairly stable organization of atoms, chemically combined in definite proportions. Every molecule therefore has a definite structure—a definite chemical formula. Chemists know how to determine formulas representing the architecture of molecules, and have set forth hundreds of thousands of formulas. And once chemists find the formula of a given compound, they are able to take steps toward synthesizing the molecule. Hence man can find the formula for a virus, then proceed to the test-tube manufacture of the germ. Then man will have created life—provided you admit to begin with that a virus is a living thing.

Is a virus truly alive? Until recently, every one who was aware of the existence of such germs thought of them as living agents of death, similar to—though much simpler than—lowly plants, the bacteria. Virus-germs remain indubitably agents of death. They are transmissible from host to host, wherein they reproduce, become as numerous as the sands, assume control of life reactions in many tissues which they invade, cause illness, destroy the host.

Nevertheless, each virus-germ, being only a single molecule, is far simpler than any other known germ, such as a bacterial cell, which consists of thousands of molecules of many different kinds. Bacteria range in size down to diameters of approximately one fifty-thousandth of an inch. But we could crowd 250,000 of the largest viruses single-file along an inch, and 2,500,000 of the smallest.

BACTERIA, too, like all things clearly alive, have a cellular structure—each bacterium has an outer thin wall enclosing protoplasm, the intricately organized life-material common to all plants and animals. This protoplasm absorbs water, soluble nutrients, and frequently oxygen through the cell wall, and gives off wastes, such as carbon dioxide and other products characteristically side-issues from, and evidences of, vital activity. Thus, bacteria respire, while viruses do not. Bacteria, as they carry on their biochemical reactions, develop heat—viruses do not. In short, bacteria are examples of life on a plane where whole systems of molecules—many almost as complex as the entire virus organization—co-operate to make a living symphony. The virus, then, is comparable merely with a single *tone*—being always but a lone molecule, however active and however amazing.

Moreover, virus molecules can be extracted from diseased tissue and afterward concentrated into quite solid and apparently quite lifeless crystals, each made up of a great number of closely-packed, separate molecules. And, though the virus thus crystallized still is infective when allowed to enter a healthy host, no virus has yet been known to multiply outside of living cells. Even if man is able to keep the germs alive in the test tube for considerable lengths of time, it appears—at least at our present first sight—that a virus cannot develop or long exist in the absence of other and previously existing life.

It is even suggested that a virus is a product of cell activity gone wrong—a dangerous, automatically reproducing molecule at times thrown off by accident from the body's all-too-fragile and hazardously intricate mechanism. This hypothesis maintains, for instance, that a cell, entirely germ-free, can by mere chance throw off a splinter from a bursting protein. This splinter, itself protein and very near the threshold of life—if not entirely alive—is nothing other than a virus, a germ suddenly come into being amid formerly normal life. Death leaps full-formed from life.

Perhaps here is the astounding explanation of the birth of at least some virus diseases. In most interesting fashion, Dr. E. V. Cowdry, professor of cytology (the science of cells) at Washington University School of Medicine, sums up these considerations:

"The chance of the formation of viruses at rare intervals may be a kind of hazard or risk which Nature runs as chemical and physical forces are harnessed in the evolution of life on earth. Human beings are subject to a greater variety of virus diseases than are any other animals. Many viruses spread to us from lower forms, but some may have originated in our remote ancestors. Consider the female sex hormone, theelin. Here a risk is balanced against a gain. The production of this substance has facilitated the differentiation [evolution] of higher forms and of man. The hazard

which Nature has run to achieve this result is that theelin is a dangerous substance closely related chemically, and also in its action, both to an essential vitamin (D) and to substances that can cause cancer."*

Certain complex compounds of carbon, including several compounds derived from coal-tar, upon being constantly applied to the skin of experimental animals (as to the ears of rabbits), bring on cancer of the skin. The supposition is that such cancer-causing chemicals achieve their dire effects by upsetting the protein chemistry of the skin cells. The unhealthy cells may then produce protein fragments within themselves. And these fragments would be just-born virus molecules, which are capable of taking over the command of the cell's chemistry and running it to their own lethal purposes. The cells, rendered mad, proliferate without restraint, build up horrible and horribly painful masses of tissue. And ever the weird virus makes more and more copies of itself.

IN other diseases, the virus must be introduced into its victim from the outside, an infected individual serving as carrier of the germ. So, in the instance of the common cold, Dr. A. R. Dochez, of Columbia University's College of Physicians and Surgeons, takes material from the noses of persons with heavy colds, forces the germ-ridden substance through fine filters, and so gets rid of all bacterial balls, rods, and spirals. The filtered material, touched to the nasal membranes of healthy persons, gives rise to new colds. The virus has been transmitted, can now work its evil.

The virus molecule attacks cell after cell, therefore it must move from cell to cell. Must it not be alive? Not necessarily: many a non-living molecule wanders to and fro within the tissues. Sugar migrates into the liver, and out again, back into the blood. The virus is capable of movement in the proper medium, yet this is no decisive reason for regarding it as a live thing.

After all, then, are we to conclude that the virus is not really alive? Definitely: No. Thus far, we have considered the whole argument against the conception of the virus as a living entity. But we have not explained away the strange powers of these big molecules—reproduction, multiplication, the ability to act as a parasite and to regulate the activity of myriads of lesser molecules. And, in addition, we cannot ignore the fact that viruses *do* move, whether or not their movement is dependent solely upon purely mechanical—that is, physical and chemical—conditions involving their nature and the state of their environment. The virus may migrate solely under the proper electric influence, because of electric attraction or repulsion. Nevertheless, no scientist for a moment doubts that *our* movement depends, in the last analysis, solely upon the physico-chemical reactions occurring within our muscles.

The virus has other properties characteristic of life. For one thing, a virus can mutate. That is, it can suddenly alter or be altered to a new variety. This new variety of virus can also perpetuate itself through host after host, indefinitely. We are all familiar with sudden increases in the virulence of virus diseases. Influenza epidemics are more severe during certain winters than during others. Presumably, the influenza virus has undergone a slight change in chemical structure, enabling the germ to play greater havoc with its victims. Smallpox virus is cultivated in the body of the heifer; a less virulent germ of cowpox is the result. Cowpox, introduced as a vaccine into man, induces only a light attack of smallpox—and we happily develop immunity to possible later attacks of the most potent smallpox virus. As the virus can mutate, it therefore exhibits evolution, even as all living forms.

Sometimes the virus is said not to be alive because it can multiply only in the presence of previously existing life. Judged on this basis, however, we ourselves cannot be called alive! Besides, the science of viruses is scarcely born. No one need doubt that coming knowledge will enable us to concoct non-living mediums in which viruses can reproduce practically endlessly.

THE final decision as to whether or not viruses are alive is academic hair-splitting, and depends ultimately upon our present unscientific definition of life. Any definition of life—never scientific or altogether accurate—is always no more than a listing of the activities *commonly* observed in many living things. There are phases in the life of every individual when we cannot tell whether the organism is dead or alive. What expert can say when a dying thing is actually dead? When a cell or a man dies, death does not occur "all over, all at once." Parts of a dead man, though consciousness and soul have fled, can be cut out and cultured immortally. Dormant spores are so sound asleep that we are unable to discover their vitality until we force them to change their structure and chemistry, and make them breathe and grow. What botanist is sure that this growing spore was not a non-living organization a moment past? We may give it life when we warm it, water it, feed it, irradiate it. The mere potentialities—the proper composition for life—may be there in the dormant spore. Our manipulation may be the precise influence necessary to lift the organization to the plane of quickness.

In the light of its astounding capacities, in the light of its protein nature, and viewed against the background of all distinctly non-living arrangements of atoms and against the background of all living organizations, the virus molecule must for all time appear to be a transition form between non-life and full-flowering life—but a form vividly more alive than not. There is no denying that, in many respects, the virus is a living thing, however simple. Except for its structural simplicity (and it is only comparatively simple, being a cluster of hundreds of thousands of atoms), and except for the function of respiration, which includes heat production, the virus molecule possesses every attribute of lowly life—life as observed among the lowly plants, the bacteria.

On paper, then, the virus shows up as a living thing, a transition form just inside the threshold of life. For the virus we have been able to check off life-qualities enough against the list of characteristics which together constitute our present definition of life and together provide a means of deciding what thing is alive and what not, to convince us that we are dealing with a vital gang of atoms, however low in the animate scale. Nevertheless, though the virus may today represent a transition form, it may or may not have true evolutionary significance. Can we demonstrate that, in all probability, the virus or a very similar organization was a stage in the evolution of the higher forms, ascending to human atom-constellations? Can we safely assume that, when we are synthesizing such odd gangs, we are also on the way toward creating higher types of organisms whose structures are built up of the units, the cells? If we can perform this demonstration and attain this assumption, at once we emphasize the place of the virus in the world of life and pierce closer to the secret of the cell, which has all the characteristics of life.

DR. R. G. GREEN proposes that the virus is a degenerate. He compares it with other but more complex parasites, such as the tapeworm, wherein ages of easy living inside the mammalian intestine have brought about loss of formerly better-developed digestive system, sense organs, and other organs unrequired in the warm, food-filled peace of the host's body. According to Green's theory, even in the beginning the virus was a simple, one-celled creature; lengthy parasitism deprived it of every equipment save that necessary to survival as a reproductive, multiplying skeleton of its former self.

But, to explain the origin of the virus, why run up the scale of life only to run down again? Green merely makes the problem more intricate. He forces us to explain in terms of evolution and devolution—and devolution can only follow

*Scientific Monthly, September, 1937.

evolution. If the virus skeleton was once clothed with flesh, we have to account for the formation of that flesh. On the other hand, if such a skeleton can do all that the virus does, why clothe it, only to render it naked once more? The essential point is that the skeleton *is* the virus. And this skeleton, this virus, this living molecule, is—even in Green's thought—the chief part and the logical starting point of higher life. We recall that protein is the framework, the reproducing and controlling skeleton, about which life chemistry is constructed. Before we develop Green's possible degenerating cell, we must first develop the starting molecule.

But did not Cowdry conclude that the virus may at least sometimes arise as a mighty, dangerous splinter cast off by erring protein chemistry, the chemistry of the cell? Yes, and though the virus is to attack the cell which bears it, and though this cell too is in a sense a degenerating live thing, still this suggested source appears a likely one. Why? Cell protein and virus protein are alike. Were they not blood relatives, it would not occur to us that viruses can emerge from cells' protein. They are, in fact, so closely alike that the highest refinement of modern analysis fails to elucidate the nicer differences between the virus protein-molecule and the cell protein-molecule. Above all, their phenomena—their systems of behavior—are basically the very same, and also unique. In all of chemistry's universe, no other molecules even approximate the lively manifestations of these proteins, unique molecules, life's sole possible start and life's sole possible framework. So, it is easy to think of virus organization arising from slight changes in cells' protein-molecule. So, too, it is easy to think of cell protein taking its rise from virus or related atom-clusters.

Related atom-clusters are the particular proteins, the enzymes, the stimulators and regulators of live chemical reactions. And it is here that we draw upon our second line of evidence that man will soon be manufacturing life in the laboratory: the evidence from the new lore of enzymes, molecules as uncanny as the viruses, their kin.

IN warmth and suspended in a watery medium having the proper concentrations of salts and acid or alkali, enzymes grapple with great molecules—starch, fat, protein—and burst them into lesser configurations of atoms. But enzymes are constructive as well as destructive. And interest is increasingly focused on this second activity of theirs rather than on their earliest-noted phenomena. Alter the concentrations of the substances swimming in the watery medium, provide spare parts with which the enzyme may play, and lo!, the enzyme begins upbuilding exactly the architectures which it was just now demolishing. The enzyme sorts the fragments, lines them up, hooks them together—in short, synthesizes a new large molecule out of tiny ones.

Further, enzymes have lately been shown to act much more gently, to bring about much more delicate changes. Thus, an enzyme can cause a subtle shifting about of small groups of atoms which are part of, and remain part of, a giant protein fellow. The giant may so be made a more active or a more sluggish thing, depending upon its first nature and the nature of the enzyme.

An enzyme of a certain type can ferry an atom or a group of atoms from one substance to another. In this manner, oxygen is subtracted from one compound and is added to a second. Simultaneously, both compounds, being altered chemically by loss or gain, are unavoidably made into new chemical entities. So an enzyme is again seen to be a remarkable modifier.

Enzymes, of diverse kinds, can do far more—can labor almost incredibly. They can effect the production, reproduction, and multiplication of atom-gangs of many sorts. And they can themselves reproduce and multiply, even as virus. Their phenomena take place in time as well as in space: we must concede that enzymes can pace the processes in which they participate—or, as you may prefer, which they rule.

PERHAPS most striking, if not most significant, among the enzymes' powers, is the capacity of autosynthesis—the power to create oneself. An enzyme—active molecule—can spring full-fledged from inactive precursor. A step has been taken, up the ladder of life. The leading investigator of enzymes, Dr. John H. Northrop states: "Some filterable viruses are probably enzymes which possess the property of forming themselves under the proper conditions."

In handling enzymes, men of research have been manipulating the very life-stuff, the most meaningful life-stuff, the sole *active* stuff of life. Here are organizations with every imaginable requisite for co-operation upon every level of life. Nowhere are comparable molecules or molecules even remotely so potent. We cannot escape calling many of them alive: *living molecules!*

Yet, a living molecule is not a thing of the same order as a living cell, constituted of hundreds and thousands of molecules—the numerous pieces reproducing as a unit, when one cell gives rise to another. How are we to jump the gap between an individual living molecule and a cell, which is apparently dead unless it is all together, no part being alive unless the whole is living? There is no gap over which we are forced to jump. There is a smooth slide up to life, even up to cellular life.

We have not exhausted the abilities of these astounding things, our enzymes. The enzyme is a giant molecule, hence a sizable particle just beyond the limit of the microscope. It is a general characteristic of particles of approximately this size that, when separate and suspended within a medium, they attract lesser particles—little molecules, fragments of molecules, and even atoms. If the giant reproduces, another giant is among the tiny molecules and still tinier atoms. And again these bits will form a galaxy about a big fellow, our second giant. What has happened? Not just one molecule has reproduced—an entire system has been duplicated! Such a system is no less than a primitive cell, alive because of its living nucleus, the protein enzyme!

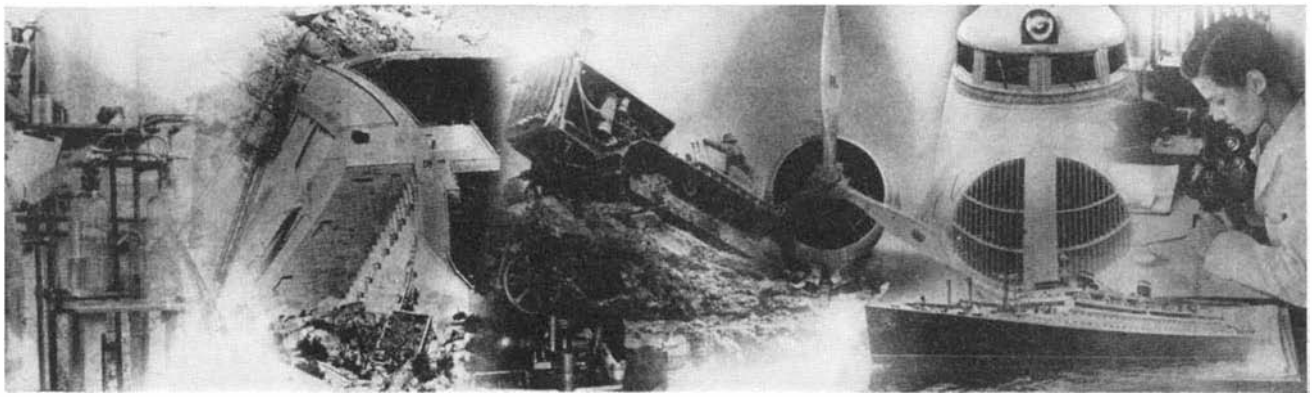
WE have won to the plane of the true cell. The co-functioning of several loosely-linked enzymes, all enclosed within a film, and the concentration of nutrient, energy-yielding bits within that same film, and the concentration of other bits adhering to the cell-membrane—these events yield a still loftier event: a respiring, moving, thinking cell—a brain cell of man.

Therefore, when such brain cells, coworking within men of research, gain additional discovery of their own nature, we shall see not only living molecules synthesized within the test tube, but, beyond, man-made cellular life.

Since 1859, when Charles Darwin demonstrated that Nature creates the new merely by accumulating subtle modifications of the old, men of science have used this thought to make uncountable discoveries. Physicists today are showing how the atom is created by subtle union of the properties of lesser things—electron, positron, proton. Chemists are setting forth the creation of molecules by union of atoms, and the construction of new molecules by subtle re-arrangements of atoms making up the old.

Now biochemists and biophysicists fascinate us with pictures featuring the play of electrons, atoms, and molecules. Within a bed of water, and nothing more or less mysterious, atoms become linked into chains: molecules. Some of these molecules are enzymes, which stimulate the atom-chains to cluster into tiny galaxies and out of such galaxies to form huger webs, giant molecules of protein.

The easy glide up to life has begun. The giant proteins are themselves very like the enzymes which stimulated them to take shape. Hence these giants stimulate the linkage of still other smaller molecules, and so force duplicates of themselves to arise. Life-like reproduction is now a reality. The harmonious interplay of particles at the threshold of life continues. Soon, as if by a miracle, that famous doorway is crossed. By subtle modifications of the old, the new is at hand: Life.



THE SCIENTIFIC AMERICAN DIGEST

Conducted by F. D. McHUGH

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Electrical Sense of Balance

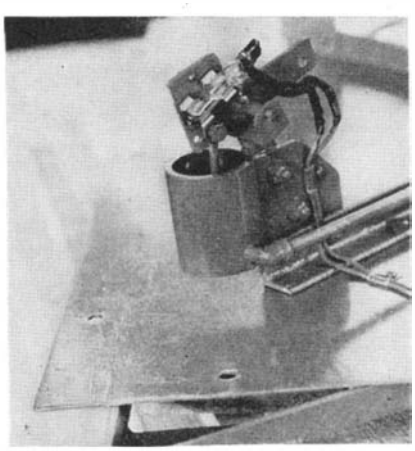
A UNIQUE electrical "sense of balance" for automatic leveling is an important feature of the newest giant shovel for coal strip mines—said to be the world's largest structure capable of overland movement on its own traveling "foundation." An arrangement of four tiny mercury switches on a plane table acts to keep the entire structure level even when the four tractor bases are moving over uneven footing. Automatically, with every change in ground level, hydraulic jacks go into operation to raise or lower the four "legs" of the 2,500,000-pound unit to an even keel.

An electrical sense of balance keeps this 33-yard shovel on a level keel

The largest electric shovel in the world, this Bucyrus-Erie stripper has a dipper capacity of 33 cubic yards, the equal of capacity loads for ten or more five-ton trucks. Towering more than 100 feet in the air, it has a 105-foot boom, and could easily dump its load on the top of a seven-story building. The total motor horsepower is some 2400, furnished by 32 motors mounted within the structure.

Under each corner of the base of this shovel is a huge tractor unit, built like a military tank with twin crawler belts, and individual electric drive. Over half a million pounds of working weight is distributed over each of these four tractors, so that the footing is likely to settle under one or more of the supports in spite of their great tread area. Ordinarily, such settling requires time by the pit crew in handling, tightening, and loosening the hydraulic jacks used to level the machine.

In the new stripper, an independent, high-pressure, electrically driven pump is connected to each jack, maintaining the pressure required to level the machine. At the propelling station, four General Electric mercury switches are mounted on a special control table to provide automatic operation of these pumps.



One of the four mercury switches of the electrical sense of balance

The patented leveling control system provides one switch at each corner of the table, each switch acting through boosters, to control completely the interlocking and electrical devices and fluid values. When the shovel tends to settle, the horizontal control table tilts with the machine, causing the mercury to flow from one end of the switch tubes to the other, completing a circuit which controls operation of the electric pumps.

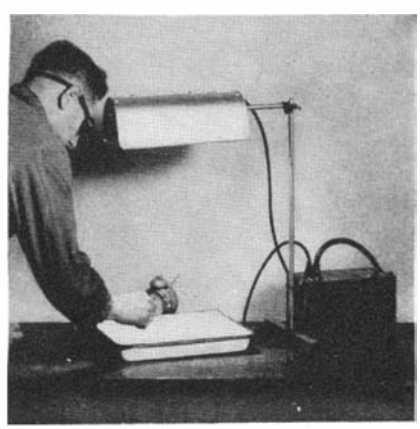
As the hydraulic jack returns the stripper to level, releveling the control table with it, the mercury switch resumes its open-circuit position. This system of automatic leveling results in a considerable saving in power consumption, doing away with the need for swinging the machine "up-hill." In addition, elimination of interruptions in the digging cycle reduces delays.

REFINEMENT

TALK of the meat packers saving everything but the pig's squeal—the volume of refined petroleum products now equal within a fraction of 1 percent the volume of crude oil run to the stills.

New Source of Ultra-Violet

A NEW, highly flexible source of ultra-violet radiation, consisting of a quartz-tube mercury vapor arc of improved efficiency mounted within a special reflector on a portable laboratory stand, has just been announced by the General Electric Vapor Lamp Company. The unit is operated from any 120-volt or 220-volt A.C. line, through a portable auto-transformer supplied as part of the complete assembly. The sealed mercury vapor tube has high radiation characteristics in both the near and far ultra-violet zones, without the high heat losses and operating and maintenance problems inherent in



New self-starting ultra-violet light source, with transformer at the right

open arcs. Rated operating life of the new tube is 2000 hours.

In contrast to previous models, the new Type H Uviarc is self-starting, requiring no tilting nor use of auxiliary moving parts. It is also "universal-burning," operating with equal efficiency either vertically, horizontally, or in any other position. The six-inch arc tube operates at 360 watts out of a 410-watt input supplied to the auto-transformer, or 87 percent of the total, whereas in former alternating current operated units, the arc wattage was below 65 percent of the overall input. Radiation at all wavelengths in the ultra-violet region is stepped up accordingly.

Cheap Magnesium

LITTLE more than six tenths as heavy as aluminum, magnesium has attracted attention as a possible light structural metal. Its cost has been a serious drawback to its wide use but recently a new method of manufacture has been developed which is expected to make it cheaper than aluminum. In alloys with aluminum and manganese, as well as other metals, magnesium has already proved useful; production at low cost is expected to enlarge its applications—*D.H.K.*

Development of a Gear Shift Control

THE motoring public accepts new features of design with little thought and still less knowledge of the great amount of detail work, and the weeks, months and sometimes years that have been spent in perfecting them.

In 1931, engineers of Pontiac Motors began experimenting with various types of design that would remove the gear-shift lever from the conventional place in the floor and put it up under the steering wheel or under the dash—at least out of the way of the front-seat passengers.

Since 1931, 15 different types of remote-control gear shifting devices have been designed and tested. None of them were adopted, however, although full-sized models were made and tried but found wanting. Some of them are shown in our photographs.

The first device in 1931 employed cables and a long shift lever attached to the under side of the dash.

Then came a series of models in which a standard gear-shift lever was bent forward under the dash and a horizontal rod attached to the top by a pin or a ball and socket joint and brought forward through a wire track or an opening in the dash.

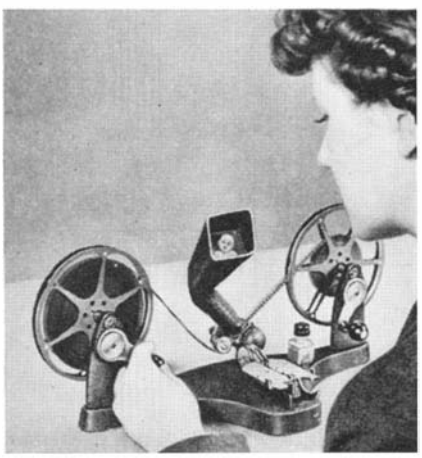
In 1935 when it was known that the 1937 model cars would have wide, three-passenger seats, the effort was redoubled to develop a satisfactory remote control gear shift in time for that model.

The position of the hand brake having been changed in the 1937 models, it was hoped that the gear shift could be moved out of the way at the same time, thus removing every obstruction from the front seat.

A number of other designs were worked out and tested until, finally, the safety shift gear control was approved late in 1936 and tested early in 1937. It was designed by Arthur A. Rubly, a Pontiac engineer. Between that time and the date of its final approval, six different variations and refinements of the first design were built and tried out in cars.

8-Millimeter Film Editor

A COMPLETE film editor which consists of a rewinder and splicer plus a special 8-millimeter film viewer has been announced by Bell & Howell Company. This viewer is so simple and compact that one



For editing 8-millimeter movie film

wonders why no one thought of it before. Actually, it took the company more than two years to design the editor, for simple things are often the most difficult to do well.

The viewer might be described as an inverted, modified cone, hinged at the small end and terminating at the large end in a ground-glass viewing screen 1½ inches wide upon which a brilliant upright image of a single frame is produced. This viewing screen is well shielded by a "sunshade," permitting a desk lamp or room lights to be used without interference.

The viewing cone swings backward from its base, out of the way entirely when the film is being wound from one reel to another, permitting easy placement of the film in its channel when the viewer is to be used. The lamp is entirely enclosed, except for the small opening through which its rays pass to the optical units in the viewing cone, and there isn't a chance for glare in the eyes of the operator. With a convenient switch on the cord, the lamp may be turned off while the operator is splicing.

The film viewer can be purchased separately, for use with the rewinder and splicer, and it is also available with a viewer elevating bracket and a rewinder elevator block for use on previously-purchased Model 136 and wood-base splicer and rewind combinations.

MOLECULES

CHEMISTRY students were formerly taught that all matter was made up of atoms and that when atoms of various elements were combined together they produced molecules of the resulting compound. Today scientists recognize six different types of chemical combinations, only one of which has old-fashioned orthodox molecules.

Styrene Resins

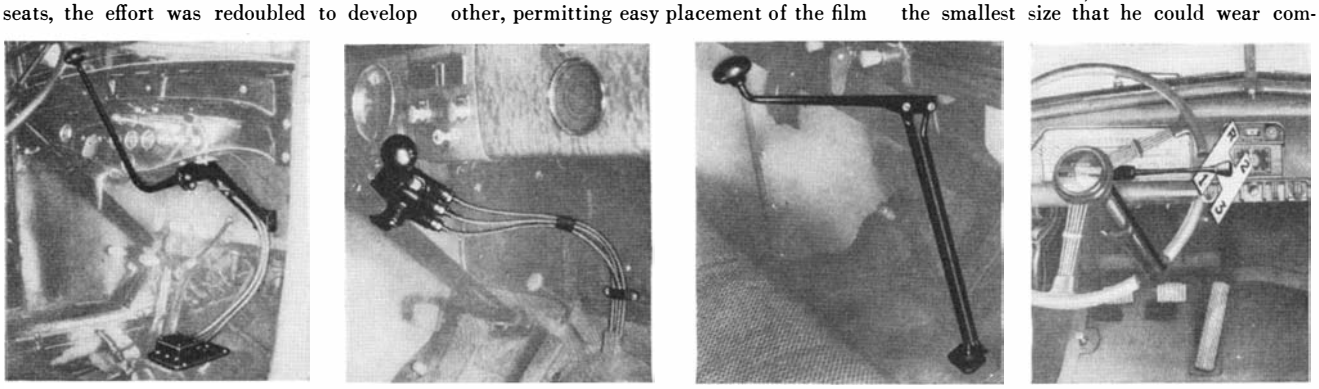
A NEW family of glass-clear resins which are easily machined and molded has recently been produced from styrene, a derivative of coal tar. The resins have a very high index of refraction, are unaffected by alkalies and by weak acids, and are used in paints, varnishes, lacquers, molded parts, and electric insulation. Their optical properties are particularly interesting and suggest their use in lenses.—*D. H. K.*

The Expanding Cranium

STRIKING confirmation of the discovery that the human head—and presumably the brain—may grow throughout adult life, which was first reported last year by Dr. Ales Hrdlicka, Smithsonian Institution Curator of Physical Anthropology, has just come from 84-year-old Sir Flinders Petrie, one of the most distinguished of living archeologists and Egyptologists.

Dr. Hrdlicka has received a letter from the famous British scientist telling of the curious increases in the size of his own head between the ages of 20 and 60. He has kept a record of the sizes of hats he bought.

At 20, Sir Flinders reports, he wore a 6½ hat. It was a good, comfortable fit. At 30, the smallest size that he could wear com-



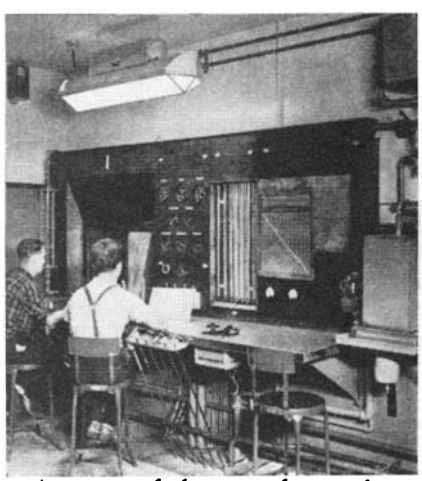
Four of the stages in the development of one of the new remote-control gear shifts for motor cars. At the left is the first type that was tried in 1931, while at the right is the model that was finally accepted for production in 1938 after many experiments

fortably was between a 7 and 7⅛. At 40, his hatter had to supply him with a 7¼. At 50, he required a 7½. Even since then his head may have increased because he finds difficulty in making any standard size hat fit easily. He is, he tells Dr. Hrdlicka, quite sound and normal.

The record is of more than usual significance because of the incessant and continued intellectual work of the English archeologist throughout his life, and which is still continuing. It would be especially interesting, Dr. Hrdlicka points out, to obtain similar records from other men of comparable intellectual activities.

Silencing a Motor Test House

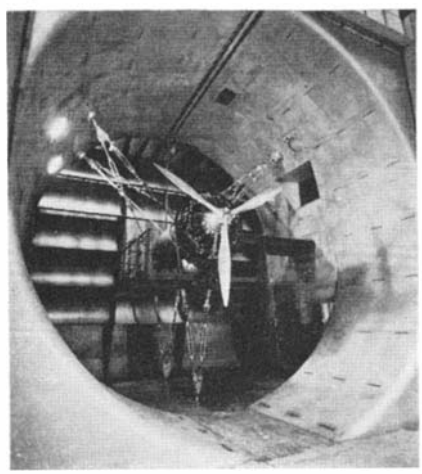
THE new Pratt & Whitney Engine Test House is surely a symbol of a modern age. Aircraft engines already develop 1500 horsepower. The prediction has been made that they will develop 3000 horsepower within a very few years. Silencing engines of this vast power, and at high speeds, is a difficult, two-fold problem. The neighborhood of the test house must be protected from disturbing noise, and the engine control room must be made entirely livable without in any way hindering control and observation of the test chambers by the engineers. The Pratt & Whitney Test House has achieved both objectives, besides providing excellent means of studying the power and fuel consumption of the engines and the characteristics of the propellers.



A corner of the control room in the new motor test house described

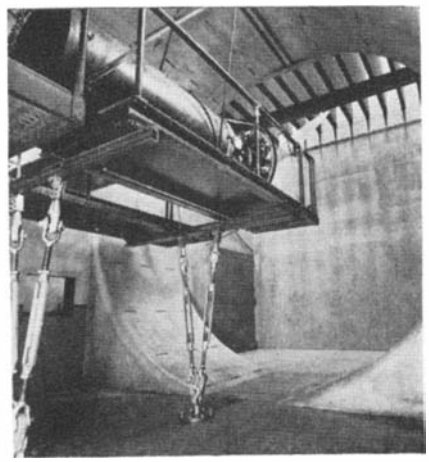
The new building houses four test chambers, in each of which 1500-horsepower engines swinging 13-foot propellers are probably under test today; it is able to accommodate 3000-horsepower engines swinging 23-foot diameter propellers in its circular chambers. Circular chambers, of course, minimize the interference of rectangular or square chamber walls. The outside of the building looks like something out of an H. G. Wells moving picture. The exterior walls are of concrete, 18 inches thick. The entire structure contains 4600 tons of concrete and 160 tons of reinforcing steel. The four test chambers are on the lower level and are grouped around a central control room. The best way to visualize the whole set-up is to look at the cut-away sketch. The central control room is equipped with four control desks and a new type of double sound-proof window through which the test chambers can be observed. One of the photographs shows a corner of the control room with one man observing the instruments and the man at the left looking through the sound-proof window. A further noise reduction measure in the control room lies in the use of an acoustical ceiling, suspended far enough below the concrete ceiling to house the fresh air and exhaust ducts. The noise level in the room is 78 decibels, which is far below the figure for a New York subway and allows comfortable conversation.

The other silencing problem, that of keeping noise away from the neighbors—which really means all the inhabitants of East Hartford, Connecticut—has been accomplished by the use of very tall exhaust and intake stacks for the test chambers and by vibration isolation of the motors. At first it might be thought sufficient only to provide exhaust stacks, but sound travels in every direction and the inlets must also be sound-proofed. Both in the inlet and in the exhaust ducts a new sound-absorbing material called Calistone is suspended in huge parallel rows.



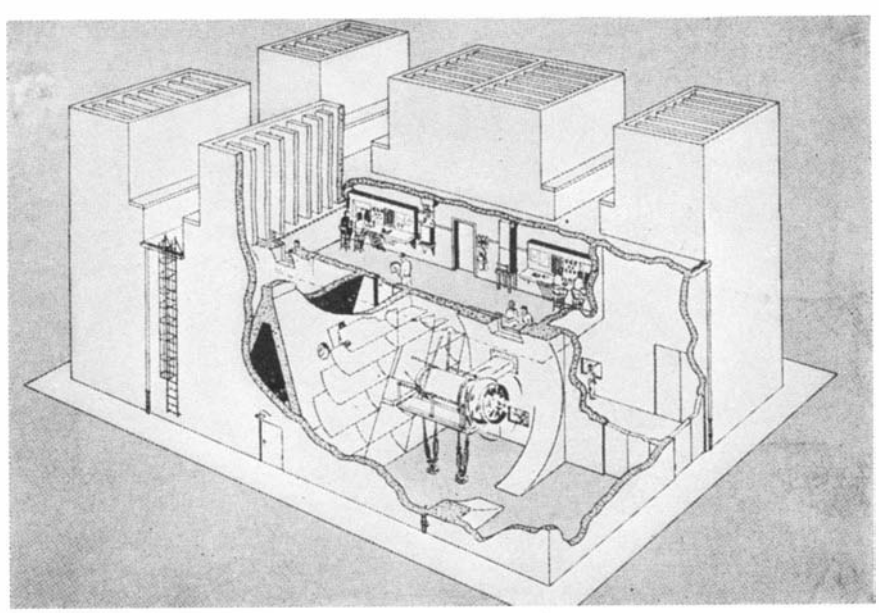
Front view of an engine in the test chamber. Cables are rubber mounted

To isolate the motors and to prevent transmission of vibration, a flexible suspension system has been used. To take up the propeller thrust, some of the cables are crossed, allowing the thrust to be taken up without the introduction of struts. A curious feature of the design is that the lower portions of the exhaust and inlet adjoining ducts are in the form of an "A." It is within this "A" that stairways are provided from the control room to the test chambers.



Side view of the engine suspension. Note sound-absorbing strips in duct

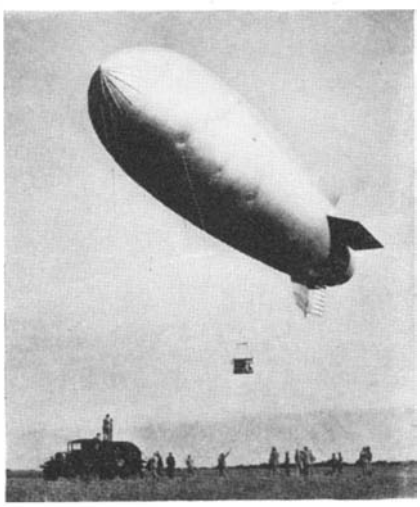
There are several other features of interest in the design of the 200,000-dollar test house. For example, the test chamber can be cut off from the outside air by lowering two electrically operated heavy canvas curtains, so that the chamber can be rapidly heated to a comfortable temperature. A working platform supported from the cables is permanently installed on each stand, and a telescoping portion of this platform can be extended forward and around the engine, when it is stopped for adjustments. The carbureter air is taken in from the roof and led down through large ducts just outside the ends of the control room and thence through temperature regulators to the engine. The quantity of air used is measured by a system of calibrated orifices. Air to the propellers enters the intake stacks at the corners of the building and, after leaving the engine, passes through a series of heavy steel baffles to the exhaust stacks. Incidentally, we must not forget to mention that the propellers may actually be a greater



Cut-away sketch of the test house, showing one of the four test chambers

source of noise than the engines, owing to the high tip speeds of the blades which approach the speed of sound during some tests. No wonder that the noise level in the test chamber is 135 decibels (that is to say, a good deal louder than a boiler factory).

There are also arrangements for measuring fuel and oil consumption, rate of oil flow through the engine, and so on. There are 48 thermocouples for measurements of the temperatures at various points of the engine; the electrical currents generated by the thermocouples are led through wires to the instrument boards in the control room. Of course the control boards are also provided with tachometers, fuel and oil pressure gages, remote reading thermometers



for measurement of oil and carbureter air temperatures. A special torque meter or dynamometer is also provided.

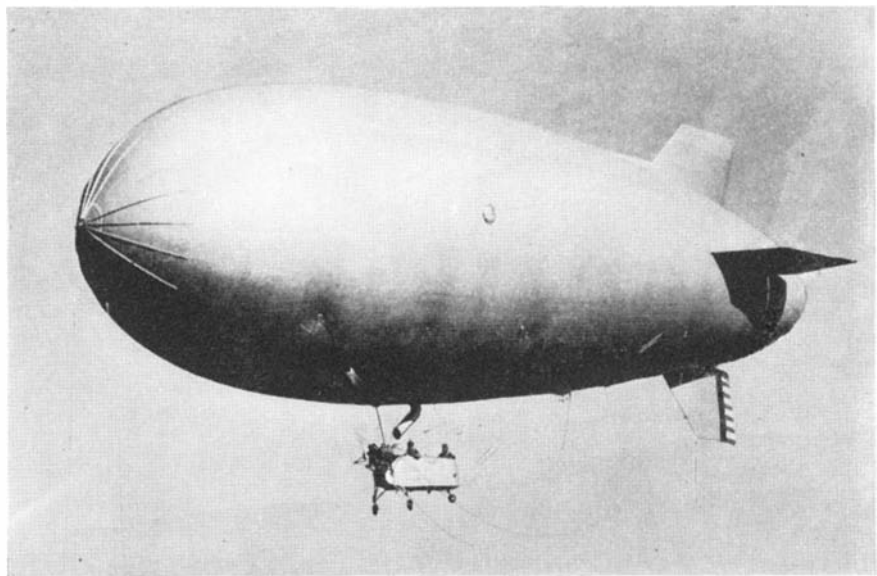
All in all, this is a magnificent example of the technique of modern experimentation. No task is more fascinating than to conduct a test under such conditions and to learn rapidly and comprehensively all that a new engine and propeller combination can do.—*A. K.*

Who Really Inspects our Airplanes?

ON January 1 of this year there were 17,681 pilots and 9152 aircraft holding active Department of Commerce certificates. Now, while the Bureau of Air Commerce is ever concerned with safety, and while its inspectors are a splendid body of men, it is physically impossible for them to give every airplane in service a thorough inspection, even if only once a year. What happens is that the visiting inspector asks the mechanic in charge of a ship when it was last overhauled, what he thinks of her condition, and what he wrote in the log. He then certifies the aircraft. But perhaps this is the best way after all. Why should not an experienced and licensed mechanic know far more about his plane than any visitor from Washington?—*A. K.*

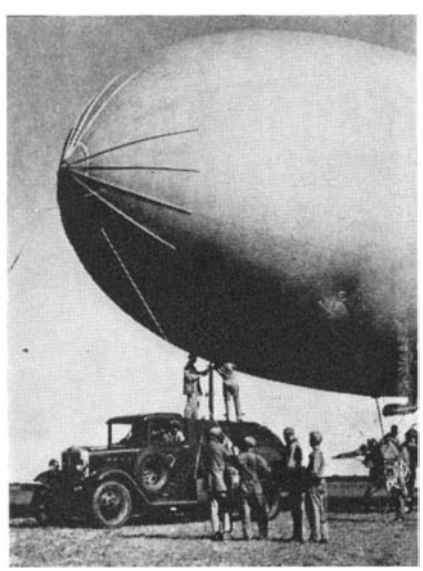
Tests of a Motorized Balloon

DURING the World War, captive balloons or "sausages," as they were frequently called, played a useful rôle in artillery observation, even though they were frequently shot down. These captive balloons, stubby,



Official photographs, U. S. Army Air Corps

***Left:* The *C-6* being released as a kite or captive balloon. *Above:* The same balloon, equipped with an airplane fuselage and motor, functions as a small blimp. *Below:* Attaching the motorized balloon to a mobile mooring mast in a manner similar to that employed for larger airships**



with inflated lobes at the rear for stabilizing purposes, have remained practically unchanged to this day. But to move the "sausage" cross-country when changing its station for observation purposes, it is necessary to "walk" it; power lines, trees, and other obstacles make progress quite difficult. The new motorized balloons, like the *C-6* which has undergone successful tests at Fort Sill, Oklahoma, is more popular with the Army Air Corps. The balloon is like a small blimp, with a true airship form. Equipped with an observation basket and moored by a cable to a winch, it functions just like a "sausage." When the station is to be changed, basket and cable are disconnected and a small fuselage, like that of an airplane, is attached in lieu of the simple basket. With a 90-horsepower Lamber engine and a two-bladed propeller, the *C-6* can fly to another destination at a speed of over 40 miles per hour. Meanwhile the winch is sent by motor truck.

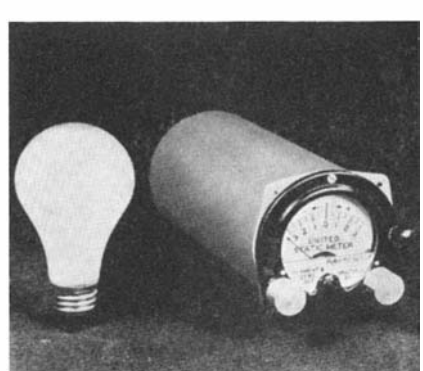
One of our photographs shows the balloon with its basket, being released for kite balloon duty. In another photograph, it is flying like a small airship; a third picture indicates that the *C-6* may be moored to a mobile mooring mast just like its more ambitious brethren, the huge rigid airships.

The *C-6* is 107 feet long, 30 feet in diameter, and contains 52,000 cubic feet of helium. The old type sausage was only 95 feet long, 27 feet in diameter, and was inflated with only 37,500 cubic feet of hydrogen.—*A. K.*

Static Detector

IN the laboratories of United Air Lines there has been developed an interesting static meter which is essentially a vacuum-tube electrometer with associated controls. It is intended for operation from a 200-volt radio dynamotor and a 12-volt aircraft storage battery. The unit contains two voltage regulator tubes. The knob on the right side of the meter as shown in the photograph allows a number of different radio ranges to be used, depending upon the intensity of the static charge. The device may be connected to any radio antenna on the aircraft, but for testing purposes United uses a smooth metal rod, ten inches long, projecting out into the airstream at a point along the fuselage.

In operation, the meter indicates the amount of static charge accumulated by the plane in arbitrary units, although it will be ultimately calibrated to indicate volts. Test flights indicate that a voltage lower than 10,000 seldom disturbs radio operation, and



Aircraft static detector, with an electric bulb for size comparison

that peak voltages as high as 1,000,000 are often encountered in extreme static conditions.

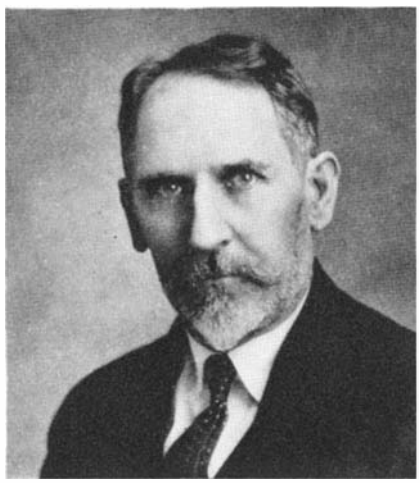
Three of these units are in daily service in flight. Some will be placed at ground stations. Pilots will report the readings of the static meter along with other weather conditions when they make their position reports. An important research problem to be tackled is the relationship between the electric charge in cloud particles and the movement of air mass fronts.—*A. K.*

A Master of Aircraft Supercharging Retires

IN these columns we have again and again referred to the aircraft supercharger, without which high-altitude flight is impossible. In no small measure the development of the aircraft supercharger is due to the continued, steadfast, and skilled efforts of Dr. Sanford A. Moss, who is now retiring from the General Electric Company after 34 years of service and 15 years of work on the supercharger. A master of thermodynamics, an ingenious mechanical engineer, Dr. Moss exemplifies the modern scientific engineer at his very best, carrying through a development from its first theoretical conception to the final practical embodiment. Dr. Moss was never a professor but he often showed the absent-minded traits of the professor when on the aviation field. On several occasions in his eagerness to examine the functioning of one of his superchargers he has been pulled away from the propeller blades and well nigh certain death by his associates. In fact, the writer of this column is proud to remember that he rendered the same service to the famous engineer at McCook Field.—*A. K.*

Designing a Sub-Stratosphere Plane

THE Lockheed sub-stratosphere airplane, the *XC-35*, has recently been delivered to the Army, and is making a wonderful record for itself. At an altitude of about 20,000 feet, with its supercharged cabin and supercharged engines behaving splendidly, the *XC-35* reached a top speed of 350 miles



Dr. Sanford A. Moss, pioneer in development of the supercharger

per hour over a test course of 220 miles, a distance which was covered in 38 minutes. As can be seen from the photograph, the sub-stratosphere plane is of the low-winged. twin-engined type, with a hemispherical nose and long narrow windows. In other respects it follows conventional modern design.

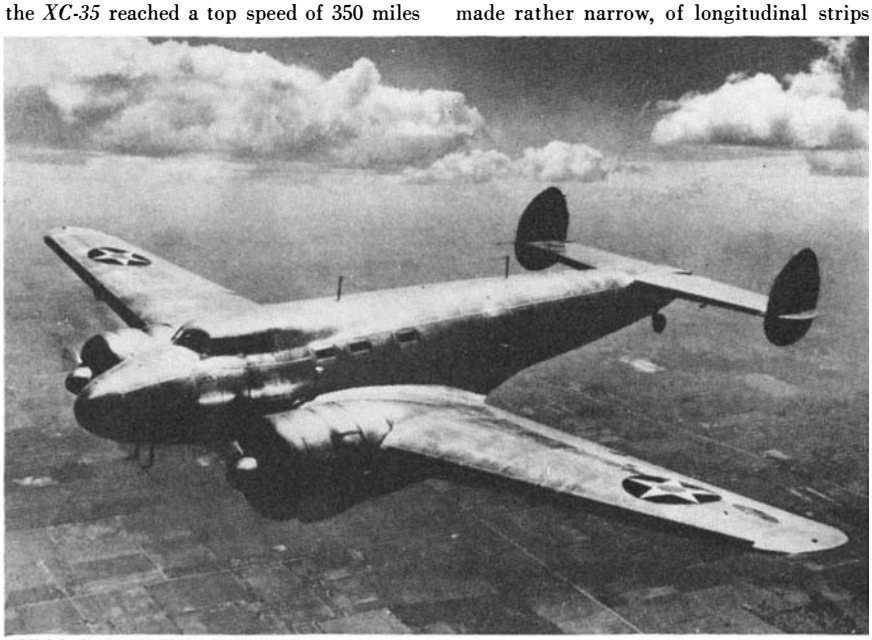
A paper read by Professor Younger at the Annual Meeting of the Aeronautical Sciences deals with the preliminary research work on this ship which was carried out at Wright Field before an order for design and construction was placed with the Lockheed Company. This research work is described in a 250-page report, covering two years of effort; 25 "sub-problems" had to be solved before the design engineers could really get to work.

One of the problems which had to be met from a structural point of view was to keep the fuselage from bursting outwards, since the inside of the cabin is raised to something like atmospheric pressure while the thin air outside may have a pressure of only five to six pounds per square inch. This is best achieved, so theory and tests indicate, by making the fuselage a long cylindrical body with hemispherical ends. For maximum strength the windows should be made rather narrow, of longitudinal strips of glass; the luxury of large, wide windows is not possible in the sub-stratosphere plane. The doors should open inwards; in such a case just a few spring clips will keep them in position since the differential pressure acts to close them. The internal pressure tends to extend the fuselage; the decrease in temperature tends to shorten the fuselage. The two effects counteract each other, but still the fuselage must have incorporated in its structure a certain degree of flexibility to take up these extensions and contractions.

For every passenger about 10 to 20 cubic feet of air per minute must be supplied. While auxiliary engines for the cabin supercharger have been considered, the simplest method is to use the main motor itself as the source of energy for the cabin air compressor. Two entirely independent supercharger systems should be provided.

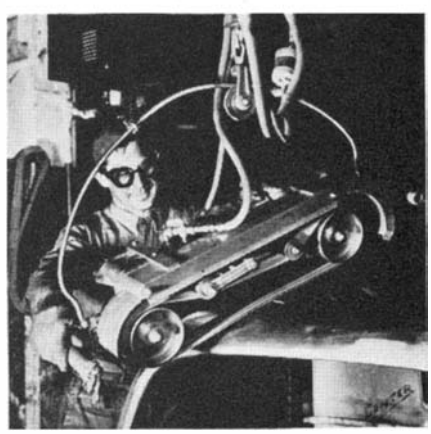
Many control cables and other leads must pass out from the fuselage. It is very important to lead such cables through oil-sealed passages; to minimize friction the cables slide in brass tubes.

These are but a few of the technical problems which have been successfully met. The complications and weight are far from being as overwhelming as some authorities have expected. Now that the Army Air Corps, together with the Lockheed engineers, has shown the way, there is not the slightest reason why supercharged cabin transports for passenger service should not be readily built.—*A. K.*



Official photograph, U. S. Army Air Corps

***XC-35*, sub-stratosphere airplane, in flight**



"Contentment." This photograph of a Studebaker workman smiling as he guides a flexible sanding belt over the steel surfaces of a truck cab, won an award at an exhibit of the Photographic Association of America at Chicago. It was submitted by Charles I. Center, who won four other awards in the same exhibit with other photographic entries

A Record of Service

MANY years ago, "Soda Ash Johnny" Horan worked out the process, from which his nickname was derived, of using soda ash to dissolve lime deposits in the tubular boilers of wood-burning locomotives. It has saved for his employing road, the C. M. St. P. and Pacific, and other railroads, many thousands of dollars. He could have retired with honor years ago, but scorned a pension in his desire to remain active. On April 17, John M. Horan will celebrate the anniversary of his employment with the same company 83 years ago. He was 100 years old in January, and is now inspector of the boiler

washing department in the Milwaukee shops.

We quote these facts, not to preach a sermon; you may write your own. It would be interesting to know, however, what Soda Ash Johnny would have to say, should someone persuade him to talk, on the subjects of the dignity of human labor, the joy of work for its own sake and, on the other hand, labor relations, strikes and strike-breaking, and government doles for able workers. If he should ever speak his mind on these current topics, it's a safe bet that he wouldn't be very popular thereafter with the "ism" boys.

New Balsam-Wool

LOWER application costs and increasing efficiency are the two outstanding advantages claimed for the new improved Balsam-Wool Sealed Insulation just announced by the Wood Conversion Company. Those advantages are made possible by a new spacer flange along the edges of the insulating mat and a new fibre cleat used to seal the cut edges.

The new flange is scored to fit over the face of the stud, joist, or rafter. It is fastened to the face with a staple hammer. The fibre cleat seals the cut ends at top and bottom edges and where it has been necessary to trim the mat length-wise for narrow openings. Lath is no longer required here.

Applying the new Balsam-Wool

Because the flange controls the position of the Balsam-Wool in construction, important air spaces are assured front and back. The flange, fitting over the face of the stud, assures a tight joint as lath is placed directly over it. As the flange does not completely cover the stud, a guide line is left for lathers. The Balsam-Wool mat is sealed in an asphalt coated moisture barrier both front and back.

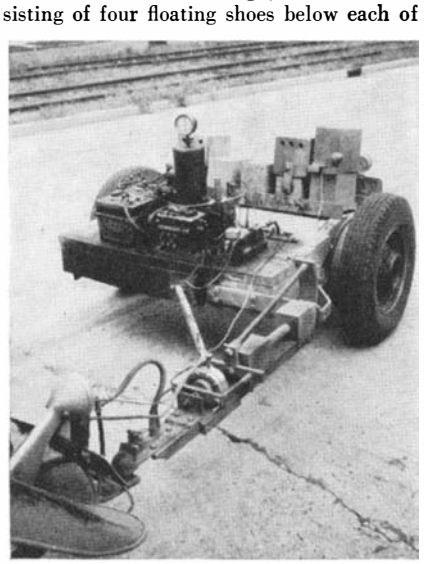
Skid Danger Increases with Speed

IMPORTANT findings from an automobile safety standpoint have been revealed as the result of a study of 20,000 tests on skidding tendencies at Ohio State University.

Among the findings are: 1. Regardless of tire tread design, adhesion between road and tires decreases with the speed of the vehicle, reducing resistance to skidding and increasing the difficulty of bringing the car to a stop in an emergency. 2. This effect is most pronounced from a braking standpoint. 3. A light sprinkle causes the average road to be about one third more slippery than a drenching rain. 4. Sliding the wheels of an automobile when applying brakes results in the vehicle traveling much farther before it is brought to a stop. 5. Tires which have been worn smooth may as much as double the tendency for wheels to slide when brakes are applied. 6. Increasing or decreasing tire pressures on ice or in snow does not help traction, as is commonly supposed.

The tests were conducted under the direction of Professors K. W. Stinson and C. P. Roberts in co-operation with tire companies and highway commissions of several states. In these tests a two-wheel trailer, with a Linderman hydraulic brake on one wheel, was used, the other wheel running free. The trailer was attached to a tow car through a diaphragm connection which translated the effort required to pull the trailer, into hydraulic pressure. The latter, in turn, was recorded on instruments within the tow-car.

The trailer was provided with a gear pump which maintained a constant hydraulic pressure in a tank on the trailer. When ready for a test, the operator in the tow car tripped a switch. This opened a valve on the trailer, permitting liquid to flow gradually through a needle valve into the brake operating diaphragms. These diaphragms are a part of the Linderman brake design, the brake consisting of four floating shoes below each of which there is a diaphragm extending the entire length and width of the shoe. Since the brake is not self-energizing, hydraulic pressure under the shoe is directly proportioned to braking effort.



The brake trailer used in the Ohio State University skid experiments

The use of this installation made it possible to increase braking effort gradually and smoothly until the wheel locked and the tire slid. The amount of pressure (measured by the pull of the trailer) required to do this, is a measure of the "coefficient of friction" between tires while rolling on a road under the specific test conditions.

The pull of the trailer after the wheel locked is, in turn, a measure of the "sliding coefficient" of friction under the same conditions. The sliding friction under all conditions was found to be less than the adhesion with the tire still rolling.

From a car-operating standpoint, the tests would indicate that brakes which lock too easily are a hazard rather than a help, and that adjusting brakes so that the car can be slid to a stop as is the custom in many brake service stations decreases rather than increases driving safety.

Many automotive engineers feel that these tests substantiate the feeling that "self-energization" of brakes should be eliminated, since self-energizing action—while decreasing pedal pressure in modern brakes—has the effect of increasing tendency of wheels to lock and slide.

One of the hinged arch bridges discussed below

Unique Hinged Arch Bridges

A UNIQUE method of bridge design, providing speed and economy in construction, as well as beauty of appearance, has been used by the Civilian Conservation Corps in the building of nine bridges in northeastern Illinois park areas. The design was originated by John Taggert, architectural engineer of the central design office of the Forest Preserve District of Cook County, Illinois, and has been approved by the Branch of Engineering of the National Park Service for use in park areas.

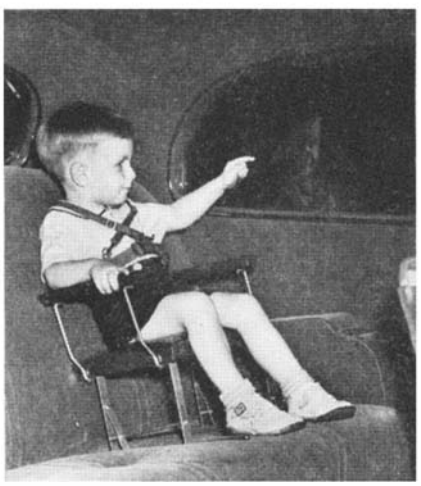
The bridges were constructed by CCC enrollees under the technical supervision of the National Park Service which has worked with the county park agencies and the Illinois State Park Department.

The structures are two hinged arches in which the arch ribs are seated in a lubricated socket which is formed in the abutment. The two outer sections of the arch

ribs are precast, each section being a little short of one-half the span. These are centered in the socket and the center section poured in to form the key. The manner in which the socket is formed and lubricated is expected to prevent any excessive frictional stresses during the normal life of the structure.

The bridges were designed specifically for use in park areas developed with foot trails and horse trails over streams and ravines. Because of the comparatively simple design of these bridges, less time is required for their construction and there is also a saving in the expenditure for material. The bridges require, however, absolutely stable abutments, as any movement tends to destroy the hinge action. Bridges of this type are practical only on sites having excellent foundation characteristics.

The majority of the bridges are used by pedestrians, but in some cases carry equestrian and light truck traffic. They range in length from 40 to 90 feet.



A child is held in place by a belt and shoulder straps in this new safety seat for use on either the back or front seat of an automobile

Sewing Machine with Eight Needles

THE last word in efficiency in the manufacture of upholstery is the new Maniplex sewing machine which was built to special order for the Hudson Motor Car Company. It is used for sewing automobile seat cushions.

This machine operates eight needles simultaneously, sewing the braid on four plaits and forming the piping in one continuous operation. Besides the advantage of sewing absolutely straight and parallel plaits (because of the accurate guiding of the cloth made possible by this machine), the job is done in about half the time required by smaller machines and less accurate methods. The new machine requires four operators to feed, cut, and handle the cloth.

GROWTH

IN 1932 Willis H. Carrier predicted that air-conditioning systems in 1948 would require approximately 1,432,000,000 kilowatt hours of electricity. On the basis of the growth since 1932, such systems may need in 1948 actually 8,350,000,000 kilowatt hours.

Colored Insecticides

TO prevent accidental poisoning by mistaking the arsenates of calcium and lead for harmless compounds, the Surgeon General of the Public Health Service has ruled that hereafter all such materials must be given a distinctive pink color. This safety measure, recommended after a careful investigation by the Public Health Service, is being adopted for all insecticides of this type, made for the 1938 crop year, by voluntary agreement of the manufacturers. —*D. H. K.*

Tractor is Fast; Wades, Too

AN innovation in commercial track-laying tractor design recently was seen for the first time by men concerned with road building. The tractor is the newest product of the Marmon-Herrington Company, Inc., engineers and manufacturers of four- and six-wheel motor vehicles with all wheels driving.

The new tractor has attracted widespread interest with its speeds of more than 30 miles an hour, ease of handling, pulling power, quiet operation, and economical performance. Ice, sand, water, snow, and mud are no obstacles to the sensational accomplishments of this new tractor; once on the highway it travels at passenger-car speed without damage to the pavement.

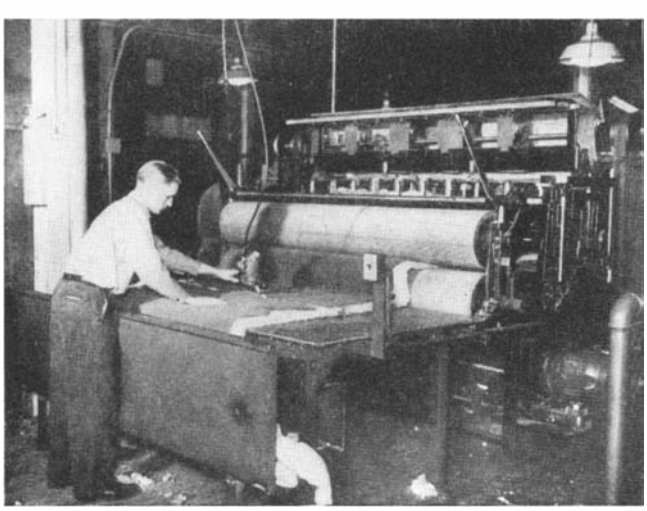
Speed with a track-laying tractor

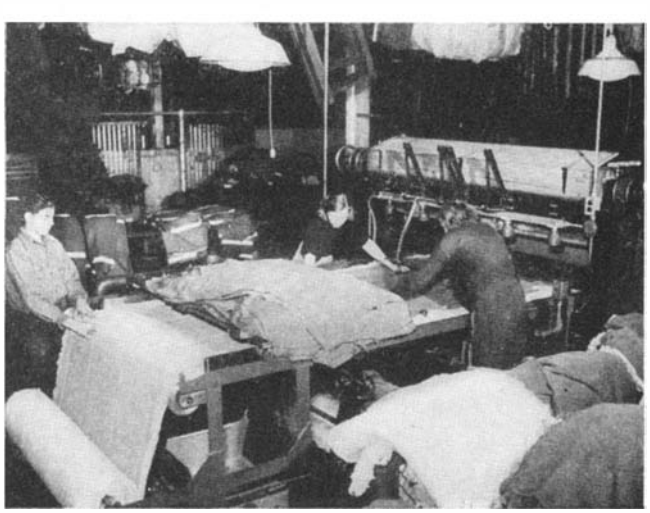
The new tractor is reported to be the first track-laying vehicle that does not have to be transported to the job by truck or trailer. Its water-tight hull allows it to ford streams of considerable depth. Its specially developed rubber track is said to outwear the conventional all-metal track, and the track will not stretch while providing unusual tractive ability. The unit has a top speed greater than any wheeled tractor and fuel economy of from four to five miles per gallon.

Versatility of the tractor on any terrain under the most difficult conditions in excavation, construction, and maintenance work is its strongest feature.

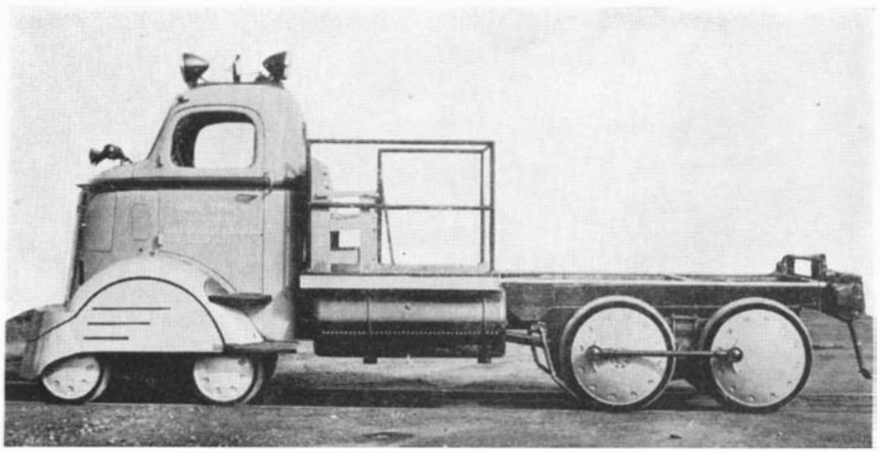
Bismarck and the Telephone

POSTMASTER General Heinrich von Stephan, the founder of the World Postal Union, always took great interest in the development of the telephone. In October, 1877, he read an article on the subject of Bell's invention in Scientific American. He then immediately ordered one of the Bell telephone instruments. Before this instrument reached him from America, he received as a gift from the Director-in-Chief of the London Central Telegraph Office a complete Bell telephone set. Stephan immediately set to work to dem-





The feed and delivery ends of the eight-needle sewing machine used for stitching automobile upholstery



A four-wheel-drive rear axle is a feature of this rail truck, designed to solve railroad problems. *Right:* Controls in the cab of the truck

onstrate the merits of this new discovery in mechanical science. Just 60 years ago, on November 12, 1877, Bismarck, with whom Stephan had corresponded on the subject, consented to have a demonstration of the telephone made at his country seat at Varzin. The new invention impressed the Chancellor favorably, so that it was not long before Emperor William I took an interest, and permitted the telephone to be demonstrated and explained to him.

Rail Truck

CROSS-COUNTRY trucking services nowadays use, within the larger cities, light pickup and delivery trucks to distribute merchandise to and from trucking terminals. At the terminal the merchandise is loaded into large vans for inter-city shipment. The local truckmen get no revenue from the interurban trucker. It is believed that if railroads gave service on the rails comparable with highway service, and made arrangements at each town for local truckmen to pick up and deliver the merchandise, the railroads would have an advantage over the interurban trucker. A new rail truck has been designed for precisely this sort of service.

This new truck, designed and built by Coordinated Transportation, Inc., is to operate entirely on the railroad, never on the highway. It is essentially a highway truck transformed into a rail unit, the transformation being made by incorporating certain patented features together with standard railroad equipment. The truck's front and rear axles, together with their wheel assemblies and the steering gear assembly, are removed, and then a four-wheel-drive rear axle, a four-wheel truck in the front, and high speed reverse transmission and auxiliary radiator are installed. Standard railroad air equipment is added to supply the air brakes of cars that may be pulled.

The patented features of this rail truck consist of the four-wheel-drive rear axle, rubber insulated wheels, and auxiliary radiator. The new rear axle bolts to the rear springs and the drive shaft. The elimination of inner differentials and other gears greatly reduces the loss of power usually experienced in four-wheel drives. The rubber-insulated wheels are made by inserting two circular rubber inserts between the steel tire and steel wheel itself. This insulation absorbs vibration, deadens track noises, and prevents destructive action of steel pounding against steel. The auxiliary radiator is necessary, because the truck has a high-speed reverse transmission and can travel as fast in reverse as forward. This radiator makes use of the vacuum created by the moving vehicle to give adequate cooling.

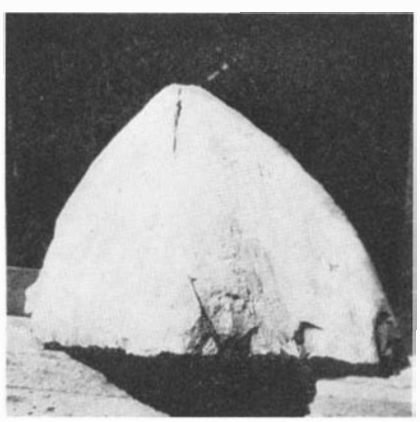
These rail trucks may be powered by either gasoline motors or Diesel engines. Generally speaking, the gasoline motor is more efficient in the smaller units and the Diesel engine in the larger ones. A 1½-ton rail truck can handle one loaded railroad freight car. The larger trucks can handle more loaded railroad freight cars in proportion to their increased power.

Besides their use in a trucking service on rails for branch and secondary lines, these units may prove economical for use in switching and for inspection, repair, and maintenance crews.

A Puzzle Solved, and How

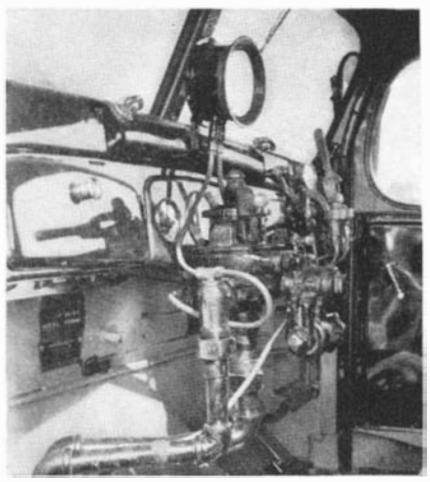
FROM a reader of this magazine, Mr. Norman E. Hills of Kelley's Island, Ohio, a photograph of a conical stone, reproduced on this page, was received some time ago with the following letter:

"The fossil of which this is a photograph was found in Devonian limestone in an old quarry at Kelley's Island, Ohio. It is a three-sided pyramid 10 inches in altitude. The sides are smooth but the bottom is uneven, as though, after the flesh of the creature that once occupied the shell had decayed, the base had been filled with different material from that which later filled the remaining space, and which is limestone containing small fossils common to the middle Devonian period. The actual shell has been dissolved. The space surrounding the cast once was occupied by the shell."



A "fossil" that turned out to be something entirely different. The accompanying text tells how these odd-shaped specimens are formed, with particular reference to drawing at the right

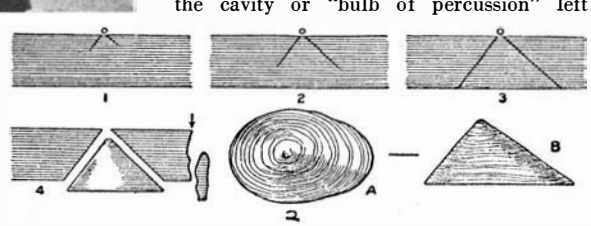
The description and photograph were submitted to Dr. Rudolf Ruedeman, State Paleontologist of New York, a specialist on Devonian fossils. The reply received indicated that three other geologists to whom these were shown by Dr. Ruedeman agreed with him that the specimen apparently "is

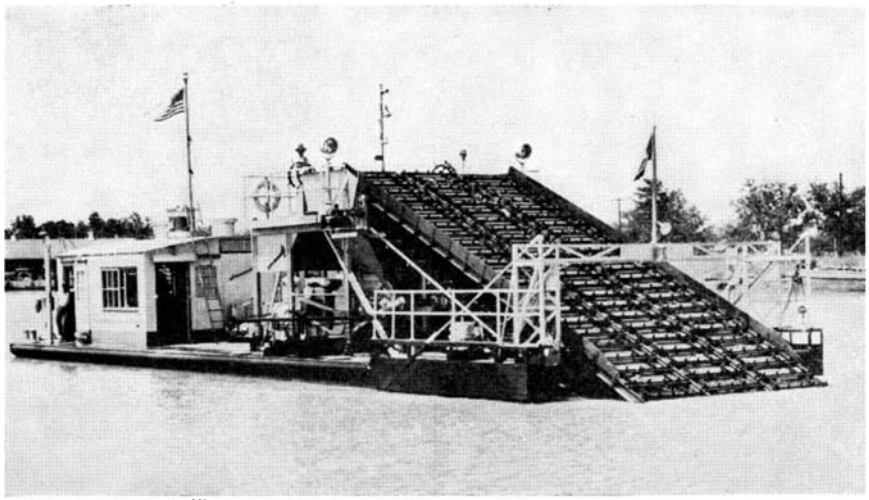


not a fossil and suggests a percussion core such as are found in quarries where a charge has been set off." The reply further stated that such cores had also been picked up in quarries near Albany, New York.

To make clear how a percussion shot in a quarry could make such cores as this, the common experience of workers in flint artifacts such as arrow heads may be drawn upon. If a localized, sharp blow is struck in the middle of a flat piece of flint the stresses are distributed downward and outward, expanding as they go and outlining a conical form. If these stresses are strong enough they may produce a conical fracture whose section is shown in 1 in the accompanying diagram, taken from the illustrated manual of the Stone Age on "Flints," issued by the British Museum. Stronger blows may produce 2 or even 3, in which case a conical piece of the stone drops out, as is shown at 4, also in plan at *A* and in section at *B*. By geologists this is called "conchoidal," meaning shell-shaped, fracture, (incidentally accounting for our Kelley's Island reader's natural assumption that the object he found was a fossil shell of some kind). The same effect is often seen in the glass of windows where a pebble or other round object, striking the glass, sometimes removes a neat core of the same shape but far smaller.

Ordinarily, when seen in glass windows, the cavity or "bulb of percussion" left





Courtesy Westinghouse Electric and Manufacturing Company

A menace to navigation, water hyacinths are destroyed with this equipment

when this has happened measures an inch or less in diameter, but in the stone quarry the blow delivered to the stratum at the level of which the explosive is detonated is sufficiently powerful to spread its fracture downward and outward some distance, making large cores such as the one shown in Mr. Hills' photograph.

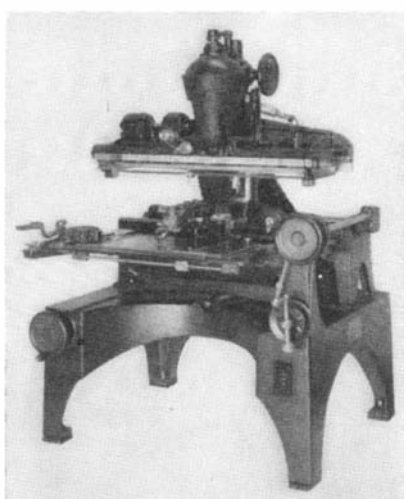
When this explanation was submitted to Mr. Hills he was at first inclined to doubt it. However, he soon discovered, on consulting with another person who had found similar objects in the same quarry, that these objects "were found by this man exactly under the hole marks made by the drill for the use of the explosive." In fact, Mr. Hills states that the same person previously had "seemed to think it miraculous that the drill should have stopped just where it did, and that it did not penetrate the (supposed) fossil!" Mr. Hills adds, "I now agree that the solution of Dr. Ruedeman *is* the correct solution, and a more careful examination reveals that some of the fossils at the surface of the core are sheared in the fracture plane, which further corroborates the interpretation given by Dr. Ruedeman."

Photo-Lettering Machine

A NEW mechanical artist that operates photographically has been designed to supply the lithographer, typographer, photo-engraver, or printer with a new means for setting up display headlines and small amounts of text which are now laboriously hand lettered or composed from type by hand.

The photo-lettering machine assembles photographic images of letters and composes them into words, giving the effect of fine typesetting or hand-lettering, but using neither type nor pen. In place of type, the photo-lettering machine uses master alphabet plates. These are glass plates of transparent letters which fit into the machine and slide back and forth semi-automatically, bringing one letter after another into focus over a small precision camera. As each letter comes into position, it is photographed instantaneously on film or sensitized paper. All this takes place in daylight where it may easily be seen; in fact, the operator visually controls the mechanism with a layout which he has prepared on the layout spacer, and places the letters precisely where he wants them. When the exposures have been completed, the film or paper is developed.

The machine will expand letters or condense them, stipple them, screen them, overlap them, shade them, or even heavy them. A change of focus gives all sizes from small text to giant headlines with no appreciable loss in sharpness. Justification of lines is automatic; letter-spacing is automatic; borders, backgrounds, trade marks, signatures and repeated designs may be stepped up. This application of the machine is frequently used in preparing all-over patterns such as check tints, backgrounds, and so on.



***Above:* Photo-lettering machine that is simple to operate. *Below:* Master alphabet and layout plates used**

The speed of the machine is not comparable with linotype, but in production of material which would ordinarily be hand-lettered or hand-set, it offers a combination of speed, flexibility, and precision far surpassing all other methods.

The Projection Layout Device, which is included with each Rutherford Photo-Lettering Machine, is a separate piece of equipment and is used for layout work of a special nature.

Operation of the lettering machine requires no particular skill on the part of the operator. Many plants employ boys for this work. An artist, or someone with a knowledge of typography, usually prepares the layout and the operator of the machine has only to select the indicated alphabets and sizes in order to produce quickly the artist's conception of the job.

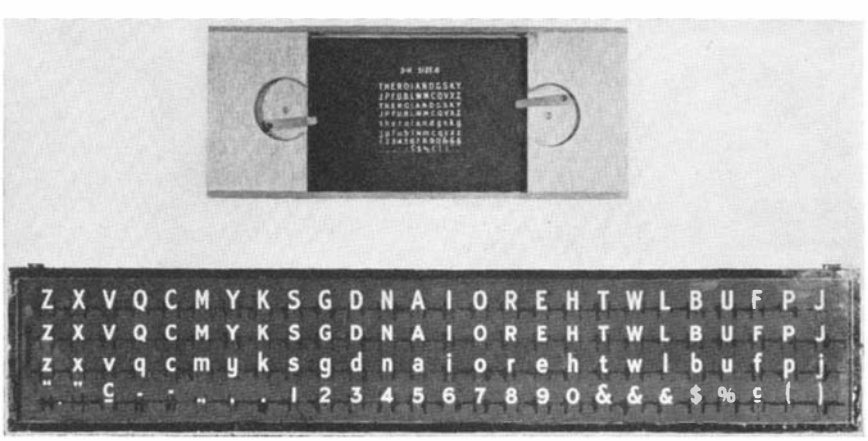
The range of the machine is from practically zero to 192 point. This range can be obtained with only three different sizes of alphabets.

Hyacinth Destroyer

A VERY interesting and unusual installation, though small, using a Diesel electric propulsion system was made recently on a boat designed by the United States Engineer Department, at New Orleans, for the purpose of destroying water hyacinths. These hyacinths infest many of the tributaries and bayous of the Mississippi River and are a serious menace to navigation. For many years the Department has endeavored to control this pest by spraying from special boats, using an arsenic solution. This method is dangerous, not only to the crews of the boats, but to the live stock along the rivers. After considerable effort, the new hyacinth destruction boat *Kenny* was designed and built and is now in operation.

The boat is propelled by twin screws, each driven by a 25-horsepower propelling motor. Power is supplied by two 80-kilowatt Diesel-generating sets. These generators also supply power to a 20-horsepower motor driving a 15-foot wide conveyor at the bow of the vessel, a 50-horsepower motor driving a crusher, a 20-horsepower motor driving a flushing pump and other small auxiliaries.

The boat is propelled slowly through the hyacinth beds and the plants are caught on the inclined conveyor, which extends about two feet below the water line, and are carried to a large hopper directly over the crusher. They fall into the crusher which consists of two heavy steel drums with



cutters revolving together. After passing through the crusher the material is flushed overboard and sinks to the bottom. If this experimental boat works out satisfactorily, as present operation indicates it will, additional units will be built so that the old method of spraying may be abandoned.

Full Vision Gas Masks

FULL vision lenses, which permit the wearer to see, read, work, walk and observe surroundings in safety, feature the new full vision gas masks manufactured by the Acme Protection Equipment Company, of Pittsburgh. The lenses are made of shatter-

proof laminated polished plate glass and afford 90 degrees vertical and 170 degrees lateral vision.

These new canister masks are available in both corrugated tube and snout types. The light weight, all-rubber face piece is fully molded and cured to master face-fitting proportions. Head harness connections are strategically located to eliminate all forehead pressure points, permitting wearing of hat or helmet without discomfort.

Another feature of this face piece is the elimination of the build-up of used (exhaled) air in the fresh air ducts. This problem is met by employing one-way flap valve ends on the fresh air ducts, which close upon exhalation.

Full vision gas masks are available with a choice of elastic, all-rubber or permanent non-rubber head harnesses and a wide selection of canisters covering organic vapors, acid gases, ammonia, and industrial smokes, hydrocyanic acid, and all known military gases and smokes.

Water Repellent Textiles

TREATMENT of textile fabrics to prevent wetting or staining by water or other liquids has been a serious problem of the textile industry. Lately several new agents for treating cloth have been developed which resist wetting and which do not otherwise change the properties of the fabric. Some of these are based on the incorporation of wax or wax-like materials into the fiber itself and others produce water-repellent surface coatings on the outside of the individual fibers. Such treatments have been developed which are highly resistant to

laundering and dry cleaning. One of the advantages of these treatments is that many stains which ordinarily get on cloth in water solutions (ink, fruit juices, and so on) cannot attach themselves to the fibers after treatment.—*D. H. K.*

Heart Pain Often Due to Overweight

SEVERE chest pain resembling that of the dread heart malady, angina pectoris, is in many cases due to excessive overweight, Dr. William J. Kerr, professor of medicine in the University of California Medical School, has found.

The huge pot belly, or "bay window," of very fat men forces them to adopt an abnormal posture which cramps the chest, causing breathlessness and preventing the heart from getting a normal supply of oxygen. Severe pain and low blood pressure accompany the condition.

The pain and other features clear up when the weight is reduced and the posture brought back to normal, Dr. Kerr found. Diet, exercises, and properly fitted abdominal belts are used in the treatment.—*Science Service.*

DEADLY

DURING 1937 there were delivered to the United States Army 410 airplanes twice as large as their immediate predecessors.

Is Tellurium Light Coming?

LIGHTING engineers have discovered how to change an odor worse than garlic into a light closely resembling sunshine, the *Journal of the Franklin Institute* recently reported.

Three researchers of the Westinghouse Electric & Manufacturing Company's lighting division laboratories reported in the journal the results of a year's experimentation with tellurium vapor as an artificial light source.

Predicting a new lighting system?

Dr. J. W. Marden, Dr. N. C. Beese, and George Meister demonstrated that tellurium, a semi-metallic element which produces a "garlic breath" if inhaled, gives off a continuous spectrum, when incandescent, like

The Editors Recommend

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sunlight, instead of a line spectrum as ordinarily found in metallic vapor lamps.

"I don't know what its possibilities are," commented Dr. Marden, "but the idea of duplicating sunlight is a gorgeous thing to dream about and the spectral color distribution from blues through white to yellow may make the tellurium vapor lamp ideal for certain special applications."

Dr. Marden gave tellurium a demonstration workout in an inverted U-shaped bulb equipped with a reservoir containing inert neon gas which is used as a starter. The bulb is made of quartz because glass would not withstand the tremendous temperatures developed in the liquid tellurium and would turn black as a result of the chemical action.

Tungsten wire was used as the external connections of the tube, attached at the two ends of the "U" and completely immersed in the liquid tellurium pools in the bottom of the tube. When the lamp burned brightest the temperature at the electrodes varied between 1300 and 1500 degrees Fahrenheit, two-and-a-half times hotter than molten lead.

Heat is one of the most serious problems that have to be solved before the tellurium vapor lamp can be put to a practical use. "It has been found," Dr. Marden pointed out, "that a very high efficiency will be possible once we find a container that will withstand the chemical action and the heat, and still let the light through. For the present, quartz is the best container we have found."

Like many developments of the research laboratory, the tellurium vapor lamp has arrived before the practical demand has materialized. But, as Dr. Marden commented: "It's our business to pry into every type of discharge we can imagine as a source of light."

For the time being, the new lamp will remain a laboratory curiosity, but it is another step forward in man's search for the best light.

DIRECTORIES

NEW YORK CITY'S five alphabetical phone directories, of which more than 1,500,000 copies are distributed in the city, would fill a book shelf 50 miles long.

ELECTRO-PLATED PLASTICS

BY a new process of electroplating, developed in England, metals may be deposited on molded plastic articles to produce decorative or protective effects. Copper, brass, nickel, chromium, silver, and rhodium have been successfully applied. The process supplements that of molding the plastic around a metal core or skeleton as now practiced to give the finished article strength greater than that of the plastic alone.

The combination of metals with the many colors available in modern plastics places at the disposal of the molder and fabricator an entire new range of decorative effects. With metals varying in color from copper and brass to silver and chromium can be combined the many colors of clear and translucent plastics to give effects heretofore

impossible. The new method permits depositing the selected metal on any desired parts of the molded article.

Aside from decorative possibilities, the electroplating of metals suggests the use of the new technique as a protection for plastics under conditions which might otherwise destroy them. Alkali resistance is imparted by nickel plating and both rhodium and chromium resist solutions containing salts and some acids. It is thus possible to line containers molded of plastics with metals which resist corrosive action of their contents, when that is necessary.

The new finish permits many articles to be made of plastics of light weight which hitherto have been die cast.—*D. H. K.*

TAXES

FORTY cents of the motorist's tax dollar is spent on highways, 25 cents is allocated to local units, 16 cents is diverted to non-highway uses, 14 cents goes for payment on debts, 4 cents for collection and administration expense, and 1 cent for state police.

Air Conditioning Cuts Employee Loss By Reducing Sickness

LOSS of employee's services from colds and other respiratory illnesses has been cut from an average of 2.2 days to 1.6 days during the past year in the air-conditioned offices of Procter and Gamble Company, manufacturers of soaps and allied products.

This company occupies five floors of the Gwynne Building, 13-story Carrier air-conditioned structure in Cincinnati. The soap manufacturers were the first to install air conditioning, their success with it leading to the complete building installation.

Luminescent Paint

NON-TOXIC, non-flammable luminescent paint which contains no radioactive material is now on the market. The principal constituent is calcium sulfide which, when exposed to light, subsequently glows in the dark. This paint can be applied to metal, glass, cloth, paper, wood, and almost any other common material.—*D. H. K.*

Electric Eyes Protect Human Eyes

REALIZING the vital part played by adequate and uniform illumination in any work requiring close concentration and mental effort, General Electric engineers have devised an inexpensive photo-electric lighting control that keeps the light in a room or building at the proper level for satisfactory work.

Fatigue and poor work because of eyestrain can easily be eliminated when sufficient light is provided. Persons working in a room where automatic lighting control is installed are free to go about their work without being interrupted or annoyed by poor light. When artificial light is needed to keep the illumination at a pre-determined level, the lights are turned on automatically.

When enough natural light is available to provide this amount of illumination, the artificial light is turned off.

This desirable control of the lighting in a room is accomplished by means of a phototube, or "electric eye," application. A phototube is set up so that the natural light coming through the windows falls on the tube. Any difference in the amount of light striking the tube causes a change in the amount of current flowing in the tube. This current change is amplified by a standard radio tube so that it is of sufficient magnitude to operate a relay which in turn operates the lights.

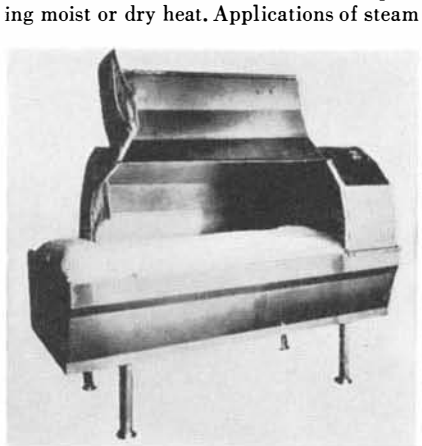
New Letters for Movie Titling

LETTERS cut from sponge rubber 3/16 of an inch thick, painted either silver or black on their faces, and having an adhesive back which never wears out have just been placed on the market for use in composing titles for movies or still pictures. The letters are deep-cut block letters in two sizes—1 inch and 1½ inches tall. They may be pressed into position on any smooth surface, the adhesive gripping firmly. They are as easily removed and used again in another set-up.

For titling amateur movies or still photographs these letters may be mounted on translucent glass panels to give interesting effects with back lighting, or may be sidelighted to give an exceptionally strong relief effect. These Spell-O-Tex letters are made by Besbee Products Corporation and distributed through most of the leading photographic supply houses.

Stainless Steel Health Bath

STAINLESS steel is filling another need in medical equipment—this time for the cabinets of electric steam vapor baths, used in the treatment of human ailments requiring moist or dry heat. Applications of steam



Health baths are given in a reclining position in this new cabinet

vapor, including oil, menthol and sulfur mixtures, may be given to patients while they are in a reclining position.

The new cabinet is manufactured by the Electric Hotpack Company, Inc. Twenty-two-gage Armco 18-8 stainless steel, manufactured by The American Rolling Mill Company, is used for the entire covering. During two years of experiments, it was found that stainless steel was the only metal

that met all of the requirements for this new product.

Special features included in the new type of cabinet are thermostatic heat control, automatic water control, automatic steam control, built-in showers for hot and cold water, and infra-red ray units.

The machine is used for artificial fever, pneumonia, high colonic irrigations, flesh reducing, neuritis, rheumatism, infantile paralysis, asthma, high and low blood pressures, sprains, fractures, breaks, and general health baths.

Pocket Letter Scales

IT is always embarrassing to mail letters or packets and have the recipient pay additional postage merely because we guessed the weight. Manufacturers of new pocket

Convenience in letter weighing

scales had this in mind in developing this handy little device in a size that busy executives, salesmen, and travelers can carry in their vest pockets. These scales, developed by the Autopoint Company and called Postalett, will weigh letters or packages from half ounce to half pound. The accompanying illustration indicates that it is as simple to use as is the fisherman's spring balance.

Elements Beyond No. 92

IF you look in any chemistry text book that is not just fresh off the presses, you will find a table of the chemical elements that ends at uranium, number 92. That is the way the chemical elements, building stones of everything around us, were first arranged back in 1871 by Mendeleeff, the Russian, and Meyer, the German, to form the periodic table.

There was no place for elements heavier than uranium, the 92nd. Yet science has discovered not one but at least four such "transuranic" elements. Little wonder they were not discovered earlier, for the discovery was dependent upon creating them first and this was done only through the use of the neutrons, discovered in 1932, to produce artificial or induced radioactivity, a possibility first realized only as recently as 1934.

Prof. Enrico Fermi of Rome was the first to make one of these super-heavy elements by bombarding uranium with neutrons. Uranium is the radioactive parent of a whole family of lesser elements and its fame comes from its natural and constant disintegration. But under neutron bombardment, occasionally one or more of the neutrons

sticks, in effect, in the heart of the uranium atom. The uranium is transmuted into a heavier element.

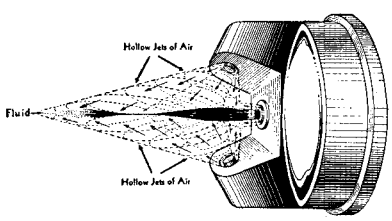
All of the newly-made elements are very short-lived. They break down radioactively, but they disintegrate much faster than radium. Half of the quantity is changed (what the physicist calls the half-life period) in 16 minutes for the most fleeting to three days for the most stable.

With such short lives, it is little wonder that the elements beyond 92 do not exist naturally. When the earth was very young and freshly carved from the sun, it may have had these elements which have long since disintegrated.—*Science Service.*

"Hollow-Air" Atomizer Head

TODAY more and more paint and enameling jobs are being done with spray guns. There are, however, some synthetic enamels, lacquers, and paints which are very difficult to atomize and yet must be applied with a uniform width and smoothness in order to avoid sagging and "orange peeling."

A new atomizer head which has two impinging jets of "hollow air" instead of the solid jets heretofore used in paint spray



How the new atomizer works

guns, is said to be capable of atomizing the more difficult materials and to prevent the defects so common with ordinary spray guns. This new device, made by the Alexander Milburn Company, operates with the usual air pressure and siphon or force feed. The jet of liquid blown from a central orifice passes between and is atomized by two rotating jets of air which face each other from opposite sides of the central orifice. It is said to enable the operator to apply synthetic paints with a fan spray of uniform width, without splitting, giving good atomization between extremely wide limits. Working with the gun at the normal distance of six to ten inches from the work, satisfactory spray widths of 18 inches or more are obtained.

Radio Waves Kill Insect Pests

HAVING recently received from an Italian Government bureau request for further information on the article carrying the above title which was published in our May, 1933, issue we asked the author of that article, Mr. J. H. Davis, of the Baltimore and Ohio Railroad Company, the present status of the work in this field. It will be recalled that the article pointed out that considerable success had been achieved in the destruction of all insect life and insect eggs in shipments of grain by subjecting the grain to short wavelengths. Mr. Davis has answered, in part, as follows:

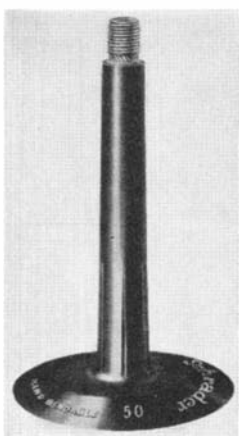
"Since the publication of my article in

Scientific American, we have continued our research work with special reference to the study of the effects on many kinds of seed irradiated by high-powered short radio waves and have found that under proper exposure as to field strength and wavelength, seeds so irradiated show enhanced germination, growth, and yield properties.

"In the case of wheat seeds with which one of the leading universities has been experimenting for about 44 years, the increased yield compared to the control samples showed an 8.5 percent increase where exposed to 42 megacycles and a field strength of about 2000 volts per lineal inch for a period of eight to ten seconds."

Bendable Tire Valve

A NEW valve for motor-car inner tubes may be single bent to any desired angle to fit any type of automobile wheel. The valve insert is made of special metal tubing that will always assure correct hand bending and will not close the air passage. The base of the valve is prepared for vulcanization to the tube and it may be bent before or after it has been applied. This item, developed by A. Schrader's Son, offers a big advantage to dealers, eliminating the necessity of stocking several styles of angle valves.



A versatile tire valve

Spray Drying Produces Tiny Bubbles of Milk, Eggs, or Soap

THE new methods of spray drying, which are used for milk, eggs, soap, potato flour, or blood, were described recently at the 4th Chemical Engineering Symposium held at Pennsylvania University.

If you have ever used any of these dried products, you may have noticed that they may come in the form of tiny, solid bubbles which are light and hollow. It is spray drying which produces this unusual form. Additional solubility attained when one wants to put the dried product back into an edible or usable form is a merit of the method.

Ben B. Fogler and Robert V. Kleinschmidt of Arthur D. Little, Inc., described new techniques. It takes only from 15 to 30 seconds for little liquid bubbles of the material to be dried into solid spheres, they indicated. Great towers, sometimes two stories high, are employed. The sprayed solution comes in the top of the tower and drops by gravity during the drying.—*Science Service.*

CAMERA ANGLES

Conducted by JACOB DESCHIN

Exercise in Lighting

THE problem consists in illuminating a still life comprising three pieces of glazed earthenware—two "glasses" and a carafe. Among the difficulties to be overcome are the facts that the body of the carafe is very rounded and has a relatively small base, the glaze introduces the problem of reflections, and the proximity of one of the glasses to the carafe as well as the rotundity of the latter necessitates a lighting scheme that will result in a minimum of shadow areas.

Because we want tonality, we start with a single light shot at an angle, as in Figure 1. But we find this unsatisfactory and at once abandon the angle altogether. So we make another lighting start, this time from overhead (Figure 2). The result is vastly improved; we are particularly attracted by the interesting surface appearance of the glasses. The shadows must, of course, be "filled" in and other illumination brought in to model the roundness of the subjects. Being in an experimental mood, we temporarily suspend this scheme and try something else.

In Figure 3, we finally employ two illuminants, this being inevitable from the nature of the subject. One is placed directly in front, that is, alongside the camera, the other is directed from the side of the subject downward at a 45-degree angle in relation to the base of the set-up. Shadows are filled in, everything is lighted, but depth and roundness are lacking and pictorial interest is low. By substituting the top light (Figure 2) for the frontal light, we find that at last we are getting somewhere.

Figure 1

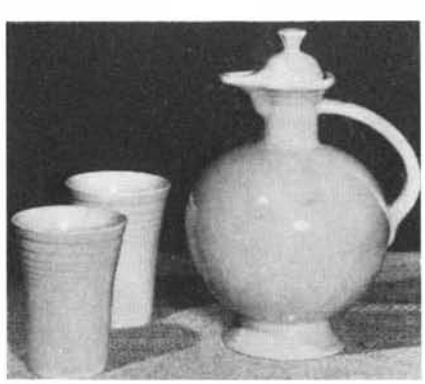


Figure 2

Figure 3

Figure 4

Thus, in Figure 4 we have what we believe might be the basis for the final picture. The only thing left to do to complete the job is to light the shadows. But we must do so without endangering the tonal range of the subject-matter. A third illuminant, or reflecting surface, is found necessary, but it must be carefully controlled and directed. It should, as nearly as possible, permit the retention of the interesting surfaces on the glasses that pleased us so much in Figure 2.

However, the use of three lights introduces grave difficulties, so we try again to get the proper result through the use of only two lights. We are loath to abandon the top light. Is not there something that can be done to make this light provide better illumination? We leave the top light where it is, but move the set-up closer to the background, thus bringing the top light a little distance forward of the subject instead of directly overhead. The glasses lose a bit of their attraction under the scheme

Figure 5

illustrated in Figure 2, but the carafe is better lighted. This is compromise Number 1.

It now appears that if we are to use only one other light, this must come from the front. Recalling the results obtained with a frontal lighting in Figure 3, we know we have a job ahead. First, we employ a weaker light than that used in Figure 3; also, we set the light back a little. But the light reaches the glasses as well as the carafe, and this is not what we want. So we "blink" the left half of the light to prevent the full strength of the light from reaching the glasses. This is compromise Number 2.

A third compromise was included in the enlargement of the negative, namely, a little dodging at the two ends of the carafe base. This was necessary because the light naturally did not reach these points in an intensity strong enough to survive the printing time required for correctly rendering the tones of the negative.

Thus, by a series of try-it-and-see lightings, we finally achieve a picture (Figure 5) that we believe is a fairly correct rendering of the subject-matter photographed. If we have had to make a compromise here and there, it is only because light, after all, will not do everything.

The Leica Camera Gun

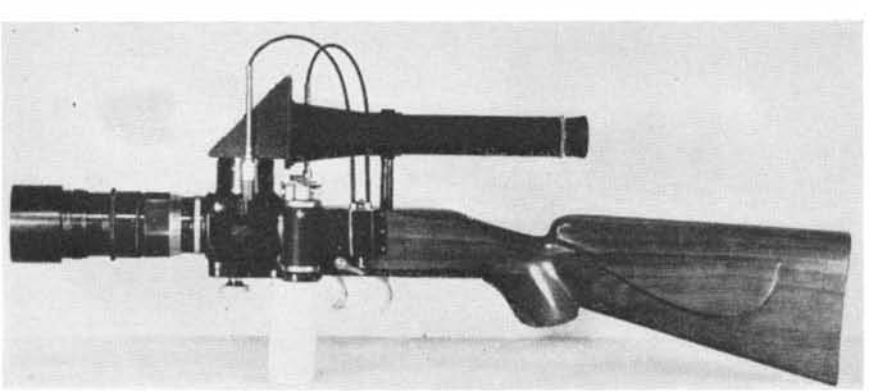
SHOOTING pictures at long range is facilitated for the sportsman, naturalist, and news cameraman by the recently introduced Leica Gun, which includes the Leitz 200 mm Telyt lens mounted on a Leica camera and the whole supported by a gun stock which takes the place of a tripod. A telescopic sight is incorporated for focusing on the ground glass of the mirror reflex housing, focusing being done by means of the lens barrel. The image is corrected horizontally and vertically by a second mirror and is thence led back to the eye by way of the telescopic sight so that it is right side up and correct as to right and left.

The Leica Gun is a rapid action gun by reason of the pistol grip and the two triggers, the latter being arranged in a natural position for the fingers. The forward trigger releases the shutter, thus making the exposure, while the rear trigger, which is connected to the camera take-up by means of a rachet, winds the shutter and brings a fresh section of film into place. The complete gun weighs 8¾ pounds, assuring steadiness when held at shoulder level.

Theme Competition

STARTING this month and continuing until further notice, this department offers its readers an opportunity to win prizes by competing in a fascinating phase of the art of photography. Each month there will be given a definite assignment in interpretive photography, to be fulfilled according to each individual photographer's own imagination or artistic ability. Prints submitted in these monthly competitions will be judged on the interpretation of a theme, as well as on pictorial appeal and technical excellence. Each month two cash prizes—$10 for the first prize and $5 for second prize—will be awarded, and there will be two honorable mentions, each to be a year's new or extension subscription to Scientific American.

The simple rules of the contest are as follows: (1) All prints submitted must be mounted, the over-all size *of the mounting* not to exceed 11 by 14 inches. Prints may be any size from 3¼ by 4¼ inches up to the maximum area of the mount. (2) Not more than one print may be submitted by each contestant, it being left up to him to judge his own work, and to select the one which, in his opinion, best portrays the theme of the assignment. (3) Prints may be forwarded by any means desired but each must be accompanied by the required return postage. (4) No names or titles are to be placed on the face of the photograph; on the back of the mounting must be given the contestant's name and address, together with the name of the camera and of the film employed. (5) The competition will be judged by the conductor of this column and the editorial staff of Scientific American. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants. Prize-winning photographs will become the property of Scientific American to be used in any manner at the discretion of the publisher. (6) No entries will be considered from professional photographers. (7) Prints may be black-and-white or toned; no color prints will be considered. (8) All entries in the first Scientific American Theme Competition (April, 1938) must be in the hands of the judges



A gun for shooting pictures at long range

by May 1, 1938. The results will be announced in our issue dated July 1938. (9) This competition is open to all amateur photographers who are not in the employ of Scientific American.

APRIL COMPETITION THEME: "REPOSE"

The assignment for the first competition is "Repose." In this case, the interpretation of the theme might involve the placid surface of a lake at sunset, a bather at ease on the beach, a dog or cat curled up in a corner, hands in a relaxed pose, a child asleep in its high-chair, or 101 other things that the active mind of the resourceful photographer will suggest. These hints are thrown out at random and are not necessarily to be considered as definite suggestions.

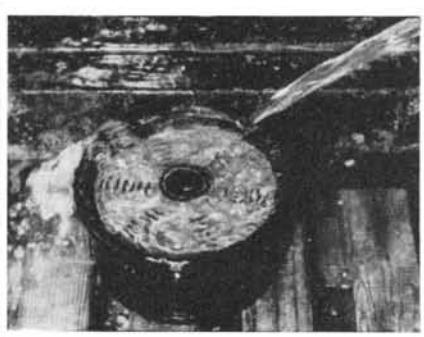
Address all entries: "Repose" Competition, Photograph Editor, Scientific American, 24 West 40th Street, New York, N. Y.

Here is something well worth shooting at, both to test your sense of photographic interpretation in competition with others, and because of the prizes involved. Go to it!

Watch for the second assignment next month.

Water "Motor" Revolves Reel

CONTINUOUS replenishment of the fresh-water supply in washing miniature negative strips in a developing tank is provided by the method illustrated here. The water is sent in a long stream through a length of rubber tubing suitably poised to



For better washing of films

reach the opened tank at the required angle. The tank is so placed that the "point of impact" between water and tank is along the edge of the tank, rather than against the reel itself. When thus arranged, the force of the stream of water not only assures a continuous change but at the same time revolves the reel, resulting in a more thorough washing within a relatively shorter time than would be required without this ceaseless agitation.

Rolleiflex Contest

A TOTAL of 450 dollars in 31 cash prizes is to be awarded for entries in the Third Rolleicord-Rolleiflex Salon to be held May 2 to 8 at Rockefeller Center, New York City, under the sponsorship of Burleigh Brooks, Inc. Last day for receiving entries is April 16. Any United States resident using the Rolleicord, Rolleiflex, Heidoscope, or Rolleidoscope cameras may submit up to a total of four prints. The salon is to be divided into two groups: Pictorial and News and Technical. First prize in each group is 75 dollars. Rules provide that prints must be

at least 7 by 7 inches, mounted in such a way that the overall size does not exceed 16 by 20 inches; name and address, exposure and printing data must be pasted or written on back of each mount and return postage must be enclosed. The judges will be: Adolf Fassbender, F.R.P.S., Margaret Bourke-White, and Herbert C. McKay, F.R.P.S.

New Super Ikonta B

RANGE finder and view finder are combined in a single large finder, permitting finding and focusing in a single operation, a feature borrowed from the Contax, in the new model of the Super Ikonta B, recently announced by Carl Zeiss, Inc.

The Super Ikonta B takes eleven 2¼ by 2¼-inch pictures on 120 or B-2 rollfilm, is

Range- and view-finder are combined

equipped with the popular Zeiss Tessar F:2.8 lens in a Compur Rapid shutter with speeds up to 1/400th second, delayed action device, exposure counter, device for preventing accidental double exposures, two-point setting for use as a fixed focus camera.

Fotofolio for Mini Negatives

THE Fotofolio book-type method of filing prints and negatives has been made available to the minicamera fan in the "Miniature" Fotofolio, which will take 288 strips of prints and negatives, or a total of 1728 35-mm prints and 1728 negatives per volume. Photographs and negatives in strips of six frames each are accommodated by the volume, which consists of eight pages, each of which is equipped with attached gummed cloth strip hinges to take 36 strips of prints. The hinges are equipped with envelopes, one for each series of six hinges, each envelope holding six negative strips. Non-scratching paper protects the negatives.

Photographic Exposition

CHARACTERIZED as "the most comprehensive exhibition of photographs and photographic and allied equipment ever held," the First International Photographic Exposition is scheduled to be held at Grand Central Palace, New York City, from April 18 to 24, inclusive.

The exposition is to have five main divisions: an all-inclusive international exhibition of photographs under the personal supervision of Willard D. Morgan, Contributions Editor of *Life;* stage show and picture-taking free-for-all, dancing, fashion shows, athletic events and other attractions to be

presented chiefly for the purpose of offering picture opportunities to candid camera enthusiasts; two lecture and demonstration halls, in which a comprehensive program of lectures and demonstrations will be presented by leaders in their fields and where information will be available on various photographic problems; complete manufacturers' exhibition section; and a retail dealer section.

The executive committee of the exposition comprises Joseph Dombroff, president of The National Photographic Dealers Association, Inc.; Henry Herbert, president of The Guild of Photographic Dealers of New York, Inc.; H. O. Bodine, president of the Photographic Expositions, Inc.; A. J. Powers, honorary member, International Photo Engravers' Union, and Col. Roy W. Winton, managing director of Amateur Cinema League, Inc.

Mask Your Negatives

WHERE the negative holder of the glass "book" type is used for negatives smaller than the size for which it was designed, some amateurs, through carelessness or laziness, sometimes prefer not to go to the trouble to mask the negative. As a result, the light coming through the negative from the enlarger light-source comes uselessly—and harmfully—through the clear glass area as well. Uselessly, because in this way it serves no purpose at all; harmfully because it fogs the paper to a certain extent. Try an experiment sometime and see the vastly different results obtainable with a masked negative and an unmasked negative enclosed in a holder larger than the negative used.

Vest Pocket Tripod

BELIEVED to be the most compact tripod extant, the Roll-O-Pod, which is shaped like a smooth round box, three inches in diameter and one and a half inches high, is now being distributed by the Intercontinental Marketing Corporation. Although fitting the vest pocket, the Roll-O-Pod stands 40 inches high and is said to be capable of supporting a fairly heavy camera. The tripod has a built-in swivel tilt top. The casing of moulded Bakelite acts as the tripod head when the Roll-O-Pod is set up. Each leg consists of one strip of high grade Swedish steel, entirely rigid when set up, yet of such cross-section that it rolls up easily inside the Bakelite casing.

Freak Film Fogging

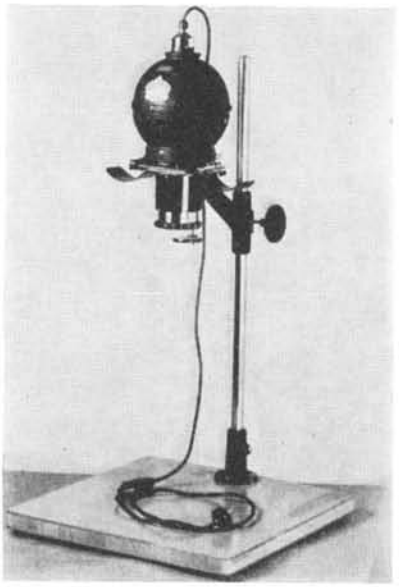
A CURIOUS misfortune befell a photographer of our acquaintance recently in airmailing some color plates from California to New York. It so happened that the same plane was carrying a consignment of radium and as a result the exposed 8 by 10 color plates were somewhat fogged. On returning to New York, you can imagine his dismay; fortunately he was able to rescue enough from the wreckage to save the day.

Precis 44 Enlarger

CERTAINLY nothing could be more indicative of the unabated interest in miniature photography than the great influx of new enlargers on the market. There is plenty of stiff competition and any enlarger

that expects to survive has got to be good.

The latest stalwart in the field is the Precis 44 Enlarger, which has been introduced by the Raygram Corporation. One of its principal features is a metal-glass com-



"... taking negatives to 4 x 4 cm"

bination pressure negative holder taking negatives up to 4 by 4 cm. Some of the other specifications are as follows:

Enlargements up to 9 by 14 inches; single 2½-inch condenser system; baseboard, 16 by 15¾ inches, of seasoned plywood, polished, balanced by rubber legs; preliminary focusing by friction wheel on 27-inch vertical post, critical focusing by turning helical oversized tube in which lens is mounted; red filter attached to focusing gear post.

THE CLICK IN TIME

RECALLING the advice of writers that the photographic journalist should never venture forth without a camera somewhere on his person in anticipation of the chance shot that comes once in a life-time—or so—the Leitz company quotes the experience of a New York amateur, Victor D. Solow, in this connection:

"While going about his accustomed tasks where he is employed, he was electrified at the news that an upper story window had fallen from a building across the street and had hit several pedestrians. Solow grabbed his camera, rushed to the street, made pictures of the men awaiting the ambulance and, after its arrival, pictures of them being treated at the scene. To complete the series he made a close-up of the broken window casement.

"Solow then called the New York *Daily News*, which immediately dispatched a messenger to secure the pictures. So excellent and dramatic were the shots Solow had made that three of them were reproduced."

CAMERA ANGLES ROUND TABLE

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

Q. I seem to be having trouble with glossy prints lately. I enclose two recent examples of what I mean. Will you please tell me what is wrong?—H. J. K.

A. Both prints indicate the following faults: The print surfaces did not make complete contact with the ferrotype tin; the surface of the tin is scratched; the tin was not cleaned before laying the print down. For best results in ferrotyping glossy prints, the glazed surface of the tin must be thoroughly cleaned before use by wiping with a clean cloth and then treating with a thin coating of ferrotype polish, procurable in any photographic store. Apply the polish with a wad of cotton and rub over the entire surface with a circular motion first to apply the polish, then, with another wad of cotton, "rub it down" so that when the job is finished the polish appears to have been rubbed off altogether. In placing the print on the tin, make sure the print makes a firm contact with the glazed surface, exerting sufficient pressure on the roller or squeegee to insure that there are no slight bulges where the surfaces of print and tin do not meet. This is the cause of the unglazed circles in your prints. If slight bulges do appear, rub them down with the fingers and apply the roller or squeegee once more. Nothing can be done for scratched tins. Because of their delicate surface, the tins should not be stored just any old way, but should be covered with soft paper or protected in some other way when not in use.

Q. Can you suggest a method of labeling solution bottles so that the labels will stay put despite frequent subjection to water?—P. R.

A. Write your legend on the label, paste the latter on the bottle in the usual way and then brush the label with varnish, the latter thus furnishing a sort of "glass" covering.

Q. What is the slowest shutter speed it is safe to use when shooting hand-held exposures with a miniature camera?—J. K.

A. One man we know says he never makes snapshots from the hand at less than 1/100th of a second because he wants to be dead sure his miniature negatives come out knife sharp. He went so far as to add that even for 1/50th he uses a tripod. Personally, we feel he is over-zealous but there is no denying the logic back of what he says. Miniature negatives often are enlarged 10 diameters and more; for a negative to stand that much magnification it *has* to be sharp. What is the use of taking the pains to get sharp focus when you don't give the camera a chance to stay rigidly "put" during the short interval of the exposure? However, most persons can hold the camera steadily for 1/25th of a second, though 1/50th is better. Some shoot at 1/10th and get away with it. Since your question intimates that you seem to be having some trouble in this connection, we suggest the following personal experiment: Focus on some object that is brightly illuminated either with sunlight or artificial light. When you have made absolutely certain that you could not possibly focus the object with greater accuracy, make three or four exposures each at 1/25th and 1/50th and possibly one or two at 1/100th of a second. When you have finished processing the negatives, enlarge all the negatives to the limit of your enlarger's capacity, being careful to identify negative with print (this can be done by marking the back of the print with pencil before immersing it in the developing bath). When the prints have dried, study each one under a magnifying glass. That will tell the story. While you may shoot sharp once by accident you won't do it four times in succession. If you find the 1/50th prints are sharper in practically every case than the 1/25th ones, by all means adopt 1/50th as your minimum for hand-held snapshots.

Q. What is the easiest, yet reliable, method to determine the definition of a used lens after it is mounted in a camera body?—J. L.

A. The real test of a lens is in its performance. Some impression of the quality of the lens may be gained from ground-glass inspection of the image that comes through it, but even if you were to use a magnifier for this purpose, the story would be incomplete until you had actually made some shots with the lens in question and inspected the negatives.

Q. I plan to make a visit to Europe this summer and hope to take some pictures during my sojourn. I have heard that Scheiner film ratings there are somewhat higher for the same film than the ratings in the United States. Will you set me straight on this?—V. A.

A. If you take your film supply with you, as well as an exposure meter purchased in

this country, you will, of course, have no trouble in this regard. However, there is always the likelihood that while you may bring your own meter your film supply may run out and you will be obliged to purchase film abroad. It is known that identical film is rated 5 to 6 points Scheiner higher abroad than it is here. Thus, film rated 23 degrees here may be rated 29 in Europe. This has given rise to the use of two Scheiner classifications, the U. S. Scheiner and European Scheiner. European meters are calibrated for the European Scheiner system, while meters sold in this country are calibrated for the U. S. Scheiner ratings. Therefore, if you purchase a 29-degree film while in Europe, your American-bought meter should be set for 23, or a compensating allowance made on your lens diaphragm, opening the iris two stops wider than called for by the meter reading for 29 degrees.

***Q.* Is there any saving to be gained in purchasing large sheets of photographic paper and cutting them down to desired smaller sizes?—H. V. A.**

A. Not enough to make it worth while. For example, if you wanted to make 5 by 7 prints and purchased 11 by 14 paper to get four from each sheet, you would, according to one catalogue, be saving only a nickel.

***Q.* How does one go about submitting pictures to a photographic exhibition?—J. L. G.**

A. It's the easiest thing in the world. The hardest part lies in selecting the four prints you think best merit the honor of salon exhibition; you are the first judge. Most contemporary photographic exhibition rules limit to a total of four the number of prints that may be submitted by any one contributor; require that prints be mounted on the standard 16-by-20-inch mounts, although the prints themselves may be much smaller (11 by 14 prints are generally favored by exhibitors); require a fee of 50 cents or one dollar to cover incidental expenses, such as the return of prints; and publish a closing date for the receipt of prints. It is important that the prints be carefully packed so that the package may not be bent or the corners of the mounts damaged. At the conclusion of the exhibition, prints are returned in the same package in which they were received. Specific rules concerning particular exhibitions may be obtained from the secretary of the society sponsoring the exhibition. Not all submitted prints are accepted, of course, but acceptance is generally held to be a mark of excellence and therefore a proof of good craftsmanship.

***Q.* Will you please advise me whether it is absolutely necessary for one to take a formal course in photography in order to get a complete training in this field? I would like to study photomicrography in particular and would like to know if any school offers a course in this work and whether this field is a paying one.—Miss P. McD.**

A. It is quite possible to become a professional photographer without taking a course, but the process takes much longer; since you say you have only spare time to devote to it at present, we should think that a practical course would be advisable. Any field in photography can be made a paying one, provided the photographer can introduce new ideas. This is especially true of photomicrography which has been found profitable by workers in your own field of medicine. We do not know of any course being devoted exclusively to the field in which you are interested, though we are sure that if you were to consult some reliable school, special instruction in this type of photographic work could be made available to you. Of course, all phases of photography are interrelated and a knowledge of the fundamentals is essential to the understanding of any specific field.

***Q.* This summer I expect to take a Mediterranean cruise and hope to do some photography, especially in Egypt. I understand that the lighting conditions in Egypt make for poor pictures with thin sky. What I want to know is: Can I use a light red filter and work without a tripod or would you recommend a different filter?—Dr. F. G. W. G.**

A. The use of a light red filter will, of course, give you a rather dark sky. You may not always want this effect; often it is better for the general spirit of the picture to have a lighter sky and still have the clouds stand out. As to the use of a tripod, this can be dispensed with if you find it possible to open the lens wider to compensate sufficiently for the increase in exposure that would otherwise be necessary with the filter used. Offhand, we should say that a tripod would not ordinarily be necessary if this method were adopted; sometimes, however, you may not be able to get sufficient depth of field unless you stop down the lens. In that case you will probably have to use a tripod. After all, you doubtless will take one along with you anyway, even if only for the possibility of night picture-taking. There are several light-weight, compact tripods on the market that would not be too much of a burden to pack or to carry.

***Q.* The lens apertures on my camera are marked 1, 2, 4, 8, and so on. Can you give me the F: value equivalents?—A. B.**

A. Your diaphragm scale is marked according to the so-called U. S. (Uniform System) scale. In converting these designations into the more widely used F: system, wherein the indicated F: value is a fraction of the focal length of the lens, computations begin at F:4, which is equivalent to U. S. 1. Thereafter, each numerical doubling of the F: value is equivalent to a quadrupling of the U. S. number. The following table gives the equivalents from F:4 to F:32. F:11.3 and F:22.6 may be read, for practical purposes, as F:11 and F:22.

U. S. Number	1	2	4	8	16	32	64
F: value	4	5.6	8	11.3	16	22.6	32

***Q.* Would you please recommend a good school of photography?—A. H. W.**

A. It is obviously beyond the province of this department to favor one school above another. And, generally speaking, it would be presumptuous anyway. Really, it makes little difference which school you choose; the chief factor about any school is you, yourself. You will get knowledge from the school in direct ratio to the time, thought, and application you are willing to contribute to the course. No school is any good if you are not willing to do this, if you "throw up the sponge" at the least sign of tough going. Likewise, practically any school is a good school if you *are* willing to do this.

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

BECAUSE so many interesting items touching on telescoptics have come to us, we have more and more neglected to publish the photographs of telescopes which their makers have sent us, and we now have about a tubful of them. How useful are such pictures as sources of ideas for design by other amateurs? Figures 1, 2, and 3 show telescopes of a similar type—fork attached to expanded polar axis rotating on rolls, as

Figure 1: **Boven, Minnesota**

in the book "Amateur Telescope Making," fourth edition, page 133, left-hand drawing.

Figure 1 is an 8½", *f*/6 reflector made by Harvey H. Boven, 304 Seventh St., Red Wing, Minn. Tube, galvanized iron. Cell, a Chevrolet hub crown filled with lead (for counterweight). P.A. bearing, an 18½" split wooden pulley on two non-bearing 3" brass rolls "which give me all the friction needed," the maker states. This brings up the fact that too little friction may be a won't-stay-put nuisance unless there is perfect balancing and a clamp. Boven also invites correspondence.

Figure 2 is a 7¼" *f*/8 made by Alfred Bryant, 516 Egleston St., Kalamazoo, Mich. His P.A. bearing is an old gasoline engine flywheel and the P.A. shaft is 1¾" in diameter. To it is attached the gearing of an old phonograph motor with an extension hand rod which is used as a slow motion. Base of fork, heavy washing-machine casting. Sides, boiler plate. Tube, 17 pounds, ⅜" thick, spirally wound paper with five coats of paint, "strong enough to hold an elephant."

Figure 3 was made by L. H. Strum, 232 First St., St. Petersburg, Fla., and has a 15" mirror. The P.A. bearing is braced with four struts.

FOR solar, and often for lunar, observation a telescope often needs some kind of light and heat reducer. In the following paragraphs D. Everett Taylor, 191 Prospect St., Willimantic, Conn., author of the ATMA chapter on the construction of the metal parts and mounting of a refractor, also of various items previously published in the present columns, and always a finished worker, tells how to make a Herschel wedge.

"In 'Amateur Telescope Making', third edition, page 147, and fourth edition, page 179," Taylor says, "the late Prof. Charles S. Hastings closes his chapter on astronomical oculars, with the following paragraph: 'I venture to add the following, under the impression that the Herschel wedge is not nearly as much used as it should be. With it Venus, so unsatisfactory an object in a dark, or darkening sky, is a delightful study. Then the moon, also, except when a rather slender crescent, is much pleasanter to view with this accessory. Ordinarily this object is so brilliant that the pupil of the eye is contracted so that only part, perhaps a small part, of the objective is effective, which may be the cause of a prevalent impression that the moon is too easy an object to afford a test for the excellence of a telescope.'

"Bell, in 'The Telescope,' page 166, briefly describes the solar diagonal devised by Sir John Herschel. He shows a schematic plan of this solar diagonal or Herschel wedge and says, 'In viewing the sun only about 5% of the light (and heat) is reflected at this upper surface to form the image at the eye-

Figure 2: **Bryant, Michigan**

piece.' On an adjacent page, in describing a star diagonal, Bell also says, 'The right angled prism is replaced by a simple elliptical prism of small angle, 10° or less, with its upper face accurately plane and at 45° to the axes of the tubes.'

"The above quotations comprise all the published data known to this writer. Albert G. Ingalls states that he knows of no other literature on the subject, aside from the references here given.

"A Herschel wedge is a most satisfactory accessory and, if constructed after the accompanying drawings, without sacrificing any of the required accuracy, the result will be most gratifying and the performance will leave nothing to be desired. Like the star diagonal, the Herschel wedge is especially suited to and indicated for the refractor. There is, however, no reason why it cannot be used successfully on a reflector—in which case the position of the eyepiece would be changed, and the normal focal and tube lengths of the reflector should permit of being shortened the three or less inches which the light travels through the accessory. There is no appreciable heat from the Herschel wedge when viewing the sun—in fact, with it there is no difference in comfort between sun gazing and star gazing. Attention is called to the glass filter disks (Figure 4). These are used when viewing the sun but are removed from the tube when the wedge is used for viewing the moon, Venus, or the landscape during daylight. The latter is an interesting pastime because of the views one enjoys, especially of trees and their foliage.

"When using the conventional methods, in photographing the sun and sunspots, the work must be hurried because so much heat is generated at or near the focus that a camera shutter which is not of metal is likely to be damaged or destroyed, but by using the Herschel wedge with its filter disks removed there is no necessity for hurrying the work, because the heat is so completely dissipated that this question is no longer a consideration.

"The following notes on construction describe materials and practices used in making the Herschel wedge shown in the drawing, Figure 4.

"Stock: Brass throughout, except the glass wedge or prism. Tubes machined from suitable sizes of brass pipe.

"Prism: Made from plate glass ¼" to 5/16" thick. Angle of finished wedge to be 8° to 10°. Upper surface which reflects the image, if plane to ½ wavelength, is of acceptable quality; ¼ wavelength, however, is better but is sufficiently good. The prism was cut to its cylindrical shape, which looks elliptical, by the method described by Selby, page 126, ATMA.

"Construction: The surfaces between parts *A* and *B* were first machined to a fit,

Figure 3: **Strum, Florida**

then the contacting surfaces were carefully tinned and the parts joined by sweating, after which the standard eyepiece O.D. of 1¼″ was machined on part *A*.

"The circular intersection on the end of part *C* was machined to fit the circumference of part *B*. It is a safe practice to fill part *C*, before machining the curve, with a turned hard wood mandrel, which will support the wall of the brass pipe when the

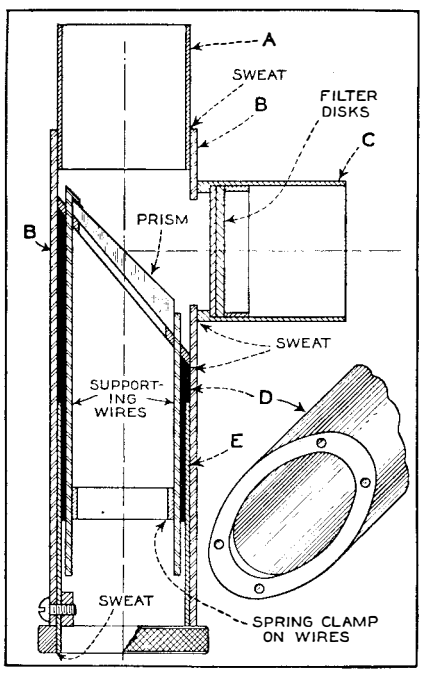


Figure 4: Taylor's wedge

latter is clamped in a two-jaw chuck. The next step is to bore the inside diameter of part *C* to a shoulder which will support the filter disks: The internal diameter of *C* should be the standard 1¼″ for a standard size of eyepiece. Locate and bore a 1″ hole in part *B*, over which part *C* is to be centered. The contacting surfaces between parts *B* and *C* should be tinned. Part *C* is centered over the hole in part *B* and held firmly in place with several turns of fine iron wire, thus binding the two parts together. By placing three or four pieces of solder the size of a pinhead, on the inside of the tube at the joint, then heating the tubes in a Bunsen flame until the solder flows, a neat soldering job will result, leaving little or no solder in evidence. Working a thin burnisher around the outside of the joint, after soldering, will finish the joint to a high state of perfection.

"Parts *D* and *E* are tubes which assemble inside of part *B*. If preferred, parts *D* and *E* may be combined as one tube. The two-part construction, however, is more complete because it facilitates adjustment and adds to the outside appearance in clean design.

"Part *D* telescopes into part *E*. The friction or fit of joint should be sufficient to hold the parts firmly in adjustment. One end of part *D* is machined to an angle (preferably on a milling machine); this angle, plus the angle of the glass prism, should make 45°. In other words, if the angle of the glass prism or wedge is 8°, the angle of the tube should be cut to 37°; if the wedge is, say, 10° the tube angle should be 35°. On the diagonally cut end of part *D* sweat a piece of 1/16″ brass plate to cover the entire angle or elliptical end of the tube. Finish the margins of this newly added

piece flush or parallel with the tube, as shown in the insert drawing.

"A hole is to be bored through the angle face of part *D*, longitudinally with the tube. Therefore, center and chuck part *D* in the lathe. The diameter of this hole should be approximately ⅛″ smaller than the diameter of the glass prism. It is assumed that the prism has been made after the method presented on page 126, ATMA, which gives the prism a cylindrical shape with elliptical sections or faces. Therefore, its diameter is the greatest dimension of the prism's width or minor axis.

"Before removing *D* from the chuck, locate the prism on it over the hole, with equal width of brass showing around the prism. Scratch the outline of the prism on the brass base. Outside of this scratched line drill four 1/16″ diameter holes, parallel longitudinally with the tube. These holes are to be spotted as shown in the insert drawing, and they are to carry the 1/16″ diameter wires which will hold the prism. This method of holding the prism was chosen in preference to several other methods, because it is simple and direct to make, holds the prism securely without pinching it, and simplifies the assembly and disassembly. These four wires should be long enough so that, when in place, they can be seized with pliers through the rear and open end of the complete assembly. Each of the two lower wires which hold the point of the wedge or prism should have a small piece of soft brass or copper soldered on the end, which is to be bent over the prism when in place, thus making a hook. A paper-thin piece of cork should be placed between hook and prism. The other two wires are straight pieces which will easily be understood when the parts are assembled. The clamping ring for holding the four wires in place (also a similar ring for holding the filter disks in place) should be a ¼″ to ½″ length of thin-wall (.030″) brass tubing of suitable diameter. Open this piece of tubing to make the spring, and cut out a piece of the tubing to permit snapping it in.

"Part *E* requires no comment except to call attention to the knurled collar which should be sweated on the end of the tube, also the locking screw with nut in front of the collar, as shown in the drawing.

"Assembly: Telescope part *D* into part *E*. Put the four wires in place and clamp them with the clamping ring. Adjust the upper wires so that they extend through the face of part *D* ⅛″ or more. Adjust the lower or hook wires to extend beyond the face of *D* an inch or less. Now place the prism under the upper wires and with pliers pull the hook wires through the clamping ring until the prism is held in place with the hooks. Remember to place the thin piece of cork under the hook just before the hook is made up snug against the prism. The remainder of the assembly is of course obvious, as is also the necessary adjustment. To preserve the outside finish of the brass parts, lacquer them with a thin coat of Bakelite lacquer No. B13128 or BH1805. Allow this to dry for one half hour. Then bake in the kitchen oven for one hour or a little more at 200 degrees F."

IN Figure 5 the Herschel wedge is shown at the left. Near it is a three-lens Ramsden eyepiece made by Taylor and at the right is another of his gadgets, a micrometer focus control. This may be used on any telescope having a standard 1¼″ diameter eyepiece fitting and it moves the eyepiece assembly in or out of focus, similar to a rack and pinion. It employs the helical slot principle instead of a thread and Taylor says it is a sweet device in operation. It is also *large enough* to get hold of.

Figure 6 shows Taylor's RFT refractor, recently completed; in fact, he states that it is pretty close to the RRFT specifications in ATMA. It is a 2½″ *f*/6 and the knurled band is the rotor of the micrometer focus control shown in Figure 5.

THE following is taken from a letter from H. E. Dall, 166 Stockingstone Road, Luton, Beds., England, a co-author of ATMA: "I've made a strain viewer, using Polaroid, which is so easy and comfortable to use that there is no excuse for working on any untested glass. It consists merely of (1) a lamp in a blackened box having a hole covered with a Polaroid disk, (2) a ground-glass screen on a stand (mine is 10″ x 10″), (3) a pair of American Polaroid goggles worn by the viewer. It shows up the strains so brilliantly that there is no need even to test in a darkened room. The glass to be tested is just held between the screen and the observer. The analyzing Polaroid has its axis at right angles to that of the goggle."

WE learn that the Bailey and Sharp Co., Hamburg, N. Y., who handled Chance Bros. optical glass, have sold their manufacturing facilities to the Optical Glass Products Inc., of Hamburg, which will mold lenses, prisms, and other optical parts. The Ednal Company, 160 Fifth Ave., New York, N. Y., are now the American agents for the glass of Chance Bros. and Co., Ltd., Birmingham, England.

CIRCULAR dividing engines are discussed in ATMA, which shows a picture (page 297) of an "ultra" type at the

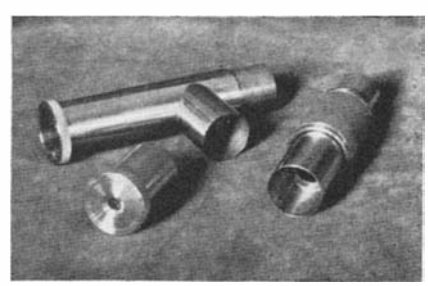


Figure 5: **Upper left, the wedge**

Bureau of Standards, capable of dividing a circle within an accuracy of about one second of arc, about a millionth of the complete circle. The late Dr. Ambrose Swasey, the professional telescope builder, made one of comparable refinement and the following, taken from an article in the *Journal of Applied Physics* (New York), written by the astronomer, Prof. J. J. Nassau, of the Case School of Applied Science, Cleveland, may make readers take in their breath.

"Last May Mr. Swasey was asked, 'What in your opinion is the greatest thing you have done?' All at once his eyes sparkled, his face brightened more than ever, and it seemed that a war veteran was getting ready to describe a famous battle. 'The highest type of construction and piece of work I ever did,' he said, 'was the dividing engine. When you can take a spindle 4″ in diameter and about 25″ long with ⅝″ taper to the

foot and make that spindle fit into a bearing easily and when you drop it a thousandth of an inch it goes hard, you are getting down to a refinement about which we knew nothing in those times. Dividing engines had all fallen down on the spindle—could not get a spindle in the bearing that would fit.' The dividing engine was built primarily for graduating circles of astronomical instruments used for fundamental star work as well as for instruments in geodetic surveying. It has an error of closure of one second of arc and required three years in building."

Figure 6: **Taylor's RRFT**

Feats like this rank with making ruling engines—*ne plus ultra.*

ACTIVITIES on 20″ reflectors: The New York group—the Optical Division of the Amateur Astronomers Association—have worked a 20″ Pyrex disk (20¾″), solid type, to *f*/2.4 curve and are boring it out for a Cass. Their optical workshop is in the basement of the Hayden Planetarium, which provides spacious and ideal quarters. It is even air conditioned—what sybaritic luxury! In Philadelphia the Amateur Astronomers of the Franklin Institute are "exploring possibilities of building a machine to grind the 20″ blank," according to their monthly publication, *The Observer*. Their headquarters are in the Fels Planetarium. They have a luxurious machine shop.

A group of advanced engineering students at the College of Engineering, University of Kentucky, Lexington, Ky., is said to be designing and is to build a 20″ reflector. Earl G. Welch is one member of this group. At the College of Liberal Arts, University of Louisville, Louisville, Ky., a similar project was under way some time ago, according to Walter L. Moore, but we hear no recent news.

In Boston, the Amateur Telescope Makers of Boston are also planning a 20″, and drawings of the proposed mounting were recently published in *The Telescope* (Cambridge, Mass.). The mounting is unique and distinctive: it is half German equatorial, half double yoke and half fork. The tube, like all Gaul, is divided into three parts, the first of which is closed, the middle part absent and the top part latticed. The space occupied by the non-existent middle part is filled up with the ether if there really is an ether, and the top part is held aloft by this ether and/or hypnotism. The Pyrex disk is to be half solid and half ribbed, because there are two schools of thought in this club just as in all others. Similarly, there is to be half a hole in the disk, representing a sensible compromise between the Newtonian and Cassegrainian factions. All this once more shows the marked flair for compromise which we Anglo-Saxons (or what are we?) usually do more bragging about than exercising. The telescope, however, is still in the paper stage and there are hopes that a single type can be settled on—either peaceably by Boston methods, or by a gang fight à la New York.

CURRENT BULLETIN BRIEFS

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

THE MCKAY PHOTOGRAPHIC TEST CHART is a four-color chart which enables the photographer to check his equipment—lenses, filters, films, developers—and technique. The four-color chart (15 by 20 inches, mounted on durable board) is photographed in the usual manner; the resulting negatives and prints reveal various sources of trouble that may have been preventing the photographer from obtaining the best possible results. The chart folds to 15 by 10 inches. *At your photographic dealer or direct from Chess-United Company, Mohawk Building, Fifth Avenue at 21st Street, New York City.—$2.50.*

HOW TO MAKE TIME AND MOTION STUDIES, by Howard Campbell, is a pamphlet of interest to plant executives and managers. It gives information regarding the proper method of making time and motion studies with an eye to increased plant efficiency. *Write for Bulletin 438A to Scientific American, 24 West 40th Street, New York City.—3 cents.*

FOREIGN LANDS AT STAY AT HOME PRICES is a revised edition of a booklet that deals particularly with "freighter cruises." It tells of the advantages of this inexpensive method of travel, quotes prices, and gives brief sketches of the interesting trips that can be made. *Harian Publications, 270 Lafayette Street, New York City.—25 cents.*

RIGGERS' HANDBOOK is an up-to-date manual showing the latest equipment for handling materials by means of cranes of various types. It illustrates the latest accessories and technique and gives complete specifications and dimensions. *Write for Bulletin 438B to Scientific American, 24 West 40th Street, New York City.—3 cents.*

GEORGE WESTINGHOUSE is the title of a 78-page illustrated book on the life and work of George Westinghouse and those with whom he worked. *Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.—Gratis as long as a limited supply lasts.*

PROGRESS IN IMPROVEMENT OF CAST IRON AND USE OF ALLOYS IN IRON, by Paul D. Merica, is a reprint of a lecture delivered before the American Institute of Mining and Metallurgical Engineers. *Write for Bulletin 438C to Scientific American, 24 West 40 Street, New York City.—3 cents.*

THE MICROSCOPE, a magazine for microscopists, described in these columns in our January issue, is published in England. United States and Canadian residents can place their orders for subscriptions through *Harry Ross, The Merchandise Mart, 84 West Broadway, New York City.—$3.00 per year.*

PHOTORELAY UNIT is an eight-page pamphlet describing new types of relays for use with photo cells in such applications as fire alarms, smoke alarms, burglar alarms, illumination control, counting, and so on. Descriptions of various applications are given as are also prices of the units described. *Write for Bulletin 438D to Scientific American, 24 West 40th Street, New York City.—3 cents.*

HOW TO ENLARGE, by W. Peterhans, is a pocket-size manual on the subject which gives compact yet complete directions on the proper making of enlargements. *American Photographic Publishing Company, 428 Newbury Street, Boston, Massachusetts.—50 cents.*

THE OLD PATHS OF CONSERVING THE AMERICAN TRADITION, by Frank Halliday Ferris, is a transcript of a sermon recently delivered, which dealt particularly with present-day conditions in the United States and with some of the solutions which have been offered. Words are not minced in the treatment of the all-too-wide-spread philosophy of a new Utopia in which hard work is to be avoided. *Write for Bulletin 438E to Scientific American, 24 West 40th Street, New York City.—3 cents.*

USED CAR VALUE GUIDE is a small folded sheet that gives definite information on the points to be watched when buying a used car. Check-lists furnish an easy means of analysis. *Automobile Research Bureau, 520 North Michigan Avenue, Chicago, Illinois.—25 cents.*

WHAT IS A JOB is an 18-page booklet that tells the human side of the various factors that go to make up a job. It is designed particularly to stress the necessity of a better understanding of these factors and their relationship to employment. *General Motors Corporation, Detroit, Michigan.—Gratis.*

DIRECTORY OF ASSOCIATION MEMBERS, 1938 edition, lists consulting chemists throughout the country and tells specifically of the particular work which these leading research men are prepared to undertake. If you have a chemical research problem to solve you will undoubtedly find the best man for the job in this listing. *Association of Consulting Chemists and Chemical Engineers, Inc., 50 East 41st Street, New York City.—Gratis.*

ANNUAL REPORT OF THE GOVERNOR OF THE PANAMA CANAL, 1937, is a formal report, with the usual statistics, but it is also less "statisticky" than most reports and more readable. It gives to the American citizen a good idea, in detail, of the way his investment at Panama is being handled. *Superintendent of Documents, Washington, D. C.—15 cents, cash.*

GEOPHYSICAL ABSTRACTS 88 (Geological Survey Bulletin 895-A) is a pamphlet containing abstracts of numerous papers pertaining to geophysical prospecting, covering January to March, 1937. *Superintendent of Documents, Washington, D. C.—10 cents, cash.*

LEGAL HIGH-LIGHTS

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

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

Price Cutting

ON several occasions we have referred to the so-called Fair Trade Acts which have been enacted in many of the states. These Acts permit a producer or distributor to fix by contract the re-sale price at which merchandise bearing his trade mark, name or brand may be sold. Most of these Acts provide that knowingly selling merchandise below the price fixed in the contract constitutes unfair competition. The constitutionality of these Acts and the right of a producer or distributor to maintain a suit for unfair competition where a retailer sells below the specified price has been sustained by the United States Supreme Court.

The New York State Supreme Court recently had occasion to pass upon a rather novel application of the Act. A retailer brought suit against a competitor, charging that the competitor was guilty of unfair competition because he was knowingly selling merchandise bearing the trade mark of the producer below the price specified by the producer. The Court dismissed the suit on the grounds that the Fair Trade Act was intended to protect the good will of the producer or distributor rather than the retailer. The Court further pointed out that the Act provided for vertical price maintenance as distinguished from horizontal price maintenance. The basis upon which the Court dismissed the suit is summarized in the following quotation from the Court's opinion:

"In other words, while the enforcement of the contract may be obtained at the instance of the producer or wholesaler against the retailer, the same right to enforce the contract does not vest in another retailer."

Outside the Pale

IN a case of more than usual importance, the United States Supreme Court has decided that a patentee cannot prevent the sale by a competitor of an unpatented product which is to be used by the purchaser in an infringing process or product. Prior to this decision there had been some confusion as to whether the seller of an unpatented article of commerce, which was subsequently used in a patented process or product, was guilty of contributory infringement and as such liable for profits and damages to the patentee.

In the case in question a prominent manufacturer of asphalt and bituminous products was the owner of a patent for the process of curing concrete, as used in road building, by means of a bituminous emulsion. Purchasers of the bituminous emulsion from the patentee were permitted to use the patented process. A competitor of the patentee sold bituminous emulsion to road builders knowing that they intended to use it in the patented process without license from the patentee, and the patentee brought suit against the competitor charging that the sale of the bituminous emulsion contributed to the infringement of the patent.

The history of this case from the Trial Court to the Supreme Court reveals considerable judicial conflict. Thus, the District Court before which the case was tried held that the patent was invalid and dismissed the suit. The Circuit Court of Appeals reversed the District Court and held that the patent was valid and infringed by the sale of the bituminous emulsion. The United States Supreme Court reversed the Circuit Court of Appeals and held that anyone had the right to sell the bituminous emulsion as it was an unpatented article of commerce. The Supreme Court pointed out that if the seller of the bituminous emulsion was held to be an infringer, the patentee would be granted a limited monopoly on the sale of an unpatented product. In this connection the Court stated:

". . . every use of a patent as a means of obtaining a limited monopoly of unpatented material is prohibited. It applies whether the patent be for a machine, a product, or a process. It applies whatever the nature of the device by which the owner of the patent seeks to effect such unauthorized extension of the monopoly."

This unequivocal statement by the Supreme Court would appear seriously to curtail, if not destroy, the doctrine of contributory infringement as previously expounded by many experts.

Co-Owners

THERE is a great deal of misunderstanding as to the rights of co-owners of a patent. It is frequently thought that co-owners must share all profits received from exploiting the patent. Also, it is often stated that where a patent is jointly owned by two or more people a license to practise the invention of the patent must be granted by all of the co-owners.

However, in the absence of a partnership, joint venture, or some definite understanding to the contrary, each of the co-owners of a patent has the right independently to promote and exploit the invention without accounting to the other co-owners.

A Federal District Court considered this question in a recent case, and made the following comment:

"For example, one co-owner of a patent right, whatever his undivided interest may be, may exercise that right as he pleases, regardless of the consent of any co-owner. Thus, no recovery of profits or damages can be had against such a co-owner if, without the consent of the others, he makes, uses, or sells the patented invention. That is to say, he may, at will, make, use, or sell the patented invention or license others to do so, and neither he nor his licensees may be enjoined from so doing."

Rubber Tire

THE provision of a rubber tire for a lawn mower does not amount to invention, according to a recent decision of the Court of Customs and Patent Appeals.

The tribunals of the Patent Office rejected a patent application for a demountable rubber tire for a lawn mower and the applicant for the patent appealed to the Court of Customs and Patent Appeals. The Court found that similar rubber tires had been used on perambulators and on children's wagons and concluded that the use of the tire on a lawn mower did not involve invention. The court stated:

"As we see it, appellant has done nothing more than use a well-known old art vehicle tire for a lawn mower without any modification which required invention."

Folding Box

INFRINGEMENT of a patent for a folding paper box formed of a single strip of paper is not avoided by forming a box from two strips of paper glued together.

In a recent suit for patent infringement the patent disclosed a hexagonal folding hat box formed of a single strip of paper. The infringer made his box from two separate strips of paper but in other respects it was substantially the same as the patented box. The court pointed out that making an element in two pieces when it is described in the patent as being formed of a single piece does not avoid infringement where the elements function in substantially the same manner. In reaching its conclusion the court pointed out:

"Thus appellee's box, although formed of two parts, fastened together by glue, is an integral structure; it operates and functions identically with the box made under the patent and does not avoid infringement."

Revision

A COPYRIGHT on a book or play does not protect revisions made after the copyright was obtained. This question was recently considered by a Federal District Court in a suit charging that a photoplay was an infringement of a copyright on a play. The bill of complaint alleged that the plaintiff had written and copyrighted an original drama. After the copyright was obtained the complaint alleged that the play was revised, and it was charged that the photoplay copied the revised version of the copyrighted play.

So far as the complaint revealed, no copyright was obtained on the revisions or on the revised version of the play. The Court held that the copyright on the original play did not protect the revisions, and that in so far as the suit charged the defendant with copying the revisions it should be dismissed. The Court pointed out that a new copyright could have been obtained on the revised version of the play and in that manner the plaintiff could have protected himself.

Books SELECTED BY THE EDITORS

SUNSPOTS AND THEIR EFFECTS

By Harlan True Stetson, Research Associate, Massachusetts Institute of Technology

IN this volume the author, now the most outstanding scientist in the combined fields dealt with, has compacted a vast amount of information on the sun: sunspots and human behavior (ups and downs of our feelings); sunspots and growing things (tree-ring cycles, plant growth, vintages, animal fluctuation); sunspots and radio; sunspot periodicity and business (the much-talked-of parallelisms); measuring sunlight; weather and sunspots (long-range prediction); solar utilities; light and power; earth's magnetism (including theory of its effect on carrier pigeons); sunspot causes and prediction. His treatment is popular and most readable. Big things, largely practical, are expected to follow from the studies now being made of these subjects. (201 pages, 5¼ by 8 inches, 15 illustrations.)—$2.15 postpaid.—*A. G. I.*

DISTILLATION

By J. Reilly

THIS work has been carefully and thoroughly carried out by Professor Reilly, who is a technical member of the Irish Free State Industrial Advisory Board, and is an authority on the azeotropic process. In this book some of the newer developments have been considered both from the theoretical and industrial aspects, as, for example, evaporative distillation and the azeotropic dehydration of alcohol. (120 pages, 4 by 6½ inches, illustrated with drawings.)—$1.35 postpaid.

THE COMMAND TO LOOK

By William Mortensen

"A FORMULA for picture success" is the sub-title of this little book made up with plastic spiral binding. The author claims to have discovered a "definite photographic formula" by means of which he is able to produce effective photographs. The purpose of the present book is to tell of the discovery of this formula, analyze it in detail, and show its concrete application in a series of prints that have won the approbation of publishers and salons. The book does not touch upon technical problems; it is solely concerned with the making of effective pictures. If you are serious about your photography and can learn by reading of the experience of others, this book should provide much inspiration. (190 pages, 4½ by 5¾ inches, drawings, 56 photographs.)—$2.15 postpaid.—*A. P. P.*

SEGMENTAL FUNCTIONS TEXT AND TABLES

By C. K. Smoley

PRIMARILY a compilation of logarithms of segmental functions, this is a volume for advanced engineers and mathematicians. It offers simple methods of solving a circular segment, and of computing its area, when the segment is given with any two of its five parts, viz., the arc, the chord, the radius, the central angle and the height, with numerous examples illustrating the application of these methods. (Limp leather, 491 pages.)—$5.15 postpaid.—*F. D. M.*

THE NATURE OF VARIABLE STARS

By Paul W. Merrill, Mt. Wilson Observatory

A COMPACT outline of our present knowledge of variable stars: how variables are discovered and catalogued, how their light changes, what the spectroscopes show, their motions and their significance. The treatment is semi-technical—certainly not typically popular but not abstruse; in other words, it is well adapted to its logical readers—serious amateurs. (134 pages, 5¼ by 8 inches, 12 illustrations.)—$2.15 postpaid.—*A. G. I.*

THE MATTHEWS-NORTHRUP NEW INTERNATIONAL ATLAS AND ILLUSTRATED GAZETEER

ATLASES come and atlases go, and it is seldom that the layman who desires an atlas for the home is able to determine which one would best suit his needs. This volume is a most convenient home reference atlas, and particularly for those who, like this reviewer, pore over a map for hours at a time, making their world tours vicariously in an armchair. Complete detailed maps of all sections of the world are given, and in the Gazeteer there are compact descriptions of all those queer places you have always wanted to visit, from hot and dusty Aden to the Zanzibar Protectorate which, we learn, produces 82 percent of the world's supply of cloves. Other features are: important dates in world development, facts and figures concerning areas, rivers, mountains, waterfalls, dams, tunnels, and—but, briefly, it is practically an encyclopedia of facts concerning the physical world. (264 pages, 11 by 14 inches.)—$3.15 postpaid.—*F. D. M.*

ECONOMIC GEOLOGY

By H. Ries, Prof. Geology, Cornell

FOR a generation Ries' "Economic Geology" has remained a standard text on its subject, since its author has consistently kept it up with the changing times. This is the seventh edition and large sections have been completely rewritten. As a text, and particularly as a concise, dependable reference, this work in its successive editions has been kept for years on the reviewer's desk, as it contains the answers to many a practical question asked by readers of this magazine. Its emphasis is mainly on industry, not on abstract geology. Part I, on the Non-metallics, covers coal, petroleum, natural gas, bitumens, oil shales, building stones, clay, limes, calcareous cements, salt, bromine, calcium chloride, borates, iodine, potash, gypsum, phosphates, abrasives, asbestos, glass sand, graphite, monazite, and precious stones. Part II, on Ore Deposits, covers iron, copper, lead, zinc, gold, silver, aluminum, manganese, mercury, and the minor metals. Most of these items have their own separate chapters and the ground covered in each is shown by a typical sample, the chapter on gypsum: properties and occurrence, impurities, origin, distribution in the United States and Canada (area-by-area, with maps), typical analyses, uses, amount and value of production, references to literature. A ruggedly bound, practical book. (720 pages, 6 by 9 inches, 267 illustrations.)—$5.25 postpaid.—*A. G. I.*

ATLANTIC GAME FISHING

By S. Kip Farrington, Jr.

ADVENTURE on the briny deep is the key-note of this beautifully produced and handsomely illustrated volume. Fishermen of all kinds will go for it in a big way; non-fishermen who thrill to factual adventure stories will get as much from it as will a fisherman who has been on the right end of a fishing line at the right time. The author covers the subject of salt water fishing from Nova Scotia to Bimini—from dories, from high-powered motor boats, from the beach. Part instruction manual, but all intensely interesting reading, the book tells what to fish for, where and how. (298 pages, 8½ by 11½ inches, 125 action photographs, and seven full color paintings by Lynn Bogue Hunt.)—$7.75 postpaid.—*A. P. P.*

CATALYSIS

By Georg-Maria Schwab. Translated from the first German Edition with addenda by H. S. Taylor and R. Spence

CATALYSIS, the remarkable effect of accessory substances on chemical reactions, remains somewhat of a mystery despite the vast amount of research devoted to it and the enormous importance of its industrial applications. In this volume an outstanding German treatise on catalysis has been amplified and brought up to date by eminent authorities, American and English. The result is a book of greatest value to the student and to others interested. The presentation is clear and covers the field in an understandable manner, but without sacrificing subject matter. (369 pages, 6 by 9 inches, unillustrated.)—$4.45 postpaid.—*D. H. K.*

METAL AIRPLANE STRUCTURES

By Major Flavius Loudy

WHEN airplanes were built of wood, their structure was simple and well-nigh standardized. Now that aircraft are built almost solely of aluminum alloys and stainless steels, the variety of structural forms and the complexity of structures are much greater. There are riveted and welded

joints to think of. Fuselages may be of tubular steel, monocoque, or semi-monocoque, with every imaginable type of bulkhead and stringer. Wings are metal covered and the metal covering is made to give a large proportion of the strength in what is known as the stressed skin design. Metallurgical knowledge has to be brought into play, methods of stress calculation are exceedingly complicated, and sometimes the best calculations have to be supplemented by tests to proof load and to destruction. The very difficulties and complexities of the subject make Major Loudy's book all the more attractive for the technician or the practical constructor. Consideration of structural elements is supplemented by concise and practical suggestions for calculations. The many illustrations give a very fine survey of modern practice. Even the private flier or the layman interested in knowing how the airplane appears under its skin will read the book with pleasure and benefit. (445 pages, 293 figures.)—$5.20 postpaid.—*A. K.*

THE SECRETS OF TRICK PHOTOGRAPHY

By O. R. Croy

PHOTOGRAPHY without a camera, moonlight—real and faked, homemade snow flakes, silhouettes, photography of glass, photographic ornaments, optical caricatures, photomontage, pencil drawing with the camera, printing on silk—these and dozens of other subjects are thoroughly covered in clear, compact style. In general, the text for each subject comprises a single page with, facing it, a full page photograph illustrating the effect described. The amateur photographer who is looking for new ways of photographing old subjects or for obtaining odd and unusual results will find straightforward and practical instructions in the pages of this book. (174 pages, 6 by 8½ inches, thoroughly illustrated with photographs and diagrams.)—$2.65 postpaid.—*A. P. P.*

AXIAL BIFURCATION IN SERPENTS

By Bert Cunningham, Duke University, with Foreword by Raymond L. Ditmars

AN author with a passion for double-headed, two-tailed and Siamese twin snakes has fine-tooth-combed the past scientific literature of several languages and brought together in one book all available previously published scientific descriptions of these freaks. (91 pages, 6 by 9 inches, 134 illustrations.)—$2.65 postpaid.—*A. G. I.*

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By Harriet Salt

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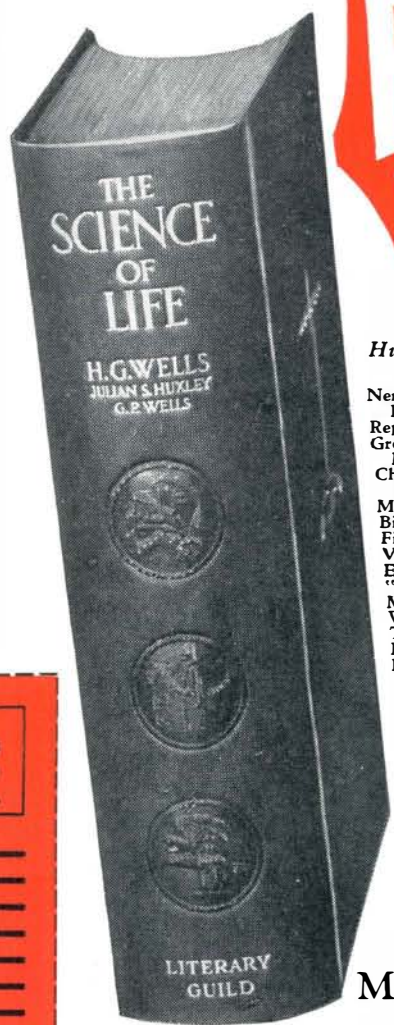

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