OUR NAVY'S AIR ARM . . . Page 121

SCIENTIFIC AMERICAN

MARCH · 1942

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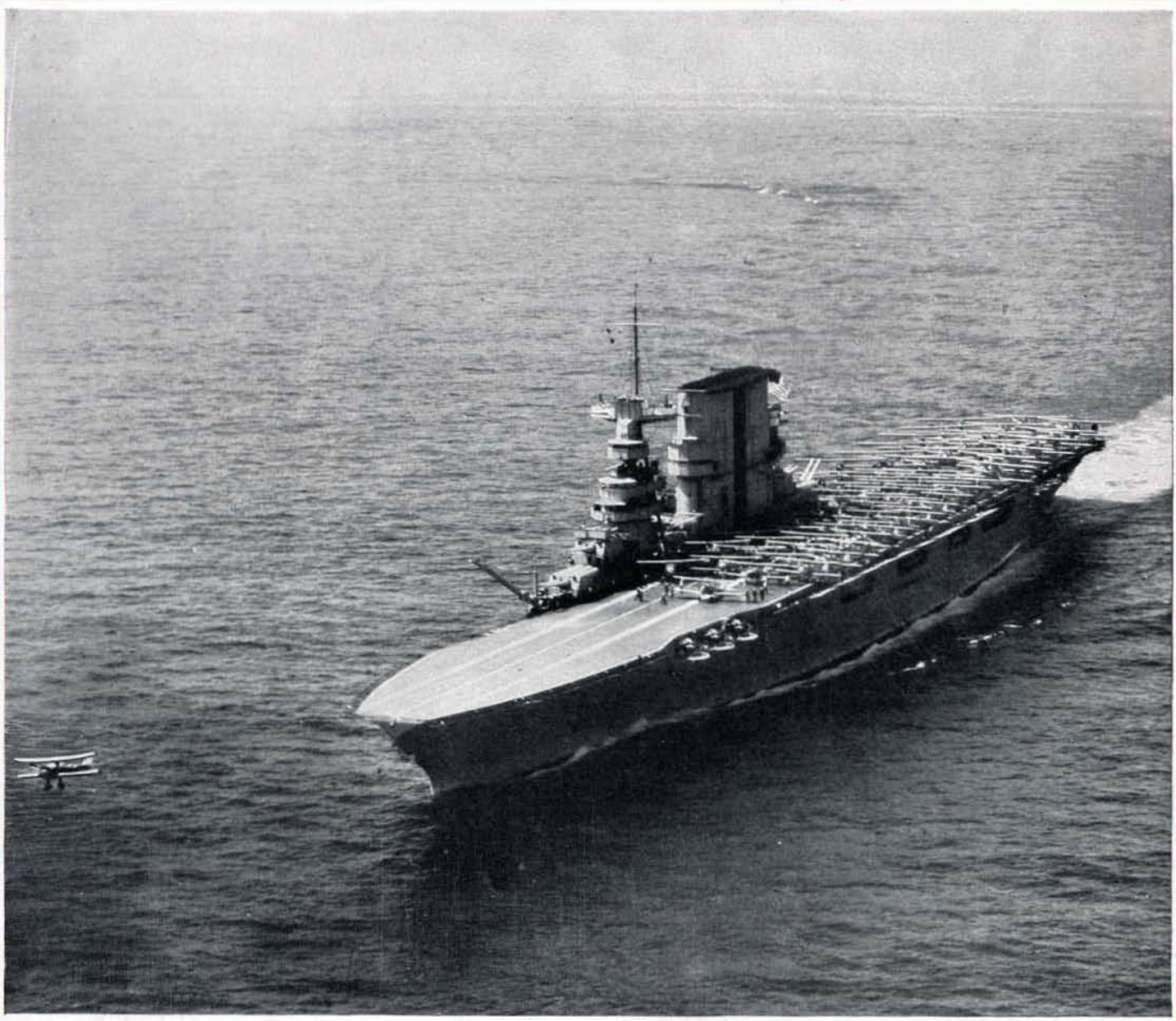

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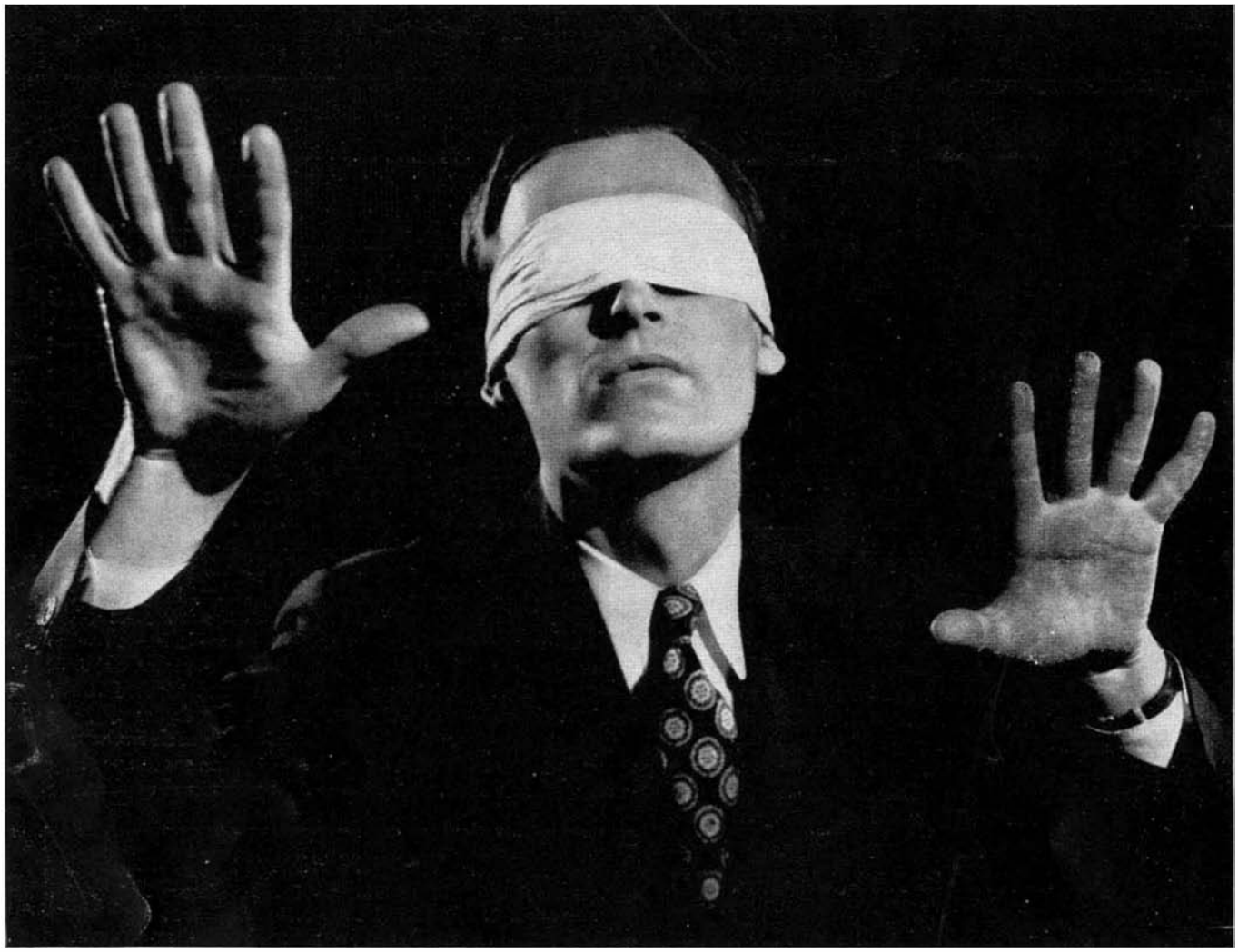

WHITE COLLAR MEN ARE STILL A DIME A DOZEN!

LOOK around your office. A few men have "arrived". They are the executives, earning big money. The others are what the top men in the company call "white-collar workers"—able, conscientious, hard-working—perhaps with specialized training, but they are nevertheless figuratively worth a dime a dozen.

WHAT'S THE DIFFERENCE between the executive and these "white-collar workers"? That's the question being asked by men who have hopes . . . men who want to climb out of the rut and into the top-flight class themselves. The answer is—*there's very little difference!*

Has the man who makes $5,000 twice as much brains as the man who makes only $2,500? Has the man who makes $10,000 twice as much brains as the man who makes $5,000? Of course not! And it would be amazingly easy for *many men* to transform an average salary into a large salary!

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HOW YOU CAN DO IT. The Institute has organized and formulated the knowledge of the country's most successful business men. Co-operating with it are dozens of leaders like Edward R. Stettinius, Alfred P. Sloan and Thomas J. Watson. As a result, the Alexander Hamilton Institute offers you modern, up-to-the-minute training and information you would almost have to give your right arm to gain by any other method!

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PUT IT UP TO US. Why not prove to yourself that you have the first quality of an executive—the ability to make a decision? Write us for a free copy of that important little book, "Forging Ahead in Business". For many men this simple act has been a major turning point in life!

Alexander Hamilton Institute, Inc.
231 Astor Place, New York, N. Y.

Please mail me, without cost, a copy of "Forging Ahead in Business".

Name.....

Business Address.....

Position .....

FLOATING airports of the Navy — plane carriers — will total 18 when the present Navy program is complete. Each will have a complement of 160 pilots and will carry from 70 to 90 planes. Our cover illustration, an Official United States Navy photograph, shows a plane being launched from the *Saratoga*.

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SCIENTIFIC AMERICAN

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NINETY-EIGHTH YEAR **ORSON D. MUNN, Editor**

MARCH • 1942

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OUR Point OF VIEW

SCIENTIFIC AMERICAN AND WAR

WAR—all-out war, total war, call it what you will—is reaching deeply into the very lives of every resident of the United States of America. There is no phase of existence that modern warfare does not affect. And while it is not news to tell of the inroads that war-time production is making on civilian materials of all kinds, it seems proper to record here some of the things that are happening or are in prospect and which will influence the future course of this magazine.

Physically, a magazine consists merely of ink on paper, and it is the paper that you can hold in your hand, see the color of, feel, and—if you want to—taste. That is, the paper itself is really the physical material that you buy when you obtain your copy of Scientific American. Here is where you will notice the first change. The color of the paper—it is white, but there are many degrees of whiteness in paper—will incline more toward a natural or yellow shade. This is due to restrictions on civilian uses of chlorine, the chemical that is used to bleach the pulp from which paper is made. Then, too, we have already been restricted in the amount of paper which can be bought during 1942—a serious situation when circulation figures are climbing.

What are we going to do about it? In the matter of paper color, there is nothing that can be done. We can only exercise every effort, with the assistance of the printer, to achieve the best possible printed result with the paper available. As to quantity of paper: There is every hope that the restrictions will not be too drastic but it will undoubtedly be necessary in some of the issues of 1942 to reduce the number of pages. This will, of course, be done only as a last resort, but already steps have been taken to make up, at least in part, for any such restriction. As will be noticed, the issue now in your hands is set in a different type from that of previous numbers. This new type, while just as readable as the former font, is a bit more compact; as a result it is possible to get about 10 percent more words on a page. Thus, as long as we are able to maintain normal size, the reader will get the benefit of more text; when reduction of pages becomes necessary, if it does, the net result over a period of months will just about balance.

Then, too, photo-engravings, from which photographs and drawings are reproduced, use copper, zinc, and a number of chemicals; the metals are strategic materials needed for military purposes, as are also some of the chemicals. How soon photo-engravers will be curtailed in their operations, due to inability to obtain their necessary supplies, is not yet known. When and if this does happen, it is obvious that fewer and fewer illustrations will grace the pages of all magazines.

In any event, and no matter what happens, the publishers of Scientific American pledge that the magazine will continue on the same high plane that it has occupied for the 97 years of its existence. Nothing will be permitted to interfere with the character of the editorial content. When it comes to belt-tightening in the material things of production over which we have little or no control—and we hope that any such belt-tightening will not be drastic or long-lasting—we trust that our readers will understand the reasons for it and will continue to lend the loyal support that has always been the pride of the publishers of one of the oldest magazines in the world.—*A. P. P.*

MILTON WRIGHT

ON December 29, 1941, Milton Wright, formerly an associate editor on the staff of Scientific American passed away at his home in Freeport, Long Island. Mr. Wright, who was connected with this magazine from 1925 to 1929, will be particularly remembered for his outstanding articles on successful but little-known inventors in the United States. From 1929 to his death, Mr. Wright devoted his energies to writing and lecturing on business procedure and psychology. His passing has left a definite gap in that group of former associates of the editorial staff who, while going into other fields, have remained firm friends of Scientific American.

THE PATENT OFFICE MOVES

IT SEEMS strange that, in a country built on an industrial foundation, which foundation in turn is based on the bedrock of a patent system second to none in the world, even the emergency of war should be allowed to interfere with the smooth functioning of the Patent Office. Yet just that is being done, despite the fact that the operations of the Patent Office assume vastly increased importance to the welfare of the nation in times of war.

What actually is being done is that part of the Patent Office is being moved from its convenient and well-designed quarters in Washington to an old tobacco warehouse down in the freight yards of Richmond, Virginia. Reason? Vice President Wallace, recently made Chairman of the Economic Defense Board, wants the present housing facilities of the Patent Office for his agency. And he is getting them.

At the time of writing it appears that files of patent and trade-mark copies will be kept in Washington for purposes of conducting searches. Patent applications and amendments will continue to be filed in Washington, after which they will be transferred to Richmond. That this procedure will throw an added burden on an already overworked Commissioner and executive staff goes without saying. That it will slow up the intricate and time-consuming tasks of the entire Office is equally obvious.

An integrated Patent Office is essential to the economic structure of the entire nation. Even the sacrifices made necessary by national emergencies should be carefully weighed before deciding upon such upsetting and radical changes. Surely there are other government agencies that could better be put to inconvenience than the Patent Office. How about the Economic Defense Board itself?

It is to be hoped that, costly though it would be in time and money, the error of this change will soon be detected, and the Patent Office will once more be restored to a unit basis.—*O. D. M.*

Personalities in Industry

ALFRED P. SLOAN, JR.

OFTEN referred to as an outstanding example of the new school of corporation executives, Alfred P. Sloan, Jr., Chairman of the Board of General Motors Corporation, has expressed his industrial philosophy in the following manner:

"My objective is to impress the vital necessity of searching aggressively, and with an open mind, for the fundamental truths in the broader relationships of industry to society; the separation of truth from the fallacies; and the promotion of the broadest possible understanding on the part of all people as to the effects of these fundamental truths on industry's ability to accelerate human progress. Industry must further expand its horizon of thinking and action. It must assume the role of an enlightened industrial statesmanship."

Mr. Sloan was born in New Haven, Connecticut, May 23, 1875. When Alfred, Jr., was five years old, his family moved to Brooklyn, New York. Before completing his high-school education in Brooklyn, young Sloan gave up his regular studies and took special instruction to prepare for college. He was disappointed when he found that he could not enter college immediately, because he was too young. A short time later he entered the Massachusetts Institute of Technology, where he completed a four-year course in three years. He was graduated with a degree of Bachelor of Science as the youngest member of his class.

Young Sloan began work as a draftsman with the Hyatt Roller Bearing Company in Newark, New Jersey. At this time the automobile industry was becoming more active. Experience proved that a steel axle bearing of the roller type was needed. Mr. Sloan worked on the bearing invention of John Hyatt, found funds to finance the project, and went on the road to sell the bearings. From the start Mr. Sloan's activities brought him into direct contact with automobile leaders and the years which he devoted to the activities of the Hyatt Roller Bearing Company gave him a diversified schooling in many phases of the automobile business. He gained an intimate knowledge of draftsmanship, designing, engineering, production, sales, advertising, and executive direction.

Because of his aptitude for organization and his penetrating business sense, Mr. Sloan was named President of the United Motors Corporation, organized in 1916. In 1918 United Motors Corporation became a part of General Motors Corporation. Mr. Sloan was named Vice-President of General Motors in charge of accessories and was made a member of the Executive Committee. He proved his ability to direct successfully the many activities of the Corporation and on May 10, 1923, he was elected President. Mr. Sloan served in this capacity until May 3, 1937, at which time he was elected Chairman of the Board.

A striking figure, well over six feet in height, Mr. Sloan is broad-shouldered and lank. His face is long, narrow, and mobile; his skin clear and tanned; his eyes are set well apart, surmounted by a high forehead. He has an attractive smile and a voice characterized by an almost Southern drawl at times. He is filled with nervous energy.

As an executive, Mr. Sloan is a distinct contrast to the "sledge-hammer" business personalities of an earlier era. He does not lack force, but force is not his outstanding quality. He is a doer, but perhaps even more conspicuously, he is a thinker. His task is to deal with human relationships upon a vast scale, to study economic principles, to lay out policies for the permanent direction of his prodigious company. He combines in a most interesting way the qualities of a man of action and a philosopher.

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of March, 1892)

CRUISERS—"The splendid steamer *Majestic* reached New York from Liverpool on the 24th ult., her average speed being 20.41 knots for the voyage, or about 23½ miles per hour. What the navy of the United States needs is a fleet of twenty-five cruisers like the *Majestic,* which in time of peace should be employed in active service, such as transport of the mails, thus keeping them always in effective condition."

GATLING—"The latest model of the Gatling gun, shown in the accompanying illustration, has been given the name of

the 'Police gun,' from its admirable adaptation for police or mounted service, for guarding railway trains, banks, or safe deposit institutions, or for use on vessels, yachts or boats. Its weight is but 74 pounds, so that it can be carried if necessary by a single man, or, with all accessories for the field, on a single animal. It has six barrels, and the feed is positive, enabling it to be fired at the rate of 800 shots per minute at all angles of elevation and depression. When set up in the back part of a patrol wagon, and served by two or three men, it is designed to do more effective work in dealing with a mob or in dispersing rioters than could be accomplished by a whole company of infantry."

POWER TRANSMISSION—"In a recent lecture on 'The Induction Coil,' at the Royal Institution, by Prof. Fleming, the employment of transformers for raising or lowering the pressure of alternating currents was illustrated. . . . A current of electricity, supplied to the lecture table at a pressure of 100 volts, was raised to 2,000 volts by means of a Mordey transformer. At this high pressure it was sent across the room by means of two very thin wires; then reduced again in pressure to 100 volts by another transformer, and used to illuminate a large incandescent lamp. The lecturer pointed out that a great economy was effected in the cost of transmission of the energy by thus sending the current at high pressures."

RIVERS—"Geographers claim that there are twenty-five rivers on the globe which have a total length each of over 1,000 miles. Of these, two, the Mississippi from the source of the Missouri in the Rocky Mountains to the Eads jetties, and the Amazon from the source of the Beni to the isle of Marajo, are over 4,000 miles in length. To be exact, the former is 4,300 and the latter 4,029 miles from the source to the places where their waters are mingled with those of the ocean."

REQUIREMENTS—"The internal organism of the traveling salesman should be a mixture of mule, ostrich, and camel. Part mule, that he may be able to sleep on his feet if no better accommodations be at hand; part ostrich, that he may be able to eat and digest anything set before him; and part camel, that he may, if necessary, go a long time between drinks."

ALLOY—"The advantages of an addition of aluminum to fluid iron are important. With moderate care absolutely pure and solid castings can be obtained capable of receiving a high polish. An addition of aluminum is especially to be recommended for the manufacture of steam cylinders, engine castings, press cylinders, and generally for castings which are to be subjected to high pressure."

RESISTANCE—"'If you take a good conductor like copper, and run the temperature down, its resistance almost disappears at very low temperatures; hundreds of degrees below zero copper is almost a perfect conductor. If you heat it up, it becomes more and more resisting. Let us take glass—a good insulator—or any insulating material, and run its temperature up; it loses its insulating power, and if we run it up until it gets to red heat, it approaches a conductor; so that all substances are conductors when they are hot enough.'—*Prof. Thompson.*"

AIR *vs.* ELECTRICITY—"Compressed air is, perhaps, the chief rival of electrical transmission. It is at present used chiefly in mines, where it is still a very successful rival of electricity, but from present appearances it is likely that it will gradually be replaced by the latter method. In Paris there is a large central station for the distribution of compressed air, and it seems to be in successful operation. It does not appear, however, that the advantages over electrical transmission are so great that it will not soon be replaced by electricity. Its introduction is not making the rapid strides that the introduction of electricity is now making."

GEMS—"Unfortunately, for some reasons, the sapphires of Montana have slipped through the fingers of the people who should own them, and are now mined by an English syndicate, that has paid in $2,000,000, the best stones being sent to London, where high prices are demanded for them. The diggings are known as the Spratt sapphire ground, and are about twelve miles north of Helena, on the Missouri River."

DIGESTIVE—"Pineapple juice is an acid fluid of specific gravity of 1.043. An ordinary pineapple yields 600 to 800 cubic centimeters of it. The proteid-digesting power is quite remarkable in its intensity. Three ounces of the juice will dissolve ten or fifteen grains of dried albumen in four hours. The action takes place in acid, neutral, or even alkaline media, thus resembling trypsin more than pepsin. . . . A well-known meat powder is said to be prepared with the help of pineapple juice."

CIRCULATION—"Blood travels from the heart through the arteries ordinarily at the rate of about twelve inches per second; its speed through the capillaries is at the rate of three one-hundredths of an inch per second."

PSYCHIC (?)—"A mysterious ringing of electric bells in a Swiss house was traced to a large spider, which had one foot on the bell wire and another on an electric light wire."

98TH YEAR SCIENTIFIC AMERICAN MARCH 1942

FOOD FOR BRITAIN HELPS US

An Apparent Paradox in Modern Nutrition

T. SWANN HARDING

WHEN the first 2,000,000 selectees had been examined for the draft, exactly half of them were turned down for poor physical condition. About one third of this disability was attributed to malnutrition. The Department of Agriculture chimes in and says that only one fourth of all our families customarily have good diets, something over a third have fair, and the rest have poor diets.

Then, right on top of that, came an announcement in November, 1941, that we had sent to Great Britain 2.2 billion pounds of cheese, dried milk, evaporated milk, pork, lard, eggs, and other food, between April and November 1, 1941. Furthermore, it was stated that we planned to send Britain enough food in 1942 to fill a freight train that would reach clear across the United States. That food would supply one fourth of the British people.

Now does all that make sense? Isn't there a paradox here? Actually it does make sense but, like everything in modern civilization, the subject is complex.

First off, it is true that we Americans, though fed better than any other people on earth in history, have not been well fed. That means we have not all had a "best adapted diet," as the nutrition scientists say—a diet containing ample protein, calcium, phosphorus, iron, vitamin A, thiamin, ascorbic acid or vitamin C, and riboflavin.

The survey made not long ago by Hazel K. Stiebeling and her aids of the Bureau of Home Economics indicated that almost one third of our people live on poor diets. Underfeeding extends also to farm people, only half of whom have really good diets, while one fourth have fair and one fourth poor diets. The reason for that is that so many single-crop farmers fail to grow a part of their own food, a step the Department of Agriculture now urges them to take.

Approximately 54 percent of our non-relief people in villages and cities are in families with annual incomes of $1499 or less, and can afford to spend only from 6 to 10½ cents per person per meal for food. Families with annual incomes of $499 or less can spend but 6 cents, those with incomes between $1000 and $1499 can allow about 10½ cents, but in families with incomes between $3000 and $4999 a year, this sum goes up to 18 cents. How much, then, does it cost to buy an adequate diet?

HEALTH SCIENCE

American soldiers get a complete, well-balanced, but not over-fancy diet. A soldier's weekly food allowance includes: 4 pounds, 6 ounces of fresh beef; 14 ounces of chicken; 1 pound, 12 ounces of fresh pork; 9 pounds, 3 ounces of fresh and canned vegetables; about 1 pound of cereals and dried vegetables; about 2 pounds of fresh and canned fruit; 14 ounces of coffee; and 7 eggs. The Army spends 21 cents per soldier per meal, retail prices, for that ration.

You can readily make your own comparisons from the figures above. It is also of interest that the weekly allowance of the British in October 1941 was 7 ounces of meat, 3 ounces of cheese, 4 of ham and bacon, and 1 egg, plus certain other unrationed items.

The monetary and social cost of this malnutrition is huge. What we Americans could do if we were all well fed surpasses our wildest dreams. Malnutrition destroys nerve health, lowers work efficiency, impairs learning power. For many years we spent hundreds of millions trying to educate children who were too far gone in malnutrition to learn. They were retarded in their work. It took twice as long to get them from one grade to another as it should have, and that points to plain extravagance.

Public attention has now been drawn by the National Nutrition Conference to such facts as these—facts which nutrition scientists had known for years. One physician, for example, announced in 1929, as a result of his own investigation, that one fourth the school children in the United States were suffering directly from malnutrition. That was 4,000,000 underfed youngsters. He said that one third of the Chicago school children and two thirds of those in New York were afflicted with nervous disorder, which often accompanies malnutrition. About 14,000,000 children then had defective teeth, another evidence of undernourishment.

YET numerous studies both here and in Great Britain have shown that supplementing the ordinary diet of underfed children with a pint or so of milk a day will alone produce mental alertness, normal activity, improved learning capacity, and all-'round well-being and efficiency. This frequently happened when the child's previous diet was supposedly a good one. Indeed, Sir John Orr said not long ago in a speech in Washington, D.C., that undernourished women become "co-operative" when properly fed, and that is really something.

Not even intelligence is a constant, nor is it a purely hereditary characteristic. A decade ago Dr. John Monroe demonstrated that many low-grade intellects become normal or even high grade when the stomachs of their possessors get an eggnog (no rum, please) twice daily to stoke up on.

Fatigue and nervousness are not necessarily unavoidable, or incurable, either. In this connnection consider 11 white women at Mayo Clinic who were the subjects of an experiment. The idea was to find out what happened when people didn't get their thiamin, or vitamin B_1. So these women, who normally

did ward housekeeping, laundering, and sewing, were fed the following thiamin-deficient diet:

White bread, corn flakes, potatoes, polished rice, sucrose, skim milk, beef, cheese, egg white, butter, vegetable fat, cocoa, gelatin, canned fruits and vegetables, and coffee. The diet was supplemented with brewer's yeast, halibut-liver oil, vitamins C and D, iron, calcium, and phosphate, but it contained only about 0.45 milligram of thiamin daily, which is so little that we may ignore it. What happened?

Nothing—for about three months—then plenty. Then capricious appetites appeared, with nausea, vomiting, anemia, loss of weight, lowered basal metabolism, and "changes of behavior and other objective evidences of psychosensory and psychomotor disturbances, not manifested during the period of preliminary observations." In short, the good ladies got so irritable, quarrelsome, and inefficient that they couldn't do their work.

They became weak, inattentive to details, confused in thought, uncertain of memory. They lacked manual dexterity and began to fight and argue with each other all the time. But once thiamin was sneaked into their diets these disturbances ended and they could go back to work. It took only a milligram or two of thiamin daily to do that, too, and there are a thousand milligrams in a gram—which itself is about one thirtieth of an ounce. Fancy that hair line between healthy efficiency and complete uselessness.

IF people are to fight an enemy or to work in a factory or on a farm upon defense projects, they must be well fed. The Nazis have been very careful to see to it that all Germans who do anything of importance get a complete, if somewhat monotonous, diet. But they have deliberately used malnutrition as an instrument of political action in the territories they have subjugated. For if people are kept underfed, they are too listless to revolt or to make much trouble. The British, on the other hand, say to us: "We can increase our production 25 percent more and lick the Nazis, too, if you Americans will surely provide us with the animal proteins needed to stoke our biological furnaces."

Since we are making of the British Isles an outpost in the effort to destroy Hitlerism, it is extremely important that the British be well fed. It is worse than useless to supply them with the guns, the ammunition, and the other instruments of modern warfare, if we deprive them of the food which alone can keep them in proper shape to fight a good fight.

But it is also important that all our own people be well fed. The basic freedom of the four mentioned by President Roosevelt is freedom from want. Unless people are well nourished they fail to appreciate freedom to worship as they please and freedom of speech; while fearfulness, or apprehensiveness, is one symptom of malnutrition.

Then what have we done for our own underfed? Through the Surplus Marketing Administration we have arranged to purchase huge quantities of food nearest the source, the basic producer, thus procuring it cheaply, and we have distributed this food to the undernourished—often, as in the school-lunch plan, utilizing idle labor to do this. Some food is purchased directly and then turned over to State welfare agencies. Some is used under the food-stamp, free school-lunch, and cheap-milk programs. Some farm commodities have been diverted to by-product or other uses.

Between October, 1933 and July, 1940 about $565,000,000 worth of farm products were bought from farmers and distributed to the needy in this country. This involved, among other things, 250,000,000 pounds of butter, 27,000,000 pounds of cheese, 76,000,000 quarts of fluid milk, and so on. In short, we have fed millions of our own half-starved people. Whatever happens in the future, we have decided, at least, that we cannot afford to let a generation grow up physically and mentally handicapped through malnutrition during childhood while we debate the form that basic social and economic reorganization should take.

What, then, of the future, and how does the better nutrition of American citizens tie in with food for Britain?

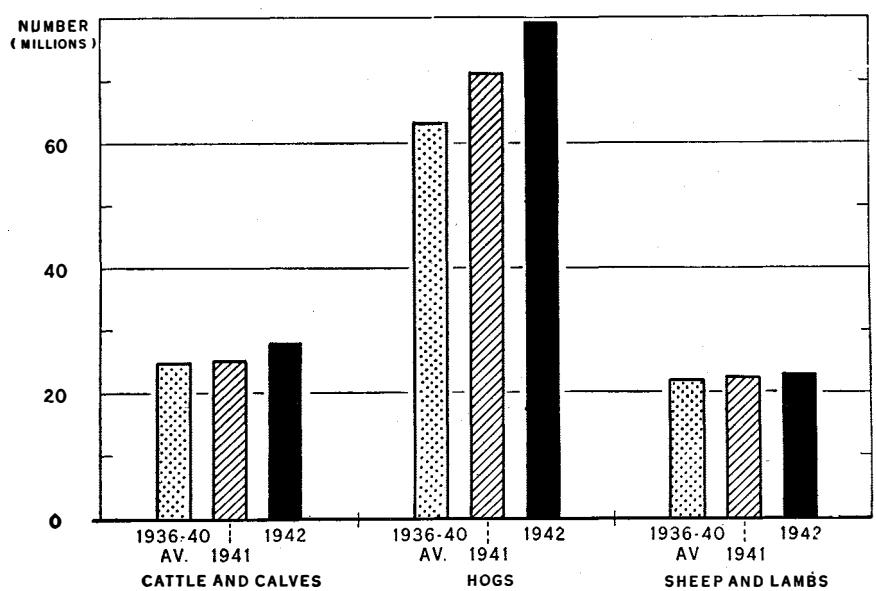
In September, 1941, Secretary of Agriculture Wickard announced the so-called food-for-freedom program. It involved the establishment of 1942 production goals for all essential agricultural commodities. These goals had been established scientifically on the basis of a thorough canvass of the needs of improved nutrition in the United States and the requirements of nations fighting Hitlerism. Every farmer will be contacted by his local committeeman in a nation-wide sign-up campaign.

The agricultural adjustment machinery will be utilized to increase the production of hogs and lard (by feeding Ever-Normal Granary grain to hogs), milk and milk products (by stepping up the grain feeding of dairy cattle), and eggs. Those are Great Britain's main requirements. At the same time the agricultural adjustment machinery will be used still further to curtail production of cotton, wheat, and tobacco, of which we have ample surpluses.

SHIPMENTS to Great Britain for 1942 will be simply stupendous—the equivalent of five billion pounds of milk, for example, in the form of dried milk, evaporated milk, and cheese—or enough milk to fill a pipe half a foot in diameter reaching around the Equator three times. The British will also get 1.5 billion pounds of pork and lard, representing enough 230-pound hogs, stand-1½ feet apart, to reach from the northernmost point in North America to the southernmost in South America.

Our 1942 production goals also require us to send Britain a half billion dozen eggs, some 18,000,000 pounds of canned poultry, enough fresh fruit to fill 750 miles of railway cars, and enough canned vegetables to fill 22

MEAT ANIMALS: TOTAL UNITED STATES SLAUGHTER, 1936-40 AVERAGE, INDICATED 1941, AND GOALS FOR 1942



Data on actual slaughter, but not including production goals

miles more. Now what relation do these quantities bear to our normal domestic production and consumption?

Much depends on how you look at it. Great Britain normally produces only about 37 percent of her own food, and her food consumption as a whole dropped below normal during the 1940–41 winter. To balance her national diet she would need from us one half our normal output of cheese, one and one half times our normal production of evaporated milk, and five times our normal production of dried eggs. Yet such quantities do not bulk so very large when compared with our total agricultural production.

For example, while wheat production is to be reduced 15 percent under the 1942 goals, lamb and mutton production will have to be increased only 2 percent, milk 7, eggs 10, chickens 13, pork and lard 12, and the quantity of beef and veal marketed 10 percent. If we use 100 as the index of farm production for the 1924–29 period, the average for 1936–40 was 105, the 1941 index will run about 113, and the 1942 production goal only 115. So we simply need an over-all increase of 2 percent in farm production to achieve the goals.

Britain will take only 6 to 8 percent of our output of the particular farm commodities she requires of us.

Take milk as an example. During the latter 1930's we produced about 106 billion pounds a year. In 1940 we had an all-time high in farm production and the output was 111 billion pounds of milk. The 1941 output is expected to top that by being 117 billion pounds. The goal for 1942 is only 125 billion pounds, of which 5 billion will go to Britain and 3 will remain here to improve the American diet.

But if all Americans had a "best adapted diet," this country would utilize 20 percent more milk and 15 percent more butter. We should use fluid milk at a rate of 295 quarts a head a year instead of 168 quarts as at present. Incidentally, we should also use 70 percent more tomatoes and citrus fruits, 100 percent more leafy green and yellow vegetables, and 25 percent more eggs.

Getting back to the milk can, though, this nation would use 140 billion pounds of milk annually, if all had "best adapted diets." Compare that with the 125-billion pound production goal for 1942 which includes Britain's 5 billion pounds.

Consider also what it would mean if we all got our full quota of the other foods mentioned above. It would mean an increase in our crop acreage equal to that used for export farm commodities in our best foreign-trade years. It would require a cultivated area equal to that in the State of Iowa—just to feed our own people.

WE shall step up our agricultural productive capacity to help lick the Nazis. We shall aid in feeding the nations which are fighting aggression. But, at the very same time, we shall improve the nutritional status of our own people. When peace comes, we shall not destroy this productive capacity we have built. Instead, we shall let it run to full capacity and learn how to distribute the wealth it produces equitably to all who need it.

Corn into hogs, hogs into food, food into victory

Secretary Wickard, a dirt farmer himself, with a profound feeling for the underfed underdogs, is determined that all citizens of the United States shall be guaranteed a full basic diet after the war. Secretary Morgenthau has echoed this by saying: "My own feeling is that we should guarantee to every man, woman, and child the right to have

They thrive on penny milk

enough milk and butter, enough fruits and vegetables, enough of the protective foods of all kinds so that every one can be fit to do his part in the world of tomorrow."

This country is rich enough agriculturally to recognize every citizen's right to have a minimum standard of food upon which he can live the life of a free man. Exactly that is what officials of the Department of Agriculture mean to see provided for all.

A period of maladjustment, depression, and despair could follow this war. But post-war plans are already being formulated to prevent that. These plans include rural public works, reforestation, soil conservation, flood control, electrification, education, medical care, better market facilities, better housing, libraries, and also industrial decentralization, along with such extension and modification of the food-stamp and school-lunch plans as proves necessary to give every American his minimum basic diet. These plans are of supreme importance as a bridge to a better way of life.

UNTIL recently, we Americans have displayed little ability to make equitable distribution of the vast wealth that science and technology have lavished upon us. Yet, considered as a functional or engineering problem, provision for the material needs of the common run of men offers no insuperable difficulty. We have the resources, the equipment, the techniques, the processes, the research laboratories, and the trained manpower.

Fundamental in post-war days will be experiments in and study of distribution. These, alone, can aid us in effecting the required readjustment of agricultural and industrial production, and in cushioning the social damage that might otherwise ensue. When adequately financed, they will maintain a floor beneath the physical health of our people and prevent the nation from repeating past mistakes. Ultimately, by making full provision for the basic needs of our own people, we shall greatly increase our national income and well-being.

That is what the food production goals for 1942 and food for Britain really mean.

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TRANSFUSIONS

Blood Types Now Quickly Determined

A NEW testing technique, employing the dried serum of rabbit's blood, will be used by army surgeons to classify soldiers' blood into one of the four known groups quickly, safely, and cheaply, according to Lederle Laboratories, Inc., who developed the new method. The rabbit serum is used only for testing purposes and not for transfusions. Thus invaluable time will be saved in giving blood transfusions, when needed, to soldiers in the United States Army because each man's identification tag will now be stamped to designate his blood group determined by army surgeons in advance. With this information always available, the selection of the man to give blood safely to another can be made immediately.

Transfusions can be given safely only after tests have shown that the blood of the donor will safely mix with that of the recipient, and only human blood can be used. If blood of the wrong type should be given the patient, clumping of the donor's cells would occur in the body of the recipient, causing a shock reaction and possibly death. The necessary tests, made by the old method with the serum of human blood, were time-consuming when minutes might mean the difference between life and death for the patient.

The new testing technique employs dried serum from the blood of rabbits which have been previously injected with human blood corpuscles of known groups. This treatment increases the potency of the rabbit's blood in the substances which differentiate the several groups of human blood. The corpuscles are separated from blood drawn from the treated rabbits, the clear serum is treated to remove non-specific substances and then reduced to a powder by careful drying. In the dry, powdered form, the serum retains its value for test purposes indefinitely.

Two types of dried rabbit serum are necessary for the typing of human blood. In making the test a single drop of the unknown blood drawn from a person is diluted with a small amount (about eight drops) of normal salt solution and two drops of the blood solution are placed separately on a clean slip of glass. To one drop is added the tiny amount of Anti-A powdered serum that can be picked up on the end of a tooth pick. Anti-B serum is similarly added to the other drop. At the end of half a minute, the two drops are examined with the naked eye or a hand lens. If no clumping of the blood occurs in either drop, the blood is Group O. If clumping occurs in both drops, the blood is Group A-B. If clumping occurs with one and not the other, the blood belongs to Group A or B according to which kind of dried serum causes the visible clumping.

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SENSITIVE—Light so feeble that it cannot be measured by the most delicate optical instruments can be perceived readily by the human eye, experiments conducted at Columbia University show. The human eye, it was found, can perceive light if it falls on as few as five molecules of the receiving substance of the retina.

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GRAY HAIR

Darkened by Doses of Vitamin B

"A MARKED darkening" of previously gray hair and growth of "new natural colored hairs" in 30 human beings has been achieved by small daily doses of one of the newest of the vitamin-B group, para-aminobenzoic acid, according to Dr. Gustav J. Martin, of the Warner Institute for Therapeutic Research, and S. Ansbacher, of the research laboratory of the International Vitamin Corporation, states *Science Service.*

This is the first report before a scientific society of the "cure" of gray hair in humans by this vitamin, although there have been a number of reports of the darkening of gray hair in rats and mice with doses of both para-aminobenzoic acid and other B vitamins.

Like the other B vitamins, the para-aminobenzoic acid is found in yeast and liver. For the treatment of gray-haired humans the synthetic vitamin, which costs about ten cents a pound, was used. The daily dose is 100 milligrams (about two-hundredths of an ounce). But Dr. Martin warned that it should be taken only under a physician's direction because this chemical has other effects, some of which are only just being discovered. It counteracts the curative effect of the sulfa drugs, for example, and under certain conditions might raise the blood pressure.

MIND AND BODY

Does Mental Receptivity Control the Physical?

AN amazing story of how a childless couple were finally able to have a child of their own after they had decided to adopt a baby has been told in *Psychosomatic Medicine* by Dr. Douglas W. Orr, Menninger Clinic, Topeka, Kansas. Not infrequently a childless wife becomes pregnant some time after adopting a child. Some psychologists believe the supposed "sterility" was really caused by an unconscious opposition to childbearing. This opposition disappears with the adoption and rearing of a child. Deep psychological barriers are lowered, and the machinery of pregnancy is enabled to function.

Dr. Orr's case was somewhat different. The wife's apparent previous inability to bear a child was traced by psychoanalysis to her own childhood. Her father had wanted a boy. To grant this wish as far as possible, the mother brought her daughter up to be tomboy. She was made to wear tailored clothes, her boyish figure was praised, and she was encouraged to express her athletic abilities by playing golf with her father.

Because of this, Dr. Orr continues, the young girl came to believe "she could not have a child because she was not enough like a woman, and she had no confidence that she could care for a child if she were to have one."

This state of mind carried over into married life because her husband encouraged her to work. To her this meant, "you must go on being like a man." This belief that she was too masculine, the psychoanalysis indicated, prevented her from becoming pregnant.

However, when husband and wife decided to adopt a child, she was encouraged by her husband to stop work. Her resignation, Dr. Orr concludes, "enabled her better than ever before to turn toward and accept her basic femininity." Shortly after her resignation and adoption of the child, the wife became pregnant.—*Science Service.*

Our Navy's Air Arm

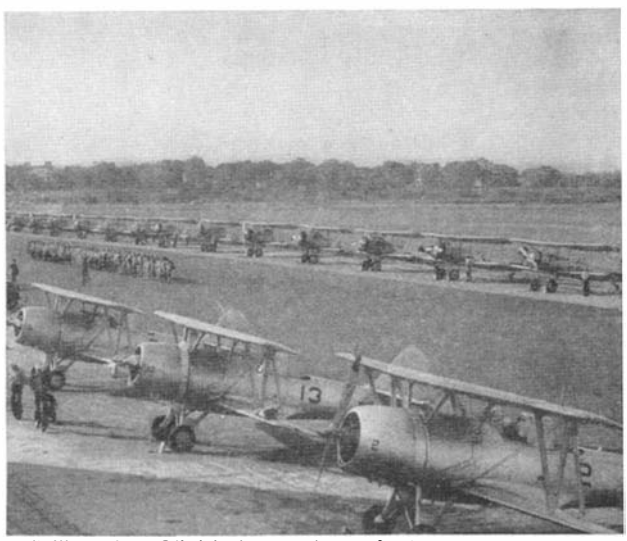
Flying Sailors of the United States Have Long Been Regarded as Best Trained in the World

JAMES L. H. PECK

OUR Navy is at war. Its operations in both the Pacific and Atlantic involve two principle strategic missions: the ability to obtain enemy information quickly and with reasonable security; the firepower and flexibility to strike at these Axis sea forces once their intentions become apparent. This applies equally to cruisers, submarines, or aircraft—or the Navy as a whole—but the aircraft, because of their speed and range, are particularly suited to carry out these tasks. No matter how formidable sea power may be on the surface, it requires the support of aviation to gain a decision against an enemy's sea-air combination. Deprived of such support, surface vessels cannot operate with the necessary freedom of action.

This is not news to the United States Navy. In February, 1913, Lieutenant John H. Towers—now Rear Admiral and head of the Bureau of Aeronautics, Navy Department—performed the fleet's first patrol flight and "discovered" the enemy at sea. Even before this flight was accomplished, Towers and Glenn Curtiss—who had taught the former to fly in 1911—envisioned a long-range flying boat. The Curtiss planes of the famous NC type were the first of such craft to be built, the forerunners of our crack "VPB" patrol planes. In November, 1918, one carried aloft 51 persons in a test flight. That was news in those days. In the Spring of the following year, another flying boat, the NC-4, completed the first transatlantic flight; which was also big news. Today, our patrol bombers are capable of speedy non-stop crossings in routine operations. Three of the newer types can make it a round trip or remain awing for a couple of days at a time.

Not so farsighted are the eyes of the "VSO" aircraft which are carried to sea aboard battleships and cruisers and launched from catapults for scouting purposes. These seaplanes, however, are highly essential for a number of reasons which will be examined later. In November, 1915, Lieutenant-Commander H. C. Mustin made the first catapult launching of an aircraft from the U.S.S. *North Carolina.* Although this artificial take-off was the first to be made from a vessel, Lieutenant T. G. Ellyson—along with Towers and Lieutenant John Rodgers, one of the three original Navy aviators—had piloted a flying boat three years prior to this from a catapult built on a small dock at the Washington, D. C., Navy Yard. Present-day scout-observation craft take wings from our battleships and cruisers by means of 70-foot catapults motivated by compressed air.



All illustrations Official Photographs, U. S. Navy

Advanced trainers — obsolete service planes

Just as America pioneered in these means of finding an enemy at sea, so did we conceive and develop methods for carrying out the second tactical purpose in naval warfare; that of striking with flexibility and heavy firepower. There is the dive bomber. We made it first. Germany made it famous. We make it best. The Martin BM-1, closely followed by the Curtiss O2C-1 *Helldiver*, both of which were of 1926-27 vintage, were the first dive bombers as such to take to the air anywhere. Both the planes and the tactics in which they are employed have undergone continual refinement in the interim. Although the Nazi *stukas* made the world dive-bomber-conscious during the Spanish, Polish, and Low Countries campaigns, the Navy's four new types are now far superior to any in the world in speed, warload, range, and armament.

Then there is the torpedo plane which is doing yeoman duty in the war at sea. It is, perhaps, the flying fleet's most potent striking force. Although the British Admiralty used several types of planes for carrying torpedos before and during World War I, and they launched the first successful attack against a surface vessel late in 1915 in the Sea of Marmara, the development of the torpedo plane to its present tactical efficiency is the handiwork of the United States Navy. Until the carriers *Lexington* and *Saratoga* entered service early in 1928, the torpedo bombers were fitted with twin pontoons: since that time, they have operated from the carrier decks as wheeled landplanes.

THE aircraft carriers, great floating airports on which much of the flying fleet roosts, are last, but far from least, among America's contributions to naval science. The carrier, also, is not too new an idea. Eugene Ely, Curtiss test pilot and the original member of that now highly specialized profession, in November, 1910, made a flight from a platform built on the bow of the U.S.S. *Birmingham* at Hampton Roads, Virginia. In January of the following year, Ely landed his plane upon a large platform built over the stern of the U.S.S. *Pennsylvania* anchored in San Francisco Bay. These were sensational flights, and were considered in the light of stunts rather than as practical demonstrations. After landing on the *Pennsylvania*, Ely took off from the same platform and returned to his base ashore. The aircraft carrier had been born. Authority was given the Naval Aeronautical Service, as it was then called, in October, 1919, to convert the collier *Jupiter* into a carrier, and this ship was renamed the *Langley.* Three years later, to the very month, the first landing upon a carrier deck was accomplished by Lieutenant-Commander G. deC. Chevalier. A few minutes later, Lieutenant-Commander V. C. Griffin lifted the plane from the *Langley's* deck in the first take-off from a carrier. Seven of these floating air fields are now in the commission of the United States Navy, and eleven more

Helldiver, best and fastest dive bomber; better one is under experiment

are now in the course of construction.

Navy ingenuity is not confined to these larger items; any number of important devices and much aircraft material were conceived and developed by the Bureau of Aeronautics. Included is the carrier arresting gear, very secret and said to be finest in use anywhere; flotation gear to keep both plane and pilot afloat after emergency landings; the Sperry bombing sight, which gained fame in Army hands, but which was originally built to Navy specifications; a vital process for corrosion-proofing of aircraft metals; and many important gadgets and instruments which are the brain children of the design and engineering divisions of the Naval Aircraft Factory.

WHEN the fleet goes to sea, the air force—with the exception of occasional bombing operations—remains a component of the fleet; just as much so as the battle force, cruiser force, or the scouting force. Despite its tactical importance, the air arm is but a part of the overall naval picture.

Let's take a look at this picture. The fleet is far at sea in cruising formation. ships are strung out over miles of tossing, angry ocean, one vessel barely within sight of the other. The maneuvers are worked out aboard the flagship on the admiral's chart.

Curtiss *Seagulls* (SO3C-1's) and Vought-Sikorsky *Kingfishers* (OS2U-2's) are shot from the catapults of the dreadnaughts and cruisers. These scout-observation planes sweep ahead of the fleet to spy out the movements of enemy vessels. They are joined by Brewster *Buccaneers* (SB2A-1's), Curtiss *Helldivers* (SB2C-1's), Douglas *Dauntless* (SBD-3's), and Vought-Sikorsky *Vindicators* (SB2U-2's) from the carriers. These latter four types of craft will stop scouting and commence bombing when the enemy is sighted; they are designated as VSB scout bombers but go into action as dive bombers, which they are insofar as design and armament is concerned. Radio contact reports from the other observation planes to the flagship greatly facilitate the "chart maneuvers" by keeping the admiral and his officers informed of the goings on. When the engagement starts, these scouts will also maintain contact with the "spotters" and "plotting rooms" of their respective ships to aid in range correction, thereby defeating the purpose of the enemy's smoke screens, which are intended to conceal vessel movements and formations.

Meanwhile, the carriers' other planes are taking off. Crack fighters streak off to engage those of the enemy. Big, fast torpedo bombers such as the Douglas *Devastators* (TBD-1's) and Grumman *Avengers* (TBF-1's) roar away to strike at the hostile main body. These craft carry either torpedos or large bomb loads, depending upon the circumstances. Higher up in the now smoky sky are the "big boats," the patrol bombers that have come forth from distant mainland or insular bases. These include the giant Consolidated *Coronados* (PB2Y-2's), *Catalinas* (PBY-5's), and Martin *Mariners* (PBM-1's and PBM-2's).

The Naval Air Service's position of pre-eminence is due largely to this sparkling array of aircraft, many of which have proved themselves nobly in service with Britain's fighting Fleet Air Arm. Brewster and Grumman fighters have bested the vaunted Nazi Messerschmitts on many occasions, as well as the best craft Italy can put into the air. The *Catalina* boats have done yeoman duty in the Mediterranean, and it was one of these ships—with an American observer aboard—that spotted the *Bismark* after 1941's greatest sea hunt. The Grumman F5F-1 and Vought-Sikorsky F4U-1 are among the world's six fastest fighters; and none of the other four are naval craft carrying the many extras demanded by over-seas operations. The naval expansion program calls for thousands of these crafts, the total to include the highly essential trainers and utility airplanes. The largest naval air arm in the world for several years, our flying fleet is rapidly growing even stronger wings.

This speedy growth necessitated the immediate training of thousands of pilots, navigators, bombardiers, gunners, flight mechanics, and ground personnel. Like the planes they fly, our naval airmen have long been regarded as the best trained anywhere in the world, and this is the result of the philosophy of "naval aviators for naval aviation"; these young men are flying sailors rather than sea-going fliers. The time spent in learning about things nautical and becoming accustomed to maritime practice pays big dividends. Without this specialized training, the fliers would be unable to identify types of warships, or distinguish between theirs and those of the enemy; they would be unable to interpret certain tactical maneuvers they might observe from above or to carry out numerous other duties requiring sea training, such as scouting and search problems.

THE Naval Air Stations at Pensacola and Jacksonville, Florida, and Corpus Christi, Texas, are bearing the brunt of the training of the new pilots called for by the expansion plans. The flying cadets enter one of these three schools with the rank of seaman, second-class, after they successfully complete a 30-day preliminary course at one of the several Naval Reserve Aviation bases throughout the country. Advanced training for carrier flying is conducted at the Miami Naval Air Station for graduates of the three larger schools who are to specialize in this type of work. The regular one-year courses at Pensacola, Jacksonville, and Corpus Christi have been cut to seven months duration in order to step up the training program, but the change does not result in a reduction of flying time.

The embryo aviators still receive about 225 hours of flight instruction, and are better equipped to fly one particular type of plane than they were under the full-year training scheme. This has been made possible through specialization: If the cadet is chosen for

fighter duty, he begins his training in landplanes and, upon completion of his advanced work, flies older fighter types. Cadets chosen for other carrier branches —scouting, dive bombing, torpedo bombing—follow a similar course. Only the selectees for battleship and cruiser seaplane duty and those for patrol work receive seaplane training; formerly, all Navy pilots flew seaplane trainers during the primary phase of their instruction. Upon completion of the courses, the cadets receive their hard-earned gold wings and Ensign's commission. Post-grad work, a sort of aerial internship, involves further training and seasoning with tactical squadrons of the Fleet.

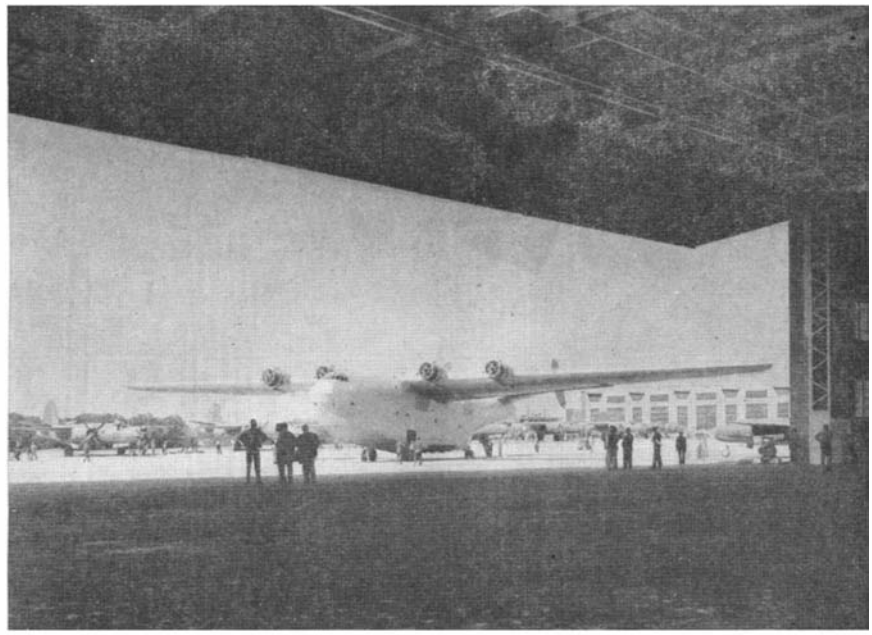
BACK of the pilot training program are crew members, mechanics, and additional ground personnel who "keep 'em flying." Enlisted men enter the many Navy trade schools to receive one-year apprentice courses, after which they go to naval station overhaul bases for further training. Officers are afforded special courses at the Naval Academy and certain colleges and universities that have to do with areonautical engineering, naval architecture, and meteorology. When the flying fleet is at work a thousand or two miles from the nearest base, this Navy personnel must make repairs and perform the necessary engine, aircraft, and accessory checks without the help of the specialists normally available at a large base. An operational unit carries with it engine and aircraft mechanics, metal workers, carpenters, radio technicians, armorers, and so forth. The squadron engineering officer—who is usually a graduate aero engineer as well as an experienced naval pilot—must know not only operating maintenance but also the practices and methods of repair maintenance. Each of the carriers and seaplane tenders has extensive shops and laboratories available for this overhaul work.

Gunners, also, are usually mechanics, and these men are trained at the San Diego and Norfolk air stations. Bombardiers and navigators are trained at the Miami school.

The Naval Air Service must have bases from which to operate. The expansion has already increased stations and airdromes from the seven shore establishments in 1939 to more than 30 major bases, and, in addition, several auxiliary bases. All the new stations and bases in the Western Hemisphere will be in operation by the time this is in print: these extend from Iceland and Greenland down to Georgetown, British Guiana; from Alaska down to Honolulu.

Before this war is over, the Navy will undoubtedly have an opportunity to prove that its planes, the men who fly them, and the tactics in which both are employed have no equal in the world. Secretary of Navy Knox phrases it best in his own words:

"Since the invention of the airplane, our Navy has used more aviation than any other major power, has put aviation to more uses in co-ordinated combat, including bombing and observation. It is a tribute to the officers and men who run our Navy that the lesson of sea-air power in World War II bore out a theory they had already put into practice."



Large Navy flying battleships have high-speed, long cruising range

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WATER 'CHUTING

Marines Use Gas Inflated Jackets

AN interesting and additional note on the training of Marine parachute troopers, supplementing the detailed description published in our January issue, has to do with water jumps. When United States' sea soldiers are forced to "have the situation well in hand" by an attack from plane carriers, provision is made for landing the parachutists in the water.

For this work the Marines are equipped with inflatable rubber jackets under their 'chute harnesses. As the parachutist approaches the water, he slips out of his harness while still 10 or 15 feet above the sea and drops into the water. Freed of the weight, the 'chute drifts away so that as the Marine rises to the surface after plummeting into the sea he is not likely to be smothered by having the silken canopy land directly above him. Meanwhile, the Leatherneck paratrooper must remember to release the toggle on a small, metallic cartridge—much like the one used in a charged water bottle—which is attached to the mouth of his deflated life preserver. The cartridge is charged with carbon dioxide and blows up the rubber jacket, helping the 'chutist to rise to the surface, and to remain there.—*A. D. R., IV.*

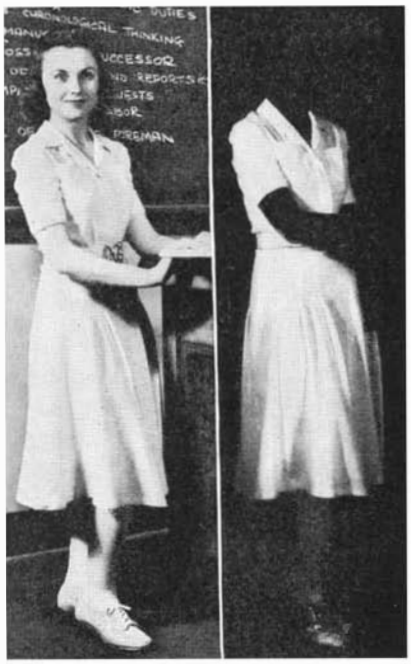
FLUORESCENT

Fabrics for Use in Blackouts

WORKERS in factories and pedestrians in traffic can be made visible during blackouts by fluorescent-dyed clothing and ultra-violet lighting. Clothing dyed with fluorescent colors glows in invisible ultra-violet light—permissible in blackouts—with a subdued radiance bright enough to be seen nearby but too weak to be visible at a distance, even in a blackout otherwise complete. In blacked-out plants equipped with ultra-violet lamps, workers wearing such garments are readily visible to their associates.

Traffic control during blackouts can be effected by using ultra-violet lamps in traffic lights and in the headlights of vehicles. In the invisible radiance from these lamps, clothing dyed with fluorescent colors glows brightly enough to make persons wearing it visible to drivers or other pedestrians but not to aviators at a distance.

Dyes of many shades, possessing fluorescent properties, are available for



Left: **Fluorescent-dyed clothing in light and,** ***right,*** **in the darkness**

application to various textile fibers and fabrics, according to officials of the Calco Chemical Division of American Cyanamid Company. In ultra-violet light, they give fluorescent colors varying from violet through blues, greens, yellows, oranges, and browns to rich reds.

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AIR CONDITIONING—In protecting power and equipment, in speeding the production of thousands of articles of defense machinery back of the lines, and generally in helping men and machines to work better, air conditioning is month by month increasing its service to the all-out war efforts of the nation.

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OVERPASS

For Speeding-Up Cross Traffic

BRIEFLY referred to in the article on the army engineers, "Builders For the Army," published in our issue of December 1941, was "a portable overpass invaluable when one column of troops must cross another's line of march." Such a portable overpass has also been developed by R. G. LeTourneau, Inc., which not only has military implications but also can be brought into service during especially heavy traffic periods or can be left permanently in one location for civilian use.

The portable overpass, shown in one of our photographs, consists of three 60-foot sections with detachable legs having adjustable piers to fit any site contour and provide the required clearance for under-crossing traffic. Rigidly built of alloy steels, arc-welded throughout, the overpass incorporates box-beam side girders and floor joists and a solid steel floor plate. It is claimed that it can be assembled and ready for use in as short a time as two and one-half hours. When the overpass is to be moved to another location it can be carried by a two-ton truck-trailer outfit or on railroad flat cars.

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RESPIRATORS—The Chemical Warfare Service of the United States has recently received delivery of 100,000 respirators which weigh only one and a half ounces and yet will exclude dust particles as small as 1/25,000 inch in diameter.

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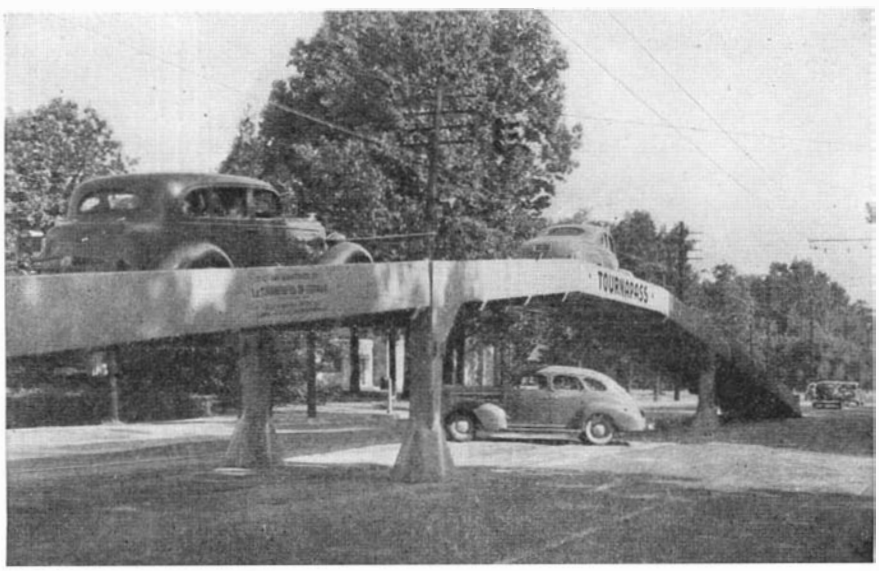
CURTAINS

For Blackouts: of Wool, Paper

"BLACKOUT" requirements at present are puzzling many people in all sections of the country. Due to the heavy demand for appropriate material for such use, shortages have occurred in some localities. The Felt Association, Inc., stated recently that it had been noted that many people do not realize the adaptability and advantages of wool felt, an available commodity, for blackout curtains. Ordinary light will not penetrate felt of suitable grade, and it may be readily used for window shields for office buildings, power houses, water works, and other types for factories and defense plants working night shifts. For windows in homes, felt is practical, as it can be tacked, glued, or pasted in almost any form without tearing, and can be cut to shape without ravelling. It also may be attached to shade curtain rollers, replacing the usual shade cloth. Colors—brown, green, navy and dark blue and olive drab—are just as satisfactory for the purpose as black, and of course are more desirable from the interior decorator's standpoint. Felt may be flameproofed and mothproofed.

Another material that has been proved satisfactory for "blackout" use in the home and factory is Sisalkraft. This sheeting has been war tested in England since 1939 and it is still being used today. It has been approved by the Air Ministry, Admiralty, War Office, H. M. Office of Works, Ministry of Home Security, and other departments of the English Government.

One reason that Sisalkraft is effective for blackout purposes is that it is composed of two sheets of kraft paper cemented together with two layers of asphalt and reinforced with sisal fibers. This composition makes Sisalkraft opague, strong, pliable, and, above all, highly reflective, so that a factory using this material as a blackout does not need any additional power for lighting, whereas black cloth absorbs light and painting prohibits the use of daylight. Sisalkraft can be used as a screen on wood frames, made to fit the window opening tightly, or as a roll curtain. In England they have found that a 9-inch overlap on the sides of the windows is essential when used as a curtain. Sisalkraft reflects approximately 70 percent of the light that impinges on it, and, furthermore, the material can be rolled up or removed during the day, thus permitting the use of natural light.



Expedites traffic movements, both military and civilian

Rolling Off a Log

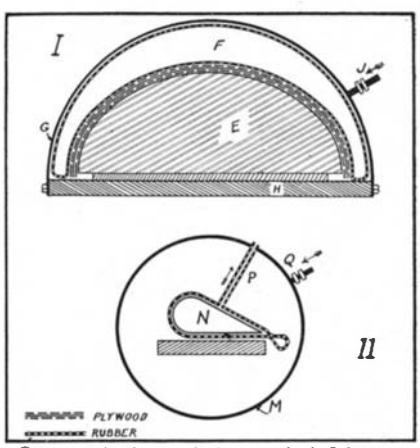
Plywood Made Available for Many New Applications by Development of Synthetic Adhesives

THOMAS D. PERRY

PLYWOOD, which consists essentially of layers of veneer bonded together with adhesive, is an ancient material that in very recent years has been freed from former limitations to an extent making it of pronounced value to defense activities as well as to normal peacetime uses. Limitations on the use of plywood have always been those of the available bonding agents and the technique of using them. Until the practical development of synthetic resin adhesives during the last ten years, many fields of possible application were barred to plywood by the inferior durability of conventional glues. Now, with dependable bonding agents, plywood not only is meeting what might be termed its logical uses but is being put to work in unexpected fields, where it can satisfactorily take the place of less generously available materials, such as the lighter metals.

The rudiments of modern plywood construction—that is, with the grain of alternate layers at right angles—were first recognized between 1830 and 1840, in piano pin planks made of sawed veneer. The purpose of the cross layers was to insure a firm grip of the wood fibers on the shank of the tuning pin, so that after many years of twisting, the grip would still be firm and no signs of splitting would be manifest in the wood.

The making of cross-laid veneer products began to emerge as an industry early in the 1880's but grew rather slowly until about the beginning of World War I. The unusual ratios of strength to weight in plywood attracted the attention of the early aircraft engineers, who used plywood extensively in the primitive aircraft of that time. One of the handicaps to the new industry was the terms "veneer," "veneered," and "veneering," which suffered from somewhat sinister dictionary definitions. Manufacturers, trade associations, and government agencies joined in the search for a better name. The author well remembers the earnest discussions of those days, resulting in the choice of the term "plywood," which has since become the standard description of basic veneer assemblies. It had been an obscure technical term, little used and less understood, but has come to carry its new responsibility most efficiently. Plywood is a product made of veneer, as shoes are made of leather, as machines are constructed of iron and steel, as houses are built of wood and masonry, and as cloth is woven from thread and yarn.



Courtesy Institute of Aeronautical Science

All-directional pressure for bonding plywood structures, as in forming half-fuselages, is secured by the flexible-bag method. I: Bag *F* is inflated through *J* and restrained by shell *G*, attached to base *H*. Mold *E* (metal or wood) is recessed for frame members; veneers thus are bonded into plywood and plywood is attached to frame in one pressure application. II: Bag encloses aileron *N*, temporarily fastened together. Bag is deflated through *P*, which remains as a vent. Tank *M* is filled through *Q*, imposing external pressure through the bag on the aileron, fabricated of plywood

Serviceable plywood requires a suitable quality of veneer and a dependable adhesive. The older conventional glues—animal, casein, vegetable, and soybean—had their good qualities and would render acceptable service under ordinary conditions. When subjected to severe heat, moisture, and exposure to weather, however, none of them would withstand prolonged service, and, as a result, the use of plywood was restricted to moderately protected locations. Plywood made with the old glues was, of course, often blamed for failures that were caused by unintelligent adaptations.

During World War I, both cold-pressed casein and hot-pressed blood albumin were used in airplane construction, as they were then the best-known water-resistant glues. Both were of limited durability, were attacked by molds and fungi, and would deteriorate under severe exposure. The inadequacy of these glues, coupled with the vigorous promotional efforts of the rapidly developing aluminum industry, more or less sidetracked the use of plywood for aircraft. As a consequence, the airplanes of the succeeding 20 years were largely made of the lighter metals.

IN THE early 1930's resin adhesives were little more than interesting laboratory experiments, but of definite promise if their cost could be reduced. Around 1935 a phenol formaldehyde resin film, from domestic sources, became available at reasonable cost. It required curing, or hardening, under simultaneous heat and pressure, and the bond was irreversible; that is, it would not weaken or deteriorate from heat, moisture, or fungus. In durability, the bond would outlast the wood itself. It was soon recognized to be an adhesive with such service characteristics as to make plywood fully available for aircraft and boats. Supplementary to this resin film were a number of other resin adhesives, both urea and phenolic, with similar service qualities. The ureas were not quite so durable as the phenolics but could be cured even at room temperatures. The phenolics, which equaled the first film in durability, became available in liquid and dry forms for a wider range of applications.

Veneer is the raw material, direct from the tree or log, from which plywood is assembled with a suitable adhesive. Over 90 percent of the veneer used is rotary-cut on a lathe, much as paper is unrolled. Sliced veneer is cut similarly from the flat side of a log segment, but can be no wider than the log. The cutting of rotary veneer gives much higher log yields than does sawing into lumber. Veneer is used, of course, for many products other than plywood, such as fruit and vegetable containers, hand baggage, and so on.

Since wood is strong lengthwise and weak widthwise, the crisscross structure of plywood, offsetting this widthwise weakness, imparts to the material

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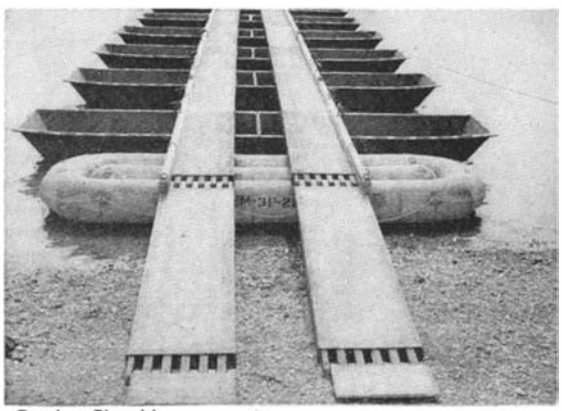
Courtesy *Technology Review*, from which the present text was slightly condensed. The author is Sales and Development Engineer of the Resinous Products and Chemical Company and author of a book entitled "Modern Plywood."

substantially equal strengths in both directions. The original strength of the wood is reinforced by the adhesive, so that the aggregate strength of the integrated plywood is greater than the total strength of the veneers composing it. Plywood in its simplest form, three-ply, has two outer layers with parallel grain, each half the thickness of the center layer, or core, which has its grain at 90 degrees to that of the faces. The result is what is called a balanced construction.



Courtesy Plyweld

One application of the ultimate product of the process of rolling off a log. This experimental plywood ramp, developed by the United States Army, will carry large loads. The individual sections are quickly joined at their finger-like ends with pins and are easily transported by Army trucks to the point of use

Another common construction is five-ply, in which the strength of the wood fiber may be equalized in each direction, or in which a thick lumber core may be used to give a dominant strength in the direction required. In the standard five-ply type, the cross layers between the core and faces are called "crossbands." Crossbands of $\frac{1}{16}$ inch will give adequate stability to plywood one inch thick.

MULTI-PLY constructions, seven, nine, eleven, thirteen, and so on, are often used when strength distribution and durability factors are important, as in aircraft and boats. An even number of plies is seldom used, as it results in an unbalanced construction and tends to cause warping and twisting. An exception is two-ply, which is often made for curved work, where the reinforcing of the double layer reduces the hazard of rupture of the veneer during bending. Two-ply is seldom an ultimate product but is, rather, an intermediate step toward the manufacture of a higher ply.

Laminated wood, a term used to describe a veneer construction in which all layers are parallel, is usually made in plywood factories. Its purpose is to maintain lengthwise strength and stiffness, which are sacrificed in standard plywood constructions. In fact, laminated wood is stronger than normal solid wood of the same dimensions, because of the overlapping of the slightly angling wood grain.

Generally, the thinner the veneer layers, the stronger the plywood or laminated wood. Veneer can be cut as thin as 1/100 inch, but economic considerations prevent the extensive use of veneer thinner than 1/40 inch.

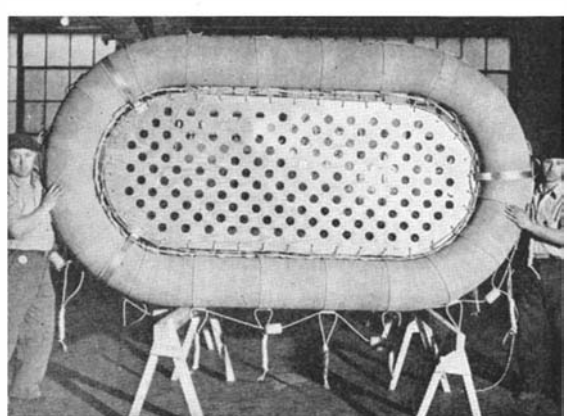
The applications of plywood rely upon qualities peculiar to the material, which may be summarized thus: The strength of plywood may be distributed equally in both directions, whereas normal wood has a predominant strength in one direction only. Plywood cannot be split, because of the holding power of its adjacent layers. The shrinking and swelling of plywood, under exposure to moisture, are relatively slight. Wood does not shrink appreciably endwise, and the widthwise veneer is held to stable dimensions by the immediately adjacent endwise layers. This factor reduces warping far below that of normal solid wood. After gluing, plywood can be bent and curved to a much greater extent than normal wood, because of the reinforcing effect of the neighboring layers. The limber veneer layers can also be bent during bonding, when they easily slip by each other but are sturdily held in the curved position by the adhesive. The strength-to-weight ratios of plywood are exceptionally good, especially for aircraft and watercraft.

Consideration has so far been given to normal plywood, in which wood compression is nominal and only enough to bring the veneer surfaces into close contact. If greater pressures (500 to 1500 pounds and even higher) are exerted, the veneer is compressed into a high-density plywood with a larger amount of wood fiber per square inch of cross section and a proportionately greater increase in strength. If the veneer layers were originally 1/30 inch thick and are compressed to 1/45 inch with a resin adhesive between them, a substantial amount of resin impregnation occurs. A 50 percent increase in material will double both tensile and shear strengths.

Several types of high-density plywood are made, depending on the ratio of wood fiber to resin, on the pressure exerted, and on the kind of resin used. A phenolic resin film can be employed to give a product which is essentially wood reinforced with resin, with wood characteristics predominating. The film process is simple, and the amount of resin can be controlled by the thickness of the veneer layers.

ANOTHER method for high-density work, which produces what is referred to as "impregnated wood," forces liquid phenolic resin into the voids of the wood fiber, and then, after reducing the solvent content by predrying to avoid blisters in hot-pressing, compresses the whole in a hot-press, as with the resin film. The result is a resin reinforced with wood fiber, in which resin characteristics dominate. The resin content is considerably higher (of the order of 30 to 10) than in the film product, and water absorptive capacity is less. Both products are affected far less by moisture than is normal wood or plywood.

An interesting development of high-density plywood is that of variable-density construction. Here more layers of veneer are used at one end than at the other and the whole assembly is compressed to an even thickness, resulting in greater compression and higher density at one end.



Courtesy Bristol Aircraft Corporation

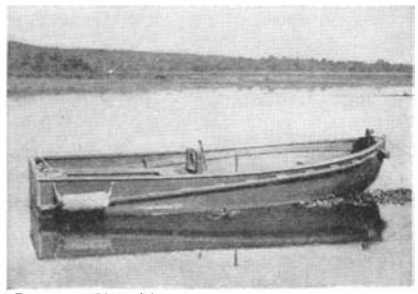
Laminated lumber and plywood in a life raft. The ring is made of balsa wood, resin bonded, doweled, and tightly wound with canvas strips. The floor is perforated plywood. Ten by five and a half feet, the raft accommodates 25

The ability to predetermine density and strength gives to designers of plywood structures a facility that exists with few basic materials. While this procedure can be compared with the alloying and heat-treatment of metals, it has an even wider application range.

Plywood lends itself efficiently to forming and shaping. Attachment or connector clips made of plywood are easily bent and bonded between pairs of heated metal dies. These clips and braces can be made of normal or high-density plywood, depending on strength requirements. The use of them, with adhesives, in constructions involving plywood-to-plywood or plywood-to-frame members, reveals one of the marked advantages of plywood over the metals. Riveting, spot welding, or strip welding must be employed with metals, whereas the clips or braces used with plywood can be glued over their entire area and supplemented, if necessary, with mechanical fasteners to maintain pressure until the adhesive gets its initial grip. Rivets are costly, the installation of them is time-consuming, and the irregularities of the resulting surface are most unfavorable in air or water currents. Glued plywood provides the smooth streamline surface, strongly attached to its framework, which is so essential in aircraft and boats. This forming and shaping can be done best in heated dies, using thermosetting resin adhesives.

ONE OF the newer techniques in the plywood industry, although it has been used in rubber vulcanizing for years, is the flexible-bag method of applying pressure. A distinct advantage of this process is its quality of fluid, or all-directional pressure—in other words, the pressure is perpendicular to all flat or curved surfaces within its range. This fluid pressure can be exerted in a number of ways and the fluid-pressure medium can be air, steam, hot water, or a combination of them, the chief problem being rapid application.

The assemblies on which the technique is usable can be of veneer or of two-ply, of such widths and shapes as will make tight-fitting joints without overlapping. In the half-fuselage shown in one of the drawings, the inner strips of veneer are longitudinal and tapered like barrel staves, the center layer is of moderately wide half hoops, and the outer layer is parallel to the inner layer. If a boat hull is to be made by this process, large two-ply sheets are customarily used, with V's, or gores, cut to permit proper curving or tapering of the layers. In an aileron, the skin covering may be made of either veneer or plywood, often laid at an angle of 45 degrees to the axis of curvature and temporarily attached to the inner framework until the adhesive acquires its grip. These are only two relatively simple constructions using resin adhesives of the phenolic type; many others employ combinations of these processes and apply flexible pressure in other ways.



Courtesy Plyweld

An experimental plywood towboat for the United States Army. It has an overpowered engine and marked qualities of maneuverability. Special rails for handling the boat in and out of the water are shown in illustration

The flexible-bag process permits making shell or monocoque constructions of an infinite variety of shapes and range of complexity. The method may be compared to the drawing of metals between pairs of dies, but it has the distinct advantage of resulting in a product that is more nearly free from internal stresses than is drawn metal. It is also true that plywood can be molded into many complex shapes which are beyond the practical range of drawn metal.

WELL demonstrated is the fact that resin adhesives have definitely greater durability when cured with heat than when cured with chemical reagents. For plywood constructions up to an inch in thickness, the surface application of adequate heat is entirely practical. For assemblies several inches thick, other methods of heat application are imperative. The most satisfactory solution, so far, is to put the clamped plywood assembly in a high-frequency electric field of some five million alternations each second, provided by flat metal electrodes which are insulated from the metal parts of the press and are placed at the bottom and top of the assembly and within the press. The heat thus generated raises the temperature of the assembly within the field to the point necessary to polymerize the resins. The lines of resin adhesives are found to be some 20 degrees hotter than the adjacent wood, which is a favorable gradient that does not tend to dry the wood excessively. Other than this differential, the entire assembly in the field is heated instantly and the cure of the resin can be effective in a matter of minutes, depending on the intensity and capacity of the field.

Applications of plywood which are becoming increasingly important in the defense program are more readily visualized with these recent developments in perspective against the contrasting background of earlier limitations. Airplanes are one of the major products in which plywood can be of substantial importance in the present defense program. Perhaps the most obvious way in which plywood can serve the airplane builder is that of skin covering for the wings, tail parts, rudder, ailerons, stabilizers, and the like. Here the external streamlining of plywood, combined with its factor of stiffness to weight, gives it advantages over thin metals, which require riveting and welding and are less able to resist the aerodynamic forces without buckling and vibrating. The multitude of ribs and framing members required to support metal facings can be substantially reduced in constructions where several layers of plywood covering are superimposed for stiffness, all within permissible weights and strengths. Adequate resin adhesives are available for both the plywood bonding and the assembly operations. Plywood wings are now extensively used in military training ships.

PLYWOOD fuselages, of molded monocoque shapes, have been made and flown successfully. Molded noses and nacelles, from plywood, are in actual production for several types of Canadian fighter planes. The chief drawbacks here are the lack of scientific strength-data and the formulas essential for efficient design.

Spruce spars are almost universal in smaller planes, yet solid spruce is scarce and costly. Laminated spruce is stronger than solid spruce, easier to obtain, far more uniform, with greater yield from the log. The chief problem in the use of spruce spars is that of attaching them to the fuselage and the landing gear; normal spruce has relatively low bolt-holding power. Solution of this problem is offered by high-density plywood with raised, or embossed knobs on one side. The knobs can be pressed (that is, drawn by bolts) into the lighter and softer spruce and firmly glued in addition. These high-density plywood attachment plates distribute the load transmitted from the landing gear, over as large an area of the spar as is necessary. Not only do they serve to reduce the use of metal but they can be made by woodworkers on woodworking machines, both of which are far more plentiful than the corresponding facilities in the metal field.

Propellers need to be sturdy at the hub, where weight is not objectionable, and light in weight at the tip, where centrifugal forces are serious. Variable-

density plywood meets these requirements and gives to the blade the resiliency of wood and the excellent fatigue characteristics of wood. Propellers so made are extensively used in England. These adaptations of plywood to airplane construction refer specifically to the smaller and lighter planes, including perhaps all types of training ships for military aviators. Experience must be gained in these smaller units, so that changes from metal to plywood in the larger planes may be based on actual demonstrations of serviceability under severe conditions. For the present, many non-stressed parts of the larger planes, such as bomb-bay doors, instrument boards, manhole and handhole rings, covers, doors, floors, and the like, may be safely made of plywood. An ingenious ribbed plywood floor, combining great stiffness with light weight, has recently been patented.

In large seagoing vessels, plywood has established a distinct place for itself in partitions and bulkheads. Crossbands and faces are glued to a lightweight asbestos core, providing fireproofness together with attractive and noncorrodible surfaces. Plywood can also be made with metal faces, or metal inner layers. Curved and rounded partitions can be made of plywood of still different constructions.

MANY smaller vessels, such as destroyers, Coast Guard cutters, and the like, are designed with plywood bulkheads, dividing the boat into many compartments, for safety. Such bulkheads also serve as important strength members in the boat structure. They are lighter and more resistant to the elements than is metal, more free from shrink and swell than is solid wood, and far less prone to cracks and leaks. Plywood sheets up to 80 feet long by eight feet wide have been made for the hulls of such boats and are now in production. Several layers are used on the hull, with staggered joints. For the superstructures on such watercraft, streamline housings of molded plywood are beyond the experimental stage and may soon become standard.

The utility of plywood in boats increases as the size of the boat decreases. For boats 20 feet and under, thousands of hulls have been made by the flexible-bag molding process. Ribs and framework can be substantially reduced and often eliminated. Angling strips can be placed inside to serve as bracing members. Plywood for such boatwork is usually made in two-ply sheets, several layers being used to add up to a total thickness of ½ inch and more. These boats are far lighter and sturdier than those of the conventional construction, and the problems of shrinking and calking are practically eliminated.

Another interesting development is a pontoon molded from veneer and plywood. It weighs far less than sheet metal, so that fewer men can handle the units and truck-carrying capacity is multiplied several-fold. These pontoons are clamped together to support the runways of temporary pontoon bridges. The pontoons nest on the truck bed and require a height of less than one foot per unit. Ramps, or walkways, for use in pontoon bridges are also being made of plywood. Life rafts and towboats are other applications of the material.

Periodic rumors are heard that the supply of black-walnut lumber for gun-stocks is inadequate; in any event, the elapsed time from the green tree to the seasoned blank is unreasonably long. Plywood has been tested and found adequate, and is much more quickly available. Several species of veneer, pressed to the desired density, can be used.

When made of solid lumber, army lockers for soldiers' personal possessions are heavy and likely to develop unsightly and untidy cracks. With metal lockers, moreover, rust, corrosion, and denting become serious problems. Waterproof resin-bonded plywood hence has been used extensively in recent contracts.

Other uses of plywood, common to both civilian and military life, include concrete forms, prefabricated houses for defense workers and for military cantonments, furniture for living quarters and for offices, truck bodies, profiles for shipbuilding, patterns for foundry work, industrial buildings and equipment, partitions, and many other products.

Those who have studied the many problems involved in the intelligent use of plywood are becoming more keenly aware of the fact that it cannot be adequately evaluated and utilized according to the experience and knowledge gained from the use of metals. Wood and plywood have qualities and advantages that frequently are quite different from those of other materials. Certain tasks can be performed better by metal products, others by units made of veneer and plywood. In no sense is one a substitute for the other. The skilful combination of both materials will result in an effectiveness, a suitability, and an economy that cannot be secured by either alone.

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Duplicating Without Dies

Short-Run Production Requirements in Metal Shapes Met by Ingenious Hand-Operated Tools

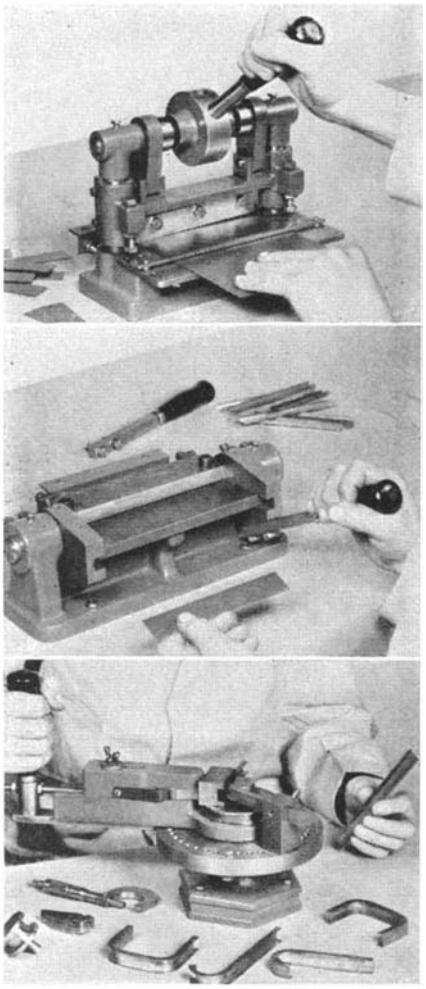
A. P. PECK

A MID-WESTERN manufacturer had closed a contract for 400 medium tanks for the British government. Hence the plant would require 400 each of various types of eyes formed on arms and links for operating engine and turret controls. Also needed would be 400 each of specially shaped angle brackets for panel and dashboard mountings and a variety of other metal forms, each in multiples of 400.

Under ordinary circumstances these production requirements would be filled by means of a series of special forming dies, with consequent loss of time while the dies were being designed and made. Then, when the job was finished, most of the dies would probably be worthless for other purposes, after having been used for only 400 operations. Not only would the time element militate against the use of dies, but the cost would be out of proportion to the results.

Such production problems, not unusual under present-day circumstances, can often be solved by the use of a

Hand operated "production line"



Close-ups of the unit tools shown in the illustration on the opposite page. *Top to bottom:* The shear, the brake, and the bending device. To the left in the bottom picture are shown the two parts which are used for converting the unit for forming either right or left-hand radii with the side members turned out instead of in

series of hand-operated duplicating tools which turn out precision work for short metal runs and for experimental development projects. These tools, known by the name of Di-Acro, include a bench shear, a brake to produce non-stock-size channel and angle forms, and a bending unit which can produce a wide variety of curved and angle forms from any ductile metal, the range of contour bending being limited only by the expansion and contraction limits of the material being formed.

One of our photographs shows a shop "production line" using these hand tools. In the background one operator is shearing stock material to correct size. The worker in the center is using the brake to create the required angle in the sheared material, while the third operator is bending the angle members in right- and left-hand radii as called for by specifications. On the bench in the foreground are a variety of the shapes that can be produced by the bender through simple adjustments of the mechanism—adjustments that can be made by any ordinary apprentice-machinist and do not require the skill of a tool or die maker.

Since these tools are designed to produce duplicate shapes with the same accuracy as can be obtained with blanking or forming dies, it is obvious that the tools themselves must be of precise construction and provided with accurate stops that will make possible working within the ordinary tolerances of die accuracy.

The shear in the "production line" illustrated is designed to meet the requirements for a machine that will fit into industrial operations between the heavy floor-type foot-operated shear and the small thumb-and-finger "tinsmith" shear. By means of adjustable stops it can be set for die duplicating work, for trimming metal stampings, and for working stock size materials. The operator of the shear has close observation of his work at all times; the hand-operated lever provides a sensitive cutting control, yet the stability of the device makes possible accurate light shearing.

The brake device fits into the industrial picture in the same manner as the shear—between the floor-type brake and the hand-operated vise and pinchers. Angle and channel forms can be produced in sizes from $\frac{1}{8}$ inch upward and other types of folds can be accomplished to 110 degrees of radii.

The bending unit is a basic type of machine which will duplicate many varieties of metal pieces throughout a wide range of contour bending. The unit will receive without alteration to its design simple conversions for forming angle, channel, rod, round or square tube, round, square, half-round or flat wire and strip stock (flat or on edge).

As noted before, these units are designed for co-operative application to short metal runs, producing by hand an accurately duplicated run of pieces long before conventional blanking or forming dies could be completed for regular operation. Thus they can be applied either to a complete job, as in the case of the 400 tanks mentioned, or can be used as stop-gaps to fill in between the completion of a design and the completion of forming dies, where the ultimate aim is high-speed mass production. In such a case these hand-operated units will permit actual production to start much earlier than would otherwise be the case.

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TELEPHONE SAVINGS

Reclamation And Substitution For Conservation

A SAVING of more than 5,000,000 pounds of metals vital to defense needs including enough aluminum to build more than 275 fighter planes, or half as many bombers, was effected during 1941 by the Bell Telephone System through a materials substitution program.

In addition to such savings are the reclamation activities which the Bell System has been carrying on since 1931. At Tottenville, on Staten Island, New York, its reclamation unit, the Nassau Smelting and Refining Company, last year supplied the System with more than 42,000,000 pounds of metal, obtained chiefly from non-ferrous metals in outworn equipment, structures, and supplies junked by telephone companies. The amount thus junked in the course of a year totals upwards of 100,000,000 pounds, three-fourths of which is in metals.

How to make the most effective use of materials, particularly of new materials as they become available, has been under study by the Bell System since 1925. Immediately after the outbreak of the present war in 1939, a survey was made of critical materials used in making telephones and telephone equipment, and the determination of suitable substitutes was undertaken. With this advance preparation, the System is now able to make various substitutions in ways that interfere as little as possible with the continuation of first-class service.

The substitution program is made possible by long range planning, research by the Bell Telephone Laboratories, and readjustments in manufacturing by the Western Electric Company, manufacturing arm of the Bell System. These efforts diverted for defense use in 1941 nearly 1,700,000 pounds of aluminum, about a third of a million pounds of nickel, more than 3,000,000 pounds of zinc, and 8300 pounds of magnesium.

An example of substitution is the use of steel instead of aluminum in making the "finger wheels" in dial telephones. In this item alone the Western Electric Company is now saving about 65 tons of aluminum annually. The use of zinc is being materially reduced by coating much of the hardware used on telephone pole lines with lead instead of putting these products through a galvanizing process.

With the need to conserve rubber,

Western Electric planned to be using 20 percent less of this material by the end of 1941, chiefly by using more reclaimed rubber and careful use of materials having similar properties. For some materials research engineers have not yet found working substitutes. For instance, there is no known substitute for the zinc electrode in a dry cell. Other materials in telephone manufacture which are rapidly approaching the critical state are phenol plastic, phenol fiber, and silk.

The telephone companies throughout the country have an important part in the effort to conserve materials. Their engineers point out that protection against raw material shortages is in normal times merely a matter of good "industrial housekeeping." But now such protection is vital to defense itself.

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STEEL—Over half a million tons of steel were bought in 1940 by American housewives through their purchases of refrigerators, kitchen ranges, and washing machines, the American Iron and Steel Institute has estimated.

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ALUMINUM CLAY

New Process Opens Vast Sources of Light Metal

A NEWLY discovered process for the economical manufacture of aluminum from clay instead of bauxite was announced recently by Professor Arthur W. Hixson of the chemical engineering department of Columbia University. It is believed that the process may hold the key to United States independence of foreign sources of bauxite.

Developed at Columbia under the direction of Professor Hixson, assisted by Ralph Miller and Ivan J. Klein, the process consists of digesting selected high-silica clay with hydrochloric acid and decomposing the resultant product to obtain hydrochloric acid and aluminum oxide, or alumina. The aluminum metal is then produced electrolytically in the conventional manner.

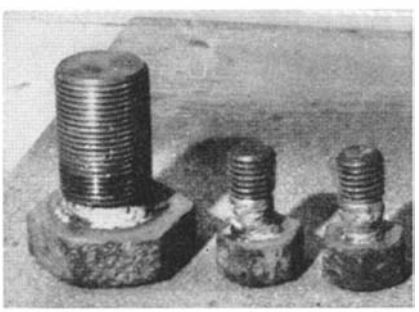
Quoting Dr. Hixson: "All present day processes for the production of aluminum utilize only high-grade ores, which consist of the mineral bauxite. The government's defense requirements for aluminum will soon exhaust the available supplies of bauxite in this country, with the result that the United States will soon depend entirely on imports for this important material.

"The economic feasibility of the new process results primarily from two things: First, the process utilizes a new technique never before employed in the metallurgical field. Secondly, it makes use of recently developed materials of construction and chemicals which are abundantly available because they are by-products of processes operated on very large scales."

BROKEN STUDS

Removed by Unique Use of Welding

A KNOTTY problem often encountered by mechanics and machinists is the broken stud bolt, a problem that has been solved by an unusual application



Extraction rate: about 20 per hour

of welding. After a year's test by welders William F. Kramer and Alex F. Morton, the method was found 20 times as fast as the previous procedure involving drilling.

The new technique involves the use of arc welding. When a series of stud bolts are sheared off in a casting, the welders place nuts in position above the broken studs and center them. In each case the inside diameter of the nut is slightly larger than the outside diameter of the broken stud.

By means of the electric arc, the studs then are built up to the nuts by several layers of weld metal. Then the nuts are welded to the studs.

Where a number of studs have been broken, Morton and Kramer advise welding them all before removing any. This permits the heat from the arc to accumulate in the casting, expanding it and in most cases making removal of the studs as easy as the removal of an ordinary nut from a bolt by a wrench.

RUBBER SAVING

By Common-Sense Practice in Industrial Plants

BY following a few simple rules during the war-time emergency, every industrial plant in America can extend the life of its equipment made of rubber, thereby adding to the nation's supply of this vital product, according to a statement issued by W. H. Cobb, of the United States Rubber Company. Every time a plant saves 13¼ ounces of rubber, for example, another gas mask is made possible.

"Certain general rules can be applied to all goods made of rubber," according to Mr. Cobb. "Among the greatest enemies of natural rubber are oil, grease, and gasoline. These are all very destructive, and rubber products should be kept away from them as completely as possible. The life of a conveyor belt, for example, is often cut short by destructive operations such as unnecessary abrasion, misalignment, uncushioned impact, as well as being subjected to leaking oil conditions.

"Also, rubber goods should be stored in a cool, dry atmosphere and kept from sunlight and high temperatures.

"Never place rubber in enclosed generator rooms or near electric motors. If the air around these contains even a minute quantity of ozone, which is created by these machines, it will have an extremely oxidizing effect on hose, belting, packing, and other mechanical rubber products, aging them to an abnormal degree."

DISPLAY

Of Samples Enhanced by Clear Plastic

TO GIVE greater interest and identity to otherwise uninteresting and easily lost samples, a technique of molding a block of transparent Crystalite around the samples has been developed by the Adolph Beuhler Company. The plastic, which is stated to be 4 percent more transparent than plate glass, protects the products from corrosion or scratching and permits permanent labelling. The plastic is also less than half as heavy as glass and practically unbreakable, which enables it to withstand rough usage on desks and in desk drawers. Only products which will withstand molding pressures and temperatures can be thus imbedded.

Not Mr. Moto — samples in plastic

INDUSTRIAL TRENDS

WAR, WORDS, PAPER

IF RECORDS of the paper industry were taken as the only criterion, it would appear that this war, as was almost every war of history, is being fought with paper rather than with hardware. During times of duress, the paper mills hum 24 hours a day, seven days a week, turning out the material on which words are written, with which goods are wrapped. And their associated plants, the pulp mills, work just as steadily to produce a raw material—sulfite pulp—which can be made into paper, or which may become an important ingredient of the explosives that keep wars going.

But we are more concerned at the moment with the product on which words are printed. For several months, now, there have been uncounted rumors about the condition of the paper industry in general, ranging all the way from complete famine to an equally disastrous surplus. So let's look into the mechanism of the industry and analyze its present status as it casts a shadow of future operations.

Perhaps the best starting point of OPM. From this now dead unit came the estimated demand for paper, during 1942, of 26 million tons of all grades. Present estimates of the paper industry's ability to produce shows a figure of about 21 million tons. Is this bad? Not too much so, particularly from the standpoint of the paper manufacturers. Past performances indicate that, when pushed by necessity, they are able to pull figurative rabbits out of the hat—rabbits that will, with the co-operation of paper consumers, tide things over until more normal times arrive.

There is little need to go deeply into the reasons why wartime brings greater demand for paper and paper products. Pulp, mentioned above, is one of them; increased paper work in government circles, is another; demands on the part of the public for news is still a third. But, again, consideration of this phase of the situation is of little moment here: What is of more immediate interest is why the paper industry is being pushed and what they are doing to meet the demands of wartime.

To gain a more comprehensive picture of the industry, it is needful to survey some of the background. Basis of paper is wood-pulp, except in that relatively small part of the production that uses all or part rag content. Until early 1940, a relatively large part of the pulp used in this country was imported from abroad. Canadian and United States forests furnished the rest. When foreign sources were cut off, there was a fair inventory of pulp available in this country, sufficient to keep up paper production until other pulp sources in the United States and Canada could swing into production.

An over-simplified view of the paper industry shows two main factors: Pulp mills, where the basic wood is converted into a form ready for processing, and the paper mills, where the base pulp is made into various grades of paper. Some companies maintain both mills, integrating the two processes into one "production line" unit. In other cases the pulp is produced by one company and sold to the paper maker. In any event, whether the paper producer controls an integrated unit or is dependent upon an outside pulp supply, the effect of war on his business is very nearly the same.

Technological developments during the score of years since 1921 have placed the paper industry in a somewhat better position to meet increased demands than was the case in prior years. Forests of the southern pine regions and of parts of the Pacific Coast, formerly considered worthless for paper making, have become available as sources of pulp. This has been made possible by refinements in processing the raw material so that the resulting pulp will have the requisite characteristics of color and felting that are necessary to produce paper of standard shades and strengths. With these sources of pulp, and with the increasing attention which is being given to controlled cutting of pulpwood and reforestation of cut-over areas, the paper industry as a whole is in a position to meet a large part of the increased demand for its products. And, along with many other industries, producers of paper are gaining valuable lessons through the present emergency. Because of the better business generated by war-time demands, and the consequent increased profits, and because of the technical progress just mentioned, the paper industry as a whole should be in a position to meet most of the requirements thrust upon it during the days of stress yet to come, and to emerge into post-war days with a minimum of dislocation of either pulp production or the manufacture of the finished product.

(A brief comment on the present paper situation, and upon the co-operation which will be necessary between paper manufacturers and consumers, in order that temporary shortages of paper may be dealt with as they arise, will be found on the editorial page, "Our Point of View."

AFTER THE WAR

WITH all the attention that is being given to war-time production of military and naval needs, it would be short-sighted indeed if industry in general were not giving at least some thought to the course that will be pursued after war clouds pass away and our whole economy must be readjusted to peace-time operations. And regardless of the insistent and necessary cry for all-out production of material of war, conclusion-jumping must not lead to the inference that this thinking-for-the-future is, in one iota, affecting the speed and efficiency with which that all-out production demand is being met. Rather, the two courses, divergent as their ends may be, are supplementing each other, the vision of brighter days to come serving to implement the urge for speed in producing the needs of the moment.

Actually, the two problems involved are identical in almost every respect, and research is the keystone upon which each depends. We must have new, faster, better methods of producing, let us say, tanks. Research in metallurgy and welding shows the way to fabricate these monsters of war without the use of rivets. Result: A better tank, produced more rapidly, and safer for the crew that operates it because there no longer are rivets in the structure that can become lethal missiles when struck on the exterior by projectiles. It is not conceivable that this development is being thought of only in terms of tanks: Other structures, for civilian purposes, will feel the impact of this work in post-war days, if not before.

In every industry a similar process is evolving, sometimes subconsciously, sometimes consciously. Regardless of the mental workings involved, American industry always has had a pretty good memory. When it finds a new way of doing something, it is not long before that way is being adapted, in one form or another, to a variety of uses. Lessons once learned, no matter what the impetus for learning, are rapidly assimilated to the benefit of many.

—*The Editors*

Our Search for the Supernatural

Medium Fails to Appear for Clock-Stopping Test; Dunninger Shows How it Could Have Been Done

A. D. RATHBONE, IV
Secretary, Scientific American Committee for the Investigation of Psychic Phenomena

As STATED in these columns last month, it appears at the moment that most exponents of alleged psychic powers do not desire to try to establish basic, truthful, scientific data concerning their so-called phenomena. The belief that this attitude exists is borne out, we regret to say, by the consistent refusal of Signor Raduano to re-appear before our Committee for further study and test demonstrations of his clock-stopping and table-tilting exploits, performed on the evening of July 21st, 1941, in the presence of our investigating body, guests, and representatives of the press. (September 1941).

As we have repeatedly stated, "demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration." This agreement was followed to the letter in the case of Signor Raduano, who was given absolute freedom to perform whatever feats he deemed pertinent, and he was in no way put to any form of test. However, it is also part of the agreement between our Committee and persons who appear to demonstrate alleged psychic powers that the Committee "reserves all rights to request repetition or duplication of the demonstration or seance under its own conditions, at such time and such place as it may designate, and will undertake to the best of its ability to see that its conditions do not hinder or inconvenience the medium or demonstrator. Failure of the demonstrator to comply with the Committee's request to reproduce or to attempt to reproduce phenomena under the Committee's conditions will nullify any claim the demonstrator may file for the award." (April 1941—Regulation Number 4).

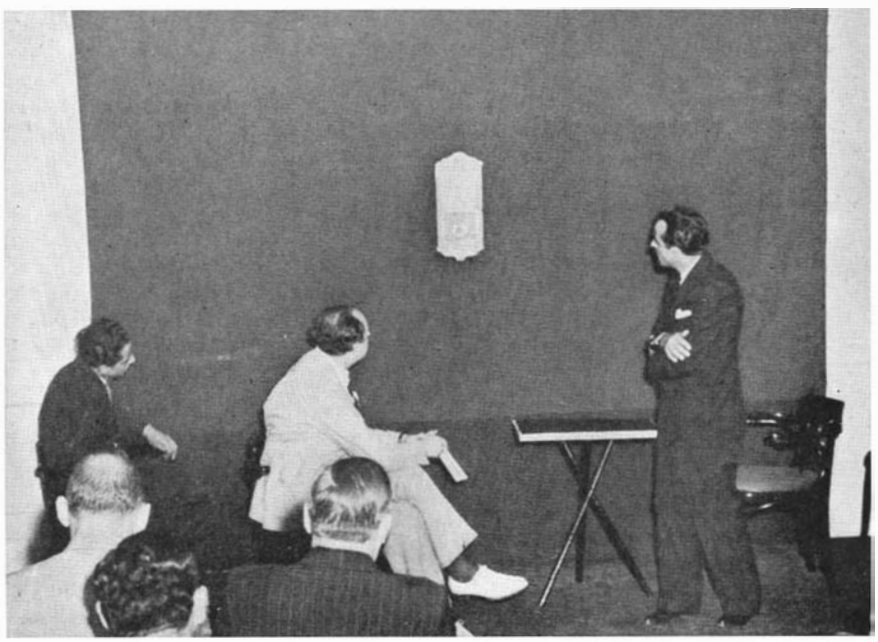
Originally, Signor Raduano agreed to re-appear before the Committee. After his initial and only demonstration, Chairman Dunninger discussed arrangements with the signor and suggested a choice of two forms of simple tests, to both of which Raduano agreed. Notwithstanding his acceptance of both sets of conditions, however, he has consistently delayed his re-appearance, offering various excuses and, more recently, telegrams and special delivery letters have failed to elicit any response whatever.

As stated, the suggested test conditions were elementary. Dunninger proposed: (1) that the identical clock be suspended in a glass case, in full view of witnesses, but completely enclosed so that no mechanical contrivances could possibly be utilized; (2) that the meeting room be divided by a mesh cloth, through which witnesses could discern the clock suspended from the ceiling in the other half of the room. In both plans it was proposed that no one should touch the clock once it had been placed in position for the test, and to these proposals Signor Raduano acquiesced—yet more than six months have elapsed and the agreement has not been carried out.

As the Committee could not render an official report in the absence of test conditions, we have, in deference to the interest shown in our investigation by our readers, requested Chairman Dunninger to draw upon his broad experience as an investigator of the psychic for a possible and plausible explanation of how this particular clock *could* be stopped solely by mechanical means, under the conditions prevailing at the Raduano demonstration. In presenting this explanation, however, it must be remembered that neither Dunninger nor the Committee claims this method was employed by Signor Raduano on the night of July 21st, 1941. Despite this understanding, and unless and until the signor submits to one of the two proposed tests—according to his agreement—Dunninger's explanatory demonstration will be accepted as conclusive and final in this case.

As shown in one of our illustrations, three persons were closer to the clock during the experiments last July than anyone else in the room. Signor Raduano's assistant sat at the left of the clock with his chair not more than a foot or two from the black curtain which had been hung prior to the demonstration at the instigation of the signor. Dunninger sat a little to the left of the timepiece and fully six feet from the curtain. Raduano stood at the right, somewhat closer than Dunninger, but not near enough to touch the clock. The positions of these men are important in expounding this particular theory of modus operandi—particularly that of the assistant, when it is known that the hinges of the clock are on the right-hand side, and that the door, therefore, opens on the side toward the assistant.

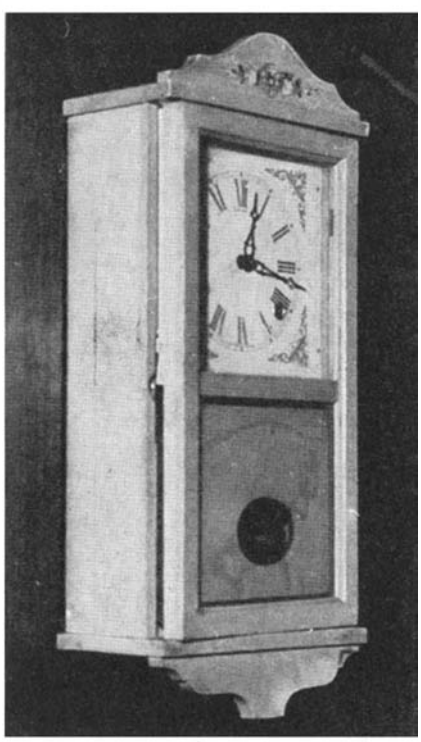
Another pre-eminent factor is that although the clock in its entirety—and also the pendulum weight separately—were each carefully examined by mem-



At Raduano demonstration. The signor's assistant at extreme left, close to the curtain. Dunninger is seated in the center, Raduano stands at the right

bers of the Committee, the clock was taken from the wall and replaced thereon by Raduano's assistant. The pendulum weight, likewise, was both removed and replaced by this assistant, who was the last person to touch either the timepiece or the pendulum prior to both of the demonstration attempts.

It therefore would have been entirely possible, pointed out Dunninger in the course of his own demonstration, for the assistant to have quickly and secretly affixed one end of a black thread to the pendulum weight as he replaced it on its hook. A bit of beeswax, kept plastic by the warmth of the hand, or a tiny piece of ordinary chewing gum, would serve as an adhesive between thread and pendulum. To retain the other end of the thread, allowing slack for the motion of the pendulum, and to leave the clock door open but a fraction of an inch, would be the next move in a routine of this sort. Inasmuch as the door opened on the side where the assistant sat, and inasmuch as the opening would be extremely minute and not



Clock, with door slightly open

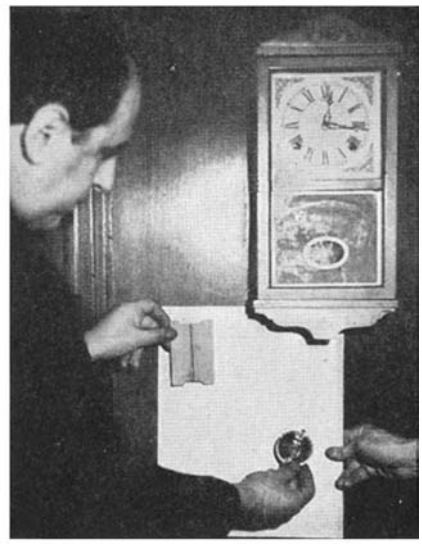
visible to persons sitting directly in front in the audience, it would be a simple matter for him to manipulate the thread, wholly camouflaged by the black curtain background, in order to stop the clock.

It will be recalled that Raduano's first attempt was a failure, which may be accounted for by Dunninger's theory that the adhesive failed to stick, or that perhaps it inadvertently fell from the fingers of the assistant, who could hardly have reached down to pick it up without calling unwanted attention to his strategic position. Anticipating a possible objection to this theory, that if the clock was stopped by this means, the pull on the thread might unfix the bit of adhesive, which would be seen or heard as it fell from the pendulum weight, let it be remembered that (1) the adhesive could not fall *out* of the clock as the door was closed too tightly, although not completely shut, and, (2) the amount of adhesive necessary would be so minute that a drop of an inch or so from the pendulum weight to the bottom of the clock case would scarcely cause an audible sound to people seated a dozen feet away.

FROM his position at the left of the clock and close to the black curtain, it probably was next to impossible for the assistant to tell exactly where the hands of the clock were. If he were commissioned by Raduano to exert a pull on the thread at exactly 4½ minutes to nine (the time chosen by newspaper men present at the demonstration for the first trial), his visual perspective of the clock hands would be greatly to his disadvantage. How, then, would it be possible for him to know precisely when to exert pressure? We quote from our report of the demonstration (September 1941): ". . . the signor turned his back to the audience, stretched out his left hand, fingers open, toward the obstinate, still moving clock." This action took place in the first attempt just as the hands pointed to 4½ minutes to nine, and it was the first time Raduano, had either turned his back to the audience or extended his arms, both of which had been tensely folded across his chest up to that moment.

In the second attempt, the signor stood in the same arm-folded attitude until—"At exactly 23 minutes past nine (the time chosen was 9:24) Signor Raduano's right hand shot forward in a determined gesture toward the face of the clock. . . . His fore-finger pointed; then the second finger joined the first." Within 30 seconds after this gesture the pendulum wavered, slowed down, and finally stopped. Therefore, states Dunninger, might not the arm gesture serve as the signal to the assistant that it is time to pull on the thread?

In his own explanatory demonstration Dunninger used a bit of chewing gum as adhesive. He displayed the pendulum weight to witnesses, and as he replaced it in the clock, which was hung on the wall, he affixed one end of a special type of thread, known as "magician's thread," and used by prestidigitators in producing their illusions, to the weight with the speck of gum. He then started the clock, closed the door save for an almost imperceptible crack



Dunninger displays the pendulum weight and the magician's thread

—visible only from the side—and handed the other end of the thread to this correspondent who had been seated in relatively the same position as Raduano's assistant. The thread, even at close quarters against the wainscotted wall and without benefit of the black curtain, was extremely difficult to see, let alone to follow its course to the slightly open door of the clock. Wrapping the thread around his left little finger, this correspondent laid his left hand on his knee, the same relative position as the assistant's left hand, as shown in our illustration. At a signal from Dunninger, the hand was moved slowly and casually toward the hip, tightening the thread. There was a brief feeling of tension to an almost imperceptible degree; the pendulum slowed down, and the clock stopped.

In conclusion of this month's story, we wish to stress heartily the following statements: The explanation herewith presented is not an official report of our Committee, but rather an explanation requested from our Chairman, Dunninger, of simple mechanical means by which a clock of this type, set up under the conditions described, might be stopped. Neither Chairman Dunninger nor the Committee claims that Raduano used this method, although assuredly it is a feasible one, but until such time as the signor is willing to appear again before the Committee, and in the face of his failure to do so under the above described test conditions—which would certainly preclude use of a thread—we are obliged to accept this theory. However, should Signor Raduano desire to re-appear before the Committee, he will be most welcome.

(The subject of table-tilting as demonstrated by Signor Raduano and as practiced by others, will be dealt with in a future issue.—Editor).

Orbit Sleuthing

How the Astronomer Determines the Size and Shape of a Double Star's Orbit

HENRY NORRIS RUSSELL, Ph.D.

Head 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

FROM the first days of the telescope, astronomers must have noticed that many stars were double. Pairs, some equal and others unequal in brightness, too close to be separated by the naked eye, were clearly resolved by telescopic aid. Rather strangely, no serious attention appears to have been paid to these objects for a century and a half. Finally, about 1780, Herschel began to make measures of double stars—recording the apparent distance and direction of the fainter component from the brighter. His observations were made with the hope of determining the distances of the stars—then wholly unknown. When a bright star showed a faint companion near it, it was assumed that the faint one was much farther away and appeared close to the other only by the accident of its position behind it. If this were the case, the motion of the Earth around the Sun would cause the nearer star to appear to shift back and forth every year, compared to the farther one, just as the frames of a window seem to shift across the landscape beyond as one moves one's head from side to side.

His measures failed to show any perceptible shift of this sort (parallax); but, as years went on, they revealed something far more interesting. In a number of cases the companion star moved steadily around its brighter primary in a curved path. It was not far behind the primary, but was a satellite belonging to it, moving about it in an orbit under the influence of its attraction. The domain of gravitation extended not to the solar system alone, but to the stars. Herschel had made a greater discovery than he had hoped for. He compared himself to "Saul, who went out to seek his father's asses and found a kingdom."

Systematic and intensive study of double stars began with Wilhelm Struve in 1830, and has led to the discovery of more than 20,000 pairs. Knowing the number of stars of a given magnitude in the whole sky, found by actual counting, it is easy to calculate in how many cases two stars of, say, the 6th and 8th magnitudes should be within, say, 10″ of one another, provided they were sprinkled quite at random over the heavens. It is thus found that only a small fraction of the observed number of double stars can be "optical" pairs, due to chance, with one star really far behind the other. The great majority must be "physical" pairs, not much farther apart in space than they look. In a great many cases the physical connection is proved by the fact that the two stars are moving together across the sky with a common proper motion; and there are more than 2500 pairs for which slow orbital motion has been detected. The number for which even tolerably good orbits have been calculated was 166, two years ago (at the time of an extended study by the writer), and is probably about 170 today.

WHY should this difference be so great? The obvious answer is that most double stars move so slowly that they have not had time to go around their orbits, or to complete any considerable fraction of a revolution, in the short interval of 112 years for which there are reliable observations. Unless our observations cover a considerable fraction of the whole circumference of the orbit, we can get no reliable results. This may seem strange, when, in the case of a planet, such as Pluto, a good determination of the orbit can be made from observations extending over only a few percent of the period.

The main reason for the difference is that the observations of a planet are of an enormously higher percentage of accuracy. It is easy to observe the position of an asteroid in the heavens to a second of arc, that is, to less than a millionth part of the circumference of the celestial sphere. By the time it has advanced one tenth of the way around its orbit, the observations determine the angle through which it has moved to better than one part in 100,000. With data of this precision, refined analytical methods may be employed, which, despite the complications arising from the fact that we observe the planet from the moving Earth, lead us to our goal. But the percentage of precision of the observations of a double star is low. Most of the rapidly moving pairs can be separated only with powerful telescopes, and never appear as much as 1″ apart. An accuracy of about 5 percent in the measures of distance, and a corresponding uncertainty in the "angle of position," is all that can be expected from even good observations.

Now the real orbit is an ellipse, with the bright star at one focus. It is not at all likely to be seen squarely, "in plan"; its plane is almost always tilted at an angle to our line of sight, so that we observe a foreshortened orbit—still elliptical in form, but with the star not at the focus. Occasionally we see the orbit edgewise, and the smaller star appears to oscillate from one side to the other of its primary along a straight line.

TO FIND the size and shape of the real orbit from the foreshortened projection of it which we observe, is a purely mathematical problem, which has been solved in more than a dozen different ways—all correct, but some quicker and more convenient for the calculator than others. To work this through takes but a few hours.

But to draw the apparent ellipse from which the calculations start is much more difficult. If we had observations covering a whole period, and fixing points all round the orbit, even with low accuracy, it would be easy enough to draw an ellipse to represent them; but astronomers, being human, are impatient, and do not like to wait for decades, or perhaps centuries, until this has happened. They naturally want to determine the orbit from as small an arc of the whole ellipse as possible and here the errors of observation become troublesome.

For motion along a straight line, things would not be so bad. Given a number of observations—represented by the dots in *A*, Figure 1—not only the position of the mid-point of the line, but its direction are determined with fair accuracy. But if, as in *B*, we have to represent these points by a circle which passes as close to them as possible, our results are far less accurate. The mid-point of the observed arc, and the direction of the tangent there, can be determined nearly as well as in the case of the line. But the radius of the circle, or, what is equivalent, its

curvature away from the tangent, is badly determined. The observed arc is but a small part of the whole circle, and an arc of a circle of considerably larger or smaller radius can be drawn so that within this small range, it deviates from the first circle by less than the errors of the observations. Even a straight line would give a fairly good-looking, though not a satisfactory, fit.

For an ellipse the case is much worse, for its complete specification depends on five quantities (instead of three for the circle), and it is possible to draw great numbers of ellipses, very different in form and size, which all lie so close to the circular arc that they could hardly be distinguished from it within the small observed region. This is illustrated in *C* (copied from one of the beautiful diagrams in Burnham's "General Catalogue of Double Stars"). The circular apparent orbit, which gives a period of 300 years, and the ellipse with a period of 130 years, represent the observations from 1830 to 1900 equally well. Later observations show that the companion has been moving a little outside the smaller ellipse, and that the period is about 150 years. The law of areas holds true in the apparent orbit; hence the period corresponding to any ellipse can be found by comparing its total area with the area swept out by the line joining the stars in a known time.

WITH ordinarily good observations, such as are shown in *C*, it is rarely possible to fill in the remaining portion of the apparent ellipse with any assurance until the observations cover about half its circumference. With more accurate observations, a shorter arc should suffice.

The most precise method of measuring the relative positions of the stars is by photography; but photographing double stars is peculiarly difficult. To begin with, the image of a star on even the best plates is very much larger than the optical diffraction image in the focal plane. This happens partly because the photographic action spreads on the plate, partly because, even with the steadiest air, the star-images dance about a little. The visual observer can take advantage of the best moments when the images are sharp; on the plate, the good and bad moments combine to produce a smeared-out image. Close doubles therefore are the exclusive province of the visual observer. Somewhat wider ones show on photographs as elongated images, unsuited for measurement. Even when the two stars are just separated upon the plate, there is trouble. The photographic effects on the inner edge of the two images may overlap, bringing them too close together. On the other hand, the developer may be partially exhausted in this region of the plate, and act more strongly on the outer edges of the images—which makes their apparent centers too far apart.

Practical experience has shown that these effects spoil the accuracy of the photographs, unless the images are approximately $\frac{1}{5}$ of a millimeter apart. With a focal length of 10 meters—a big telescope—this corresponds to 3″.5. Pairs as wide as this have usually been observed with small telescopes, as observers who have larger ones naturally work on the close pairs which the small instruments cannot separate; but this is no longer the case.

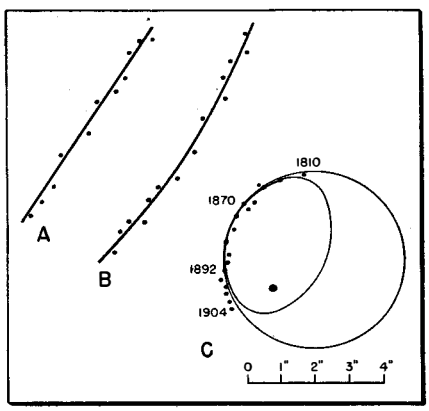


***Figure 1:* Working principles**

THE FIRST serious photographic measures of double stars were made in 1914 by Hertzsprung and showed at once that a previously unprecedented accuracy was within reach. Fifty or a hundred exposures can be taken on a single plate, so that the random errors are greatly reduced in the mean. Difficulties due to atmospheric dispersion—which raises the apparent altitude of blue stars more than red ones—can be eliminated, and the sharpness of the images improved, by photographing through a yellow screen, which transmits only a narrow range of the spectrum. If the components are of unequal brightness, the images of one will be under-exposed, or of the other over-exposed, with serious loss of accuracy. This is avoided by placing in front of the objective a coarse grating, consisting of narrow metal bars, equally spaced. Observed through this each star image is flanked by fainter ones on each side (actually very short spectra) whose mid-point coincides exactly with that of the over-exposed central image. The difference of brightness between these and the central image depends on the ratio of the width of the bars to that of the spaces between them. With three or four suitably designed gratings, it is always possible to pick one such that the brightness of the lateral images of the bright star is nearly equal to that of the companion. Accurate measures can then be made with only a little extra work.

Hertzsprung's work has been continued, first in Holland and then in this country, by his pupil, Dr. K. Strand, who has specialized upon bright, slow moving, binary stars. For such pairs, the photographs give positions whose errors are hardly more than a tenth of those of the old visual measures.

Observations of this sort, continued over a decade or two, fix the position of the corresponding portion of the orbit so accurately that there is far less latitude left in drawing the ellipse, even though the observations cover but a small part of it.

DR. STRAND has in this way determined reliable orbits of a number of well-known, but slowly-moving pairs, for example Eta Cassiopeiae (period 526 years) and Castor (period 380 years). He has just reported success in what has previously been regarded as a hopeless case—61 Cygni.

This is the first star whose distance was measured—by Bessel in 1838—and still ranks as one of our nearest neighbors. The relative motion of the pair has been carefully followed for the past 110 years, but shows so slight a curvature that no one has been bold enough to extend the observed arc into the whole ellipse.

Modern photographic observations from 1914 to 1941 have been supplemented by measures on photographs taken by Rutherfurd in New York between 1871 and 1874.

Utilizing these, and a great mass of visual measures, Dr. Strand finds a period of 720 years, and a mean separation, after allowance for foreshortening, of 24″.64—the largest yet found for any double star orbit. The real separation corresponding to this is 84 astronomical units, and the combined mass of the two stars 1.16 times the Sun's—which is what might be expected, as they are red dwarfs, much fainter than the Sun.

The system is approaching the Sun at 63 kilometers per second, and after 720 years its distance will have diminished by one part in 75. Hence, when the astronomers of the future observe it in the same part of its orbit, the companion will not appear to follow exactly the same track, but one 0″.3 farther from the center. Followed through further centuries, it will appear to move in a slowly expanding spiral, till, at long last, the star reaches the point on its track nearest the Sun.

Fidgety Atoms Purify Water

Ozone Treatment of Community Supplies Has Proved Efficient in Practical Applications

R. G. SKERRETT

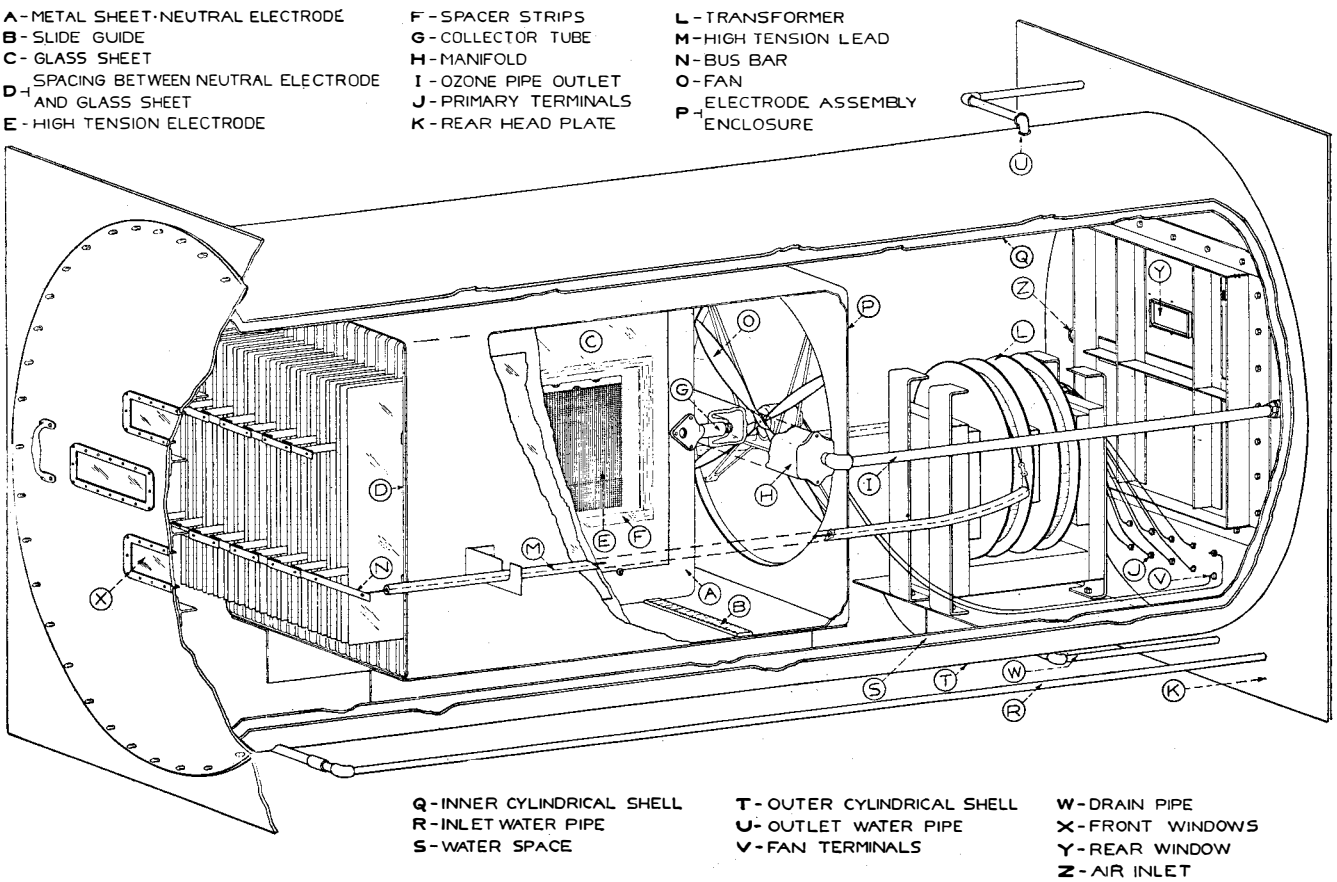
OZONE, today, has attained both industrial and technical significance, thanks to the joint labors of electrical and mechanical engineers. As a result of these collaborative efforts ozone, among other applications, is now making it possible to transform unpalatable water into a hygienically suitable liquid that is completely acceptable to discriminating tastes—a matter of vital interest to a steadily increasing percentage of the nation's population. As the sizes of communities grow and existing water supplies diminish relatively, the problem of pure water and plenty of it is becoming more pressing year by year. To offset deficiency, water must be sought from sources that may be polluted—and the responsible sanitary engineers have to resort to treatments, chemical and otherwise, to remove the impurities. Because of the percentages of chemicals used, such water, when delivered to the householder, for example, may have a decidedly unpleasant taste. Here it is that ozone now comes into the picture.

Perhaps what ozone can do can best be understood by describing how it has helped in two cases. Denver, Pennsylvania, a community of 2100 people, for many years relied upon spring water to meet its needs. Then, increased consumption necessitated the damming of a nearby creek and running that occasionally turbid water through a sand-filtering plant having a daily capacity of 300,000 gallons. During a drought in 1939 the lowered water of the creek developed disagreeable odors and tastes that persisted after the water had been filtered and sterilized by chlorination. The citizens of Denver complained loudly: to provide corrective measures, ozonation equipment was installed. The plant has a rated capacity of five pounds of ozone daily; and, small as that may seem in comparison with 300,000 gallons of water per diem, the effectiveness of the ozone was equal to the situation, and the water was found entirely satisfactory to Denver's people.

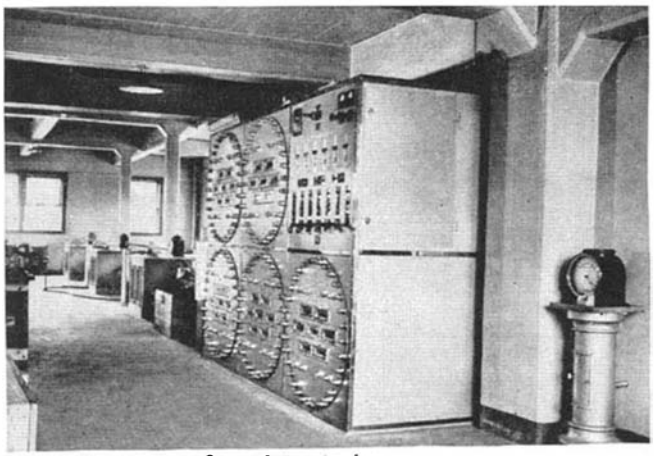
Whiting, Indiana, put the ozone treatment to a still more difficult test. Whiting is a city of 11,000 people that draws its water supply from Lake Michigan in an artificially created basin flanked by two steel bulkheads jutting out from the shore line and spaced several miles apart. Into that partially enclosed water area is discharged most of the waste of 150 industrial plants.

POLLUTION is further increased by the sanitary sewage of 250,000 people living in the neighboring region, through which flows the Calumet River. Raw water for Whiting enters an intake about 1400 feet offshore, and, prior to 1939, this lake water was filtered and treated chemically to make it safe for use. But when it reached the consumer, it had objectionable odors and an oily, tarry, and phenolic taste. Something had to be done, and the local authorities decided to try ozone.

A pilot ozone plant was installed and for more than a year was run success-



Cutaway drawing of an ozonator — ozone generator for water purification



Illustrations courtesy Ozone Processes, Inc.

***Left:* Five ozonators and control panel. *Right:* Upper sections of two ozonizers**

fully under the varying seasonal conditions and consumption demands, which ranged daily from 2,000,000 to 4,000,000 gallons of raw water, first passed through a filtration plant. Before the test was started, the established treatment of the water followed these stages: aeration; preammoniation, just before prechlorination; prechlorination; coagulation with alum; mixing in a baffle tank; sedimentation in two large tanks; rapid sand-filtration in six gravity filters, and then, when needed, final chlorination—this last chlorine treatment imparting to the water its particular added measure of taste and odor. Because of the effectiveness of the ozone pilot plant, the city contracted for ozone-generating equipment consisting of five units, each having a rated capacity of 10 pounds of ozone a day, although actually able to produce 16.5 pounds every 24 hours.

Previously, at Whiting, chlorine was applied at two stages in the purification process in order to combat the normally heavy initial pollutions of the raw water and to assure proper sterilization before turning the water into the city mains. The ozone plant was primarily added to eliminate bad tastes and odors but, in the end, some of the ozone was used as a sterilizer, and so brought about a very substantial reduction in the use of chlorine, alum, and ammonia. The changes effected have been summed up: "The days of consumer complaints and the extensive use of bottled spring water were ended. For now, Whiting, despite the well-nigh impossible conditions governing its supply, had an acceptable and safe drinking water."

Normal oxygen and ozone—which is born of oxygen—differ in their make-up. The oxygen of the free air is represented by the symbol O_2—the numeral indicating that the molecule of oxygen is a union of two atoms of oxygen—while the symbol of ozone, O_3, indicates that a molecule of ozone is made up of three atoms. This third atom in ozone is not strongly attached to the two other atoms, and, with suitable provocation, will break away from the combination and hungrily attack any nearby oxidizable substance. The main difference between oxygen and ozone in oxidization is that ozone is far and away the more active agency. Due to this vigorous oxidizing action, ozone is a powerful germicide, peculiarly valuable in rendering tainted water fit for human consumption. This is not a new discovery: Europe has led us for the better part of half a century in this use of ozone, but its application to water purification on a large scale is decidedly recent in this country.

Ordinarily, in purifying water by any of the commonly employed methods, oxidation is one of the stages of treatment; sterilization and precipitation of suspended organic matter are brought about by the use of chlorine to deal with bacteria, and the employment of alum to induce precipitation. Chlorine, because of the quantity necessarily used, leaves an after-taste that is objectionable to the domestic user. However, ozone is able to destroy disease-causing bacteria as well as to rid water of offensive odor and unpalatable taste. That fidgety third atom, which characterizes a molecule of ozone when it breaks away from its two associate atoms and becomes a "free agent," does its good work rapidly in attacking oxidizable matter and then disappears without leaving any trace of itself behind.

Ozone is today generated by the most improved process in an ozonator to which compressed air is delivered in a prescribed condition of cleanliness and dryness. The air is passed through a silent blue corona discharge which is induced between electrodes on the opposite sides of a dielectric plate operating at from 8000 to 16,000 volts. Just what happens to the air so exposed to the discharge is not fully understood, but that need not concern us at this time. An accompanying diagram reveals the essential features of an up-to-date ozonator: the air that issues from it carries about 0.5 percent ozone. Still under some of its initial pressure, the ozonized air is then piped to an ozonizer to meet the filtered water that is to be treated.

The ozonizer, shown in one of the photographs, and not to be confused with the ozonator in the diagram, is an upright cylindrical tank into which water enters at the top, and in dropping meets the rising ozonized air which is discharged from nozzles near the bottom of the cylinder. Power-driven paddles, placed midway in the contrary courses of the water and the ozonized air, induce thorough mixing of the fluid and the gas, and the treated water is drawn off from the bottom of the tank. That water, according to given conditions, may undergo further treatment before being turned into the distributing system of the local community, or it may be led directly into the mains.

At the present time, the city of Philadelphia is operating a pilot test plant at its Lower Roxborough filter station to ascertain how far ozone may be depended upon to "sweeten" raw water drawn from the Schuylkill River which, because of industrial wastes, has an objectionable chlorophenol taste when distributed to users. Actual performance figures cannot be disclosed at this time, but ozone will probably be found the means of bringing about the desired betterment, for the conditions at Philadelphia appear to be easier to master than those that prevailed at Whiting before ozone was tried and proved to be a satisfactory hygienic agent in that city.

Excavating for Meteorites

One Large and Two Small Craters Made by Violent Impact are Under Geologic Exploration in Texas

EXCAVATIONS at the site of three meteorite craters, a large one and two small ones, nine miles southwest of Odessa, Texas, recently have attracted geologists and tourists to the sand-hill dotted prairies in the western part of the state.

Discovery of two new craters adjacent to the giant pit, which has been under exploration for two years by field crews from the University of Texas with the assistance of the Work Projects Administration, has heightened interest in the study of the phenomenon.

All three meteorites are believed to have crashed to the earth about 40,000 years ago, their terrific speed resulting in a concussion far more than comparable with that caused by the bombs of modern warfare.

The main crater, second largest in the United States, has been studied and explored since 1939. It is about 500 feet in diameter at the level of the earth's surface and 50 feet deep. The meteorite itself, according to Dr. E. H. Sellards, director of the University of Texas's Bureau of Economic Geology, who is in charge of the project, has been determined to be about 164 feet below the bottom of the crater.

One of the newly discovered craters is 70 feet in diameter and about 17 feet deep, and contains as many as "six to seven thousand meteorites with a total weight of about six tons," Dr. Sellards estimates. He believes that the crater was caused by the smashing into the earth of a closely packed swarm of small meteorites, rather than by a single mass breaking into thousands of pieces as it struck.

The other pit is similar in formation but smaller. The two new craters were discovered last Autumn, hence there has been no time to make an exhaustive study.

Under the direction of Dr. Sellards and Glen Evans, assistant, 35 exploratory drill holes have been put down in and near the main crater. Observations have also been made from additional trenches cut at the sides, and from core drilling.

An elevator shaft is being sunk in the center of the crater. When it is completed, visitors will have an opportunity actually to see the meteorite fragments. Present plans are to maintain the site as an educational exhibit open to the public, when excavations are completed.

From their observations of the main crater, Dr. Sellards and Mr. Evans have determined that rock from as deep as 70 feet below the surface was thrown out by the impact of the meteorites. Also, that all rock strata in and immediately around the crater were moved from their original position, and that rock strata forming the crater walls were lifted, broken, folded, and faulted. "On the surface, the rock debris is chiefly blocks of limestone, often covered and cemented together by caliche," they state in their report on the progress of the investigation. "Pits and trenches cut outward from the rim show that large blocks of shales are included with the limestones. Search among the rock debris enables one to recognize rocks coming from various parts of the geologic section of this locality down to a depth of about 70 feet. The largest of the limestone blocks are three or four feet across. Some of the shale masses are of equal size and larger. Many of the limestone boulders have disintegrated, and the shale persists only when protected by overlying debris. At some places a secondary accumulation of caliche cements the ejected rock, indicating considerable length of time since the crater was formed and the rock thrown out. The maximum thickness of the debris around the rim is now 10 or 12 feet. It was doubtless thicker when the crater was first formed.

"At the present time the crater is filled within five or six feet of the level of the surrounding plain. The latest fill consists of fine, red, incoherent silt with some fine sand. The stratum is lens-shaped, having a thickness of 25 to 30 feet at the center and thinning out to the margins. Some of the sediments are of a degree of fineness such as to indicate that they probably settled from the atmosphere slowly, while the others are coarser and were probably wind-blown. This stratum of silt and wind-blown sand, with few pebbles and little or no caliche, readily separated throughout the entire crater from the older, more consolidated and more or less calichified underlying sediments.

"NEXT underlying the silt is a stratum, lighter in color, which consists in part of silt with which is included pebbles and pieces of rock washed in from the rim of the crater. Caliche has formed in this stratum, resulting in partial cementation. In the central part of the crater this material is 45 to 50 feet thick. The definite line of separation between this and the overlying stratum, together with the difference in texture and origin, suggest that an appreciable time interval separates them.

"Some of the rock thrown out by the meteor fell back into the crater. In the

Sectioning excavation of the small crater near the main one

central part of the crater this stratum of fragmental rock at the bottom of the crater is 10 or 15 feet thick and is readily distinguishable from finer materials above and below."

Immediately below the fragmental rock, they say, is a stratum of rock flour. "In this zone the sand grains were completely shattered by the meteor so that, when rubbed, they remain only as a coating on the hand," the report states, "The rock flour is thickest near but somewhat northeast of the center of the crater. From its place of maximum thickness it thins in all directions, forming a lens lying within and not extending to the margins of the crater."

The conclusion reached by Sellards and Evans is that the rock flour is shattered limestone, and that the impact which shattered the sand grains may have originated from the vibration waves.

The land elevation at the crater is near 3050 feet. The greatest depth at which rock flour was found by drilling is at an elevation of 2946.9 feet, or about 103 feet from the plain's surface. The meteorite encountered in drilling lies at an elevation of 2880 feet, or approximately 67 feet below the lowest known rock flour and about 170 feet from the original surface.

Placing plaster around one of the meteorites to remove it safely

A magnetometer survey, verified by drilling, indicates that the principal meteorite masses lie very nearly under the center of the crater.

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WEED KILLER

For Lawns, Does Not Injure Grass

A CHEMICAL weed killer which does not permanently injure grass, yet is claimed to rid lawns of practically all common weeds, is applied in liquid form by spraying it over the surface of the lawn. Exhaustive field tests of this material, known as Lawn Sinox, have been conducted in co-operation with agricultural colleges and experimental stations.

After a lawn has been sprayed according to directions, a temporary browning of the lawn grasses will be noticed. This condition exists for from several days to two weeks but the lawn grasses will fully recover while the weeds will not.

BATTLING BATS

Bright Lights Solve a University's Problem

FOR more than 25 years, bats have been a problem in the buildings now occupied by St. Mary's University, San Antonio, Texas. They infested the attics, or worked themselves into the very narrow space between the metal roof and the sheeting, or attached themselves behind rain-spouts, or even entered below the window sills and behind the window frames. Efforts have been made periodically to get rid of them, with little success. But the problem has finally been solved, quite simply, by making use of bright lights.

Efforts made at St. Mary's to dislodge the bats, without injuring or killing them, yet to keep them away permanently, fall roughly into four classes, according to a recent communication from W. R. Lamm, S.M.

Disturbing the bats during the day and keeping them moving was only partially effective. Soaking the bat lodging places with kerosene or creosote or pressing lime into them was effective for only a short time. Noises of various types—bells, buzzers, whistles, supersonics, radio, and the like were partially effective; the bats left for a while but came back again. Furthermore, the noise was as annoying to human beings as to bats.

The fourth method solved the problem. Bats don't like light. They roost in dark places and leave the roosts at night, returning at dawn. Hence bright lights were placed at the opening where the bats entered and left the building and these lights were turned on in the morning when the bats were returning. Within a few days all the bats were gone and did not return. Should they do so, the lights will simply be turned on again and will be kept burning for about 45 minutes every morning and evening. The method is effective, simple, inexpensive, safe, and not bothersome to the human beings in the buildings.

LO, THE SWOOSE

Or you Might Call it the Gwan

THE SWOOSE, a hybrid between swan and goose, was one of a strange Noah's Ark of cross-bred fowl recently paraded before an audience of geneticists by Dr. Charles W. Knox and Dr. Joseph P. Quinn of the United States Department of Agriculture. Another was a hybrid of guinea-hen and ordinary barnyard fowl, which you may call guin-hen, or guiowl, or guicken, as best suits your fancy, says *Science Service*.

The swoose is a very peculiar-looking bird, Dr. Knox stated, intermediate between goose and swan in size and shape, but with the swan's long neck. Sweese (presumably that's the proper plural) have been produced several times in the past. The first one on record was described by the famous French naturalist Cuvier, in 1808, and there have been a half-dozen scientifically authenticated sweese since that time.

Since they are incapable of normally rapid reproduction, the hybrid birds have no economic future, and are of interest mainly as scientific curiosities. This is a pity, at least as regards the guinea-hen-chicken hybrid, because most specimens are much bigger than either of the parent stocks—sometimes twice the weight of the heaviest parent.

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LEG BANDS: Metal substitutes have even reached the chicken farm. Leg bands, identifying markers used by poultrymen and formerly made of aluminum, are now being fabricated of various plastics or of soft metal composition.

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FUSE-CHANGING

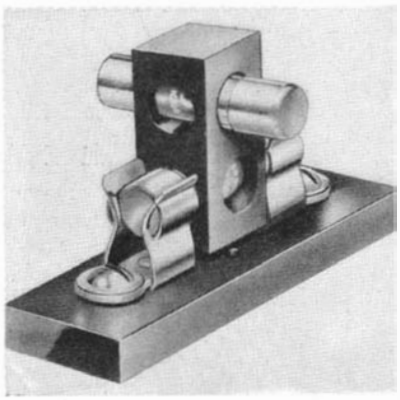
Made Convenient With New Holder

ENTIRELY new convenience for changing fuses in close quarters—replacing a blown fuse in a twinkling and giving notice on inspection that another spare is required—are features embodied in a spare fuse holder and puller combined, just announced by Littelfuse, Incorporated.

The fuse in circuit goes through one end of the soft rubber rectangular holder, between the clips. Above, and

at right angles, is an opening in the holder for the spare fuse. When inserted, the caps of the spare fuse project beyond the holder, affording an easy grip for two fingers.

When the fuse in circuit blows, all the operator has to do is to pull and reverse the Littelfuse holder. This puts the spare fuse in circuit and brings the blown fuse on top in the same position



The spare is right there

that the spare was in before. One end of the holder is painted red. Until a fuse change is necessary, the red end is underneath, out of sight. When a reverse is made, putting the spare fuse in circuit, the red end is brought into full view on top. To an inspector or service man this red signal indicates that a fuse has blown and that another spare is required.

SLIDE RULE

Adds, Subtracts, And Converts Decimals

An aid to making and checking calculations for mechanical drawings, laying out machine-shop jobs, making patterns, and so on, is to be found in a new calculating device, known as the Sum-Up Slide Rule. Unlike the usual slide-rule which multiplies and divides, this new device adds, subtracts, and converts decimals of an inch, fractions, and millimeters interchangeably.

MILEAGE

Determined For Average Stock Car

A new car is a new car, if you can get one, but—breathes there a motorist with curiosity so dead who hasn't wondered how much mileage was left in the old one?

In a four-month road test on a fleet of 1940 stock cars, oil company researchers found the answer—mileage up to 112,000 miles—and still going strong. During the test period in which the cars were driven night and day at an average speed of 50 miles per hour over a 171-mile Florida course, top speed was two miles less than when the cars were new and mileage per gallon of gasoline was better! No carbon was cleaned throughout the test.

At 10,000 miles the fleet made 18.5 miles per gallon on an average; at 75,000 miles 19.1, and at 100,000 miles it was 18.9. Gasoline economy increased as driving speed increased up to about 20 miles per hour, and then fell off. In 10,000 miles of driving the anti-knock requirement increased from 64 to 73 octane and at 50,000 miles it leveled out to about 75 octane. With suitable fuel, lubrication, and servicing the cars maintained throughout at least 100,000 miles what is—for all practical purposes—new-car acceleration time.

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HEAT LOSS—Approximately 50 percent of loss of heat in a home is due to air infiltration through the walls. Plywood panels 5/16 of an inch thick have about twice the insulation value of ½-inch plaster on lath.

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CURIOSITIES

Of the Laboratory Meet Commercial Demands

Two new industrial chemicals—sulfamic acid and ammonium sulfamate—costly laboratory curiosities only three years ago with few known practical uses, are now in tonnage production at du Pont's recently completed Grasselli, New Jersey, plant. Formerly produced on pilot plant scale, sulfamic acid and ammonium sulfamate proved themselves valuable in many industrial processes. An interesting application of the latter chemical has been in its wide adoption as a fire retardant in textiles, insulation products, and paper. While flammable material treated with ammonium sulfamate will char upon contact with flame, it will not blaze. Thus the treated material will not support fire.

Clothing, curtains, and draperies are being "flame-proofed" with ammonium sulfamate by many laundries and dry-cleaning houses, while workers' uniforms in plants where fire-hazard is high are being protected on an increasing scale, the manufacturers point out.

Ammonium sulfamate, though harmless to humans, has proved itself effective in killing weed pests such as poison ivy, ragweed, and thistle, without injuring the soil.

Sulfamic acid is valuable in leather tanning, for nitrite removal in the manufacture of dyes and color lakes, and also as a laboratory reagent.

Chemists explain that sulfamic acid utilized in the bating, pickling, and tanning processes of leather results in a silkier and tighter grain. This white crystalline solid is odorless, highly soluble in water, non-volatile, and non-hygroscopic.

CLEAR WATER

At All Times, In Metal Containers

By adding a small quantity of a harmless chemical to water that must be kept in metal storage tanks, all formation of rust and corrosion is prevented; when the water is withdrawn from such tanks, it comes out just as clear as it goes in.

The chemical used for this purpose is commercially available under the trade name Aqua-Clear. In the case of old and rusty tanks, a few treatments will clean out the old rust and the water will flow clear as long as the film deposited on the tank interior by the chemical is maintained.

Use of this clear, tasteless, harmless liquid is advocated for drinking water tanks in boats, in hot-water heating systems to prevent rust and corrosion in the pipes and radiators, and in automobile cooling systems.

PROJECTED WRITING

For Use by Teachers and Lecturers

A class room lecture desk which allows one to write on cellophane stretched over a plano-convex lens on the desk top and have his writings projected onto a large screen on the front of the desk, may change future methods of visual education.

Invented by David Katz of Wil-

"Scriptoscope"

mington, Delaware, this desk, called the "Scriptoscope," enables a teacher or lecturer to illustrate his discourses without turning his face from the audience. Sitting at his desk, he draws his sketches or diagrams with a wax pencil on rolls of cellophane stretched across a 10-inch lens.

A beam of light from above the desk is directed through the plano-convex lens; a system of lenses and mirrors intercepts this beam and projects it on the screen.

The screen, about 24 by 30 inches, may be built above or below the desk top. It may be used in a well illuminated room or in daylight, provided it is shielded from direct rays of the sun.

The rolls of cellophane give a permanent record of a lecture, and may be used for reviewing without again rewriting all the material. Pre-fabricated diagrams and sketches, especially complex ones, may be drawn before a lecture and slipped under the cellophane; and the lecturer may write what he wants on the cellophane without spoiling the diagram.

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INSECTS—Damage caused by insects may be conservatively reckoned at two billion dollars annually in the United States.

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GEMS

The American Indian Was a Gem Collector

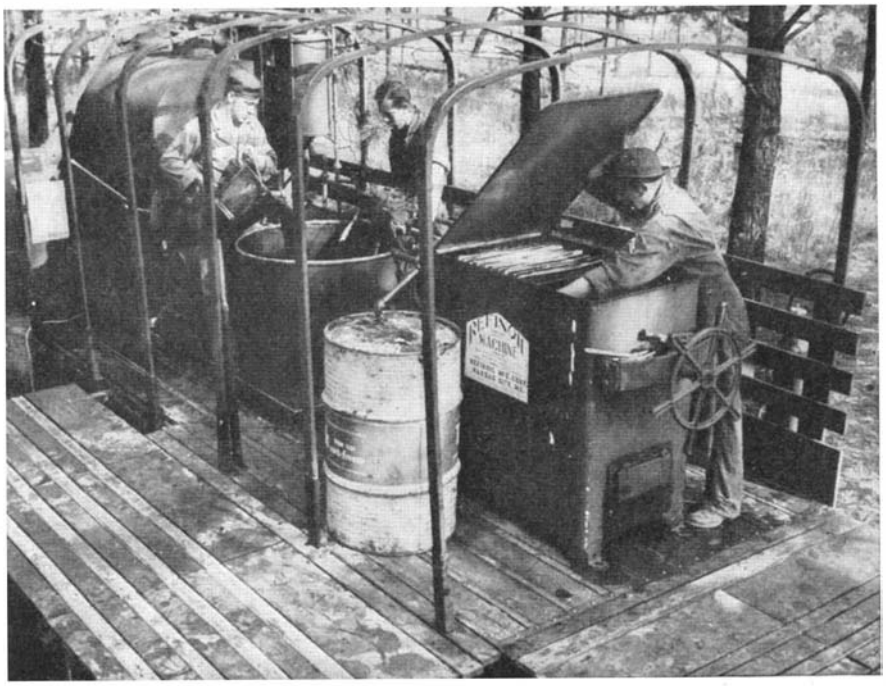
SOME of the fanciful accounts of Indian wealth in jewels which excited the cupidity of Europeans had a basis in fact, according to a study of Indian mining by Sydney H. Ball, published by the Bureau of American Ethnology of the Smithsonian Institution.

He made use, Mr. Ball finds, of at least 84 kinds of gems and artificial stones and his acquaintance with minerals suitable for decorative purposes exceeded in number that of the peoples of Europe and Asia at the time of the discovery of America. The Indian also was the first to use platinum.

Like most primitive peoples the Indian saw in gems and decorative stones not only beauty but the supernatural and awe-inspiring. Among the pre-Columbian aborigines of Ecuador a large emerald was worshipped, and rock crystal and jasper appear to have served the same purposes among certain Peruvian tribes until they were forced to adopt Inca sun worship.

Diamonds, according to one account, were used by a tribe of Brazilian Indians as playthings for their children. Emeralds were used ornamentally in Colombia, Venezuela, Ecuador, Bolivia, Peru, and Panama. The Colombian emerald mines had been worked for a long time before the Spaniards conquered the country. The mining season was inaugurated with religious ceremonies and only certain persons were permitted to dig for the gems.

Eskimos believe that quartz formations are ice so solidly frozen that it has become stone.



Makes old oils and greases better than new for the Army

USED OIL

From Crankcases Reclaimed In Mobile Unit

A MOBILE oil refinery designed to purify used crankcase oil from more than 3000 military vehicles per month received its first test under maneuver conditions in South Carolina. Capable of refining approximately 200 gallons of used oil per day, the unit turns out a product which Army experts consider as good as, or superior to, the original oil. Impurities, such as water, gasoline, and grime, are removed during the process.

The used oil is dumped into a 100-gallon vat where it is mixed by an electrical mixer with Fuller's earth, a compound which absorbs the impurities. The mixture is then drawn by vacuum into a retort tank where it is heated to a temperature of 650 degrees. Gasoline, water, and other liquid impurities vaporize under this heat and are drawn off, also by vacuum, into a condenser tank where they are returned to a liquid state. The liquified impurities are then removed into a dilution tank. The oil, still at 650 degrees, is run through 50 feet of coils to cool, and then back into a tank. After the mixture has been cooled down to about 325 degrees, it goes into a cylinder where presses separate the Fuller's earth from the newly-refined oil. The viscosity of the oil depends, mainly, on the original product, but operators of the mobile refinery reveal that tests have shown the average weight to be around S.A.E. 30.

At present, the refinery accepts all oil and grease waste, including used crankcase oil, transmission grease, and other oil derivatives. The loss during refining is estimated at about 10 percent but operators believe that, given only crankcase oil drawn from vehicles, the loss in bulk would not exceed 5 percent.

The refinery carries its own generator mounted on a trailer, but the mechanism is designed to operate on either A.C. or D.C.

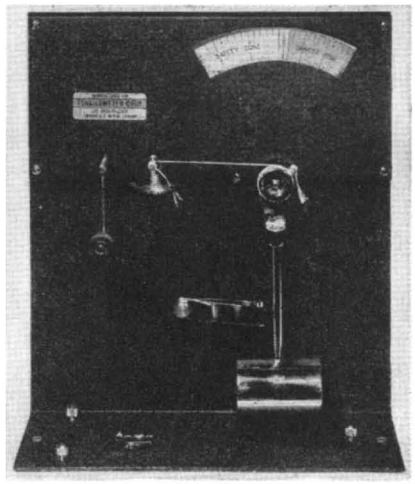
TIRED TIRES

Have Weak Cords in Carcasses

TIRES get tired. After several thousand miles of use, the tensile strength of the tire cord begins to diminish. As the tire mileage increases, the danger of blow-outs increases. The loss of strength of the tire cord is called "cord fatigue."

To test the tensile strength of cord in a tire, a scientific and accurate device has been perfected. Called the Tensile Meter, this machine is gradu-

ated in pounds and has a dial divided into three zones—green for safety, orange for caution, and red for danger. When the cord is broken, the hand remains in a stationary position and indicates the tensile strength of the cord. If the hand remains in the safety zone, this indicates a cord test of over 12 pounds; if in the caution zone, the cord will test between 10 and 12



It shows if tires are tired

pounds. Should the results find the hand remaining in the danger zone, the cord tests below 10 pounds and the carcass is not safe or suitable for retreading. The cord to be tested can easily be removed from the tire from the inside splice where it overlaps. Either fabric or rayon cords can be tested.

PROTECTING

Film For Record Cards Of All Kinds

RECORD cards that must be referred to frequently can be protected from dirt and moisture by covering the surface with a new film manufactured by Seal, Inc. The film, which is applied by an electrically heated device, is practically invisible, is flexible, and is moisture-proof. Temporary notations can be made on the surface of the film with a colored wax pencil and then wiped off.

LENS

Automatically Keeps Objects in Focus

ALTHOUGH the living eye, with its elastic lens, automatically focuses objects at varying distances, optical engineers have looked askance at many ingenious proposals to accomplish this purpose in a photographic lens. But a four-element motion picture lens has now been de-

signed by Bausch & Lomb in which one double-concave element is electronically oscillated on its axis by means of a special cell mounting developed by P. Stanley Smith, a New York radio engineer.

The oscillating element is confined to a movement of three-tenths of a millimeter but the oscillations are at the rate of 23,200 times per minute, thus continuously altering the focus so that all objects are uniformly in register from four feet to infinity. Although all objects are slightly softer in focus than with conventional lenses, many photographers regard this as an improvement.

The new oscillating lens cannot be incorporated in hand cameras.

PHOSPHORESCENT

Paint For Use In The Home

MANY are the uses to which phosphorescent paint can be put in the home, the home workshop, and even in offices and manufacturing plants. Dangerous corners can be spotted or outlined with paint that glows in the dark, electrical switches can be coated with the substance, house numbers can be made to glow in the dark, photographic dark room equipment can be painted, and so on.

Now available under the name of Lumi-Tone Phosphorescent Paints is a material which is easily applied and which, if covered with a protective coating film which is available with the paint, can be used out of doors or in locations where high humidity prevails.

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FREIGHT—Motor trucks carried 9 per-cent of the nation's freight moving on wheels in 1940, according to data compiled by the Equitable Life Assurance Society.

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BROWN EVERGREENS

May be Due to Natural Causes

THE browning or rusting of evergreens, especially arbor-vitae and pine, must be quite general, judging from the numerous inquiries received at the State Experiment Station at Geneva, New York, from home owners who are alarmed over their ornamentals, says Dr. F. L. Gambrell, Station entomologist. Generally, the browning of evergreens during the fall is a natural phenomenon and is nature's way of pruning these trees, says this authority.

"In the early fall the amount of browning may vary considerably during different years," says Dr. Gambrell, who continues as follows: "Commonly, this condition is quite natural, that is, it is a case of natural shedding or pruning of the older leaves and branches and is comparable to that which occurs on deciduous plants. Fall browning is particularly noticeable on arbor-vitae and may also be observed on pines in the form of browning and shedding of the 3- and 4-year-old needles. Occasionally, the 2-year-old needles fall, but this may be due to some organic agency or adverse weather conditions."

A browning of evergreens may occur in the early spring and again in the summer, says Dr. Gambrell, and in such cases several factors may be involved, some of which require care to prevent serious injury. If browning occurs in late February and early March, it may be attributed to a drying out while the soil is still frozen and the tree unable to replace the water lost by the needles. Exposure to the prevailing winds and direct sunlight generally accounts for this injury which may be reduced by shading or screening the trees wherever this is practical.

Summer browning of evergreens is most generally caused by insects, with the spruce mite as a common source of trouble, especially during hot, dry weather. This insect attacks other types

of evergreens as well as spruce and can be detected upon close examination as tiny reddish creatures crawling about the trees. Dusting sulfur gives good control. Summer browning may also be due to scale insects, root weevils, spruce gall aphids, unfavorable or poorly drained planting sites, hot, dry weather, or the failure of newly transplanted trees to become established.

INDEX SYSTEM

Uses Plastic Instead of Metal Strips

STRIPS of Tenite are replacing aluminum in the new Visi-Record card index system, and are said to improve its efficiency. The strips are continuously extruded and then cut in lengths to fit

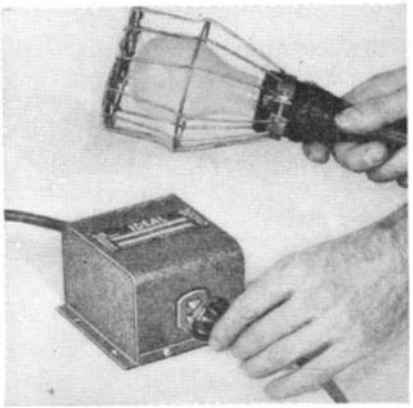
Colored plastic in file system

the vertical edges of the divider cards. Once snapped and riveted into position, they serve to support the cards and protect their edges against wear and tear from handling. By using different colored strips, indices and sub-divisions of the system can be identified at a glance. The non-resonant quality of Tenite makes for quiet operation.

LAMP

Operated At Low Voltage Increases Safety

WHERE electric extension lights are used in the shop and factory, occasional injuries are caused by shock, particularly when such lights are used in wet locations. Such danger can be eliminated by the use of a six-volt bulb in the extension light, supplied with current through a transformer. This arrangement is commercially available in the form of the Ideal Lo-Volt Transformer shown in one of our photographs. The primary lead plugs di-



Low voltage, high safety

rectly into any 110 volt A.C. supply; the secondary lead delivers current at a harmless pressure of six volts which cannot be felt even though it is short-circuited directly through the body.

PROOF?

The Joke was on Bischoff, But Too Late

BISCHOFF, one of the leading anatomists of Europe, thrived some 70 years ago. He carefully measured brain weights, and after many years' accumulation of much data he observed that the average weight of man's brain was 1350 grams, that of a woman only 1250 grams. This at once, he argued, was infallible proof of the mental superiority of men over women. Throughout his life he defended this hypothesis with the conviction of a zealot. Being the true scientist, he specified in his will that his own brain be added to his impressive collection. The postmortem examination elicited the interesting fact that his own brain weighed only 1245 grams.—*Journal of the American Medical Association.*

MOST NOTABLE

Which are the Outstanding Scientific Instruments?

HISTORIANS of the future, we believe, will choose the cyclotron and the electron microscope as the most notable new instruments of the age. Both are remarkable because they contribute to several fields of science. By its massive design and large dimensions, the cyclotron has undoubtedly captured popular imagination; but from a strictly technical point of view it might be argued that the electron microscope is a tool of wider application. Physicists, biologists, engineers, chemists, bacteriologists—all have problems whose solution is almost assured.—*Prof. Thomas H. Osgood in Journal of Applied Physics.*

Night Vision

A British Army Medical Officer Considers a Subject of Vital Interest to Aviation in Particular

ALEXANDER KLEMIN

Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

TO BE able to see in the dark is quite an important matter to night-fighter pilots, the crews of night bombers, spotters of the anti-aircraft service, drivers of vehicles by night, and others. It will be equally important to civilians as they become Air Raid Wardens. Therefore, we read with great interest an article on night vision, by Captain Brian St.J. Steadman, of the Royal Army Medical Corps, recently published in *The Aeroplane.*

The part of the eye that is sensitive to light is called the retina—the innermost of three coats that form the eye ball. In one of the outer layers of the retina lie two types of cells known as cone cells and rod cells, both distributed over the retina. A complex substance known as visual purple is present in the rod cells, and it has the remarkable property of being bleached on exposure to light but regenerating rapidly in darkness or semi-darkness. Now here, in Doctor Steadman's words, is the explanation of night vision:

"Vision depends on two mechanisms. One, governed by the cone cells, is concerned with form vision and color vision and functions only in bright light. This is known as the photopic mechanism. The other depends on the rod cells and the presence in them of visual purple. It is concerned with appreciation of light and movement and functions in conditions of semi-darkness. This is known as the scotopic mechanism. Everybody knows that after going from bright light into semi-darkness one can see very little at first, but that after an interval one begins to see more clearly. This is due to an increase in sensitivity of the rod cells caused by the regeneration of visual purple and is known as dark adaptation."

This dark adaptation increases rapidly after we are plunged in darkness or semi-darkness. At the end of one hour the sensitivity of the retina may be increased between 50,000 and 100,000 times.

What should be done to increase the night vision of those about to engage in the specific tasks we have mentioned? First of all, they should wear dark goggles or stay in a completely dark room for 45 minutes. To test whether one's eyes are dark adapted, a star should be looked at directly, and then the line of vision should be deviated slightly. If the star appears brighter in the second case, then the faculty of night vision is in full use. The reason for this is that there are no rod cells in the retina at the central point, that part used for clear vision during the day.

The quality of night vision varies in individuals and some people suffer from night blindness, which may be caused by a deficiency of visual purple, due, in turn, to a deficiency of vitamin A in the diet. Night blindness may be cured by eating liver, carrots, and so on. But, unfortunately, no amount of food containing vitamin A will improve any lack of night vision faculty that a person may have. Dr. Steadman explains it this way: "Experiments have shown that it is useless for people with a poor night vision standard to attempt to bring about an improvement by eating two pounds of raw carrots a day."

Since selected food is no cure, the best that the British have been able to do for their night-fighter pilots is to devise tests for the standard of night vision and to give selected candidates a course of exercises. The quality of night vision may be improved by constant practice. With eyes fully dark adapted, an endeavor should be made to recognize at night the outlines of trees and buildings against the sky, both with and without field glasses. Commencing with familiar outlines, the distance may be gradually increased and use made of unfamiliar outlines. Large letters or diagrams of aircraft may also be employed. The amount of training done in this way, and its helpfulness, is determined by the individual himself and depends largely on his keenness.

SHOP LIGHTING

Fluorescent Tube Used in Portable Unit

WITH all the good will in the world, our aviation notes seem to drift away from the progress of aviation science to the progress of aviation manufacture. One reason is that the most important scientific advances in aeronautics are apt to go on the secret list, to discuss

which means the risk of dire penalties. Another reason is that emphasis today is on production and practical advance rather than on radical development.

Thus we can and should devote attention to the use of a portable fluorescent light for night work in the aircraft plant. The new light is encased in a tube of transparent "Lucite," methyl methacrylate resin. The light is of low

It brightens the corners

weight, handy, and gives off spherical lighting so that shadows are eliminated. It is cool, which is a real advantage. One of our photographs shows a foreman using the light while working on a Lockheed P-38.—*A. K.*

"HAPPY" SPEAKS

And Tells Something of the Army Air Corps

THE first Chief of the Army Air Force, Major General H. H. Arnold, is frequently spoken of as "Happy Arnold," but his character and energy are such that the nickname does not fully become him. General Arnold, a veteran flier with a thorough knowledge of every phase of military aviation, is just the man we need today when aviation is all-important in our war plans. His resumé of Air Corps developments for the last year or so is significant and encouraging.

Fighters are the best defense against air attack, but bombers alone can lead to victory. "The heavy bomber," says General Arnold, "in which type we lead the world by several laps, remains the backbone of air power." We need only recall the Boeing Flying Fortresses to agree with the General. With their pressurized cabins and supercharged engines the Boeings can operate at over 40,000 feet altitude where they are, for the moment, immune to attack by pursuits or anti-aircraft guns. The fighter, with

its superior maneuverability, can outfight the bomber, but its ceiling will have to be boosted. Dive bombers have become synonomous in the public mind with German aviation; but as a matter of fact it was the United States Navy which first introduced dive bombing and it is the Curtiss-Wright Corporation which has built the world's best dive bomber.

Another achievement of the Army Air Corps lies in its ferrying program. The Air Corps Ferrying Command takes planes, with rare accidents, from the West to the East Coasts, from the East Coast to Greenland, to Iceland, to Georgetown in British Guiana. Here is what the General says: "Except for our short-range planes, the Air Corps Ferrying Command is capable of operating around the world. Its navigators are studying globes, not maps, and they would take a bomber to Tibet or Little America on 48 hours notice."

Since Crete, there has been a general feeling that glider-born troops have proved their value. The Air Corps is keeping step with this new development also by the procurement of gliders and by training pilots in gliding and soaring. Army and Navy alike are interested in the towed glider capable of transporting many armed men. Altogether, General Arnold's message is very encouraging. It shows that our Air Corps is wide awake, following every air development of the war.—*A. K.*

TELESCOPE MAKING?

Doctor Urges Pilots to Take Up Hobbies

TODAY's high and fast flying pilots will take up stamp collecting, gadget making, or the study of foreign languages if they listen to the advice of Mayo Clinic's Dr. M. N. Walsh.

The modern pilot's nerve-splitting profession not only requires that he groom his body like Joe Louis, but that he save every possible milligram of his nervous energy by learning how to relax, Dr. Walsh declares. To combat excess drain on nervous energy, he urges perfect physical condition aided by frequent rest periods and hobbies. "The importance of hobbies in securing mental relaxation is much underestimated. The chief value of hobbies . . . lies in their capacity to release pent-up nervous tension. The most satisfactory hobbies are those which involve making something with the hands or forming collections, so that the individual can enjoy the feeling that he has created something worth having, and can spend a quiet and restful hour with his hobby in forgetfulness of the worries of his daily occupation."—*Science Service.*

Industrial Growth

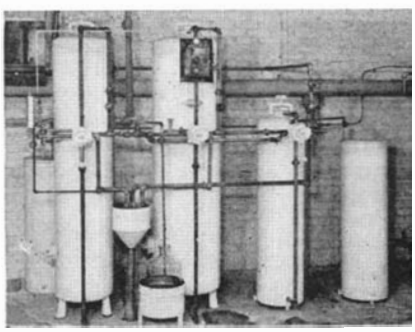
New Products and Processes That Reflect Applications of Research to Industrial Production

"DISTILLED" WATER

Obtained By Process Using No Heat

WHERE industrial operations require the use of pure water for any of a number of purposes, distilled water is usually used. For such operations it is now possible to obtain pure water comparable to single distilled water without the use of heat and at a small fraction of the cost of distilled water.

This "synthetic distilled water," as it is called by the Illinois Water Treatment Company, manufacturers of the



Complete heatless water "still"

equipment which produces it, may be obtained with as low as four parts per million of dissolved solids.

The treatment process uses equipment which passes the water successively through two beds of special minerals, the first of which removes, by base exchange, the positive, or metallic ions, such as calcium, magnesium, sodium, or iron, substituting hydrogen. The effluent from this tank is acidic in that the hydrogen ion combines with the negative sulfate, chloride, and nitrate ions. (The carbonates form H_2CO_3 which passes on through as CO_2 and water, and the CO_2 can be very largely dispelled by aeration if its presence is undesirable.)

This acid water passes to an anionic reactor tank where the negative ions (chlorides, sulfates, and nitrates) are removed and replaced by the hydroxyl ion. The H and OH combine to form water, giving a final effluent which compares very favorably to commercial single distilled water.

The equipment has both an hourly capacity or flow rate in gallons per hour and an overall capacity when the minerals become exhausted and are regenerated similarly to a water softener. The chemicals used in regeneration are commercial acid and soda ash which are cheap and readily obtainable.

It is stated that this "synthetic distilled water" is already being used in many industries where processes call for extremely pure water. In other industries the low cost of "distillation" makes it possible to take advantage of this purity where cost was formerly so high as to be prohibitive.

JACK

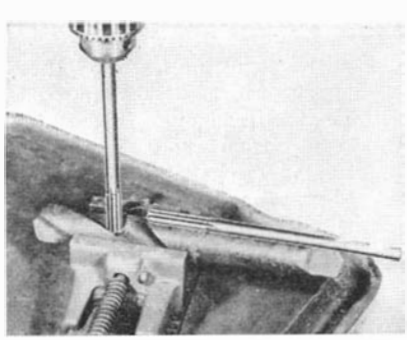
Wedge Blocks For Leveling Machines

A SIMPLE arrangement of two iron castings and a shouldered screw, placed under a machine, makes it possible to level the equipment quickly and accurately. The two iron castings are wedge shaped, the head of the screw bearing against a slot in the lower casting. As the head of the screw is turned, it forces the upper casting to slide on the lower one, thus increasing or decreasing the height of the assembly and hence making it possible to bring the machinery to exact level. The device, manufactured by Enterprise Machine Parts, is known as a "Machine Jack."

REAMER

Operates in Hardest Steels

A NEW type of reamer, made of Hardsteel and capable of reaming hardened steel of any degree of hardness



Reamers described above can be used even on hard steel drill stock

without annealing, has been developed by the Black Drill Company. The reamer, made of the same secret-process metal which is used in Hardsteel drills, [See page 93, February 1942 Scientific American.—Ed.], is designed to operate in the same manner as the drills and, it is claimed, will easily outlast any high-speed reamer now in use. While the ordinary high-speed reamer will ream metals up to 35 degrees Rockwell, Hardsteel reamers will ream metal of any hardness up to and including nitrided surfaces, without unusual wear. They have been used successfully on carburized, oil hardened, water hardened, cyanided and nitrided pieces of high carbon, high chrome, and high-speed steel.

The accompanying illustration graphically shows the possibilities of Hardsteel reamers. A hole drilled by a Hardsteel drill in a twist drill, with a Rockwell 60 C., is being reamed without effect on the reamer.

ACID INDICATOR

Used in Controlling Industrial Process

INDICATIVE of the possibilities of the solu-bridge controller for industrial purposes is the recent application of this unit, manufactured by Industrial Instruments, Inc., to the processing of mineral oil. Mineral oil is treated with concentrated sulfuric acid in large vats. At the end of the treatment cycle the concentrated acid which has not entered into reaction settles to the bottom of the vat. Above this there is sludge, with treated oil above the sludge. The sulfuric acid is first drawn off from the bottom of the vat, followed by the sludge, and finally the treated oil comes through. The conventional method of ascertaining when all the acid and sludge have been removed is by means of a by-pass pipe and visual observation. The operator at times does not notice when the withdrawal of sludge has ended and treated oil starts coming through.

When the problem was first put up to the industrial instrumentation engineers, their first step was to check liquids withdrawn from the vat by means of the solu-bridge. It was found that sulfuric acid read over 7 percent, the sludge approximately 0.2 percent, and the treated oil gave a reading of 0. Thus by placing a special conductivity cell in the by-pass line, and setting the indicator of a solu-bridge controller at 7 percent, the self-contained relay of the instrument closes and actuates an alarm when sludge begins to come through. Again, setting the indicator at 0.01 percent, the relay will close and give indication when oil starts to come through.

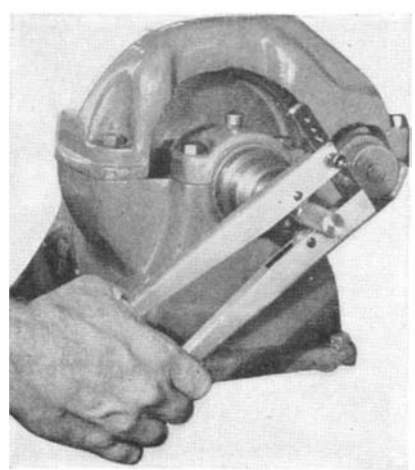
The solu-bridge controller is an electronic device which not only indicates the conductivity of a given liquid in any desired terms, but also, by means of its self-contained relay, actuates an external warning signal such as a flashing lamp or audible alarm. The relay can also be employed to control some suitable corrective means, such as opening or closing solenoid-actuated valves.

KNURLING

Plier-Type Tool Is Adjustable

KNURLED surfaces can be produced on metal rods having diameters between $\frac{5}{16}$ of an inch and two inches with a new adjustable plier-type knurling tool announced by the Pacific Specialty Supply Company.

Two knurling wheels are mounted on one arm of the tool and a third on a hinged arm which can be adjusted by means of a removable hinge pin. In use, the tool with its three knurling wheels is placed over the work and pressure is applied by hand to close the wheels against the work surface. The work can be rotated by any means as in a lathe or drilling machine, or it can be held in a vice and the tool revolved around it.



Hand knurling on a lathe

NOZZLE INSERT

Of Ceramic, for Air Blasting Equipment

AN extremely hard, abrasion-resisting ceramic, now being used instead of metal for the inserts of "Long-Lyfe" abrasive blast nozzles manufactured by American Foundry Equipment Company, is claimed to have a hardness and density that is superior to many of the metals now being used for this pur-

pose. Its manufacture is not affected by the present scarcity of certain alloys.

Economy of operation is achieved with these inserts because the cost of compressed air is kept at an absolute minimum since the nozzle wears slowly and evenly. Also, because the original orifice is preserved without appreciable wear, even after hundreds of hours of service, the contour of the blast stream is maintained and the work is cleaned faster and more uniformly.

Additional features of this nozzle include: High finish bore; no soft spots to start uneven wear; non-metallic, thus reducing static to a minimum; does not "bell out" rapidly; excellent mechanical strength.

SWITCH

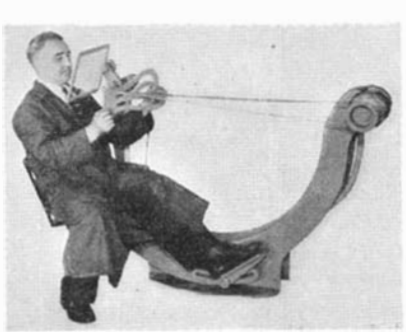
Foot Operated For Start-Stop Operation

A FOOT-OPERATED switch which solves many problems of frequent start-and-stop operations of machines, incorporates tungsten contacts which are held in open position by spring pressure but are brought together to close a single-pole circuit when pressure is applied to the top of the rubber housing of the switch. The switch responds to the slightest down pressure of the foot; it is claimed that less pressure is required than is applied to the average automobile accelerator. Rated at 1000 watts, these switches have a conservative guarantee, by the Nathan R. Smith Manufacturing Company, for 40,000 operations per year. They can be used to control the operation of any small machinery within the rating range.

SANDING

Machine For Use On Inner Surfaces

FOR use in production work which requires sanding of the inner surfaces of wood grilles and other shapes, a unit machine has recently been developed by the J. M. Nash Company. Built into this machine is an adjustable chair for the operator and an adjustable foot pedal which controls the tension of the continuous sanding belt.



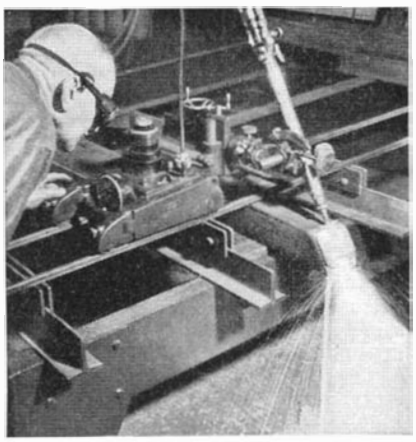
For inside sanding

One of our photographs shows this sanding machine in use. The operator can apply the work to either the upper or lower surfaces of the belt. When he finishes with one interior opening, it is only necessary to depress the foot pedal, whereupon the belt action stops and the belt can be released from the pulley nearest the operator. The work piece is then removed from the belt, the belt is introduced into another opening to be sanded and then slipped back on the pulley. Releasing the foot pedal tightens the belt and starts it in motion.

GAS CUTTING

Torch Holder Is Adjustable

A NEW torch holder has been developed for the Radiagraph gas cutting machine by which the torch can be set at any angle in vertical and horizontal planes and can be adjusted laterally and vertically with reference to the vertical support on the machine housing. The arrangement facilitates application of the machine, which travels on a track for feed movement over the work. The new unit is known as the Protractor Torch Holder.



Cutting at angles—with gas

The torch is held in a clamp on a spindle secured at right angles with a supporting arm. The arm rotates on a horizontal support at the end of a slide riding in a bracket. The bracket mounts on a vertical post on the machine housing. The spindle rotates and clamps at a desired angle and is set with the aid of a protractor in the spindle assembly. The arm and the end of the slide also are graduated for rotation of the former to an angle and are clamped in set position. The bracket moves the arm up or down when a crank is turned, in or out when a handwheel is operated.

CAMERA ANGLES

Conducted by JACOB DESCHIN, A.R.P.S.

Stroboscopic Multiflash

STROBOSCOPIC multiflash photography is the term used by Gjon Mili, engineer-photographer, to describe the method of making such pictures as those reproduced here. To the already familiar method of multiflash, which involves the use of several flash sources to make a single picture, Mr. Mili adds multiple exposure for recording several images on the same plate.

Mr. Mili, who recently exhibited 50 prints at The Museum of Modern Art in New York City, in the first showing of his stroboscopic flash work ever held, sees in stroboscopic multiflash the nearest approach to what he considers a faithful method of photographing dancers in action.

"The dance is an expression in time and space," he says. "Accordingly, in making a record of the dance, in order to retain its quality, a motion-picture camera should be employed. A single photograph, however fortunate its composition or its expression of feeling, can at best suggest only the mood without indicating the line of movement or the phrasing. In order to record an entire movement on a single plate, use was made of the technique already known as stroboscopic multiflash photography."

Employing a 5 by 7 Deardorff studio-type view camera, Mr. Mili describes his procedure as follows:

"The camera is held open throughout the period of a phase while lights equipped with Edgerton high-speed tubes are flashed repeatedly—in order to impress a multiplicity of images on the same plate. The pattern can be changed at will by altering the rapidity of the flashing—by accelerating or retarding it; it is this controllable multiflash element which can make possible a truly artistic presentation of dance movement.

"Dance in Movement"

"The majority of the patterns exhibited were achieved with the aid of three lights which flashed at intervals from 3 to 15 flashes a second, depending on the speed of the movement. The camera was operated at aperture stops ranging from *f*/5.6 to *f*/16."

The results achieved have both pictorial and scientific appeal, sometimes in combination, sometimes one or the other. Rapidity of movement is the first requirement, beauty of movement secondary, but essential if pictorial appeal rather than pure fact-finding is the result desired. Because of the extreme speed

Markova—by multiflash

of the light, a fuzzy image is hardly possible; only poor focusing will cause lack of sharpness.

In the single stop-action photographs included in the show, when 3 to 12 single flash Edgerton units were employed, Mr. Mili tried to catch the dancer at the very height of an intricate whirl or leap. In the case of the stroboscopic multiflash photographs, however, he attempted to show a complete sequence of movement that included not only the most dramatic split-instant action but the series of split-instant actions that preceded and followed the "main event." In other words, his multiflash shots are the still-picture approximation of the motion-picture record.

Thus, he shows the accordion-like multiple movements of a dancer, or the spider-web filaments of a human cartwheel split into segments as it flashes through space.

For Minimum Blow-ups

In making tests of a new fine-grain developer, the painstaking worker will try "blowing" the negative as far as it will go short of the image falling apart. But what good does that do if, holding onto small grain size, the image actually melts away as to quality? More reasonable would it be to enlarge the negative, or a reasonable portion of it, to the 8 by 10 or 11 by 14 print you normally require. If the result is good after this test, you should be satisfied; if it is poor, then you may abandon this particular "soup" and try another or give the first a further chance by checking back on yourself to see if you followed the manufacturer's instructions and recommendations as to time, temperature, and so on.

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What's New

In Photographic Equipment

KODAK ALL-METAL PRINTER MODEL 2 ($19.75): Takes negatives from 35mm to 4 by 5½ inches. Has four adjustable, inch-wide, margin masks. Permits strip printing of many popular sized roll films; provision for introduction of printing controls such as ground or opal glass. Measures 10 by 8 by 6 inches. Includes as supplementary feature ruby Kodaloid scales illuminated from below by printer's ruby safelight. White etched scales easily read.

KODAK TESTING OUTFIT FOR ACID RINSE AND FIXING BATHS FOR PAPER ($1): Compact, two-bottle kit, one for acid rinse, the other for fixing bath.

GENERAL ELECTRIC BLACKOUT FLASH BULBS: Small bulb called G.E. "mighty midget" blackout photoflash lamp No. 5-R, identical in size and shape with Mazda "mighty midget" No. 5. Large blackout flashbulb, identical in size and shape with G.E. Mazda No. 21 photo flash lamp, known as G.E. blackout photo flash lamp No. 22-R. Bulbs have special purplish-black coating, whose characteristic is ability to screen out visible light, yet letting through the infrared. Lamps are used in conjunction with infra-red film.

"JAPS BOMB U.S.A.!": Movie depicting historic surprise attack by Japan upon Hawaii and incidents that led America into war, made available by Castle Films in five sizes and lengths, three 16mm editions, two 8mm editions.

BLUE MIGHTY MIDGET NO. 5: "Peanut" photoflash now available with blue coating for use in color photography. Color coating has same characteristics as that of G.E. No. 21B, matched by Eastman to color characteristics of daylight type Kodachrome.

SOLAR MERCURY TRI-SWITCH ($5.50): For use with double contact socket and double filament bulbs to provide selective lighting in projection printing. Light intensities adjustable for 50, 100, or 150 watts in accordance with density of negative. Designed for tabletop use. Single throw, double pole type, with levers operating the mercury contacts.

BAYLEE CINE COLOR KIT ($6.50): Contains neutral density polarizing filter; Type A filter to convert indoor Kodachrome for outdoor use; Kodachrome haze filter to absorb ultra-violet rays. Filters housed in leather kit, which also includes all-metal sunshade and filter holder combination. Kit fits practically all 8mm and some 16mm movie cameras.

WILLOUGHBY EXPOSURE RECORD BOOK (25 cents): Contains printed forms listing various data in connection with exposure and processing, gummed for pasting on negative envelopes. Offered as convenient method of keeping exact records.

JOHN-BAYLEE NEUTRAL DENSITY POLARIZING FILTERS: Made of precision ground optical glass to darken skies and eliminate glare and reflection, specially recommended by manufacturers for use in color photography. Available in all sizes; those fitting Series V and VI in the Eastman Kodak series list at $2.90 and $3.40, respectively.

EASTMAN ELECTRIC X-RAY TIMER ($15): For use in processing X-ray films. Designed for timing in ¼-minute intervals for periods up to 10 minutes. Six-inch translucent Tenite dial with opaque markings read in silhouette; dial illuminated from within like safelight. Convex glass protects dial and hands of timer. All controls on top. Repeat timing. Operates only on 60-cycle 105 to 120-volt A. C. Housed in case of die-cast metal, finished in smooth dark-grey enamel. Included is 48-inch rubber-covered electric cord, with plug.

8MM RENTAL SERVICE: Initial listing of 75 subjects consisting of features, cartoons, sport shorts, travel subjects, musicals, and novelties, announced in Bell & Howell's 1942 edition of catalogue of recreational films.

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the co-operation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want and you will be furnished with a list of available titles, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for.

CIVILIAN DEFENSE

By Lt. Col. A. M. Prentiss

THE means and methods of air attack, the effects produced by each, and the scope and character of their threats to civil life. Detailed to the Chemical Warfare Service since 1917, writer of *Chemicals in War,* the author discusses and factually describes civilian protection against high explosives, incendiaries, gases. Likewise, organization of aircraft warning for both active and passive defense; necessary protective services for the public; methods of protection for homes and industrial establishments; probable influence of civil air defense on our national life and future development of large cities, including relative present safety in tunnels, subways, cellars, and skyscraper basements, roofs, and middle stories. Of the utmost importance to everyone; vital for those responsible for the safety of others. (334 pages, 6 by 9 inches, 42 illustrations.)—$2.85 postpaid. —*A. D. R., IV.*

MODERN PLYWOOD

By Thomas D. Perry

IDENTIFIED for more than 30 years with plywood manufacturing, the author of this book brings to his subject an intimate knowledge of the technicalities as well as the practical applications of this material which is finding more and more uses in modern industry. Plywoods are conveniently classified into types and techniques of manufacture, are fully and effectively described. An excellent bibliography is provided. Mr. Perry is also the author of the aricle "Rolling Off a Log," published in this issue of SCIENTIFIC AMERICAN. (380 pages, 6 by 9 inches, 188 pertinent illustrations.)—$4.60 postpaid.—*A. P. P.*

MATHEMATICS—ITS MAGIC AND MASTERY

By Aaron Bakst

SUGAR-COATED approach to algebra, geometry, trigonometry. The sugar coating consists of brightness, humor, and downright inherent interest. This book has no text-book earmarks, but was written by a human being. You not only learn these branches of mathematics, but are beguiled along the way by an immense collection of mathematical oddities, time-savers, short cuts, recreations. Of course, it is not altogether painless—another way of saying that this is no freakish, frivolous book to be taken lightly; it is pretty solid stuff; an investment. Simply, the author saw no reason to be dull, if a thing could be made bright. (790 pages, 5½ by 8½ inches, illustrated.) —$4.10 postpaid.—*A. G. I.*

THE STORY OF VARIABLE STARS

By Leon Campbell and Luigi Jacchia

ONE of the new Harvard books on astronomy. Aimed at serious amateur astronomers. Amateur astronomers who wish to see what variable star work for the semi-professional is like, and to understand the background of the subject of variable stars in general, will find the account in this book, the senior author of which is the well-known patron saint of the variable star observers in this nation. The book is thoroughly practical—gets down to cases. Chapters: How Variables are Found; Observing the Variables; Using the Observations; Pulsating Stars; Red Variables; Explosive Stars; Erratic Stars; Stellar Eclipses. (226 pages, 5¾ by 8⅜ inches, 82 illustrations.)—$2.60 postpaid.—*A. G. I.*

BUILDING INSULATION

By P. D. Close

WRITTEN by a former Technical Secretary of the Americal Society of Heating and Ventilating Engineers, this is a book that gets down to particulars; its reader, or serious student, would carry away a pretty solid knowledge of the physical science behind building insulation as well as the practical aspects. A meaty book, technical, but not abstruse. It lists the various brands of insulation and names names. (328 pages, 5¼ by 8¼ inches, well illustrated.)—$3.10 postpaid.—*A. G. I.*

THE COLORADO CONQUEST

By David O. Woodbury

BOULDER DAM is only the last chapter of this rapidly running account mainly of the everlasting fight, fight, fight in the winning of the sub-sea level Imperial Valley from the ever-threatening Colorado River, termed the "Red Bull." First, projects. Then defeats. Growth. Quarrels among men. Dark years. Floods. Struggle with the River. Tussle titanic. Defeat. More battle. More defeat, defeat, defeat. No hope but—fight on. Inundation. Tragedy. Fight on. Near

victory, then all lost again for the fifth time. Start again—fight with $1,500,000 and all for naught. Begin once more and, at last (1907), victory and prosperity—to be followed by internal troubles with crooks, politicians. Finally—the last quarter of the epic—Boulder Dam, and the Red Bull was cowed at last. The author is an engineer and explains the events with an engineer's knowledge, but the events were so dramatic that no novelist could improve on their cussedness. The account reads like a historical novel—especially where the old horse relieved himself copiously! You'll be able to put this book down—about 4 A. M. (367 pages, 5¾ by 8½ inches, illustrated.)—$3.10 postpaid.—*A. G. I.*

AUTOMATIC ARMS

By Melvin M. Johnson and Charles T. Haven

COMPREHENSIVELY treating one of the most important factors of the present war, this book covers the true "automatic" arms, such as machine guns, machine rifles, and machine pistols, or submachine guns. Also, pocket pistols, shotguns, sporting and military rifles which technically may be described as semi-automatic, since they load automatically, but fire only a single shot with a single pressure of the finger. Beginning with earliest history and development of multi-firing arms and progressing to latest models, this publication tells how they work, how to keep them firing, how employed in combat. Appendices include table of weapon types, many operating diagrams. First named author is Captain in Marine Corps Reserve, inventor of semi-automatic rifle and machine gun which bear his name; second is noted arms collector and co-author of *A History of the Colt Revolver*. Invaluable and fascinatingly instructive. (344 pages, 6 by 9¼ inches, over 150 illustrations.)—$4.60 postpaid.—*A. D. R., IV.*

HE'S IN THE NAVY NOW

By Lt.-Commander John T. Tuthill, Jr.

ON life in the Navy. A Bluejacket's Day; The Recruiting Office; The Training Station; Service Schools; Aboard a Battlewagon; the Fleet and its Auxiliaries; Submarines; Sick Bay and Health; Liberty—these chapters give the scope of this book, which is largely pictorial, but usefully informative in picturing what sort of life everyday Navy life is. (256 pages, 6½ by 9½ inches, many illustrations.)—$2.60 postpaid.—*A. G. I.*

WORKING WITH THE MICROSCOPE

By Julian D. Corrington

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TELESCOPTICS

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FOR a long time, this department has sought opportunity to reprint and thus make available to the average amateur a lengthy paper on the tests of the 82″ mirror at the McDonald Observatory in Texas, written by Dr. J. S. Plaskett, late Director of the Dominion Astrophysical Observatory in Canada, originally published as *Contributions from the McDonald Observatory, University of Texas,* No. 1, later in *The Astrophysical Journal,* Vol. 89. The astronomer Plaskett was also an optician, acting as advisor on a number of large mirror jobs and as final acceptance tester for purchasing institutions.

The amateur who studies this paper will follow the tests exactly as the professional sees and makes them—and will discover no mysteries but mainly the same things he does on smaller mirrors, and some of the same old headaches. Perusal should flatter his vanity, also confirming him in his methods.

One professional astronomer, director of a new observatory, asked this department to suggest the names of men qualified to make the acceptance tests on a very large mirror. Dr. Plaskett was of course named, as were others; and then A. W. Everest and other advanced amateurs were suggested. The astronomer had had the same thought—for many amateurs do more mirror testing than any professional, and in this way become highly expert in the eye-detection and interpretation of shadow subtleties. It turned out that the chief practical problem was not about the amateurs *per se,* but the university's trustees: "What would *they* say if I nominated amateurs! They'd never understand. I'd never live it down." We suspect he was right. The word "amateur" has two connotations.

Dr. Plaskett's article, which will require close study, follows:

THE Warner and Swasey Company, who have designed and constructed the mechanical parts of the Lick, Yerkes, Victoria, and other large telescopes, have never undertaken, until the contract for the McDonald Observatory was signed in 1933, to supply the optical parts for their instruments. The deaths of Dr. Brashear and Mr. McDowell, who had in recent years provided the optical parts required, and the desire to make the complete telescope, were probably the main reasons inducing this famous firm of telescope-builders to include an optical department in their organization. This was established in 1933 under the direction of Mr. C. A. R. Lundin, who had previously acted as chief optician for the well-known firm of Alvan Clark and Sons.

The optical shop was fitted with a grinding and polishing machine for the 82″ mirror and with a smaller machine for a 57½″ flat to be used in testing the 82″. Work on the latter and on some smaller jobs occupied the time until the arrival of the 82″ disk from Corning in October, 1934. Grinding was commenced on October 19, 1934; and nearly four years later the mirror was completed, on October 14, 1938. The figuring was not, however, continuous throughout the period, as in the hope of early completion the figuring with the full-sized tool was unfortunately continued so far that, early in 1937, the focal length became too short. Even though the parabolizing was nearly completed and the reduced focal length was within the range of adjustment provided in the mounting, neither the firm nor Mr. Lundin was willing to allow such a departure from the specifications. It required several months' work with the large tool to flatten the curve sufficiently, so that the final figuring—for the earlier close approach to the paraboloid was wiped out in the flattening process—did not begin until October, 1937. Twelve months can hardly be considered an unduly long time to figure an optical surface of this size in a newly established shop.

Early in 1936 I was asked by the Warner & Swasey Company to act as consultant in optical and other scientific matters connected with their instrument work, and in 1937 I visited Cleveland twice—once in May during the flattening process and later, in October, after the commencement of the refiguring. I was summoned again in March, 1938 when it seemed desirable to make a change in methods and remained, with two intermissions, consulting with Mr. Lundin until the mirror was completed on October 14.

During a visit, late in March, of Dr. Struve, the director of the new observatory, and two associates—Dr. Van Biesbroeck and Dr. Kuiper—a different method of testing was proposed, depending on measurements at the center of curvature from which a "curve of shape" was developed, the purpose of which was to give the true form of the surface with exact numerical values of the deviations from the paraboloid. The results from this method, which was extensively used and which will be more fully discussed later, were, however, at first disappointing; and early in May the 57½″ flat, which had been given a very fine figure by Mr. Lundin a year earlier, was silvered and thereafter was used as the principal means of testing the surface of the 82″ mirror.

It may safely be said that, after the flat was set up and the shadow pattern at the focus could be observed—the method which Mr. Lundin had always hitherto used in figuring mirrors—the

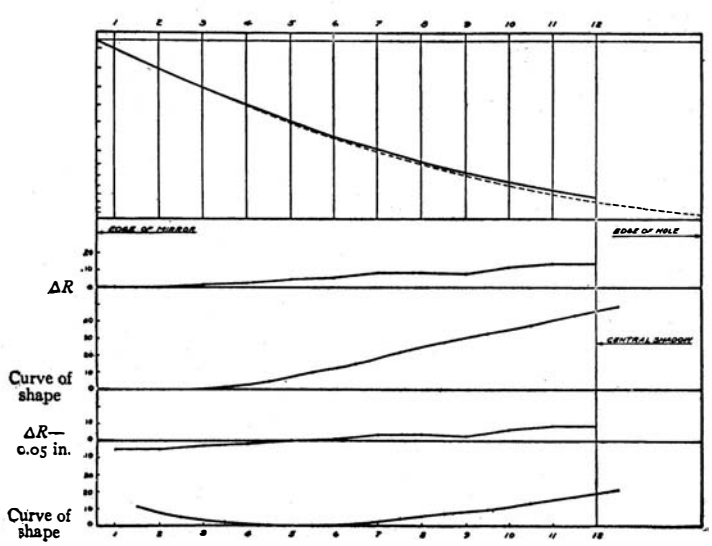

Figure 1: **Curves of October 5, 1938**

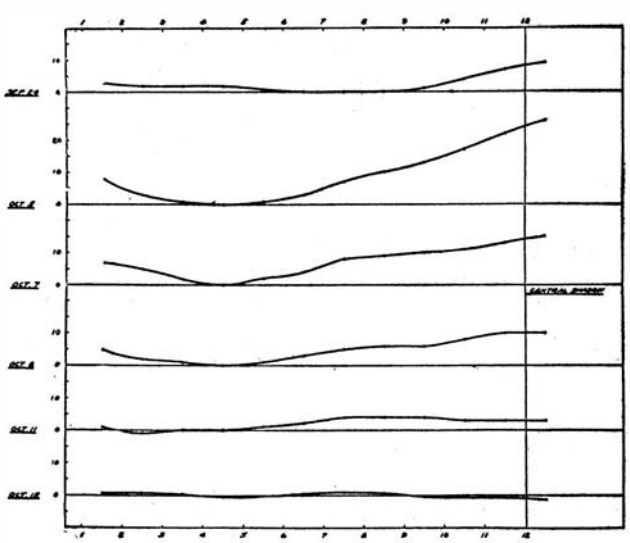

Figure 2: **Curves of shape, 82" mirror**

progress toward the final result was steady, if not quite continuous. As is probably the case with all optical work, especially large surfaces, various difficulties and occasional setbacks were encountered. It may be sufficient to mention first a sharply turned-up edge—much preferable, however, to one turned down—which required considerable handwork with small tools to reduce, at which Mr. Lundin is remarkably expert. A second difficulty was irregularity and lack of general smoothness over the surface, a problem completely solved by substituting for the full-sized tool a half-sized tool, with a long sweeping stroke.

The final figure came quite rapidly at the last, as can be seen in the graphs in Figure 2, where the units are millionths of an inch and where the curves of shape of September 24, when the half-sized tool had barely come into use, and those of the final week of figuring are given. Dr. Struve and Mr. Fred Pearson, of the University of Chicago, paid a visit of inspection on October 6, when, under the knife-edge test at the focus, the figure looked so smooth and uniform that they adjudged it as nearly finished. However, tests at the center of curvature next morning and formation of the curve of shape showed it as still undercorrected to the extent of 20 millionths of an inch, a whole wave, and work was continued. Progress on one day enabled an estimate of the required time of polishing to be accurately made, and on this basis the paraboloid was considered completed on October 12, when the curve of shape showed deviations only slightly larger than a millionth of an inch, an eighteenth of a wave. Tests at the focus showed a high central zone, which Mr. Lundin reduced to practical invisibility in four short hand workings on October 12 and 13. The mirror was inspected and accepted by Dr. Struve on October 15 and was then made ready for aluminizing, necessary to make the Hartmann test and to figure the secondaries. The mirror was taken out of the vacuum chamber on October 24 and set up in the optical shop, where the visual and photographic tests were completed.

The method of testing the surface was a modification of the well-known method of determining the center of curvature of a number of zones spaced uniformly over the surface and comparing these measured positions with those computed from the properties of the parabola. A cardboard diaphragm was placed in front of the mirror, containing 28 circular 1.5″ holes, spaced uniformly along a horizontal diameter at a separation of 2.5″. The innermost zone, No. 14, has a radius of 7.75″; and the outermost, No. 1, of 40.25″. A series of shutters before the openings, manipulated by a rod extending through a partition, enabled the zones to be opened at will without going near the mirror. The intersection of the converging pencils from a fixed artificial star was determined at first by an eyepiece and later, more accurately, by a knife-edge. Obviously, in this case, the departures of the intersections from the computed posi-

tions are double those of the radii of curvature and four times those at the principal focus.

The knife-edge is attached to a slide moved parallel to the optical axis by a screw, the positions of intersection being obtained by lines scribed against a straight-edge on a stationary aluminum plate, rigidly attached at right angles to the slide. The positions of the intersections were either directly compared with a standard series in the computed positions, or later, as the mirror approached completion, the separations of the scratches were accurately measured by dividers on a steel scale. A modification developed by Mr. Burrell consisted in plotting the positions of the zonal openings as abscissae and the distances of the corresponding intersections from that at the center of the mirror as ordinates. The method is illustrated in the upper part of Figure 1, containing the measures of October 5, plotted as a curve which can be directly compared with a normal parabolic curve drawn in a dotted line through the computed positions. Blueprints were made of the fixed parts of this diagram, and the observed curve could be rapidly laid down on one of these prints from the scratches on the plate, the positions of longer radius being above and of shorter radius below the standard curve. The curve was at first considered as indicating where glass should be removed instead of showing where the surface was too flat or too concave.

It was the purpose of the curve of shape proposed by Dr. Struve, Dr. Van Biesbroeck, and Dr. Kuiper to overcome this difficulty and to represent graphically the actual form of the surface and the exact deviations from the paraboloid. The method is simple, the tilt of the element of the surface 2.5″ wide, centered on any zonal aperture, being determined from the deviation of the intersection of the corresponding pencils from the computed position. The departure of the ends of this element from the paraboloid is thus obtained; and joining these ends together—in other words, alegebraically summing the departures consecutively across the surface—gives its true form, the factors being so chosen that the departures of the intersections from normal, hereinafter called *R*, in hundredths of an inch, correspond to millionths on the curve of shape and on the surface.

Unfortunately, this method is also subject to ambiguity, particularly at the edge of the mirror, as the curve only begins to give reliable information halfway between zones 1 and 2; furthermore, the general slope depends upon the choice of zero, or the starting-point of the measures. This latter point is illustrated in the central part of Figure 1 in the measures of October 5. The deviations of the intersections plotted at the top of the figure with respect to the parabolic curve are repeated directly below, but on a different scale, in the broken curve drawn with respect to a straight-line base. These deviations, in hundredths of an inch, are transformed into the smooth curve of shape immediately below, showing deviations from the paraboloid in millionths of an inch. In the lower pair of curves the broken curve is exactly the same as above, except that 0.05″ is subtracted from each measure, or the base line is lowered by 0.05″. The curve of shape, however, is quite different, as not only is the slope radically different, indicating an alternative method of reaching a parabola of slightly different focus by removing glass both at edge and center instead of the center only, but also the average curvature is changed. Notwithstanding these difficulties, which rapidly diminish as the paraboloid is approached, the method is of distinct value in representing the exact form of the surface and in giving numerical values of the departure from the theoretical curve.

As soon as shadow tests at the focus were available, early in May, they were used exclusively as a guide for the next working, as there was then no chance of ambiguity in the readings and the high zones could be accurately located and marked. The knife-edge shadow tests were supplemented and confirmed by the use of a Ronchi plate, where the condition of the surface was shown by the straightness and parallelism of the resultant bands. Measures at the center of curvature were transformed into curves of shape for Dr. Struve about once a week as a numerical record of progress until toward the end of the parabolizing, when it was felt desirable to check the shadow readings by measures at the center of curvature and by the formation of the curve of shape. For the last ten days or so, this was done after every polishing, as, although the shadow test recognizes very minute departures from regularity of figure, it is perhaps not so sensitive to very gradual changes such as those due to slight under- or over-correction.

This was especially true in this instance, where the flat was a little over two thirds the size of the 82″, of which, hence, only a little over half, or just beyond the central hole, could be seen, and consequently the exact position of the knife-edge, its exact focusing, was uncertain, with resultant effect on the shadow pattern. As a result, though the shadow test was essential throughout to insure smoothness and regularity of figure and to determine where polishing was required, the final check on complete parabolization depended upon careful measures at the center of curvature and the resultant curve of shape. These were of great value during the last week of figuring, where the proper length of time for the next polishing was determined solely from past changes in the curve of shape. Thus, on October 11 (see Figure 2) the time required to complete the parabolizing, 1½ hours, was gaged correctly, as seen in the lowest curve, from the change produced by the two previous workings. And here again, the shadow test was essential, for otherwise the high central zone, which had no effect on the measures at the center of curvature, would have escaped notice.

(*To be concluded.*)

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There, in these factories is a dramatic example of how Westinghouse "know how" is doing a job for National Defense.

What is this "know how"? It is the ability to get things done in the best possible way—learned in building products for the general welfare and now used in building materials for the common defense.

The same skill and ingenuity that are building those turbines for the merchant fleet, not long ago built more efficient electric refrigerators and washing machines. Again, the research skill that developed intricate new radio equipment has found ways of utilizing that equipment in important defense work.

At 17 Westinghouse Divisions, and in the plants of more than 300 sub-contractors, our energies are almost exclusively turned to the creation of $400,000,000 worth of defense materials. It's our way of speeding the day when our "know how" will be serving you again—in the home, the farm, and the factory.

Westinghouse

For the Common Defense

Armor-piercing shot
Seadrome lighting equipment for planes
Bomb fuses
Navy ship turbines and gears
Naval Ordnance
Airplane generators
Lighting equipment

For the General Welfare

Street Lighting
Electric Irons
Generators
Electric Refrigerators
Motors and Controls
Stokers

These lists mention only some of the many thousands of Westinghouse products.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., PITTSBURGH, PENNSYLVANIA