CAN COLDS BE PREVENTED? . . . Page 20

SCIENTIFIC AMERICAN

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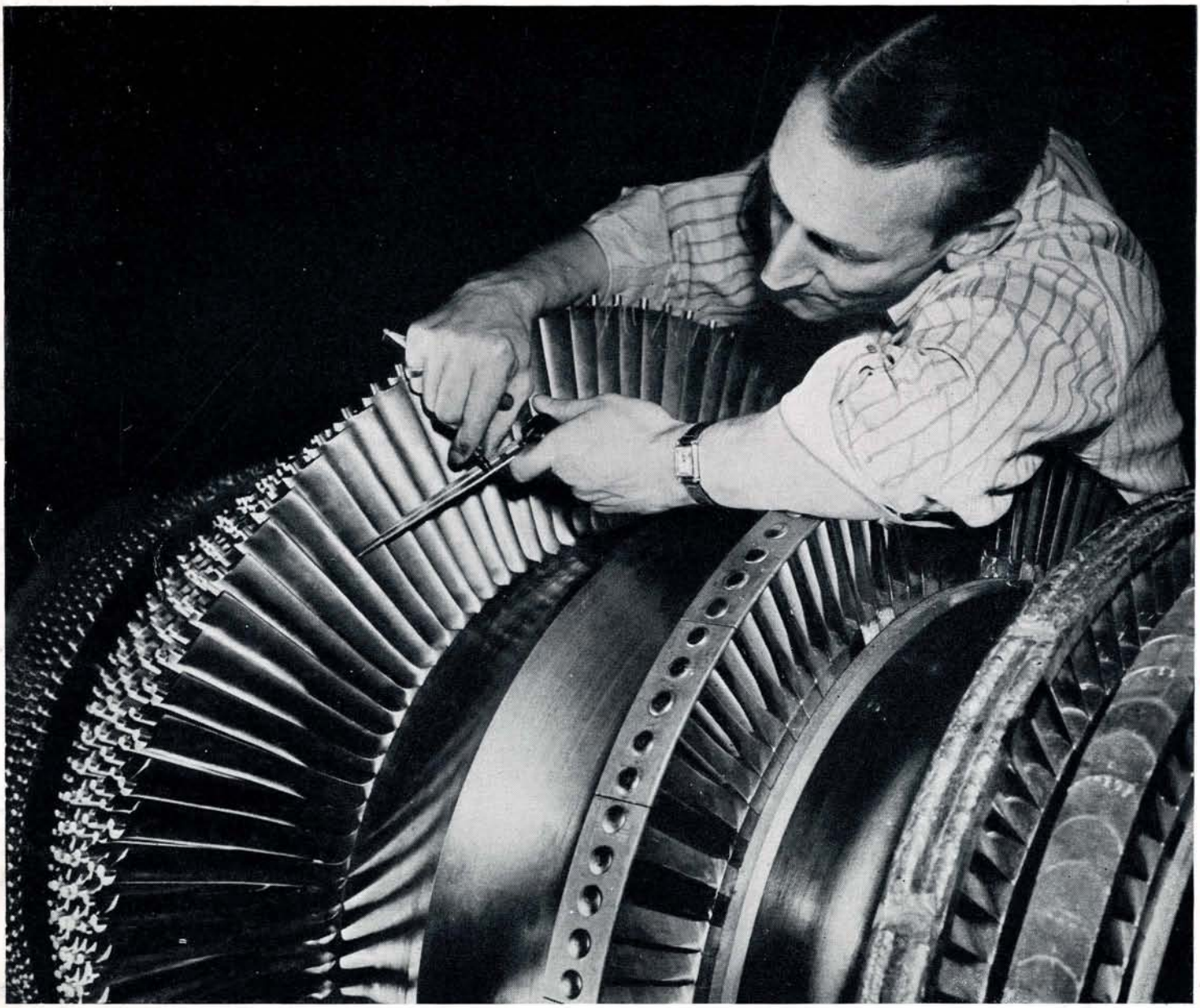


To Extract 2000 Horsepower from Steam . . . See page 1

Which comes first— Your second helping? or our second front?

YOU WANT TO SEE THIS WAR WON — and won quickly. You want to see it carried to the enemy with a vengeance. Okay—so do all of us. But just remember...

A second front takes food... food to feed our allies *in addition to* our own men.

Which do you want — more meat for you, or enough meat for them? An extra cup of coffee on your breakfast table, or a full tin cup of coffee for a fighting soldier?

Just remember that the meat you don't get — and the coffee and sugar that you don't get—are up at the front lines—fighting for you.

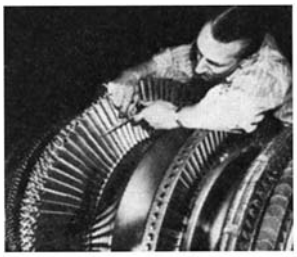
Would you have it otherwise?

Cheerfully co-operating with rationing is one way we can help to win this war. But there are scores of others. Many of them are described in a new free booklet called "You and the War," available from this magazine. Send for your copy today! Learn about the many opportunities for doing an important service to your country.

Read about the Citizens Defense Corps, organized as part of Local Defense Councils. Choose the job you're best at, and start doing it! You're *needed*—now!

Contributed by the Magazine Publishers of America

EVERY CIVILIAN A FIGHTER



CHECKING the spacing between the blades on a steam turbine spindle for a new war cargo ship is one of the exacting inspection operations in the production of these power plants. For the first time in turbine history, such ship power plants — in this case developing 2000 horsepower per turbine — have been standardized and are being built on a quantity basis by the Westinghouse Electric and Manufacturing Company.

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SCIENTIFIC AMERICAN

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

JULY • 1943

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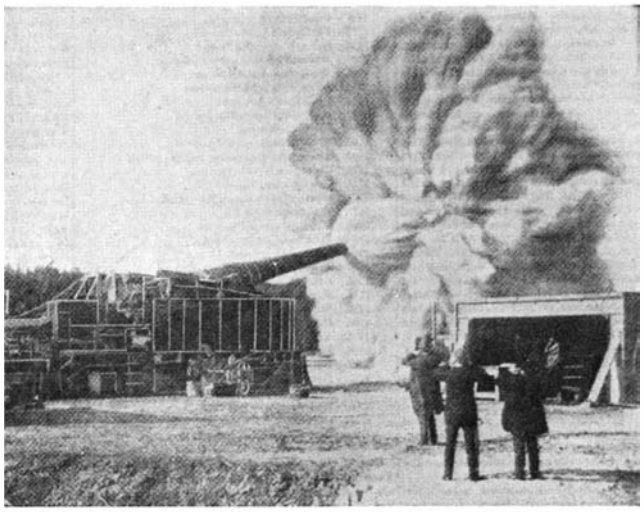
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of July, 1893)

INVENTIVE CAMPAIGNS—"Thomas A. Edison, when he was congratulated upon his forty-sixth birthday, declared that he did not measure his life by years, but by achievements or by campaigns; and he then confessed that he had planned ahead many campaigns, and that he looks forward to no period of rest, believing that for him, at least, the happiest life is a life of work."

GREAT GUN—"Of all the foreign nations that are taking part in the World's Columbian Exposition at Chicago, Germany takes the lead, in extent, variety, cost and superiority in almost every characteristic. . . . The great Krupp gun . . . the heaviest piece of ordnance ever brought to an exhibition, is a 16.24 in. coast defense gun; the total length is 33.5 calibers, or 45 ft. 11 in.,



the length of bore being 41 ft. 8 in., the total weight is nearly 122 tons. This gun has fired sixteen rounds at the Krupp testing grounds at Meppen. During these trials the following results were obtained: The projectile weighed 2,200 lbs., and the charge was 902 lb. of brown prismatic powder; an initial velocity of 1,981 ft. per second was recorded, and the striking energy was 18,594 metric tons. We give a photographic view of the firing of this extraordinary weapon."

CYCLIST TROUBLE—"One evil traceable to bicycling is the confirmed stoop which has already declared itself in many wheelmen, a result so common in the less strongly built bicyclists of the Continent as to have found its way into classification as the 'kyphosis bicyclistarum.'"

CEMENT-IRON BRIDGE—"A new bridge was recently completed over the River Neutra, in Hungary, according to a system devised by Robert Wunsch, and consists of beton arches in which iron skeleton framework has been incorporated. The iron work comprises not simply single iron rods, but complete trusses made up of horizontal upper and parabolic lower chords. Cross girders and tie rods, however, have been entirely omitted and are supplanted by the beton. The wooden false work of the bridge was built to form a series of moulds, each mould constituting one complete bridge arch, and after the iron work had been put in place the beton was dumped in and thoroughly rammed. The work was divided up, so that the beton filling of each arch was completed in one day, and the false work was kept in place for an average of 37 days for each arch."

SUNLIGHT—"In the dark, and at moderate temperatures, the spores of anthrax retain their powers of infection for many months in any of the waters experimented with, fresh or sterilized. But in direct sunlight the spores undergo rapid destruction; and it has been definitely proved that this destruction is directly due to the light rays, especially at the blue end of the spectrum."

CLAMS—"A clam mine, full of live clams and of great breadth and depth, has been discovered at the mouth of the Delaware Bay, off the Flashing Creek shore."

MALARIA—"Dr. H. M. Clark has printed a memoir of his experience with malaria during a residence of nine years in India. How formidable a barrier to civilization malaria is may be inferred from the fact that to this disease alone is attributable not less than half the deaths throughout the world. . . . Only two races are proof against it, the Negroes of the grain coast of Western Africa and the Taurus of Northern India."

STEEL TIES—"The Mexican Railroad has now some 150 miles of track, including the Pachuca branch, laid with steel ties which weigh 124 pounds each, or 126 pounds with the two key bolts."

TELEGRAPH—"The United States minister at Peking, China, reports to the State Department that the Chinese telegraph system has been connected with the Russian system, so that messages may now be sent overland between any part of China, Russia, Europe, and by cable to Africa, North and South America, and Australia. The whole world is now wired and telegraphically connected."

TANK LINING—"A mixture of coal tar and California rock asphaltum has been successfully employed by Mr. R. C. Gemmell for lining a reservoir for the city water works of La Grande, Oregon. The reservoir is of oval shape, part in excavation in heavy clayey soil and part in embankment made from the excavated material, with inner slopes of three to one. . . . The lining consists of one layer of brick on edge, covered by three-eighths inch of the bitumen mixture."

SPEED GOVERNOR—"Perhaps the most severe test that a water wheel governor was ever subjected to is the case of a Pelton wheel running a set of circular saws at the mill of the Red Cross Lumber Company, in the northern part of California. The wheel is operated under a vertical pressure of 485 feet. The saws require to drive them through the log at full feed 125 H.P. They take about seven cuts per minute, thus varying from full load, namely, 125 H.P., to only what is required to drive the saws running free. During this operation the variation in speed is not perceptible."

TRANSATLANTIC—"The designer of the steamers Paris and New York, express . . . the belief that within ten years a vessel can 'leave New York at noon and arrive at Southhampton at noon on the fourth day out.' To do this . . . will require the enormous speed of thirty knots."

A LOT GOING ON IN THIS PICTURE—
AND A LOT GOING ON IN INDUSTRY

It's big, dramatic. You can see it. But you can't see the idea that made it.

You can't photograph ideas. But they win wars. They make jobs. They make prosperity. They make well-being.

They used to come as a revelation once in a while, almost like a miracle to an individual. Now, there are teams that insure them.

Groups that keep ideas flowing. People who know how to dip into the wealth of nature for what they need.

They are scientists. They work together in laboratories.

They are working at the Bell Telephone Laboratories. Thousands of them. This is the biggest industrial laboratory in the world. Once its work was all telephone.

To help your voice reach any one, anywhere. Easily, quickly, at low cost. Now it's war. Day and night. Seven days a week.

Our fighting men see the results of American research every day.

BELL TELEPHONE SYSTEM

Help the war by making only vital calls to war-busy centers. That's more and more essential every day.

OUR *Point* OF VIEW

HOW GREAT THE CHANGES?

THE enormous strides that have been made by science and technology during the past two years point irrevocably toward a bright new world when the clouds of war are dissipated and man can once more turn his hand to the pursuits of peace. Post-war planning is now upon us in full force. Out of such planning, coupled with the lessons learned in the laboratories and plants during the stupendous drive for war production, will come new developments that will stagger the average mind, that will make daily life far different in many respects than it has ever been in the past.

Such statements are irrefutable. Readers of Scientific American have been following the reports—screened as they must be of necessity by the demands of wartime secrecy—of new developments in many fields. Foods, transportation, rubber, construction materials, textiles—the list could go on for many lines—all are being revolutionized by the results of the pressure under which science is now working and will continue to work until the last enemy of peace-loving nations has been subjugated. That the enlightened days to come will be better than any ever known in the past goes without saying.

But will the world of tomorrow be so radically different from that of the past? True enough, there are indications that the "four freedoms" may eventually be guaranteed to every living person and that life in the future will be easier in many ways. The basic fundamental of all existence, however, is the person himself, stripped of the comforts and conveniences made possible by his environment. On this basis, then, will the new world be so far different from the old?

A look into the past may furnish an answer. These great United States were settled by farmers who were largely sufficient unto themselves. With their bare hands they carved a nation from the wilderness, fought for their ideals, laid the foundations for a great future built largely on courage, resourcefulness, and creative energy, salted liberally with a concern for the whole people rather than for the privileged few. This democratic ideal worked. Of course, it had its shortcomings, as will everything ever conceived by man. Yet, it worked. It worked so well that the young nation flourished strong and mightily, gave birth to the industrial era that has made it outstanding among the countries of the world. Through all this the people as a whole remained unchanged in their devotion to first principles.

Life speeded up. Communications drew the far-flung parts of the nation closer together. Transportation brought distant areas nearer, made interchange of goods and thoughts easier and more profitable to all. Technology changed many pictures, giving radio, the automobile, better clothing, better foods, improved materials to the masses. Yet the ideal of democracy remained the unchanging factor in a changing world.

Will the future, then, from this standpoint, be so far removed from the past? We will fly to foreign lands in hours where the same trip formerly required days or weeks. We will have better homes, better automobiles, better communication systems. We will have plastics, synthetic rubbers, other products of the test-tube to make the way smoother or more convenient. We will be at peace with other nations in a world made more liveable by the products of science. But in many respects it will still be the same old world, with ham and eggs for breakfast.—*A.P.P.*

ACCIDENTS?

IS IT derogatory to a scientific discoverer to say that his discovery arose from an accident? Is it little to his credit that, as is sometimes implied, he merely blunders on his great discovery?

In the midst of a most immediate war, British scientists have recently been discussing this question in their scientific journal *Nature*.

The consensus arrived at is that it is not derogatory to say that a scientist made his discovery by accident.

Perhaps in popular, story-book tradition a scientific genius proceeds to his triumphal discovery all according to an ordered plan. He knows in advance precisely what he seeks to discover and he proceeds on an undeviating line toward his goal. In actual fact, this has seldom happened in scientific research. The greater proportion of the big discoveries have been found along the road, generally off it and to one side of it, leading toward the discoveries the scientists originally set out to make—discoveries which, if they are then made at all, prove to be relatively less important than the ones that are made. Some examples:

Minkowski and von Mehring set out to discover the effect of the pancreas on digestion—a most worthy aim. They deprived a dog of its pancreas. As a side observation of an apparently casual sort it was noticed that flies swarmed where the dog had urinated. They stopped to find out why. Sugar was found. Banting and Best were then able to go ahead and discover insulin for diabetics. Suppose, however, that one experimenter had said impatiently to the other, "That's off the main track. Come on and let's get going." We'd then have had a better understanding of the effect of the pancreas on digestion, but diabetics would not have insulin to keep them from dying.

Another example: Roentgen discovered X-rays "by accident." Near a Crookes tube in a dark room was a platinum compound. When the tube was operated he noticed that this compound, which merely happened to be there among the physicist's typical table litter, gave off a dim light. Roentgen departed from the path to his intended goal to discover the X-ray. What the intended goal was is forgotten.

Third example: Becquerel discovers radioactivity through a combination of plausible reasoning and accident. X-rays had been found to be caused apparently through fluorescence. Becquerel knew that some uranium compounds would fluoresce in sunlight, hence he planned to discover that X-rays could be produced by sunlight. He covered a photographic plate with black paper, sprinkled on this some uranium nitrate, and laid the whole in the sun. Result: The plate was blackened beneath the uranium. X-rays, therefore, were produced by sunlight. Being a good scientist he set out, however, to verify the demonstration by repetition. Unfortunately (or not) a stormy period intervened, so he kept the plate in a closet till the sun returned. Because of the interval he then thought perhaps a new plate should be used, but for some reason he *developed the one that had been lying in the dark.* The very same blackening! Gamma rays similar to X-rays had been emitted by the uranium all the time. He followed up the lead given by this "accident" (?) and suggested to Madame Curie the experiments that led to the discovery of radium.

Were these accidents? Here is the nubbin of the matter. The word is a misnomer. In every case—and the history of science abounds with cases like them—the discovery was made through incidents, not accidents; incidents that were not of the scientists' intentional making. For it is no accident when the experimenter pauses to run up the side-alley and ascertain the meaning of the incident. Here is where the greatness lies—many of us (and many scientists themselves) pass straight over trifling incidents which may conceal riches. Among themselves, experimental scientists speak, in such cases, of following up a "hunch." But as "hunches" go, they are much more than the word usually connotes; they are not accidents, they are at worst unconscious cerebration, at best genius.

It, therefore, can be argued that discovery by "accident" represents a higher, not a lower, form than discovery by plotted design.—*A.G.I.*

Personalities in Science

EDWARD C. SCHNEIDER

WHEN a small group of pioneers in aviation medicine gathered in their shack in France some 25 years ago and heard a young, quiet-spoken member of their group expound his idea for a standard test to determine the fitness of aviators to fly, particularly at high altitudes, it is probable that few had any idea that they were approving a plan which would still be in use a quarter of a century later.

It is equally unlikely that any of the group realized that the plan would, some 25 years after, win the John Jeffries Award for 1942 given by the Institute of Aeronautical Sciences.

Edward C. Schneider, Sc.D., professor of biology at Wesleyan University, was the young scientist who originated the Schneider Physical Fitness Index in that shack in France during World War I. A few weeks ago Dr. Schneider was the guest of honor at the Honors Night Dinner in New York of the Institute of Aeronautical Sciences and was recognized for his pioneering research in the field of aviation medicine.

Dr. Schneider displayed an interest in aviation medicine early in life and that interest has never waned. After receiving his undergraduate training at Tabor College in Iowa (his native state), he received the degree of Ph.D. at Yale University and then joined the faculty of Tabor College and later Colorado College, where he taught biology, physiology, and chemistry.

During these years he was keenly interested in the studies of the physiological reactions of mankind to high altitudes at Colorado Springs and Pike's Peak and in 1911 was a member of the Anglo-American Pike's Peak Expedition studying mountain sickness and adaptation to high altitudes.

When the progress of World War I brought air warfare to the front, Dr. Schneider was a "natural" for the post of physiologist in charge of the Medical Research Laboratory set up in Washington by the Medical Research Board to investigate conditions which affect aircraft pilots and to provide tests and apparatus with which to counteract the ill effects of high altitude flying.

The aeromedical laboratory was later moved to Hazelhurst Field on Long Island, then one of the larger pilot training centers, and a school for training flight surgeons was established, its first courses of study being arranged by Dr. Schneider. When a group of officers trained at the school were sent to France to establish a laboratory at Issoudun, Dr. Schneider, then a Major, went along as a member of the Medical Research Board heading the group.

It was at this laboratory, about 150 miles from the battle front, that the Schneider Physical Fitness Index was developed and first put into use. It is a system of scoring men as to health and physical fitness by a simple standardized test of the heart and circulatory condition of the individual at rest and after a prescribed amount of activity. The test indicates, among other things, fatigue and general unfitness of the body before the condition becomes outwardly apparent. Thus the onset of "staleness" in a pilot who has not had adequate rest or recreation over a considerable period can be detected before his condition becomes serious and a possible nervous break occurs.

In addition to the research leading to this fitness test, Dr. Schneider has done a great amount of research on the effects of high altitude on the human organism, learning why some persons are able to withstand the ill effects of high altitude to a greater extent than can others. He has also devised apparatus for measurement of and protection against the effects of low oxygen intake. Experiments were made in high altitude airplane flights as well as in low pressure test chambers.

When the laboratory was reorganized as the Army School of Aviation Medicine, Dr. Schneider became physiologist and director of research as a Lieutenant Colonel. Until 1925 he divided his time between this and his post as Daniel Ayres Professor of Biology at Wesleyan.

Today, in his 69th year, Dr. Schneider is little changed from the days when he originated the "Schneider test." Aviation medicine is still his chief interest and his only regret is that he cannot play a more active part in the world conflict. He is, however, continuing his research in his quiet unassuming way and his findings may yet play an important part in aviation's part in winning the war.

99TH YEAR SCIENTIFIC AMERICAN JULY 1943

SKY SENTRIES ON GUARD

Important U. S. Centers Are Protected by Barrage Balloons

R. G. PICINICH, JR.

HIGH OVERHEAD, the drone of many motors was heard as a squadron of Goering's Luftwaffe bombers appeared out of the East and headed across the English Channel. Spewed from captured French airdromes, the planes were on their way to carry another air blitz to London. It was a glorious moon-light night and visibility was perfect, except for occasional intervals when the full moon hid behind passing clouds.

A few minutes before ten o'clock, the first of the Nazi bomber fleet approached the British coast, flying in echelon. Soon the airplane spotters and fire watchers on the house-tops saw 24 Stukas silhouetted against the moon, no bigger than flies. In the distance could be heard the roar of many larger raiding craft. Crossing the coastline, each of the enemy planes dropped a single bomb at the shore installations far beneath them. This was more for psychological reasons than for destructive purposes. As the screaming projectiles fell, the gunners on the ground and house-tops sent up star shells, shining with magnesium brilliance, to high-light the ships of the attackers. Then, a green flare shot up just ahead of the first bomber and began to burn acidly in the sky. The glare lighted up the plane with a ghostly light and the sky behind was turned into a blue-black curtain. Scores of white flares followed, dancing like gnats about the on-coming Stukas, and making each stand out in bold relief. As they flew inland, the bombers were pursued by a myriad of crisscrossing tracer shells and anti-aircraft fire.

The target tonight was the highly important Battersea power plant. The plant area was ringed about with barrage balloons. During the day, the balloons were lowered so that Nazi reconnaissance fliers could not see them. These hydrogen-inflated bags, with their intricate pattern of strong wire cables forming a formidable spider-like web, were directly in the path of the on-rushing bombers—on guard against their approaching dive attack. The sky sentries were placed at heights varying from 10,000 to 2,000 feet.

Concentrating on the target, the Stukas flew ahead swiftly and with deadly rhythm, the anti-aircraft fire forcing them to remain high in the air. As spotters and watchers continued to gaze aloft, the leader approached the objective and the dives started. The lead plane peeled off and plumeted down, at a speed of more than 400 miles an hour. It was quickly followed by the rest of the fleet, which dove like a wedge of destruction toward the power-generating buildings. A cloud had obscured the moon just as the plunge toward the earth began and nothing was visible to the pilots in the blackout below, particularly since they had just left the glare of the magnesium sky torches. Down, down, down, with the wind shrieking through the ailerons.

The bombardiers of the larger raiders dropped some of their eggs on the city as they sped overhead. The earth trembled to the blasts of the bombs spewed from the death-dealing aircraft. Fires broke out in many different sections at once and a black pall of smoke hung above the roof-tops. Columns of debris reared skyward, slowly mushroomed and fell back. A tremendous explosion resulted when several bombs landed in a concentrated area and went off simultaneously, ripping the curtain of smoke apart in a shower of sparks. From below, the 3-inch 50's barked—the 20mm's spat and sprayed.

NOW THE Stuka squadron leader was on the target. His plane was coming down so fast that he never saw the barrage of balloons floating above. He crashed into the wire net, held aloft by the swaying bags, with such force that the rebound of the steel cables sent his Stuka hurtling back in the direction from which it had come. The ship, a mass of twisted metal, disintegrated in the air and went plummeting down to the inferno in the streets below.

At that moment the second bomber pilot saw the fatal predicament of his leader and, realizing the reason for the crash attempted to pull his ship out of its plunge so that he might rise above the obstruction. As he counted the seconds, the plane started up—slowly up, it seemed. As it gained altitude, the pilot suddenly saw a dark shadow above. It was sausage shaped and appeared to be of immense bulk as it loomed out of the dark. Too late! He could not clear it and plunged directly into the huge envelope. There was a rending, tearing sound as the plane went through the fabric, followed by a terriffic explosion as the hydrogen in the barrage balloon ignited. The airplane, ablaze, went spinning over and over toward the shambles below. The pilot could be seen by watchers, sitting in the cockpit, solid with flames, as he gave his life for his Fuehrer.

THE SPIDER-LIKE strands of the steel net, which had been held up by the gas bag, came tumbling down—their weight rending, tearing and crushing anything and everything in their path. On its way down, the main cable, lashing about, struck a third one of the dive-bombers, when the machine was less than 2000 feet from the ground. The blow of the steel strand crashed through the gas tank and a flashing spark set the petrol afire. Blazing fiercely, and twisting over and over, the plane plunged downward when, suddenly, another speck appeared behind it. It was the pilot. For a breathless moment his chute fouled the fuselage, then he broke clear. In a matter of seconds the airplane struck.

The Luftwaffe pilots in the rear of the formation had witnessed the fate of their fellows and were making desperate attempts to either ride over or swerve aside from the barrage of balloons. Most of the bomber craft were able to do so, but one, brushing against one of the steel strands of the sky net, was blown to pieces in the air by the thousands of volts of static electricity with which the wires were charged. As the plane exploded, its gasoline tanks burst into a mass of flames and spattered blazing fuel far and wide. The fuselage went into its last glide, losing altitude and streaming fire like a thrown torch.

Another of the Stukas struck the main cable of one of the balloons. Although the bomber did not crash but managed to survive the impact, the steel strand which anchored the gas bag to the ground parted and away soared the sky sentry. With its cable lashing and slashing in deadly swings, the run-away craft was blown inland by an offshore breeze. Careening along on its rampaging flight, the balloon's trailing cable came in contact with a water tower atop a London

Goodyear Photograph, Approved by U.S. War Department

Barrage balloons, plus a new naval airship and two privately operated blimps

hostelry, coiled about it like the tentacle of an octopus, strained for a moment and then tore the tank loose, sending tons of water cascading down on the surprised blitz workers below who were expecting fire, bomb fragments, and mortar—but not a waterfall from the sky. Free from this obstacle, the craft went sailing along again with the steel strand twisting and hissing snake-like as it swung through the night air. This time the cable wound itself about a church steeple and could not tear away. One of the Stukas, which had jettisoned its bombs and was winging toward the Channel, sprayed the bag in passing with incendiary bullets and the hydrogen-filled envelope exploded with a violence that sent the steeple crashing. The burning barrage craft fell on the church roof and soon that edifice was a mass of flames.

WHILE incidents like the above have not as yet been experienced in the United States, we are prepared to meet enemy dive-bomber attacks, for we have built many hundreds of barrage balloons and are continuing to build them in ever-increasing numbers. Few persons have seen them and few probably will, unless or until an air attack is made on us. Battalions of trained personnel and the craft are housed in convenient places near vitally important targets—industrial and war plants, bridges, ship anchorages, overseas bases, sources of power supply, rail terminals, ammunition supply depots, and a hundred other critical points which we must defend at any cost.

Both British and American military experts are agreed that the barrage balloon is the best defense yet devised against the dive bomber. The sausage bags will be used in large numbers to defend important cities, such as the Nation's Capital; New York and Boston, on the East Coast; San Francisco and Seattle, on the West Coast, together with other installations vital to our war economy. To ring these about completely with anti-aircraft artillery would require a tremendous amount of costly equipment, but to cover certain areas with the less costly balloons and other sectors with anti-aircraft artillery will simplify the task and still provide a strong defense. Our army officials have been farsighted in this matter and are seeing to it that we shall be supplied with a sufficient number of barrage balloons for adequate protection in the event of an air invasion. Most of the large rubber companies in the United States have been given contracts to produce the gas bags and are turning them out in quantity. The number of these balloons now available for the defense of our important cities and vital war installations is, of course, a military secret; enough, however, we are assured, have been produced to date to make our most highly vulnerable areas safe from Nazi and Jap dive bombers.

Aside from the uses already mentioned, the sky sentries are one of the best added defenses in the vital military zones of the Panama Canal, the Welland Canal, and the Sault Sainte Marie installations. To be assured of hits on these small targets, enemy pilots would find low flying or dive bombing necessary. By placing the bags, with their attendant deadly sky nets, in sufficient numbers about the areas, the enemy will be forced to fly at a height of more than a mile. The bomber's chances of registering a hit, at that altitude, even if he weathers the anti-aircraft gun fire, will be immeasurably less than it would be if he were free to approach close to the locks before releasing his bombs. The English have successfully protected Port Twefik, important Red Sea harbor through which much lend-lease material flows, at the southern end of the Suez Canal, with a screen of balloons. A recent and most effective innovation in the British Navy was to attach the gas bags to ships in convoy approaching home port, to protect the flotilla from enemy pilots who came out to attack. Since then, squadrons of Stukas have turned tail on seeing the balloon-protected ships.

When dive-bombers appear in the sky, speed in getting the bags into the air may spell the difference between the success or failure of a raid. No plane will willingly come near the dangling steel net held up by these sky sentries. The balloons are invaluable to anti-air-

"Staking out" a four-lobe barrage balloon where housing facilities are not available

craft gunners because they keep bombers high in the air, where the range of sound-detecting apparatus is truer. Failure to raise the usual barrage of balloons in one London area during a daylight vengeance raid, resulted in six Nazi raiders getting through the city's defenses. A school lost 48 killed, mostly children. Air Minister Sir Archibald Sinclair explained that the craft were down because of maintenance work being done on them. This would not happen in the United States for our men have been trained to use replacement bags in the event that any are temporarily out of service for repairs or routine inspections.

IN TODAY'S global war, barrage balloons are the only lighter-than-air craft yet used by any of the belligerents—except for our effective use of the blimp for coastal patrol and convoy duty against the sub menace. Preliminary studies in the use of the balloons were made in this country by the Army Air Corps and this arm of the service is still charged with the development and procurement of equipment for the sausage bags. However, the craft are now in the charge of the Coast Artillery Corps, the only branch of our combat army that does not seek out the invader to attack him. Its purpose is to keep the invader away from places which he wants to attack. The first army barrage balloon school to be opened by the Coast Artillery was at Camp Davis, North Carolina, on July 28, 1941. Another training center is maintained at Camp Tyson, Tennessee, where there are facilities for the schooling of over 7000 men at one time.

Major General J. A. Green, Chief of the Coast Artillery, says, regarding the barrage balloon: "The number of airplanes brought down by these balloons is not to be regarded as a criterion of their value as a defensive weapon. In this respect they are in the same category as sea-coast artillery. If these coast batteries are so feared by the enemy as to prevent him from coming within range of their guns, they accomplish their purpose. It is just so with barrage balloons. The enemy, if he knows a barrage of the craft is in front of him, will avoid it every time. Since the gas bags can be anchored to trucks and readily moved about from place to place, they constitute a constant headache to the dive-bomber."

As to our being attacked from the air, Axis pilots have been kept so busy in the European, North African, and Pacific war theaters that they have not yet found themselves in a position to pay us any long-promised visits. The Fuehrer's intuition, particularly after the Russian debacle, should warn him that Nipponese boasts, made before the Jap withdrawal from Guadalcanal, will never materialize —just as the boasted taking of Stalingrad never came to fruition. It will be our diplomats who will direct the signing of the peace from Washington! Until then we will be prepared to protect not only the Capital but every other American city and critical installation from dive-minded enemy pilots—protect them with barrage balloons and with every other modern weapon and vehicle of offense and defense that is available.

● ● ●

WAR PRISONERS
Study and Teach Science Behind Barbed-Wire

MANY outstanding scientists, as well as former teachers of scientific subjects in universities, colleges, and schools, are now in the war prison camps of the belligerent nations, according to Dr. Darius Davis of the War Prisoners Aid of the Y.M.C.A.

Such gifted prisoners help themselves and their fellows to endure the tedium of life behind barbed-wire by acting as teachers of scientific subjects in the educational programs for prisoners, stimulated and guided by the War Prisoners Aid of the "Y." Some of the prisoner-teachers have even written their own texts.

"Science holds an important place in the curriculum of this strange prisoner university, with branches in the war prison camps of almost all of the belligerents," says Dr. Davis. "British prisoners in Germany alone have requested more than 420 university courses! The aim of the program is not only to prevent despair and deterioration in men penned-up and idle, but also to preserve for the post-war world the wealth of scientific attainment in today's prison camps."

Sugar, A 'Chemically-Pure' Food

Highly Technical Industrial Processes, Plus Efficient Operation of Plants, Produce Beet Sugar at Low Cost

ROY H. COTTRELL
Vice President and General Superintendent, Amalgamated Sugar Company

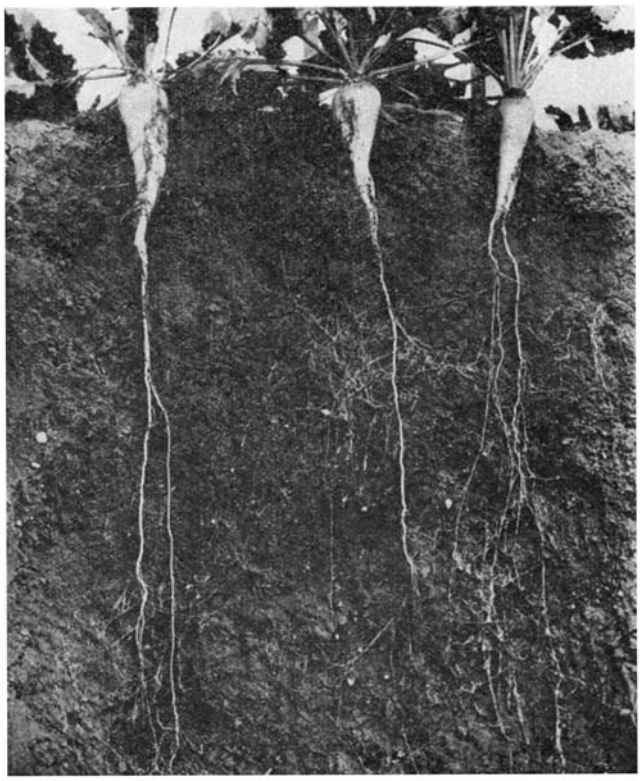
SUGAR has always been a low-price food, and is even today. Yet sugar, whether derived from cane or beets, requires high skills and relatively large investment on the farm, as well as heavy investment in processing plants and highly technical processing. The laboratory alone in a sugar factory requires greater investment than the total plant required to clean navy beans on a large scale, for example, although the price of dried navy beans at any corner grocery is about 50 percent higher per pound than the price of refined sugar. Yet beans constitute a crop easily raised in a short season with minimum agricultural hazard, require almost no processing, are non-perishable, and need no special handling. As a matter of fact, no other food product, which requires a raw material subject to agricultural hazards as well as highly technical processing and high standards of purity, is generally sold to the public at such a low price as sugar.

This is only one of the aspects of sugar that give it new perspectives against the background of war. Long an essential part of the diet, sugar has now become more than ever important in the conservation of other foods by canning, and one of its by-products—molasses—is a raw material for ethyl alcohol, which has a wide variety of essential war uses.

The outbreak of the war changed almost overnight the conditions within the sugar industry. With the loss of the Philippines, the United States was cut off from nearly a million tons of sugar which is normally received from that source. Submarine warfare in the Caribbean made shipment from Cuba and Puerto Rico hazardous and uncertain. To some extent the usual commerce in sugar between Hawaii and the mainland was interrupted. The combination of these circumstances made the United States more than ever dependent on internal production of sugar.

The backlog of beet sugar at the beginning of the war may, in large measure, be considered a reflection of advances which have been made within the industry since World War I. Not only has average production doubled within that period, but significant improvements have been made in the agricultural and industrial techniques.

Eighty-five beet sugar factories are scattered from Ohio to California, but in a true sense they do not manufacture sugar. Sugar is "manufactured" in plants alone, by the process of photosynthesis. Man contributes to sugar production only to the extent that he devises ever more efficient methods of extracting sugar from the cells of plants. The sugar of commerce is sucrose, a chemical compound having the formula $C_{12}H_{22}O_{11}$. Sugar cane and sugar beets store sucrose in relatively larger quantities than other plants, and for that reason they have become the most important sources of commercial sugar production. The completely refined product from these two sources is identical in all respects and may be used interchangeably for all purposes.



"Worm's eye" view of sugar beets ready for harvesting

Although there are minor variations in the details in the processes of extracting sugar from beets, in general they consist of five major steps: Extraction of sugar from the plant tissues in the form of dilute juice; purification of the extracted juice; concentration of the sugar syrups; crystallization; and recovery of the crystals in final commercial form.

After the beet roots have been washed to remove soil and other foreign matter, they are sliced into short, thin strips resembling shoe-string potatoes and called "cossettes." These cossettes are introduced into a diffusion battery, which consists of 14 vertical, cylindrical tanks which will hold several tons each. A fairly concentrated solution of sugar in the form of beet juice is passed through the fresh cossettes, and by a combined action of diffusion and osmosis a part of the sugar in the cossettes is recovered in the juice. The juice is drawn off for further treatment, and the cossettes are treated again with a juice of somewhat lower concentration. Again the juice takes up a part of the sugar in the sliced beets, and the juice so obtained is used to treat fresh cossettes. In this manner the sliced beets are treated with juices of progressively lower sugar concentration, and in each step the juice gains sugar and the slices lose it. In the last of 11 such treatments, water is passed through the slices.

When the cossettes have been fully subjected to the extraction processes, they are pumped to silos or to drying plants, and eventually are used as stock feed. They contain about 0.2 percent of sugar, the recovery of which would entail a cost in excess of the value of the sugar recovered.

The "raw juice" drawn off from the diffusion battery, containing approximately 13 percent of sugar, is next treated to remove the maximum amount of non-sugars before crystallization. The method universally employed consists in rendering the non-sugars insoluble by heat and chemical reagents, and in removing the resulting precipitate by filtration. The extent to which the non-sugars are eliminated determines the amount of sugar which can be recovered by crystallization.

The temperature of the raw juice is first raised to 85 degrees, Centigrade, and is then pumped to the "first carbonation station." Here milk of lime is added to the juice, the mixture is agitated, and carbon dioxide bubbled through it. As CaO and CO_2 react to form $CaCO_3$, a floc is formed which occludes suspended solids. The addition of carbon dioxide is continued until a definite floc appears, or until a predetermined level of alkalinity is reached. The juice is then passed through heaters and subsequently filtered.

The resulting juice is amber-colored and sparkling clear, having lost more than a third of its organic non-sugars during filtration. The organic non-sugars thus removed form a part of the filter cake which is washed with hot water to free it of juice and discarded as waste. The wash-water, known as "sweet water," is

used in the preparation of milk of lime and the sugar it contains is ultimately recovered.

After a second carbonation and filtration, the juice is pumped through a heater to the top of a tower in which it trickles down over baffles. Sulfur dioxide gas is introduced at the bottom of the tower and spent gases are drawn off at the top. Sulfur dioxide serves to lower the alkalinity, reduce the viscosity, partially bleach the juice, and kill bacteria.

The juice is then filtered once more. It is now a light, straw-colored liquid of about 12.0 percent concentration of sugar, and about 13.5 percent total solids, including sugar.

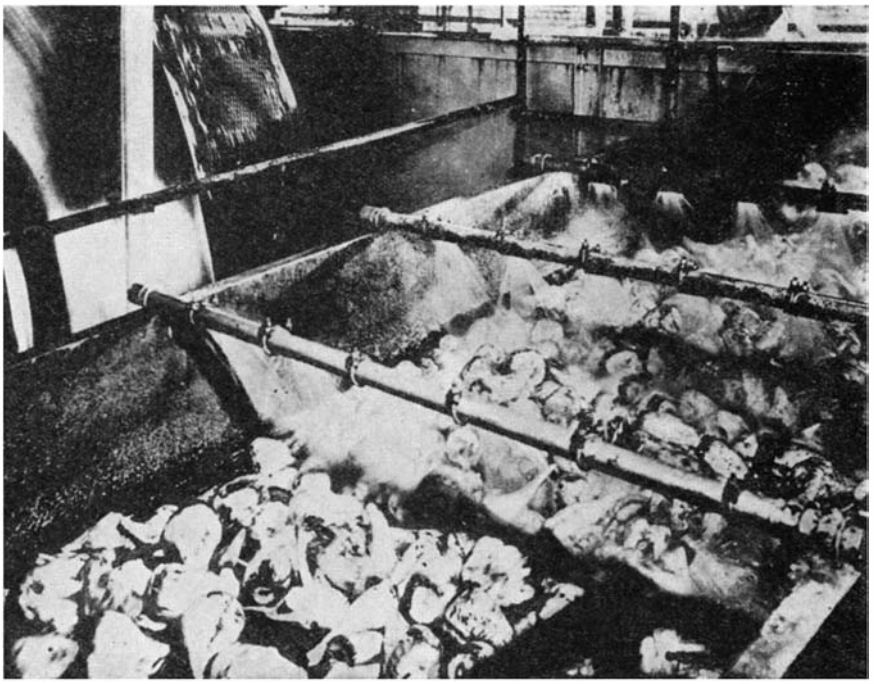
CONCENTRATION is accomplished in two operations. A preliminary concentration takes place in multiple-effect evaporators, followed by further concentration in the vacuum pan. Operation of the evaporators is entirely a mechanical process and will be discussed in connection with a description of fuel economy methods later in this article.

After leaving the evaporators the syrup, now having a concentration of about 65 percent sugar, is heated, blended with melted low-grade sugars and syrups from subsequent processes, and filtered. It is then drawn into the vacuum pan and boiled until supersaturation occurs and seed crystals appear. Samples are drawn from the pan frequently and examined by the operator to determine concentration and the number and size of crystals.

When a sufficient number of these seed crystals has appeared the operator reduces the degree of supersaturation by raising the temperature and by the addition of unsaturated syrup. From that point forward, the operator adds syrup at a rate which will maintain the appropriate degree of supersaturation. Seed crystals previously formed grow under these conditions, but no new crystals are formed. The operator must be able to judge the point at which no more seed crystals will be formed in order that the crystals will be of a desired size when the pan is full. The process of "boiling" requires the highest skill of any operation in the factory.

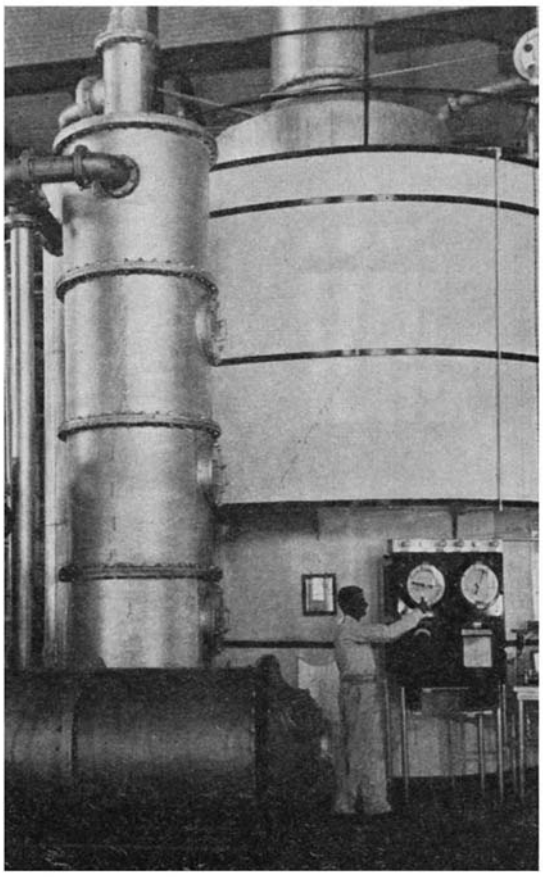
Once the vacuum pan is filled and the sugar crystals have reached the proper size, the contents are dropped into a jacketed, heated mixer located directly above centrifugals. The mixture of crystals and syrup is called "massecuite" or "filmass"—terms borrowed from the French and German.

The massecuite is next introduced into a centrifugal. The basket of the centrifugal is perforated, and lined with a brass screen having perforations so small that sugar crystals cannot pass through them.



When sugar beets enter a factory, they are first thoroughly washed, after which they are lifted by revolving paddles to a "roller picking table," shown above, where jets of water remove any remaining foreign matter

A typical sulfur station in a sugar-beet factory, where the extracted juice is treated with sulfur dioxide



With the centrifugal in motion, syrup is forced through the screen and basket walls and escapes into storage tanks. Sugar crystals are retained around the basket lining. There, while the machine is in full speed, the sugar is washed with hot, distilled water to remove adhering syrup. On further spinning the sugar is dried to about 1.0 percent moisture content. From the centrifugal the sugar is passed through a drier, in which the moisture content is reduced to 0.025 percent, and the sugar is ready for packaging and delivery to market.

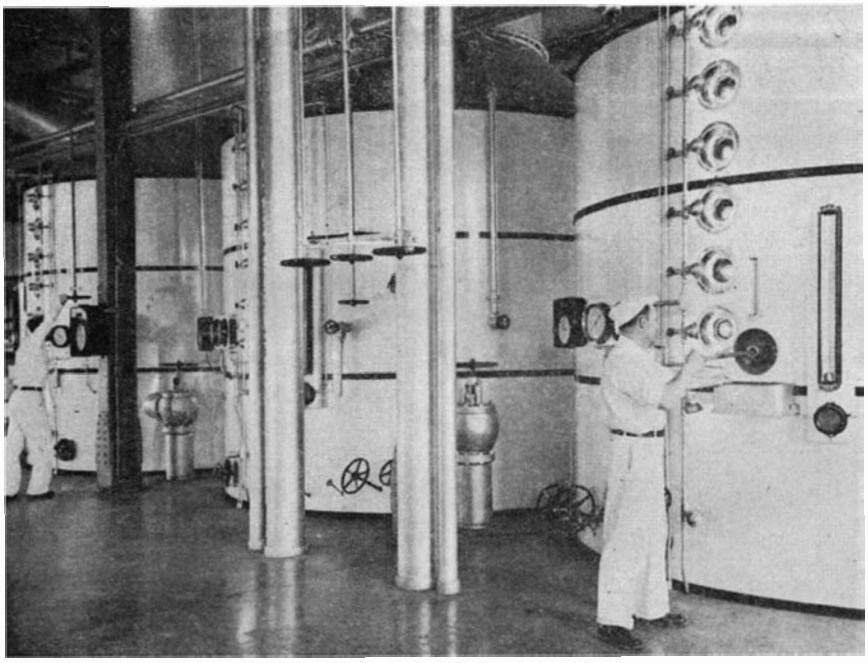
SUGAR for household use must meet rather simple, easily attained standards of purity, sanitation, size of crystal, and packaging. On the other hand, certain industries such as baking, confectioneries, preserving, canning, and soft drink manufacturing, have developed such highly technical procedures that the sugar used must meet exacting specifications. Since a beet sugar processor operates for a relatively short season of the year, he cannot anticipate his sales with an accuracy that will permit him to set aside particular lots of sugar for particular buyers. He must, therefore, maintain high technical standards for his total production.

Except for highly specialized use. the following specifications are typical of refined sugars offered in the general market:

Moisture	0.025 percent
Mineral Ash	0.009 "
Sulphates	Less than 5 parts per million
Organic non-sugars	Trace

In addition, a syrup formed when sugar is dissolved in distilled water in 50 percent solution must be water-white and free of turbidity. It must not show appreciable turbidity upon addition of ethyl alcohol.

It will be evident to the chemist that commercial refined sugar is more highly refined than many laboratory reagents



Vacuum pans for concentration of beet-sugar juice

graded "chemically pure," and in addition it must meet the biological standards of a pure food.

How is it that a "chemically pure" product can be placed on the market at the current prices for sugar? The answer lies in part in the technical efficiencies and economies practiced in sugar manufacture, among which the control of fuel may be cited as an illustration.

In a typical factory, pulverized coal of about 12,300 BTU is burned in two boilers. At maximum load each boiler generates 100,000 pounds of steam an hour at 200 pounds pressure. Efficient generation of steam requires this pressure, but since the pressure is too high for safe use in the manufacturing process, it is put through turbogenerators, and the exhaust at 22 pounds is used in the process. As a result, sufficient power to operate the 300 motors in the plant is obtained as a by-product of the pressure reduction. In fact, an excess of power could be generated since some live steam is added to the exhaust to furnish sufficient process steam.

The exhaust goes directly to the first effect of a quintuple-effect evaporator system. Vapor removed in the first effect is used as steam in the steam-chest of the second; vapor from the second is used in the steam-chest of the third; and so on until the vapor from the last effect is passed to the condenser. All non-condensible gases are removed from the condenser by a vacuum pump. The temperature difference between the exhaust steam in the first effect and the boiling temperature of the juice in the last effect may approximate 70 degrees, Centigrade. Divided between the five effects it is sufficient to insure a rapid rate of heat transfer through the walls of the tubes.

As a result of this system the live steam first furnishes power; then it is used five times over in evaporation. But this is not all. Vapor from the first three effects is also used for the juice heaters and vacuum pans. The heat remaining in the condensate from all effects and the pans is partially recovered by using the water for boiler feed water, for washing press cake, and for other process purposes. It is pure, distilled water. The evaporators in a medium-size plant remove in excess of 100 tons of water every hour for 24 hours a day. Efficient combustion of coal in the boiler furnaces, a high boiler efficiency, and economic use of the steam generated, result in major fuel economies. Where formerly it required as high as 160 pounds of coal to produce a pound of refined sugar only 60 or less are now required. Since a plant of this size produces 360 tons of refined sugar per day, the saving in coal is a substantial amount.

In recent years similar although less spectacular savings have been made in the use of other operating supplies, all leading to the low sale price of sugar to the consumer.

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DIE PRODUCTION
By New Method Reduces Time and Labor Requirements

LARGE-SCALE manufacture of "template dies" for the aircraft and similar industries, as well as fixtures, will, by new production methods, save 3/4 of the time required to produce the dies while reducing die cost 65 percent. Hundreds of individual dies have already been produced by Algoma Products for the aircraft industry as a result of a preliminary announcement of this new development to a few aircraft manufacturers.

In view of the fact that it is necessary for the aircraft industry to continuously modify designs of aircraft as battle experience is gained, it has become particularly vital that such changes shall be effected in the minimum of time. In the past, it has taken a long time to prepare die designs and produce the new dies required before a change can be put into effect. It is claimed that with Algoma template dies and the production process which has been evolved, it appears possible to do in a few hours what normally requires weeks, even months. The new dies eliminate entirely the necessity for separate die design and do not require highly specialized production equipment. Moreover, the process has been laid out in such a manner that large numbers of die makers are not required. Much of the production can be handled by mechanics with only normal skill in the operation of specific types of conventional machine tools.

ODOR PROBLEMS
Present a Challenge to Industrial Chemists

THE IDEA of a universal deodorant which would, by physical or chemical action upon any odorous substance, completely destroy it and thus do away with its odor, without introducing any odor of its own, has been proposed from time to time by ambitious inventors, but so far it is still just an idea.

When all of the usual approaches to a deodorizing problem fail—and they do frequently—the art of "odor neutralization," which is a branch of perfumery, may help. While by no means universally applicable, this method utilizes the offending odor as a constituent of a "bouquet"—as it were—of various aromatic substances, so that the offending odor is transformed to a pleasant or even a neutral one without any need of "covering it up" by sheer brute force of an overwhelming stronger odor.

The "odor neutralization" method has been very successfully applied in a large number of industrial instances, such as the rubber, textile, glue, and paint industries, to mention a few. The selection of the correct deodorizer or "reodorizer" is a highly specialized job—there is no such thing as a universal deodorant in this line, either. The laboratories of Givaudan have solved a number of such problems which are today making many articles of commerce more acceptable to the public. Usually the "deodorized" articles are rendered almost neutral, thus causing little comment among the public. But the initiated know and appreciate the value of these deodorants since they have seen their sales go up after they were used. The problem of neutralization or reodorization is a particularly acute one today for the synthetic rubber industry.

MICA REPLACEMENT
New Synthetic Has Great Possibilities in Electronics

A SERIOUS shortage of our strategic mica reserve, now largely imported from India by cargo planes, has opened enormous possibilities for the use of a new synthetic in electrical condenser-development work for electronic apparatus having Army and Navy applications.

The new synthetic plastic, "Polectron,"

achieves importance in two ways—first, as a primary substance materially reducing the drain on our domestic and imported strategic mica stock pile; second, as a dielectric material possessing controlled properties having wider applications than mica.

The composition and production of "Polectron" synthetic must remain a military secret until after the war. It will be made available to the electronic industry, thus releasing mica to other uses for which no substitute has yet been found.

As a part of its expanded research and development program, General Aniline and Film Corporation developed Polectron synthetic in a remarkably short period of time. This required by-passing intermediate steps normally taken in peace times between laboratory and plant production. Omission of these steps may bring unforeseen problems and even delay in plant operation. However, priorities were granted for the immediate production of Polectron synthetic based upon the following considerations: It will save strategic mica and thus reduce the present drain on the imported stock pile. The continued availability of sufficient block mica, transported to the United States by cargo plane, is uncertain. It is estimated that one ton of "Polectron" fabricated into mica replacement material will replace from 10 to 15 tons of imported block mica, according to its use. "Polectron" can be used in the production of electronic apparatus without material changes in equipment or methods of manufacture.

Polectron synthetic is now undergoing further experimentation, pointing toward the solution of major electronic problems important to the war effort.

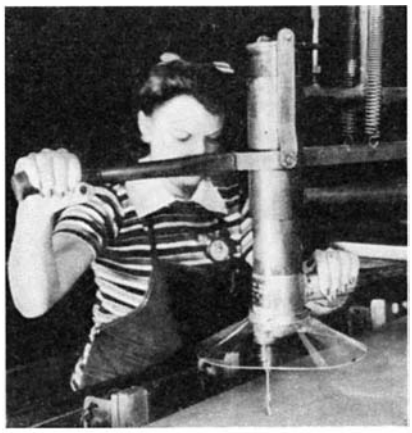
WAR ON ACCIDENTS

Turns Attention to Industrial Safety Shields

AMERICAN workers are becoming more and more safety conscious. That's not new news, but it's good news for the production front. More than 42,000 war workers lost their lives the year after Pearl Harbor because workers chose to risk a particle in the eye rather than wear safety goggles, or preferred to take a chance on burns and broken fingers rather than bother with protective "gadgets." The score that year must have pleased certain gentlemen in Europe and Japan, but it was a mighty sore point over here. To pull the accident rate out of this rut, the National Safety Council early in the war launched an all-out drive to make workers more aware of the importance of being earnest about safety devices. Results have been good. In one plant, eye-injuries—which formerly accounted for 32 percent of medical treatment cases—dropped to half in five months. In all plants workers have become so safety conscious they not only willingly co-operate in the use of devices available, but also spend time dreaming up some of their own.

One of the favorite materials from which workers now cook up safety devices is a transparent plastic, scraps of which are often left over from the Plexiglas bomber "noses," gun "blisters," and other enclosures made in aviation plants. This material has virtually perfect transparency and high impact strength, but equally important is the fact that shields are made simply by heating Plexiglas sheets a little hotter than boiling water, cooling over a form, and trimming to size with ordinary saws.

Beech Aircraft workers, to protect themselves from flying tacks in making



Safety shield prevents accidents

fuselages, have adopted Plexiglas face shields; Consolidated has worked up transparent Plexiglas skirts for drill presses; Bell Aircraft's electrical department places transparent Plexiglas shields over soldering pots to prevent spattering of molten metal; at Republic, tough, transparent saw-shields protect workers from metallic particles; at McClellan Field, Plexiglas workers have devised safety gadgets ranging from Plexiglas ear plugs to machine shields.

LACTIC ACID

Makes Sour Milk Sour, Has Many New Industrial Uses

LACTIC acid is a substance that people have known by taste for thousands of years, but it is only recently that it has been thought of as anything more than the compound that makes sour milk sour. It can be made very easily and cheaply from whey or other sugar-containing agricultural by-products, and recent research has made possible new and extensive industrial uses for lactic acid.

Because of the unusual structure of this acid, it may be converted into several interesting series of products. The acrylates, which belong to one of these families of compounds, have the property of forming flexible, tough, transparent substances that can be used as flexible glass or for impregnating material in moisture-proof clothing and packaging. One acrylate produced in the laboratories of the United States Bureau of Dairy Industry is a combination of lactic acid from milk and a compound from oats, thus combining by-products of two agricultural crops.

When water is removed from lactic acid, its molecules join in long chains that no longer possess the chemical activities of the simple acid. This so-called polymerized lactic acid is a resin that can be used in making lacquers and protective coatings for metal containers such as the cans used in transporting milk and those used in canning evaporated milk, vegetables, and similar products. Thus it may be substituted in some instances for metal coatings now on the restricted list. It may also be used as a glue in laminating wood and paper.

Lactic acid esters are particularly efficient solvents for many industrial lacquer resins. The slight tendency of these esters to form free lactic acid has prevented their very extensive use as solvents. That fault is being overcome in research now under way.

RUBBER SUBSTITUTE

Consists of Felt Coated With Synthetics

STRIPS or die-cut pads made of a new sealing material are being used in place of priority-dominated rubber materials which were formerly used for the same purposes. The substitute consists of felt coated with a layer of any one of several different synthetic rubbers according to the ultimate purposes. The resulting cushioning characteristics are similar to those of the original felt, yet the coating eliminates the absorption characteristics of untreated felt.

PLASTIC PRINTING PLATES

Save Needed Metals, Are Light in Weight

A PLASTIC lithographic printing plate, which saves from three to eight times its weight in critical aluminum and zinc, is being manufactured by The Plastolith Company from polyvinyl alcohol resin made by Du Pont.

Colored maps and other military documents for the Army are made from plastic plates, and they even are used by the Army's mobile field printing units. They give approximately the same number of impressions as metal plates and carry about 25 percent more ink without smudging.

Polyvinyl alcohol first was coated on zinc to improve that metal's printing qualities by allowing it to carry additional ink and reducing or eliminating its grain. It developed that the actual printing was from the plastic, and that any base would be the equal of zinc and aluminum, needed in the manufacture of shell cases and airplanes.

The plastic now is not only the printing surface but also is incorporated in paper used as a base. It gives the paper required strength and stability, and readies it for a water-proof coating of another resin. Two sheets thus prepared are laminated to form the base, and the printing surface is made with a coating of polyvinyl alcohol.

Creation of the printing image is the same as with metal plates. Polyvinyl alcohol is sensitized with bichromate of

ammonia. It is exposed to light, treated with the developing ink, developed in water, etched, and placed on the press.

Plastic plates used in lithographic duplicating printing weigh about one ounce, and a similar metal plate is four times heavier. For larger presses, a plastic plate 25½ by 36 inches weighs under 10 ounces and a zinc plate 4½ pounds. Thus there are large savings of space and expense in shipping and storage.

Although the Army and government take all production now, it is hoped that some plates soon will be available for the 3000 commercial lithographers who are short of zinc and aluminum. To date these plates have not been used in printing newspapers.

VERSATILE GYPSUM

Finds Applications in New Wallboards and Roofs

NEW GYPSUM products developed to meet the immediate demands of wartime construction replace more critical materials, such as steel and lumber, in both temporary and permanent structures, according to Henry W. Collins, vice-president of the Celotex Corporation. WPB is advocating the use of such gypsum products in place of less available materials.

The products include a new gypsum exterior siding covered either with smooth or mineral surfaced roofing; laminated gypsum wallboard panels suitable for demountable or permanent single-wall interior partitions; laminated gypsum roof deck slabs; and poured gypsum roof decks for use with wood frame construction.

The exterior wallboards supply both structural and weather protection needs for many "Theater of Operations" buildings such as barracks, warehouses, recreation centers, and repair shops. The products also are applicable to war workers' homes, dormitories, and industrial buildings. They are available in ½-inch and 1-inch thicknesses finished either with smooth or mineral surfaced roll roofing. The 1-inch thickness is a two-ply, laminated product with shiplap joints along the long edges. The ½-inch thickness has square edges. Sizes are 2 feet by 8, 9, or 10 feet.

Interior wallboard panels are made in 1-inch, 1½-inch and 2-inch thicknesses by laminating two, three, or four layers of gypsum wallboard. Three types of demountable partitions employing these laminated gypsum panels have been worked out by Celotex. Two are studless, non-load-bearing partitions, one of which eliminates battens at the joints. The third is a load-bearing partition, which may also be used for low partitions in high-ceiling rooms. Because of their large size —4 feet wide by 6 to 12 feet long—the panels can be erected easily and rapidly.

The Celotex gypsum slab is an improved rigid type of roof deck plank. It may be used to replace wood plank or other types of unit roof desk construction. The slabs are made by laminating together two, three, or four thicknesses of wallboard to form an integral unit. The slabs are light in weight, the 1½-inch thickness weighing 6¼ pounds per square foot, and the 2-inch slab 8½ pounds. Tests by an independent, nationally-recognized laboratory indicate an ample factor of safety for usual roof loads, according to Celotex. The slabs also are fireproof, rotproof and will not twist or warp.

Poured gypsum roof deck is designed for use on any type of industrial building, warehouse, garage, or hangar. It can be used on a flat roof, on a steep roof up to 45 degrees pitch, and for sawtooth and monitor construction. It is capable of carrying a live load of 35 pounds per square foot.

In building the roof deck, gypsum wallboard is nailed over joists, rafters, or purlins. On this form is laid wire reinforcing fabric over which is poured a mixture of Celotex gypsum stucco and water. The stucco consists of 87½ percent of calcined gypsum and 12½ percent of wood fiber or shavings. The weight of the factory mix is 55 pounds per cubic foot. It is usually applied to a thickness of 2½ or 3 inches, including the gypsum wallboard form.

TANK LININGS

Made of Synthetic Rubber Bonded in Place

A METHOD of bonding solid sheets of Koroseal directly to the welded steel, wood, or concrete of tanks, and thus extending the application of tank linings into fields which rubber cannot handle because of physical limitations, has recently been developed. Koroseal is a plasticized polyvinyl chloride which is being used in many places where its qualities are superior to those of rubber. It is a synthetic elastic material with many rubber-like properties.

Principal advantage of Koroseal in tank lining is its remarkable corrosion resistance because of the inertness of its compounds to strong corrosives such as chromic and nitric acids, which have a deteriorating effect on rubber.

The B. F. Goodrich Company declares that the Koroseal linings are the most important development now being offered in the synthetic field. Research is continuing on other applications of the same material.

In announcing the Koroseal linings the company points out that the material has certain limitations both in temperature ranges and effects of various chemicals on it, and that it is essential that company engineers be furnished complete service details before the material can be recommended.

Advantages of the lining are cited as follows: It can be applied in thicknesses up to and including 3/32 inches. It is not subject to physical damage and pin hole leaks suffered by many corrosion-resistant paints. It will not, however, withstand physical abuse and metallic gouging. In such service an oversheating of acid resistant brick is recommended. It is more resistant to abrasion than corrosion-resistant paint films. It is readily repaired if damaged. It has high electrical resistivity and prevents current losses in electrolytic action. It can be easily tested for leaks with an electric tester. It is highly resistant to oxidation, water, sunlight, and gas diffusion.

SPECIALTY RUBBER

Developed During Research on Electrical Insulators

A SPECIALTY rubber which will help meet essential war needs has been developed by Bell Telephone Laboratories as a by-product of research in insulating materials. This new material, known as

C. S. Fuller (right) and B.S. Biggs, chemists of the Bell Telephone Laboratories, who developed Paracon

Paracon, looks and feels like ordinary rubber, resembles it fairly closely in mechanical properties, and has important advantages for certain purposes. It has a high resistance to damage by oil or gasoline. It is also better than natural rubber in resistance to heat, light, and oxidation although inferior to natural rubber in resistance to steam, alkalies, and acids. Paracon can be worked with ordinary rubber machinery. In its raw state it is highly plastic and unusually well adapted to molding into intricate shapes and to use in producing rubberized fabrics.

Paracon is particularly useful as a material for special applications where, as in the aircraft field, its combination of unique properties is required. An important advantage of Paracon is that it will not compete with other synthetic rubbers for its basic raw materials since the chemical intermediates required for its production are derived by other trains of chemical processes. For its synthesis it uses two major types of intermediate material. These can be derived from agricultural products and coal products, or from coal and petroleum sources, in each case by a variety of different chemical processes. Although the equipment for manufacturing Paracon is highly specialized, it differs from that required for synthetic rubber production; consequently, Paracon can add to the present supply of rubber substitutes without interfering with the production of those already under way.

INDUSTRIAL TRENDS

WHAT'S AHEAD FOR RAILROADS?

More than half of the passenger cars on American railroads today are over 25 years old; almost half of the freight cars are over 20 years old; the number of locomotives in service has steadily declined for several years. This is the picture of the present, and it presages a trend in American railroading that will zoom sharply when the necessary shackles of wartime restrictions are removed.

Fortunately, for the railroads, the Interstate Commerce Commission has recognized the fact that the roads cannot replace equipment when such great demands are being placed on raw materials by the needs of war. Thus the Commission has granted to the railroads permission to allocate funds for maintenance, even though the money is not spent until after the war. This is only common sense, when the work that the railroads are doing in the war effort is taken into consideration. And it is applied common sense that will have a far-reaching effect on many industries after the war is over.

Through more efficient use of equipment, quicker turnarounds, higher speeds, and heavier loadings, the railroads have been able to carry their full share of the wartime burden. Equipment does wear out, however, and even faster under stress. Thus, although constant repairs are keeping as much rolling stock in service as possible, post-war times will see a great demand on suppliers of railroad equipment. When this time comes, many heavy industries will be kept busy for a long time furnishing the railroads with new material in the form of improved rolling stock that will be lighter, faster, more efficient than heretofore.

UNDERGROUND "BUILDINGS"

Based upon sound engineering principles is the proposal to locate a commercial air base in the rock of the Palisades, across the Hudson River from New York City. Here could be excavated huge caverns of relatively constant temperature that would contain hangar rooms, garages, restaurants, offices, waiting rooms, and so on. The material excavated would be dumped into the river to provide the necessary base for landing fields and ship docks.

This scheme has little of the fantastic linked with it. The facilities—compressed air drills, drill steel, dynamite, power shovels, trucks—are available. The construction of such an air base would bring to New York a close-in port without using land that would be valuable for other purposes. If started now it would provide ideal air-raid shelter facilities. After the war it would be one more advantage to the air-borne commerce that is bound to come.

There are many other locations in the country where similar projects would be advantageous and feasible. Perhaps here is a trend in engineering and aviation that someday, through someone's foresight, will mark the beginnings of a step forward in overcoming some of the difficulties that aircraft are heir to in their requirements for landing and storage space.

Parenthetically, it should be noted here that there have been persistent rumors of similarly constructed airports in Europe, concealed for military purposes.

THE FEMALE INFLUENCE

Post-war problems must, of necessity, creep constantly into this page. A recent one, and one that cannot be overlooked by those who are most concerned with consumer markets in after-the-war days, is the increased influence that women are going to have in the purchase of many products pertaining to the everyday lives of average citizens. There are millions of women who, drawn from all walks of life including the housewife, are today performing work in industry. These women are getting the feel of the mechanical. They are finding some of the advantages that accrue from the use of automatic machines, advantages that, their well-known intuition will tell them, can be translated into terms of easier work in the home.

Thus the woman who has been running an automatic machine in an air-conditioned factory is not going to be satisfied, in post-war days, to go back to the drudgery of the broom, the coal shovel, and the washboard. She is going to demand, and rightly, too, the same conveniences in her home that she had in the factory. Faced with such a fact, the appliance manufacturer who ignores the feminine influence in the future, or who deprecates its importance in the buying field, is going to find that he has missed the significance of an important trend in his field.

RADIO-ELECTRONICS

In shaping the trends of the relatively new science of radio-electronics, we can do no better than to quote from a recent statement by David Sarnoff, president of RCA. "When peace shall have come," says Mr. Sarnoff, "radio promises to electronize the industries of peace as it has electronized instruments and industries of war. . . . Radio instruments will emerge from the war almost human in their capabilities. They will possess not only a sense of direction, but a sense of direction that will open new avenues of service. The radio direction finder, which heretofore had only an ear, now also has an eye. . . . American inventive genius contributed much to the creation and perfection of the great offensive and defensive weapon known in the United States as Radar. The word means radio detecting and ranging. . . .

"Although we must first serve the present—lest there be no future—it is our duty," says Mr. Sarnoff, "to look beyond the horizon of war to survey our task in helping radio to meet its post-war responsibilities."

YOU, TOO, CAN FLY

If there is one development of the present war that has caught the public imagination it is aviation. And, without doubt, this same development is going to become a commonplace in the lives of many during peace-times. To this end there is continuing research on the development of the small airplane that will have present applications in the emergency of the day as well as implications for the future.

It is not surprising, then, that plane manufacturers have at least part of an eye fixed on the future, and that they are planning for the day when the average American will yearn for a ship that will carry him through the air with the same comfort and convenience and safety that his present motor car carries him over the earth-bound road. A recent prospectus from a light-plane manufacturer says—and the statements are linked definitely with present aviation progress—"The dependable, easy-to-fly airplane has brought the fun of flying within the reach of everyone. You don't have to be a superman to fly one of these ships, for they can be flown by anyone in average good health who is capable of exercising normal judgment."

WINDOWLESS WALLS

There are several large factory buildings in the United States today which have been constructed without windows, depending entirely upon man-made air conditioning and illumination for the factors that influence human comfort and working ability. In one recently constructed plant of this nature, the walls, of brick, are designed to "breathe," thus preventing condensation of moisture and keeping the walls dry, important factors in completely closed buildings. The "breathing" is made possible by construction methods that form a tile flue in the walls, thus not only admitting air but also contributing to the insulating value of the wall as a whole.

Since the windowless factory is a relatively new development in building design, such work as this will have important implications on future construction.

—*A. P. Peck*

Ultra-Violet—Near, Middle, Far

Many Industrial and Personal Uses Are Being Made of the Phenomena Surrounding these Radiations

LAWRENCE C. PORTER
Engineering Department, General Electric Company, Nela Park

THE ADVERTISING sections of current publications show that there is quite a variety of so-called sun lamps varying in cost from about $3.50 to approximately $100 for home use, and up to several hundred dollars for physicians' and hospital type units. Most of these are sources of ultra-violet radiation of one kind or another. Some are of value in maintaining health, some are particularly suited for treating disease, and some are of little or no value for either purpose though they may be useful in other fields for stimulating certain luminescent materials and causing them to glow in the dark.

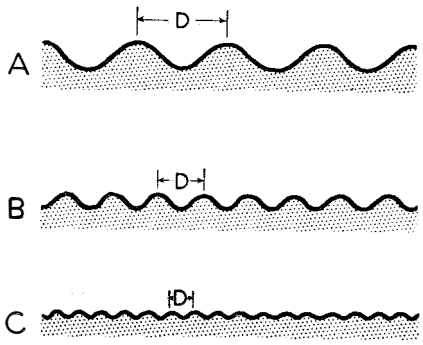
The selection of the proper lamp for any specific purpose without knowledge of the physics of radiation is difficult. It is complicated because there are ultra-violet lamps that produce reddening of the skin—thus giving the appearance of ordinary sunburn—and therefore are assumed to be of health benefit similar to summer sunshine, but which actually may even be detrimental to that purpose. The problem is further complicated by the fact that many artificial sources of ultra-violet emit a combination of several forms of ultra-violet radiation.

If a large boulder is rolled into a pond of still water it will cause a big splash and set up several large waves, separated by perhaps several feet, that chase each other across the pond. These might be represented as at A in the central drawing on this page. If instead of the large boulder we throw into the pond a good-size rock, similar waves are set up but they will be smaller and closer together, as represented at B. Now suppose we drop a little pebble into the water. Still smaller and less widely separated waves are set up, represented at C. All three of these illustrations are water waves, but of different wavelength, that is, distance from the crest of one wave to the crest of the next, as indicated by D.

This is a very simple analogy to ultra-violet radiation, which also consists of waves, but instead of travelling across the surface of water they travel through air. They, too, are of different wavelength. The longer ultra-violet waves are known as near ultra-violet, the medium ones as middle ultra-violet, and the shorter ones as far ultra-violet. Actually their wavelengths, instead of being measured in feet or inches, as with water waves, are a very small fraction of an inch, varying from approximately .0000147 of an inch for near ultra-violet, and .0000118 of an inch for middle ultra-violet, to .0000101 of an inch for far ultra-violet.

As a matter of convenience, such very short waves are measured not in inches but in what are known as Angstrom Units, variously abbreviated as "A.U.", "A°", or "λ". One λ equals .000000004, or $\frac{1}{250{,}000{,}000}$ of an inch. The near ultra-violet waves center at 3660λ, the middle at 2967λ, and the far ultra-violet at 2537λ.

Sources emitting any of the above wavelengths also emit both longer and



Wavelength, indicated by D, determines the characteristics of radiations

shorter waves than the central ones. At just what wavelengths the ultra-violet passes from near to middle to far is not a definite figure. In general, however, near ultra-violet is usually considered to cover the range from 4000λ to 3200λ; middle ultra-violet from 3200λ to 2800λ; and the far ultra-violet from 2800λ to 2000λ. There are ultra-violet waves shorter than 2000λ but they are rapidly absorbed by air and can, therefore, for most purposes, be disregarded.

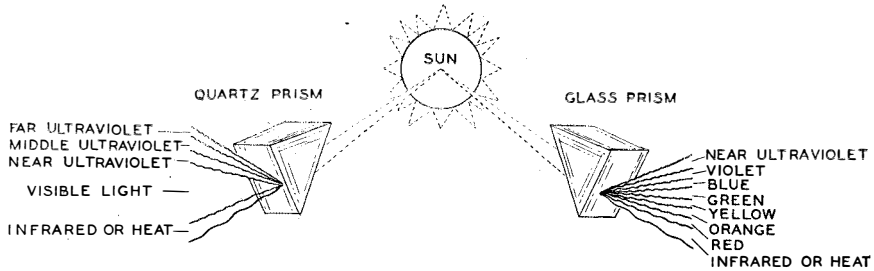
The sun emits ultra-violet over the entire range but the layer of ozone above the earth absorbs practically everything shorter than 2900λ, and ordinary window glass transmits very little if any radiation shorter than 3200λ.

As a matter of general interest the ultra-violet waves form a very small portion of the entire electro-magnetic spectrum. This entire spectrum contains waves of infinitely short lengths to waves that are a mile or more in length. The relative position of the ultra-violet waves in the spectrum is shown by the following tabulation:

Cosmic waves—extremely short
Gamma waves
X-ray waves
Ultra-violet waves
Visible light waves
Infra-red waves
Radio waves—very long

Without going into the physics of the generation of ultra-violet radiation by artificial sources, it is sufficient to say that the passage of electricity between two pieces of carbon, as in the carbon arc lamp, or through mercury vapor in a quartz tube, as in the modern sunlamp, generates ultra-violet radiation over the entire range of wavelengths from the near to the far ultra-violet. For the purpose of study—measurements of the relative amounts of energy of different wavelengths and experimental work on the effects of various wavelengths—they can be separated by passing them through a quartz prism. The effect of a quartz prism on ultra-violet is similar to that of a glass prism on visible light. We all know that a glass prism placed in a beam of sunlight will break up the beam into the different colors of the spectrum. The various colors are produced simply by a difference in wavelengths. Similarly, what differentiates near, middle and far ultra-violet is wavelength. A quartz prism separates the various ultra-violet waves as a glass prism separates the various waves of visible light.

IT WILL be noticed that a quartz prism is used for ultra-violet and a glass one for visible light. Ordinary glass will transmit very little of the middle ultra-violet and none of the far. There are, however, certain special glasses, in composition and hardness between ordinary window glass and quartz, that do transmit ultra-violet of the shorter wavelengths. By selecting the proper type of glass we can select the radiation wavelengths or kind of ultra-violet we wish to use and screen off that which we do not desire. The modern sunlamp designed for health purposes has a bulb of one of these special glasses surrounding the small quartz-tube mercury arc which generates the ultra-violet. The composition of the glass is such that it transmits readily the middle ultra-violet, or so-called "health rays," and



Just as a glass prism, right, splits up visible light, so will a quartz prism separate ultra-violet into the wavelengths that distinguish its different components, at left

screens out the far ultra-violet which is of no known health value (other than the treatment of disease and the killing of germs) and is injurious to the eyes.

Of the principal uses of near, middle, and far ultra-violet, probably the most commonly known use is the effect of near ultra-violet on the photographic film and plate. It is the near ultra-violet in daylight that is used in taking pictures. Fortunately, the near ultra-violet is readily transmitted by the glass of our windows, camera lenses, and so on.

Middle ultra-violet, supplied by ceiling-hung lamps, stimulates cholesterol in the skin to create vitaman D to produce strong bones and to prevent or cure cases of rickets

Another application of near ultra-violet which has been used for display purposes and the production of theatrical effects for years—and is now being used to some extent for signs, markers, guide lines, and so on, during blackouts—is the stimulation or charging of certain chemicals so that they start and continue to glow in the dark. That phenomenon is known as phosphorescence. There are other substances that glow only while they are being activated by near ultra-violet. That is known as fluorescence. When the visible light is filtered out of sources of near ultra-violet by means of certain black near-ultra-violet transmitting glasses, a resulting radiation is obtained which is popularly termed "black light."

Of the many photo-chemical and photographic effects of the near ultra-violet, two are of current interest. The near ultra-violet, as available from fluorescent sources, is uniquely suitable for catalyzing the chlorination of certain gases used in the preparation of synthetic rubbers. In a somewhat similar way the near ultra-violet is being used to clear up remaining traces of hydrogen from electrolytically produced chlorine, the hydrochloric acid formed being readily removable.

The middle ultra-violet is that range of wavelengths which is absorbed by a substance near the surface of our skin known as colesterol. This substance, under the stimulation of middle ultra-violet, creates vitamin D which the blood distributes throughout our bodies. The vitamin D assists the utilization of calcium and phosphorus to produce strong bones and teeth and prevent or cure rickets. This middle ultra-violet, if used in sufficient quantity (either a light dosage and a long exposure or a strong dosage and a short exposure), produces reddening of the skin—that is, sunburn—technically known as erythema, and if carried far enough results in blistering and peeling.

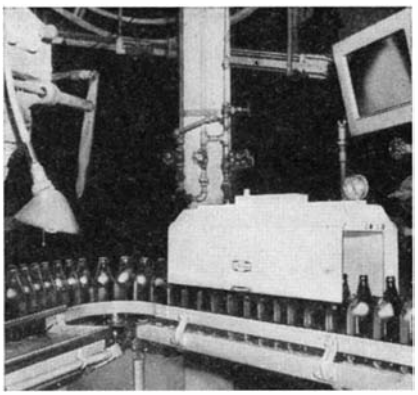
Germicidal lamps, producing ultra-violet, are being used in surgical and dental instrument sterilizing cabinets

There is no known value in far ultra-violet for the maintenance of general health. In fact, there may be some reduction of the benefits of middle ultra-violet when far ultra-violet accompanies it. Unfortunately, perhaps, far ultra-violet will also redden the skin, or even cause peeling, though it seldom causes a blister. This reddening often misleads those using a lamp generating far ultra-violet to believe that they are receiving health benefit, and it assists in selling certain cold quartz type lamps for health purposes that probably are of little if any good for such purposes.

However, there are certain powerful quartz arc lamps in common use in doctors' offices which, in addition to the far ultra-violet, emit so much middle ultra-violet that they are of very definite health benefit.

The chief function of cold quartz lamps and of the germicidal lamps and Sterilamps is the destruction of bacteria. Such lamps are useful for treating various skin infections, but should be so used only under a doctor's direction. They are most useful for irradiating the upper air in locations where people are close together for several hours at a time. Under such conditions many types of germs are breathed into the air and float about much as does an odor or smoke. Far ultra-violet radiation will kill most such air-borne germs and thus lessen the danger of the spread of such contagion as measles, chicken pox, mumps, scarlet fever, diphtheria, meningitis, small pox, septic sore throat, whooping cough, and so on.

There are already thousands of germicidal lamps in use in hospitals, and their use is being extended to surgical and dental instrument cabinets, schools, offices, barracks, factories, ships, and even to the home. It must be remembered, however, that the short-wave ultra-violet can cause very sore eyes—conjunctivitis—and peeling of the skin. The practice in using such lamps, therefore, is to confine all radiation to areas above the eye level. Fixtures for such lamps are especially designed to accomplish that end.

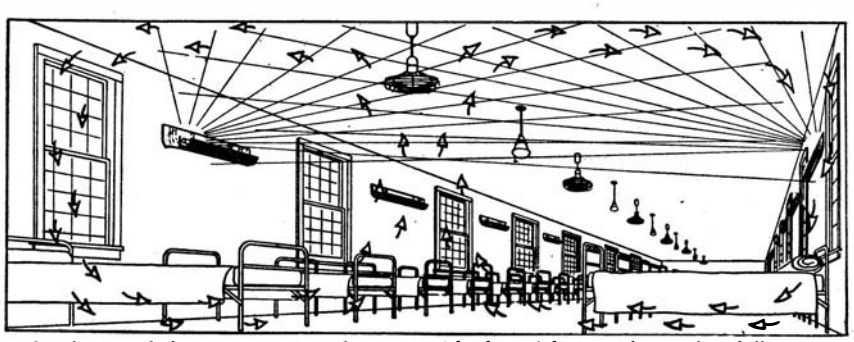


Growth of fungus in bottled goods is retarded by use of ultra-violet rays

Considerable research work is under way to determine the effectiveness of far ultra-violet or short-wave ultra-violet radiation in controlling the spread of respiratory diseases among poultry and cattle.

There are many industrial uses of the far ultra-violet which take advantage of its germicidal and fungicidal effects. It has recently become a standard way of disinfecting the air in blood bank and serum processing laboratories. It provides an economical way for the essential reduction of the thermophilic bacteria in sugar used for canning. It is used for its fungicidal effects on pre-mixed baker's flour and in bottling plants.

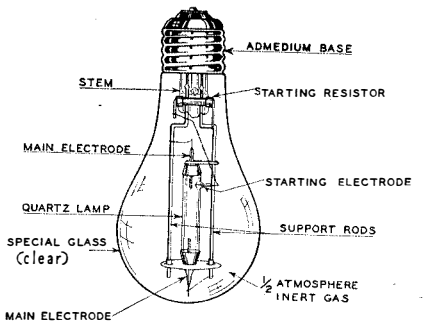
The selection of an ultra-violet lamp depends largely on the purpose for which it is intended. If black-light effects are the prime requisite, a lamp having the major portion of its output in the near ultra-violet range should be selected. Well



Irradiation of the upper portion of a room with ultra-violet may be used to kill germs in the lower portion of the room through forced or natural circulation of the air

suited to that purpose are the 100-watt mercury-arc lamps, H-4 type. They require a transformer for operation and a black ultra-violet transmitting glass filter.

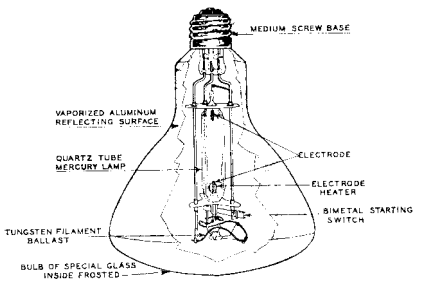
If a sunlamp is desired for human health purposes, or for use in chicken houses or dairies, the type S-1, S-4, RS-4, and RS lamps are most suitable. With the exception of the RS lamp these also require a transformer and a suitable fixture. The types S-1, S-4, and RS-4 lamps all have about equal ultra-violet output. For



Type S-4 ultra-violet lamp

the average person a 10 minute daily exposure at a distance of approximately 2½ feet from the lamp is sufficient, though the exposure may be increased or the distance shortened, or both, as one becomes accustomed to the ultra-violet, just as one may gradually increase exposure to midsummer sunlight.

The RS-4 sunlamp is essentially the same as the S-4 except that no external



Type RS sunlamp is provided with an internal aluminum reflector

reflector is necessary, the bulb itself being coated with reflecting material on the inside. These lamps are both 100-watt units.

The S-1 sunlamp has the same ultra-violet output as the S-4 group, but about four times as much infra-red, or heat, as it consumes 400 watts instead of 100.

The RS sunlamp is the latest of the sunlamp group. This lamp consumes 275 watts and is also in a reflector type bulb. Its ultra-violet output is somewhat less than that of the S-1 or S-4 lamps, but this can be compensated for either by longer exposures or by shorter exposure distance, or both. This lamp has the outstanding advantage of operating directly on 110-125 volt A.C. lighting circuits without the use of a transformer. The lamp bulb contains a ballast resistance and automatic switch taking the place of the transformer required by the other lamps. Due to war conditions the RS lamps are not now in production.

Thus continuing research has developed a number of convenient ultra-violet sources and is finding new uses for them in both routine work-a-day applications in industry and in the fields of personal health. Much of the work being done with ultra-violet must remain untold for the duration, yet sufficient is already known to serve as a basis for constructive thinking toward post-war commercial developments.

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Editor's Note: Readers who have industrial problems which might be solved through the application of ultra-violet radiation are invited to address specific questions to the Editor for forwarding to the author of the foregoing article.

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ELECTRONICS MYSTERY
Solved, May Lead to Improved Vacuum Tubes

THE DISCOVERY that gas dissolves in certain metals just as salt dissolves in water may lead to the production of longer-lasting electronic tubes which will require less power to operate, Dr. Harvey C. Rentschler, noted physicist, recently told a meeting of the American Physical Society. Dr. Rentschler, who is Director of Research for the Lamp Division of the Westinghouse Electric and Manufacturing Company, reported the results of his experiments to unravel one of the unsolved mysteries of electronics; namely, how tiny particles of matter called electrons are emitted from metals to set up a flow of current inside such tubes as those for radio and X-ray.

Experiments during the last eight years have led to the conclusion that atoms of gas—oxygen, hydrogen, or nitrogen—actually dissolve in the crystalline structure of some metals just as salt dissolves in water. These gas particles then "loosen" the electrons in this structure, causing them to be emitted from the metal more readily when heat or light is applied.

"This explanation," Dr. Rentschler declared, "should result in longer-lasting tubes and accomplish important savings in the size and number of electric batteries, generators, and other apparatus needed to supply the filament power. Such improved tubes would be the result of better 'cathode' construction," he continued. Cathodes are the metal filaments inside tubes which fire a stream of electrons at speeds greater than a million miles an hour. The emission of electrons from metal cathodes is the basic principle of all electronic phenomena. As these tiny particles of negative electricity pass from the cathode to a metal plate, called the anode, they set up a flow of electric current which is put to work to accomplish countless tasks.

Dr. Rentschler first discovered, in 1935, that a small amount of oxygen reacting with such metals as thorium, uranium, and barium speeded electron emission, but found that a similar effect was not obtained with such commoner metals as iron, nickel, copper, zirconium, titanium, and others. "Using a pure form of zirconium, titanium, and hafnium," he explained, "we now have found that these metals, too, are likewise affected by oxygen as well as nitrogen and hydrogen.

"When these metals in a pure state and mounted on a core of tungsten are heated in a vacuum, they will melt into a soft globule. When the pure metal is heated in oxygen, hydrogen, or nitrogen at a low temperature and then at a still higher temperature in a vacuum, it becomes brittle and hard.

"After an appreciable amount of gas is 'dissolved' in the metal and all excess gas removed, the metal can be heated to temperatures as high as 2700 degrees, Fahrenheit. The fact that there is no pressure increase in the vacuum tube shows that no further gas is liberated. The gas apparently dissolves uniformly to form what we call a 'solid solution' in the metal. From such metal can be made excellent cathodes."

Although scientists have known that oxide-coated cathodes emit electrons more readily than cathodes of plain metal, they have been unable heretofore to use oxides for high voltage tubes, Dr. Rentschler pointed out. This is because the high voltage sets up such a strong electric field that the oxide-coating is torn from the surface of the metal. Such a coating consists of a paste baked onto the metal.

By dissolving gas into the metal, however, it may be possible in the future to produce an oxide-coated cathode for high voltage tubes, he continued. The oxide in this case becomes an integral part of the basic cathode metal and cannot be torn off by the strong "pull" of the electric field.

MOLECULAR ATTRACTION
The Essential Difference Between Fibers, Plastics, and Elastomers

THE DIFFERENCE between a springy rubber-like substance and a hard plastic or a tough fiber, either synthetic or natural, lies in the tendency for the molecules of these substances either to contract or to form crystals, Dr. H. Mark, professor of organic chemistry at the Brooklyn Polytechnic Institute, recently reported to the Society of Sigma Xi.

The more crystallization in its structure the more the substance becomes a typical fiber, such as nylon, silk, cotton, or rayon. If the mutual attraction between the chain-like molecules of a given material is low, then it will show mainly the properties of an elastomer such as rubber, Buna S, Neoprene, Hycar, Butyl rubber, and so on. This is also true if the molecules do not fit well into a regular three-dimensional lattice structure.

In between these extremes, the substance will show the properties of a plastic, such as hard rubber, methacrylate (Lucite), vinylite, polystyrene, or ethyl cellulose.

Present experimental knowledge shows that all of these substances have about the same fundamental structure, but it is their ability to crystallize that gives them different properties.

All types of what the chemist calls "high polymers," whether they be rubbers, plastics, or fibers, have the same high order of polymerization, that is, their molecules are composed of about 2000 or more atoms.

Anthropocentrism's Demise

New Discoveries Lead to the Probability that There Are Thousands of Inhabited Planets in our Galaxy

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

WE TOLD last month of the discovery that three stars among our nearest neighbors are attended by invisible companions, which are much less massive than any bodies that had previously been detected outside the solar system. The smallest mass so far known, in the case of a star which can be seen by its own light, is about one sixth that of the Sun; the new discoveries have masses from one fifth to one twentieth of this.

This raises a question of great general interest. Are these bodies stars, or planets revolving about the visible stars which they accompany? More precisely, which of the two names do they properly deserve?

This is a matter of definition, and we must by guided, as in all such cases, by past usage, so far as this is relevant. In our own system, this usage may be expressed in the working definition: A planet is a compact, opaque body in orbital motion about the Sun, and shining by reflected light.

The words "compact" and "opaque" are introduced to distinguish between planets and comets, which are diffuse and practically transparent swarms of matter, while planets have definite boundaries—which gravitation compels to be nearly spherical, with some flattening by rotation.

So long as these conditions are met, a body may be called a planet no matter whether it is solid, liquid, or gaseous. Question might theoretically be raised about a mass of pure, "permanent" gas, free from all constituents which might condense to form clouds; but all gases scatter light, and hence obstruct its passage, and it is easy to show that a purely gaseous mass, held together by its own gravitation, and as much as 5000 miles in diameter, would be effectively opaque except at the very edge. The word opaque might, therefore, have been omitted from our definition.

One limitation remains—that of shining by reflected light. This demands that the surface of the body shall not be hot enough to shine on its own account; but this can be interpreted in two ways: first, that the body could not be seen by its own radiation by the human eye, if it stood alone in perfect darkness, and second, that any feeble light which it might emit on its own account would be overwhelmingly surpassed by the sunlight which it reflects.

The writer owes to Dr. Babcock, of Mt. Wilson, the interesting observation that the temperature at which a cooling body ceases to be visible to an observer who has rested his eyes thoroughly in complete darkness is a little above 400 degrees, Centigrade, or about 700 degrees on the absolute scale. The permanently sunlit side of Mercury is almost as hot as this; but, considering the intense illumination of the planet by the Sun, it would be ridiculous to speak of it as self-luminous.

It may be recalled that it was once (mistakenly) believed that Jupiter and Saturn might be hot up to their surfaces, so that they might be feebly self-luminous if seen alone, but no one objected to calling them planets on this account.

AT ONE point past usage gives us little help. How big would a dark body have to be to lose the right to be called a planet? All that can be said is that, before it was known that the companion of Algol was perceptibly luminous, the star's variation was sometimes described as "due to eclipses by an enormous planet," with very little protest—though this could hardly be called established usage.

Now let us turn from words to things—and see what may reasonably be concluded about the properties of the newly discovered bodies from the available information—taking as an example the faint companion C in the system of 61 Cygni for which the data are best.

The only thing we *know* about this body is that its mass is 0.016 times the Sun's; but we may reasonably assume that, like the two visible stars in the system, it is of normal composition, consisting mainly of hydrogen and helium, with a few percent of heavier atoms. The two main questions which we want to answer, if we can, are: "How big is this body?" and "How hot is its surface?"

The first question is hard. We can, however, set a definite lower limit, by assuming that the body has contracted to the smallest size which the laws of nature permit. Here we find a curious situation. In a large mass, comparable with the Sun's, this limiting condition is one in which the matter is "degenerate" and has an enormous density—as actually occurs in white dwarf stars, such as the companion of Sirius. In this state the relation of internal pressure and density are such that stars of large mass, when they settle down, are not merely denser, but actually smaller in diameter, than those of smaller mass. Bodies of the Earth's mass or less settle down into the familiar, non-degenerative, state in which the large masses have a slightly greater mean density, on account of the greater internal pressure, but are of larger radius than smaller masses of the same composition. Bodies of intermediate mass reach, at their limit, a partially degenerate state; and (for a given composition) there is a certain mass which has a maximum radius, larger than for either greater or smaller masses. The difficult theory of this has been worked out approximately by the Indian physicist, Kothari, for bodies composed of but one kind of atom. His results for helium may be adopted as the best guide. For the maximum size, in a completely "cold" state, the mass comes out twice that of Juipter, and the diameter 55,000 miles—somewhat smaller than Saturn. Our body has eight times this mass. Its limiting diameter comes out 45,000 miles, with a mean density of 150 times that of water. This is high, but only about 1 percent of that of a typical white dwarf.

THE diameter of the bright star about which C revolves may be rather closely estimated as 0.6 of the Sun's, or 520,000 miles. C is, therefore, certainly as large, in comparison to its primary, as Saturn in comparison to the Sun.

It is possible that C is in this limiting state (for several normal stars have degenerate companions); but it is probably more likely that C is not degenerate. It would be well clear of degeneracy if its density were equal to the Sun's—in which case its diameter would be 216,000 miles, or 40 percent that of its primary—pretty big for a planet, but passable.

There is no assignable reason, however, why C should not be ten times as large as this. If it were more than ten times the Sun's diameter, the attraction of the primary would raise such huge tides on it, when they were closest, as to make its stability uncertain; but there is a great range of possible sizes within which we have no present basis for making any decision.

The other main question, of surface temperature, is capable of a more definite answer; but before we take this up we must consider the internal temperature and constitution of the body.

In the limiting case of smallest diameter, the answer is explicit; the body would be completely cold, inside and out. However, for a diameter only a little larger, both the internal and the surface temperatures should be fairly high (compare the companion of Sirius). A good idea of what to expect can be derived from the case of density equal to the Sun's. If we assume that the internal constitution and composition resemble the Sun's, the central temperature comes out 1/16 of the Sun's, or 1,600,000 degrees; and any plausible assumptions make it several hundred thousand degrees.

At such temperatures, the *internal* con-

stitution of the body would resemble that of a star. The atoms would be heavily ionized, the resulting gas highly compressible, and the general theory of stellar constitution, now well established, would be applicable.

In particular, the situation is within the range of Morse's tables which make it possible to calculate the rate at which heat would escape from the interior to the surface. Applying these (assuming composition similar to the Sun's), it is found that the whole radiation of heat would be only 1/140,000,000 as great as the Sun's. The surface temperature required to maintain this is 105 degrees above the absolute zero, or —168 degrees, Centigrade.

IN SUCH a body, though it had an intensely incandescent core, heat would leak outward so slowly that the surface would be exceedingly cold, and covered, like that of Jupiter, with thick layers of clouds formed by the condensation of substances such as ammonia which, at the temperatures familiar in every-day life, are gaseous. Below these clouds would be others—for example, of condensed water in regions of somewhat higher temperature. Only at a depth of thousands of miles would the gases be hot enough to be free from condensed vapors.

These outer cloud-layers would be so opaque that the heat which flowed toward them through the clear gases below would be carried onward, not by radiation from atom to atom, but by convection—bodily transport by ascending currents of hotter gas, matched elsewhere by descending currents of gas which had cooled. When condensation is taking place, liberating latent heat, this is a powerful mode of heat-transport.

The cloudy layers, however, must form but a small fraction of the mass of the whole body, and the main flow of heat would come from the gaseous interior. There might be important convection currents in this if (as is very probable) electrons and highly charged atoms, dissociated at great depths, combined in higher regions of lower temperature. The net transport of heat by such currents might exceed that carried by radiation even in the clear gas; but, if it were a hundred times greater, it would suffice only to maintain the outer surface at about 320 degrees, absolute, or 50 degrees, Centigrade.

It appears, therefore, to be an entirely safe conclusion that this small body, if of the density of the Sun, cannot be self-luminous to even the feeblest degree. A body of greater diameter would be cooler, inside and outside, a smaller one hotter. Therefore it is entirely safe to conclude that 61 Cygni C is *a dark body* in the strictest sense of the words.

We have still to inquire whether the body would reflect enough light to be a respectable planet. As it is almost certainly cloud-covered, its reflecting power should be comparable to that of Jupiter. At the mean distance of 2.4 astronomical units from the bright star, a body of ¼ the Sun's radius, if attendant upon the brighter component of the pair, would reflect as much light as Saturn does from the Sun; if near the fainter component, about half as much. This is certainly enough to make it a very respectable planet. Even with the minimum possible size it would still be a conspicuous object if viewed from planetary distances such as occur in the solar system.

Seen from the Sun's distance, the companion would appear fainter than the 24th magnitude—that is, less than a tenth as bright as the faintest star observable with the 100-inch telescope. There is, therefore, no hope of observing it directly —even if it were not drowned out hopelessly by its primary star which is millions of times brighter.

Summarizing our results, we may conclude that the newly discovered object is a dark body, but shines by reflected light more strongly than most planets in our own system. We would have no hesitation in calling it a planet, if it were not for the chance that it may be larger in diameter than the bright star around which it revolves.

NOTEWORTHY as this discovery is from the technical standpoint of astronomy, it is much more so from the general one of philosophy. Recent observations, especially of double stars, have detected many more "invisible" companions—most of them larger in mass, compared with their primaries, and doubtless faint *stars,* which would be directly visible but for the glare of these neighbors. Such faint companions are evidently very numerous among the stars as a whole; and, the more our means of observation are refined, the smaller are the masses which we can detect. Very small attendants produce so small an oscillation of their primaries that it can be detected only when the latter are among the nearest stars. All three of those which we have been considering are within five parsecs (or 16 light-years) from the Sun. Within this distance there are probably less than 200 stars, only a decided minority of which have yet been adequately observed to detect companions, if they exist.

It is, therefore, clear that the number of stars which are attended by dark companions must be a respectable percentage of the whole. Among the hundreds of millions of known stars, there are probably millions of such bodies. Whether there are still smaller ones, comparable in mass to Jupiter, or even to the Earth, we can not find by direct observation, even on the nearest stars; but there is no sign that the number of companions falls off as they get smaller, down to the observable limit.

On the basis of this new evidence, it, therefore, appears probable that, among the stars at large, there may be a very large number which are attended by bodies as small as the planets of our own system. This is a radical change—indeed, practically a reversal—of the view which was generally held a decade or two ago. The older opinion, that planetary systems are excessively rare, was a deduction from the then accepted theory of the origin of the solar system by a close encounter, if not a collision, between the Sun and another star. Such encounters must be extremely rare. More recent theoretical work—especially that of Spitzer—has created grave doubt regarding the validity of this theory, and we are completely in the dark regarding the origin of the planets. But now, in place of a deduction from a doubtful theory, we have a moderate generalization of newly discovered facts. Small companions exist, in abundance, down to, if not beyond, the limit at which any one would call them planets, and there is no known reason why smaller planets should not exist in comparable numbers.

SUCH bodies would doubtless be similar in chemical composition to the planets of our system, as the stars are to the Sun. Under the operation of general physical laws the larger ones, down to about ten times the Earth's mass, would contain great quantities of hydrogen and its compounds, like our major planets. Those comparable to the Earth in mass could not retain these light gases, and would be spheres of rock surrounded by atmospheres and with more or less water on their surfaces. Smaller bodies would be atmosphereless, like the Moon.

Among the planets of intermediate size, some would be at such a distance from their primaries that they were maintained at temperatures at which water was liquid, at least during some seasons of the year. All such bodies would be essentially habitable—capable of supporting life of the same *general* nature as exists on earth. The number of planets which satisfy these conditions, though no large fraction of the whole, may, in the aggregate, be very large.

If, as appears to be probable, vegetation exists on Mars, life has developed on two out of the three planets in our system where it has any chance to do so. With this as a guide, it appears now to be probable that the whole number of inhabited worlds within the Galaxy is considerable. To think of thousands, or even more, now appears far more reasonable than to suppose that our planet alone is the abode of life and reason.

What the forms of life might be on these many worlds is a question before which the most speculative mind may quail. Imagination, in the absence of more knowledge of the nature of life than we now possess, is unequal to the task. There is no reason, however, against supposing that, under favorable conditions, organisms may have evolved which equal or surpass man in reason and knowledge of Nature—and, let us hope in harmony among themselves!

It may fairly be claimed, then, that this latest discovery completes the work which Copernicus began four centuries ago. Though the belief that our world was the material center of the Universe has long been dead, the supposition that it was (at least probably) unique in being the abode of creatures who could study the Universe has lingered long. Now this last stronghold of the old way of thinking has fallen, and there is no longer a basis for supposing that either this world or its inhabitants are unique, or in any way the "first, last and best of things." The realization of this should be good for us.

—Manitou Springs, Colorado, April 22, 1943.

Can Colds Be Prevented?

There is no Effective Method for the Prevention of the Common Cold—Not Vaccines, Not Vitamins

ROBERT H. FELDT, M.D.

You might as well take so many hypodermic injections of water as to take cold vaccine shots. Neither will do any good in the prevention of colds. Nor will vitamin capsules help. These conclusions are based on a critical review of medical literature. A member of the Council on Pharmacy and Chemistry of the American Medical Association recently stated that "at present there are no effective methods available for the prevention of the common cold."

When cold vaccines were first developed, glowing reports appeared. In one large factory, cold shots were given to every employee through an entire winter. The workers almost universally stated that they had fewer colds than they had noticed the year before. Other doctors reported similar results with their patients.

Dr. Alphonse R. Dochez, Professor of Medicine at Columbia University, was not satisfied with this kind of evidence. He thought it was unfair to judge a vaccine by comparing the frequency of colds during the season when the vaccine was being administered with the experience of the preceding year. He recognized the well-known principle that the controlled experiment is the only accurate way to evaluate a new therapeutic method. A group of persons taking treatment should be compared with a similar series of control subjects who receive no therapy.

Dochez and his assistants gave cold vaccine injections weekly to 20 infants. Twenty other babies of similar age and sex were observed during the same period of time. All 40 children lived under the same roof and their care was identical. Those who received the vaccine had just as many colds as the ones who didn't.

Colds were once thought to be due to infection of the respiratory passages with various kinds of germs. Therefore, vaccines were developed containing millions of dead germs of these kinds. An immunity against germs of the type found in the vaccine was supposed to develop as a result of the injections. Recent investigation has established that germs of the sort used in vaccines are not the cause of colds and it is no wonder that the vaccines have been ineffective.

Drs. Harold S. Diehl, A. B. Baker, and Donald W. Cowan, of the University of Minnesota, are famous for their research with colds. They have tried numerous forms of treatment, but they agree with other doctors that the most important step in controlling colds lies in the direction of prevention. After years of experimentation, they report that they have been unable to find an ideal preventive method.

The subjects for their studies have been volunteers from the student body whose history showed that they were unusually susceptible to colds. Only students in robust health were selected. The doctors did not wish the results to be influenced by the inclusion of persons who suffered from sinusitis, asthma, or other chronic diseases of the respiratory organs.

One half of the students who entered the "Cold Prevention Group" were given weekly or biweekly hypodermic injections of the vaccine. The other half received injections of water and unknowingly acted as control subjects. The students who were given the water placebo were under the impression that they were getting cold vaccine. Altogether more than 700 people participated in the study.

The subjects who took the cold shots had an average of 1.7 colds during the school year. Those in the control group whose only medicine had been an injection of sterile water had an average of 1.8 colds. For practical purposes, such a difference can be ignored. The number of school days lost due to colds was exactly the same in the two groups. Complications such as pneumonia and sinusitis were just as frequent among the vaccinated as they were among the unvaccinated.

When the students registered for the cold prevention program in the fall, they reported the number of colds they had experienced the previous winter. On the average, their history showed more than five colds a year. While taking the injections of vaccine or water, they had less than two colds a year—a reduction of more than 60 percent.

These figures emphasize the fallacy of trying to judge the value of therapy unless the experiment is controlled. It would be as logical to conclude that injections of water prevented colds as it would be to infer that the beneficial effect was due to the vaccine. Each group showed the same degree of improvement. It is obvious, therefore, that the vaccine was not responsible for the remarkable reduction in the number of colds.

Several factors probably account for the decreased frequency of colds. Careful examinations and accurate reports were secured during the year of observation, and the number of colds experienced is a matter of record. The history cards for the previous year were filled out from memory and there may have been some subconscious exaggeration. Perhaps the students remembered to take better care of themselves because of their visits to the clinic for a shot in the arm. This frequent reminder that they were trying to prevent colds may have prompted them to avoid people with colds, secure plenty of rest, and dress warmly.

The Minnesota doctors were sometimes mildly embarrassed by inquiries from practitioners throughout the state. A physician wrote: "John Olson, who is teaching in our high school, was at the University of Minnesota last year. He had such excellent results with the cold vaccine you gave him that he would like to have me give it to him this year. Will you please tell me where it can be secured?" As likely as not the material that gave such "excellent results" was water. At the last convention of the American Medical Association, Dr. Diehl said, "The results reported by many persons who received placebos would serve as splendid testimonials for anything" recommended for cold prevention.

Another group of students were asked to take cold vaccine by mouth to see if it was any more effective than the injections. Over 350 persons took "cold capsules" containing enormous numbers of dead bacteria. A control series of students were given placebo capsules filled with sugar. The capsules were identical in appearance, and all subjects thought they were receiving the cold prevention vaccine. Again there was a remarkable reduction in the frequency of colds as compared with the previous year. The number of colds experienced and the time lost from school was the same whether cold capsules or sugar capsules were taken.

Other doctors have confirmed the work done in New York and Minneapolis. After carefully studying the subject for years, Dr. Chester S. Keefer, Professor of Medicine at Boston University and a member of the Council on Pharmacy and Chemistry of the American Medical Association, has concluded that cold vaccines are of no value, his report being read at the Congress of Industrial Health. A few doctors still believe that specially prepared vaccines may be helpful for certain conditions, such as recurrent sinusitis.

Vitamin capsules are of no more use than vaccines for cold prevention. Again Dr. Keefer and others have recognized the findings of many researchers in reaching this conclusion.

Dr. Ann Gayler Kuttner has charge of a large group of children in a New York Convalescent Home. In such an institution, epidemics of colds have always been a menace and Dr. Kuttner hoped she could find a way to prevent them. Although the food was well-balanced and nourishing, she thought added vitamins might be helpful. Every day, one half of the children were given a special capsule containing large doses of vitamins A, B, C, and D. The other half of the children were fed and cared for in the same manner, except that they did not get the capsule. Their only source of vitamins was the food they ate. Surely the chil-

dren who took the capsules would have fewer colds, if added vitamins were of value. During two entire winters, there were just as many colds among children who took the capsules as there were among the others.

Cowan, Diehl, and Baker, despairing of the use of cold vaccines, began to experiment with vitamin capsules a couple of years ago. Their conclusions were published in *The Journal of the American Medical Association.* The same careful method of control they perfected when studying vaccines was followed. The vitamin capsules containing large amounts of vitamins A, B, C, and D were exactly like the placebo capsules in appearance. The latter held only a few drops of mineral oil—a substance which could have no conceivable effect in such small quantities.

More than 200 students were given two of the vitamin capsules daily and a similar group took the placebos. All of them believed they were getting the "cold prevention capsules." There was a 50 percent reduction in colds compared with the previous year whether the students took vitamins or mineral oil. The average number of colds per student was the same in each group. Vitamin capsules did not shorten the number of school days lost, decrease the severity of colds, or lessen the incidence of complications. The average duration of colds was 8.2 days among those who took the vitamins as compared with 8.1 days among the students in the control group.

There are certain conditions in which the use of vitamins is necessary, even life-saving; but there is no excuse for indiscriminate vitamin medication because of "lowered resistance to colds." The work of Drs. Kuttner, Diehl, Baker, and Cowan proves that added vitamins do not prevent colds, if the diet is reasonably adequate.

Dr. Diehl has said that the kind of food "these students get is probably not as good as that of the average person who buys vitamin pills." And yet the students were not prevented from getting colds by adding vitamins to their diet. How, then, can the average person, whose diet is better, hope to prevent colds by taking vitamins?

There is no cause for despair in the reports that neither vaccines nor vitamins will keep colds away. The recognition of these failures will stimulate research men to study other preventive measures. If the millions spent for vitamins and vaccines could be used to finance continued scientific investigation, a successful method of prevention might be discovered in the very near future.

Meanwhile, sensible living remains the best weapon for preventing colds. Contact with persons who have colds should be avoided, adequate rest must be secured, and a well-balanced, nutritious diet should be eaten.

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CLIMACTERIC
Do Men Also Have Such a Period?

THIS is a serious question. In an article in *The Journal of the American Medical Association,* Dr. V. Korenchevsky of London, cites a number of medical and biological scientists who suspect that some men do pass through such a period, with symptoms similar to those of castration and appearing at the average age of 48 to 52 years. These symptoms are classified as follows:

Nervous and psychic, to which belong intense subjective nervousness, headaches, giddiness, scotomas, emotional instability with an inclination to tears, irritability, sudden changes of mood, decreased interest in the usual activities (even pleasures), a desire to be left alone, decrease or loss of memory and ability for mental concentration, mental fatigability, loss of or disturbed sleep, day sleeping. A typical "climacteric" neurasthenia or involutional psychosis, chiefly in the form of melancholia, with a tendency to suicide which might develop.

Cardiovascular changes: Hot flushes, fits of perspiration, chilly sensations (for example, cold feet), tachycardia, palpitations, numbness, tingling.

General and other changes, including increase of body fat; physical fatigability; rougher and darker skin with wrinkles or folds appearing on the exposed parts; constipation; decreased sex potency and libido.

It usually is ill-advised to publish in a non-medical magazine a list of symptoms; the layman too easily inclines to assimilate his own symptoms to them and diagnose his own ills without realizing that a given symptom, taken alone, may also pertain to a wide variety of conditions other than those described. This is why the advice to ask a physician is the safest always, even though the possibility described above is of interest to men who seem during a period to go to pieces. When a given organism has reproduced itself Nature appears to lose interest in it.

HEART WATCHING
Important to Workers in War Industries

TIRED hearts which furnish strength to hands manipulating explosives are a source of potential danger to workers in the munitions industry. Recently physicians at one of the country's largest explosives manufacturing companies called upon electrical science to help them ferret out cases of heart fatigue among workers in certain departments before the tiredness became so great as to cause fainting.

The instrument they are using is called a "sound frequency analyzer," developed by Western Electric Company. A great deal more sensitive than the stethoscope, it picks up, analyzes, and records the heart sounds that disclose fatigue conditions that induce fainting.

The plant doctors use the instrument regularly to chart the heart sounds of workers unavoidably subjected to chemical fumes causing heart fatigue. From these charts they are able to tell the degree of heart fatigue suffered by each person. Workers whose charts show heart fatigue are immediately transferred to other departments, to avoid danger to themselves and to other workmen in the plant handling explosives.

WEEKS
Sedentary Workers Feel Vitamin Deprivation within Month

IF VITAMIN B were suddenly withdrawn from the diet, how soon would the effect become apparent? Would it be a matter of years, months, days, hours?

Light is thrown on this question by an article in *American Journal of Physiology.* Seven healthy physicians were themselves used as the subjects, and were put on a diet made grossly deficient in the vitamin-B complex. Measurable symptoms of the deficiency became manifest within three to four weeks, and consisted of easy fatigue, loss of ambition, and loss of efficiency in daily work. The symptoms were mild and vague.

Having acquired a vitamin-B deficiency, after several weeks, does it require the same length of time to recover from it? Generalizations are dangerous but, by and large, the neurological and mental recovery is likely to be rapid; recovery from tissue changes, if any, probably much slower. A general idea of the former is imparted by language used in *Nutrition Reviews* with regard to deficiencies in thiamin (vitamin B_1) in animals used experimentally: "There is a vast amount of evidence," that journal states, "that the administration of thiamin to an animal acutely deficient in thiamin causes a dramatic and prompt remission of the neurologic signs within a period of minutes, and complete recovery within a few hours."

CRYMOTHERAPY
Outstanding Medical Journal Urges its Adoption

ICE ANESTHESIA for shockless surgery of the extremities is brought about by immersing the limb in a pail of ice and water for one or two hours before operation, and was described in Scientific American (April, 1942) by Barclay Moon Newman. This method was developed by Frederick M. Allen, M.D., of New York. Its simplicity and effectiveness were pointed out in our article for the lay reader, and the hope that this method would be used by the military in the field was expressed.

Apparently this form of anesthesia has not been adopted as widely as some medical authorities have hoped, for we find in an editorial in *The Journal of the American Medical Association* urgings which are at once urgings and a strongly implied commendation of the method. *The Journal* states, under the caption "Refrigeration (Crymo) Anesthesia," that "Future generations may find it difficult to understand why it is taking us so many years to appreciate the significance of reduced temperature. The

usefulness of maintaining life processes at a reduced rate by lowering the temperature is still not generally understood.

"Recent reports indicate that in combat areas military surgeons are largely occupied with the care of injuries of the extremities. The older methods of anesthesia for these cases are not completely satisfactory.

"Life processes, in common with chemical reactions, have a speed which is profoundly influenced by temperature. Oxygen consumption of the tissues can be reduced about 13 percent for each degree, Centigrade.

"Refrigeration offers advantages for nearly all cases of severe wounds of the extremities. The large-scale program of medical education for war which is now in progress should include instruction in temperature physiology and advanced courses in the principles and practice of refrigeration anesthesia."

SYPHILIS

What of the Too-famous "One-Day" Cure?

A YEAR or so ago much publicity was accorded to a "one-day" cure for syphilis, and physicians raised their eyebrows. How *The Journal of the American Medical Association* regards such cures may be inferred from the following statement recently published in its columns:

"There is no royal road to the cure of syphilis."

HYPNOTISM

Is it a Fraud?

If not, Where Does it Stand?

MANY persons apparently regard hypnotism categorically as a fraud. Perhaps this is because most stage hypnotism—the variety most likely to be witnessed by laymen—is often conducted under auspices that do not inspire confidence. Even then, however, most of it is genuine—probably because it is easier to perform the genuine than to fake an imitation.

But hypnotism is also employed in psychiatric hospitals and elsewhere in the medical world. It is not new and it is not widely used, in a comparative sense, but it remains in good standing in many competent medical circles. Just how *The Journal of the American Medical Association* recently answered an insular reader, a doctor of medicine, who inquired about the present status of hypnotism as a therapeutic procedure, and its use by laymen, may be gleaned from the answer which was published in that journal:

"Hypnotism suffered the fate of other methods of therapy which have become associated with charlatanism and which have been hailed with undue enthusiasm. It fell into disrepute with physicians because, unlike psychoanalysis, it deals largely with symptoms rather than causes. It is essentially for this reason that this valuable therapeutic technique may be dangerous in the hands of the public, for symptoms may be created or intensified without a proper knowledge of the underlying pathologic condition. All physicians are aware of the power of suggestion, and in the state of hypnosis conscious resistance is reduced to a minimum. The patient is put in a condition of heightened suggestibility and he accepts suggestions without criticism.

"One of the greatest obstacles in psychotherapy is to get the patient to accept therapeutic suggestions consciously. Under hypnosis it is possible to implant therapeutic ideas on the 'subconscious' and to have them take effect when endless numbers of suggestions given in the waking state would be ignored or even actively resisted. Also under hypnosis former dissociated experiences and amnesic material can be rendered available for reassociation and reorganization. Of course, like any form of psychotherapy, the results of hypnosis are individually limited, and they vary in degree and variety with every subject, depending on the innate endowment of the patient.

"Hypnosis has a definite place in psychotherapy. It is not a mysterious art, but a scientific technique."

PLASTICS IN MEDICINE

Many New Uses are Being Developed

BRAIN plates, cups to reline arthritic hips, nylon monofilament sutures that are stronger and less irritating than silk, instruments that "pipe cold light around curves,"—these are some of the hundreds of instruments of surgery and medicine now made from plastics.

Wartime research and experience of physicians and surgeons has greatly intensified the evaluation and adoption of medical applications for plastics, forecasting their increasing use in this field, according to the Plastics Department of E. I. du Pont de Nemours & Company. Many instruments are not now generally available because of war demands and priorities on plastic materials.

Properties such as toleration by human tissues, exceptional lightness in weight, transparency to X-rays, and virtual unbreakability adapt the plastics for use in delicate brain operations as well as ordinary medicine-chest tongue depressors.

A noted New York surgeon has performed more than 300 skull operations in which a cranial defect was repaired with a plate of "Pyralin" cellulose nitrate plastic. Easily formed to the desired curvature in hot water and sutured in place, the plastic is perfectly tolerated by the tissues, is not absorbed, and becomes firmly implanted in the skull. A similar operation is made in treating certain types of epilepsy.

Pain in arthritic hips has been relieved and there has been at least a 50 percent increase in the leg motion—the criteria by which the success of a hip operation is judged—when cups of an acrylic plastic like "Lucite" methyl methacrylate resin have been used.

The material not only is non-reacting to tissue but is transparent to X-rays, which allows the surgeon to see bone structure within the cup. This plastic has also been used for jaw and knuckle joints, as a substitute for metal plates in bone grafting, and in plastic surgery.

Millions of feet of nylon monofilament, formerly used in tennis racquet strings and fishing leaders, will this year replace gut and Japanese silk in sutures for the Army, Navy, civilians, and lend-lease shipments. Nylon does not dry out and rot like the natural fiber.

These plastic sutures are superior to silk. They have greater tensile strength and smaller diameter strands can be used. They are non-absorbing and inert in the body, whereas germs can travel in silk and skin can grow into the twisted threads of a silk suture.

The ability of "Lucite" rods to transmit "cold light" around curves, plus strength and light weight, make them particularly adaptable to the familiar combination flashlight-tongue depressor and a host of other instruments needed to examine the cavities and recesses of the body.

Concentrated, shadowless illumination is given by this plastic in surgical retractors used for lighting up incisions and spreading them apart, as well as in cystoscopes, sigmoidoscopes, proctoscopes, otoscopes, pharyngoscopes, brain and tonsil probes, and speculums.

Shields to protect doctors treating infectious diseases, windows in plaster casts, stethoscope parts, transfusion tubes, incubator covers, and drainage tubes are among the numerous other medical applications for "Lucite," the same plastic from which crystal-clear noses, gun turrets, and other transparent sections of military aircraft are made.

Containers for pills and capsules, vaccination shields, nose guards, artificial fingers, splints, nylon catheters, windows for oxygen tents, respirators and therapeutic boots, dentures—the list of plastic applications in the field of medicine continues to grow.

RAPID GRAYING

Does Hair Ever Turn Gray Over-Night?

THE BELIEF than hair can turn gray over-night is a popular superstitution, according to some, who argue logically from the premise that hair is practically a dead tissue. But is this premise itself correct?

On the other extreme are thousands of persons who claim to know of cases in which hair actually did turn gray in a few hours. Not all these cases will, however, bear strict investigation.

In *The Journal of the American Medical Association* the rapid graying question was recently discussed in much more detail than can be done here. Though attested cases are rare, *The Journal* accepts some of them, and does not categorically deny all of them. It states, in sum: "The fact that in rare instances hair can quickly become gray must be acknowledged. The old idea that hair is practically a dead tissue, cut off from the metabolic influences of the body, must be forsaken."

'WERS' Calling

Radio Amateurs and Other Volunteer Workers are Setting Up a Communications System for War or Peace

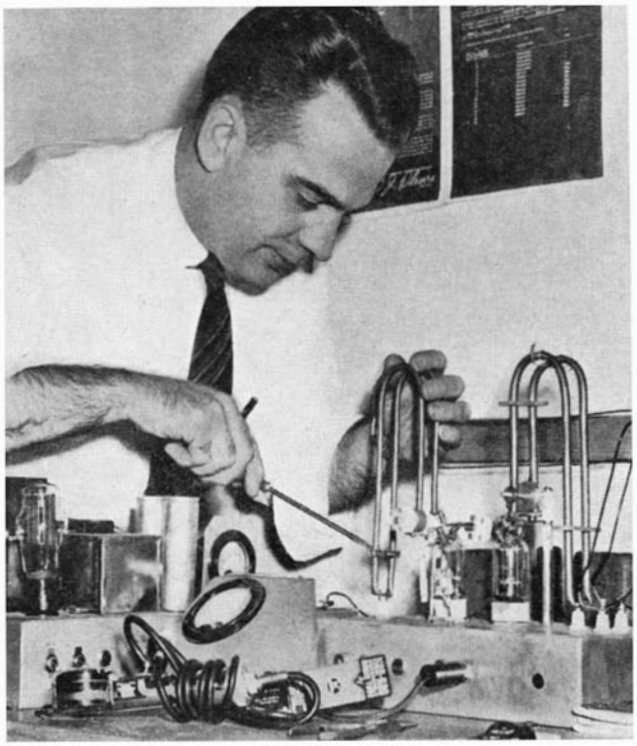
MAJOR GENERAL ULYSSES S. GRANT, III
Protection Branch, U. S. Office of Civilian Defense

ALONG the coasts of our country and inland where enemy planes may strike, wherever there is threat of disaster from war or the heightened wartime threat of civil disasters—major accident, explosion, conflagration, floods, hurricanes—alert communities are setting up a new, specifically war-planned communications auxiliary, the War Emergency Radio Service. Director of the Office of Civilian Defense, James M. Landis, says, "OCD strongly recommends that every community faced with the possibility of disasters of this character take steps immediately to give itself this added protection."

The War Emergency Radio Service, WERS, is a system of two-way radio communication, licensed by the Federal Communications Commission, for use of Civilian Defense and other defense forces in local areas. It is a characteristically American development and depends on the existence, first, of radio amateurs and other radio technicians familiar with high-frequency transmission, and, second, of a stock of radio equipment and parts unequalled elsewhere in the world.

Wartime necessity led to the banning of amateurs from the air shortly after Pearl Harbor. At that time there were about 55,000 licensed amateurs in the United States. Over 16,000 of these are now in Uncle Sam's service and many thousands more are working in essential war jobs and can give only a limited amount of leisure to WERS work. That puts a particular obligation on those left with full leisure to come forward and to help in setting up the many needed WERS systems. The fact is that few ex-amateurs require urging. On the contrary, they are more than glad to return to radio activities, and through radio to contribute their part to the war.

It must be kept in mind, however, that there are strict limitations on the work they are doing under WERS. For one thing, it is limited to the use of ultra-high frequencies, mainly in the 2½-meter band—112 to 116 megacycles. Then there is the matter of operation. WERS sets are specifically for war objectives. In Civilian Defense (there are also WERS stations for State Guards and Civil Air Patrol) the stations may be operated only during air raids or other emergencies, or during short practice periods once or twice a week. The result is that amateurs must go into it with the clear picture in mind that WERS is a limited, licensed system under FCC regulation, that they go into it to do a volunteer patriotic job, and that that job involves putting long hours into station-building, training and other unexciting tasks, and little into actual operation. Yet the operation, when it comes, can count for life and death.



A WERS volunteer installs a transmitter

WERS is just at the beginning of what is expected to be one of the great new developments in the field of defense and warfare. At the time of writing there have been 222 applications for station licenses; 156 have been granted, and about 4500 WERS operators' permits have been issued. There are over 3700 actual operating units, but everywhere in the country the construction of more is on the way and it is expected that ultimately there will be about 100,000 transmitters, 200,000 receivers, and about 300,000 operators to man all this equipment.

This expected large body of personnel will have its recognized place in Civilian Defense. WERS operators will serve in the Communications Unit of the local Defense Corps. This Unit will have the lightning-flash insignia, with a differentiating word for each of the Unit's three subdivisions: WERS, telephony, and messenger service. To qualify for Communications Unit membership and insignia, WERS volunteers will be asked (1) to get an FCC operator's license, (2) to follow a prescribed course of study and (3) to put in approximately 20 hours of in-service training. Many of the personnel who help establish WERS systems will also become operators, but even if all of them became operators, they would fill only a small proportion of the need. The larger number of operators will have to be general volunteers trained especially for the work. Fortunately, this training can be given in an easy six-hour course and does not require previous radio experience.

The part of the job where amateurs and other technically experienced personnel will make the greatest contribution is in setting the system up and putting it in motion.

What is a WERS system? How does it help in the defense work of a community or group of communities? What gives it the dramatic pull and the appeal to the imagination—as well as the good, practical utility—that make it a fast-growing wartime national asset?

The War Emergency Radio Service is a local defense-area system of two-way radio communication that gives an extraordinary flexibility and dependability to essential communications in time of enemy attack or war disaster. The FCC has assigned WERS a number of frequencies, but the main ones, as stated before, are from 112 to 116 megacycles. Within this range OCD recommends that operation be planned for three bands of several channels each. At need there would be available 16 distinct channels so that there is no practical limit to the system's flexibility.

The three bands serve three purposes:

1. One band connects the local Civilian Defense control center with the district control center and so reinforces the community's outside communications.

2. A second band connects the local control center with local fixed points such as wardens' posts, fire houses, hospitals, public utilities, and industrial plants.

3. A third band connects mobile forces like fire trucks and emergency medical teams with the control center. This band can also connect with walkie-talkies, portable sets carried by Civilian Defense volunteers.

WERS transmitters use a maximum of 25 watts input power, which gives an

The radio in this Auxiliary Police car has been converted into a shortwave WERS set, permitting maintenance of constant two-way contact with the control center

effective communicating range of approximately 10 miles, and a maximum practical transmission range of about 25 miles. Operation of sets with this limited range cannot help the enemy. Directional bearing cannot be taken on the stations and it would be useless on such a range to attempt interception of messages.

THERE are three main advantages to WERS:

1. Wide coverage.—WERS can reach many points simultaneously, once its channels are put on the alert. One district warning center can reach all local control centers. The local control center can simultaneously notify all wardens' posts of air-raid signals, for example. The need for telephone chain calling is eliminated.

The system also has value in the case of calls to only one point. All sets are listening in, and operators can break in to give advice or information, or can guide their own forces better through knowing the current situation.

2. Invulnerability.—It is virtually impossible to put the new system out of action. At most a few sets may be destroyed, which can easily be replaced. All other means of communication depend on cables, wires, and exchanges vulnerable to bomb hits and partial or total destruction. A bomb hit anywhere between the two points of communication will usually put all lines out of commission. Radio needs no wire or cable.

3. Contact with moving units.—The new system can reach defense forces in motion. WERS gives all mobile forces a continuous central command and allows them to be shifted from one incident to another without returning to the base. Walkie-talkies extend this two-way contact. By means of walkie-talkies, an incident officer or a fire chief or chief of any emergency unit can direct his squads easily and quickly from a vantage point at the scene of disaster.

The new emergency radio system is of direct use to many strategic centers and installations in the community, such as hospitals, industrial plants, railroad yards, docks, bridges, and public utilities. Its importance to these points appears in the two following representative cases:

1. Industrial plants.—Calls to an industrial plant give air-raid warning, advise the plant's Defense Coördinator of latest developments during a raid, confirm calls for emergency units and indicate the help coming, and advise in the operation of the plant's own emergency forces. Calls from an industrial plant summon emergency medical teams, rescue units, fire and police forces, demolition squads, and at need, decontamination units. Large industrial plants can use walkie-talkies to reach plant protection volunteers in outlying sections of the plant or in separate buildings or defense posts.

2. Hospitals.—It is crucial to know during a raid exactly what beds are available and what operating rooms are free in the casualty receiving hospitals of a community, and to direct casualties rapidly to available facilities. If telephones go out, the control center can still keep a complete picture of the hospital situation by WERS. By use of the new system, ambulances can be loaded and dispatched effectively because the control center is in communication both with hospitals and with the incident officers and incident medical officers. Mobile medical teams can be directed from point to point without returning to their bases. If the hospital facilities of an area become overtaxed, the radio channel to the district headquarters can arrange for reinforcing hospital facilities.

Not only in air raids but also in cases of civil disaster will WERS greatly benefit the community's emergency forces. When flood menaces an industrial plant, when fire or hurricane spread damage, and break communications over a wide area, WERS and Civilian Defense units will give the same kind of help to fixed points in the community as described above.

Under the plan recommended by the Office of Civilian Defense, blanket licenses are obtained from the Federal Communications Commission for all the Civilian Defense radio stations within one area of operations. Thus one WERS system covers a district warning area, and the equipment and operators of the entire district are available to any stricken community. This prevents "freezing," for under law, operators in one separately licensed community cannot work in any other unless they bring equipment with them.

LICENSES are issued only to municipal or local governments, such as cities, towns, townships, or counties. They are not issued to police departments, fire departments, or Defense Councils as such. But while licenses are issued to local governments, the WERS system, when set up for Civilian Defense, must be planned under authorization of the local Defense Council and with its guidance. In many cases the initiative comes from the Defense Council, but if not, local radio amateurs and professionals do and should take the initiative themselves. They know the community's possibilities and needs in terms of radio better than anybody else, and are the ones, in any case, to whom the community must turn.

When the Defense Council authorizes the setting up of a system, steps may be taken for obtaining a license. The proper application forms can be obtained from the Federal Communications Commission in Washington, D. C. Federal Communications Commission, Rules and Regulations, (Title 47—Telecommunications—Chapter I), Part 15, gives all the necessary information on how to file for a

Civilian Defense radio operators standing-by at West Control Center equipment, Akron, Ohio

WERS License. This can also be obtained from the Federal Communications Commission. A Fact Sheet describing WERS advantages and operation may be requested from the Editorial Section, Office of Civilian Defense, Washington, D. C.

The first WERS system in the country was established in Akron, Ohio. Immediately after Pearl Harbor, Akron's Buckeye Short-Wave Radio Club held meetings and discussed future emergency operations. These discussions, of course, were well in advance of WERS authorization by the FCC, and so this alert group planned in terms of what the FCC might be expected to do. It was the consensus that the FCC would not permit a higher wavelength than 2½ meters, so plans were made on that basis. The Executive Council of the County Civilian Defense Corps was brought in on the plans and appointed the Club president, John A. Bailey, county representative of amateur radio operators. In December, 1941, Bailey presented a report to the communications section of the Council that provided for a two-way system using 16 transmitters of both the portable and fixed types.

Getting Council approval, he went ahead by applying to the FCC for permission to set the system up and—assuming granting of the permission—starting Akron amateurs on the work of construction.

WHILE THEY worked, the FCC and the Defense Communications Board (now called the Board of War Communications) authorized WERS and allocated it radio channels. As Akron had expected, the main band chosen was 2½ meters (112-116 mc.). Soon Akron received a WERS station license along with operator permits. The station call was WODF, and the first test of equipment was held when the Commander of the County Civilian Defense Corps called a test blackout.

An interesting fact about the Akron system, which is increasingly typical of WERS systems, is that it is designed to tie in with WERS set-ups in nearby communities, such as Barberton, Cuyahoga Falls, Medina, and Hudson.

Since that first set-up, important systems have been developed in key sections throughout the country, particularly—as might be expected—along the costal areas and in large industrial communities. Along the Atlantic coast, Massachusetts and New Jersey lead in number of licenses granted, having 19 each (these two states, in fact, lead the country). Pennsylvania has 12, with seven pending. New York has 12, Rhode Island, ten, Connecticut eight. Maryland has six counties licensed with most of the remaining counties on the verge of getting licenses, and with a state WERS network about to go into operation. New York City and Philadelphia have leading WERS systems, New York leading the country and Philadelphia being licensed for 111 transmitters. In WERS systems, receivers equal or exceed the number of transmitters.

On the West Coast, California has nine licenses with its main systems in Oakland, San Francisco, and Los Angeles. Washington has four, with systems in Tacoma, Everett, Olympia, and Spokane. Oregon has two.

Texas has three. Michigan has four: Detroit, Lansing, Grand Rapids, and Center Line.

The story of those actually licensed, however, is not by any means an accurate picture of WERS development, because all over the country other systems are in process of construction, with equipment being assembled and installed and operators trained.

Walkie-Talkie equipment is an integral part of WERS radio equipment

Equipment is one of the main problems, yet there is no question but that our country is in an ideal position to solve any equipment shortage. Automobile radios are adaptable to 2½-meter conversion. Everywhere in the country are thousands of old radios, junked parts, and radio material scrap which in the hands of ingenious WERS constructionists can be reassembled into usable sets. WERS volunteers themselves often donate this material. In addition, some communities put on radio scrap drives for the specific purpose of equipping WERS—attics and the back rooms of radio repair shops are ransacked for old sets and salvagable materials. In many cases, factory discards and other material that seems defective or unusable is redeemed through the ingenuity of WERS workers.

The problem of obtaining personnel for setting up WERS systems is a very real one, and is taking on increasing importance. Great as the contribution of amateurs has been, many communities do not have enough amateurs to do the job. In such communities, radio repairmen and broadcast station engineers and operators have stepped in, and in their leisure hours have given extremely important help, help that should be mentioned along with that of the amateurs. Broadcast station personnel, for example, have been able to borrow precision test equipment from their stations with which they check WERS equipment to see that it fulfills FCC requirements. If the equipment needs adjustment, they make the adjustment required. They also are in a position to give invaluable constructional help and advice. In many instances, broadcast engineers and operators have been appointed Radio Aides and have organized and directed WERS work.

Radio service men have been making an equally important contribution. They have been particularly generous in donating usable or salvagable materials for WERS—in many cases they have built full units for WERS in their own shops, and have opened their shops to other volunteer construction workers, giving them an ideal place in which to work. When the sets have been built, the radio service men have volunteered on a wide scale for the equally necessary work of installation and maintenance.

Mention should be made, finally, of the help given by High Schools, Technical and Vocational Schools, and colleges which in many parts of the country are offering their shops as work places for WERS.

WERS is on its way. Although it is still only at the stage of initiation, it is developing rapidly a body of enthusiastic workers and a fund of invaluable experience derived from the ingenuity, resourcefulness, and devotion of the amateur and professional radio personnel of the country. The impetus to setting up WERS comes both from the Civilian Defense organization and from these patriotic and informed radio people who see in WERS the great communications auxiliary it is, a channel of warning and co-ordination within the community and of emergency appeal outside in time of disaster. No bomb can destroy more than a small fraction of WERS equipment, and any key point can be rapidly re-equipped. The system is always there, it goes on effectively serving under all conditions. As WERS develops, America will be better prepared for all emergencies, whether of war origin or the recurring and now intensified castastrophes of civilian life. When full preparations are made, damage to life and property is minimized, and even, to a degree, the threat of enemy attack is lessened, for the enemy is not tempted to attack well defended areas.

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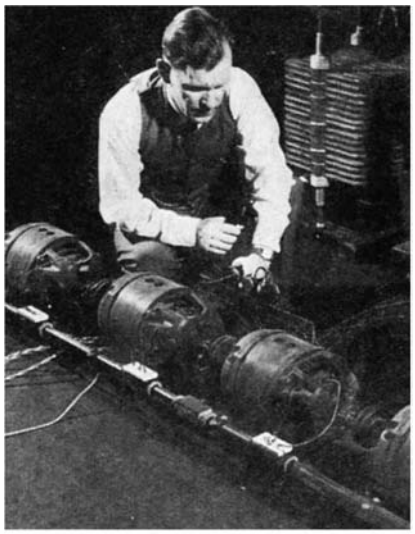
ELECTRIC "BRAIN"

"Remembers" What Happens in a Rectifying Circuit

A PAPER and aluminum "brain" that memorizes surges of electric current and records them for the benefit of research engineers is making possible better electronic tools for war production. Little bigger than a loaf of bread, the "memory machine" was built by William E. Pakala, a research engineer at the Westinghouse Electric and Manufacturing Company. It was designed to help scientists study the Ignitron, an electronic device that converts alternating current into the direct current required by alu-

minum and magnesium plants. Teamed with an oscillograph, which jots down on photographic film a record of the electricity passing through a switch, motor, or electronic tube, the "brain" tells engineers exactly what happens inside the Ignitron.

The Ignitron converts alternating electric current to direct current that flows



Adjusting a battery of "brains"

in one direction only—just as a valve in a water line lets the water flow in only one direction, the engineer explains. When water begins to flow backward, the valve closes. And so an Ignitron refuses to let the electric current move backward.

But infrequently an Ignitron will "arc-back," like a valve that fails to close when the water flows backward, Mr. Pakala says. There is no way to forecast when this undesirable "arc-back" will occur.

Previously, engineers studied such electrical phenomena with the oscillograph. "But the oscillograph alone was unsatisfactory," Mr. Pakala says, "because we never knew when the arc-back was coming and we couldn't expose hundreds or perhaps thousands of feet of film while waiting for it. From a standstill the oscillograph could not go into action fast enough to get a picture of the arc-back, which lasts only 1/60 of a second.

"Then I had the idea—why not put a machine between the Ignitron and the oscillograph that would remember what happened inside the Ignitron? This would give the oscillograph a chance to begin operating and then the memory machine would recite the message so it could be picked up and photographed."

To do this, Mr. Pakala converted an ordinary electric motor, not much bigger than the one on a washing machine. He stripped the copper wires from the revolving part of the motor and replaced them with layers of aluminum foil and paper. These electric "reservoirs" can store an electric charge, then release it when they are tapped.

Each capacitor was connected to one of the copper bars on the motor's commutator and the whole memory machine was hitched to a real electric motor that made the brain whirl at a steady speed.

"A graphite brush rubbing against the memory machine's revolving commutator takes electric current from the Ignitron and feeds it into each little reservoir as the memory machine spins around 1800 times a minute," Mr. Pakala explained.

"If the current shoots up for an instant, the reservoirs that pass the brush during that time receive a greater charge than the other capacitors on the whirling rim.

"When the reservoir completes one revolution it is discharged by another brush rubbing against the commutator. This brush drains off each charge and leads it through a wire to the oscillograph which has already been set in motion by an electronic switch closed by the arc-back."

When it is turning 1800 times a minute, the brain "remembers" things for one-thirtieth of a second, long enough for the engineers to get an oscillograph picture of what happened just before, during, and after the arc-back.

As the brain turns faster, its memory becomes shorter. But then it remembers more details of the surges or high voltages in the different parts of the Ignitron tube. If it turns more slowly, its memory is longer but it tells the oscillograph —and the engineers—fewer details.

RADIO SEWING MACHINE

Radio Current Replaces Needle and Thread

A RADIO sewing machine recently developed has promise of becoming one of the new radio-electronic machines of the post-war period, when expansion of its use may be extended through wartime developments.

Instead of needle and thread, this machine uses radio-frequency current; instead of woven cloth, it works on thermoplastics—the new synthetic materials that are finding wide application in the making of raincoats and caps, weather balloons, and in the packaging of many types of food and oils.

It "stitches" a thin, solid seam that is air and water tight, creating a bond that is stronger than the material itself. It does this simply and easily, thus promising to overcome many fabrication difficulties involved in conventional processing methods as applied to thermoplastics.

The radio sewing machine was created by RCA Laboratories to meet a definite need in the plastics industry. Thermoplastics, tough resilient materials, can be rolled into large cloth-like sheets, which makes them highly useful in any number of ways. When cut into patterns, the sections are usually put together by sewing with thread, by cementing, or by fusing with externally applied heat. None of these methods has been found to be entirely satisfactory for mass production, although fusing by heat appears to be the most desirable method. But there are problems of maintaining uniform temperature and of processing equipment becoming gummy and sticky.

By generating heat inside the material itself, RCA's radio sewing machine eliminates these difficulties. This is what happens. The material to be sealed, or "sewed," is fed across a table top through two small roller wheels which serve as the "needle." The wheels have two functions: To pull the material along and to act as plates which set up a small electromagnetic field of radio-frequency current. As this current passes through the material, heat is generated by dielectric loss, or, in other words, by the struggle of the current to get through the closely packed molecules of matter which compose the material. The heat causes thermoplastics to fuse, or weld, in a tight bond.

Somewhat similar in appearance and operation to the conventional sewing machine, the radio device derives its

A thin, solid seam is "stitched" in plastic by the radio sewing machine

current from a low-power radio-electronic oscillator. A small electric motor drives the roller wheels. Controls are in a foot pedal. Ordinary alternating current of 110 volts supplies the power.

Laboratory tests, according to RCA, have revealed that the radio machine is an effective instrument for the handling of such thermoplastics as vinylite, koroseal, and pliofilm. All three of these materials are being used in a widening field of practical applications.

COFFEE SHIPMENT

Expedited by Opening of New Bridge

THE NEW railroad bridge over the Suchiate River between Mexico and Guatemala has opened a land route for the shipment of coffee to the United States from Central America.,

In the first two months of the operation of the new bridge, according to figures from the Mexican Government Railway System, more than 60,000 bags of coffee (154 pounds each) originating in Guatemala and destined for the United States were handled by the overland route.

This is only a small fraction of the enormous consumption in the United

States, but shipping of coffee over the Mexican railways illustrates how the Americas are seeking to solve the wartime shipping shortage which has curtailed imports of coffee from Brazil and other distant sources which are without rail connections with the United States.

To facilitate overland traffic from Central America to the United States via the Mexican railways, the Suchiate Bridge was rushed to completion last year as wartime shipping shortages restricted inter-American trade. Mexican railways today are being called upon to handle an increasing flow of minerals and other strategic materials from Mexico into the United States. This movement is expected to increase sharply this year and thus may crowd out extensive shipment of coffee and other non-war commodities from Central America.

The new bridge makes overland transit between Mexico City and Guatemala practicable in 48 hours. Prior to construction of the bridge, railway freight had to be unloaded on the banks of the border river and ferried across.

The Suchiate Bridge is counted on as a substantial aid to facilitate movement of supplies into Guatemala, El Salvador, and other Central American countries, while proving a boon to northward movement of their commodities to United States markets.

WAR LIGHTING TOOLS
Will Find Numerous
Peace-Time Applications

LIGHTING techniques now being developed essentially for military needs are due to play an important part in post-war reconstruction and peacetime living, according to Samuel G. Hibben, lighting authority. He says that most of the lamps for tomorrow's lighting jobs "are ready to graduate from the research laboratories and battlefronts onto the retail counters.

"If we are to achieve our national destiny as the center of cultural living as well as of democracy," he declares, "we should begin by using all of the amazing lighting tools that science is now placing at our disposal."

Pointing out that those who have experienced blackouts and dimouts have had the discomforts and dangers of darkness strongly impressed upon their minds, Mr. Hibben says that for the first time in their lives, perhaps, they have become "light conscious." "When the war is over," he continues, "there will undoubtedly be a decided reaction from these conditions as evidenced by a much greater use of good lighting and new lighting methods, first as an expression of freedom and cheerfulness and later as a means to greater health, safety, and efficiency.

"We now have a civilian army of some 20,000,000 factory soldiers, more than half of whom are dependent upon artificial lighting during the major part of their working hours.

"The millions of fluorescent lamps now producing artificial daylight in the nation's war plants have demonstrated so thoroughly to war workers the benefits of comfortable vision that I doubt very much if they will be content to live in ill-lighted homes when the war is over."

As an example of the part to be played by lamps in guarding the nation's health, Mr. Hibben cites one product of Westinghouse research laboratories—an ultraviolet lamp which destroys germs and prevents cross-infection. "This Sterilamp," he says, "is on its way to becoming a regular part of the air-purifying systems in schools and public places where it can reduce infectious diseases. Before long it may be commonly employed in our homes."

Among the other peacetime applications of lighting developments, Mr. Hibben forecasts "controlled weather conditions," explaining:

"The compact lamp that radiates infrared or radiant heat now is being used to dry the painted surface of a military tank in three minutes and to do a similar job on plastic helmet liners for the Army. After the war this same lamp may provide 'good weather' by casting its artificial beams on our plants and vegetable gardens. As a substitute for the sun in this capacity it could do a creditable job.

"Experience gained during the blackouts and dimouts will result in vastly improved street lighting. Uncomfortable glare will become a thing of the past

since it is possible to have good lighting without it.

"Interest in new achievements should also bring into wide use the invisible ultra-violet rays known as 'black light.' Today this light enables aviators and submarine crews to see the fluorescent instrument dials which glow when struck by ultra-violet. Tomorrow, home wall decorations painted in luminescent colors, will glow brilliantly when activated by this same 'black light.'"

ALL ANCIENT
Bamboo Books, Paper, and Pencils in Ancient China

BOOKS with bamboo pages resembling a hammock of wooden slats, were widely used in ancient China 14 centuries before Christ, according to Dr. Arthur W. Hummel, curator of Orientalia at the Library of Congress, Washington, D. C.

These early books apparently were similar to later books written on narrow strips of bamboo wood, some almost two feet in length. These strips were laid side by side and bound together by cords at the top and bottom. The writing probably was done in ink with small hand brushes.

The narrow wooden strips suggest vertical rather than horizontal writing and this probably explains why the Chinese have always written in vertical columns.

Paper was invented about 100 A.D. by Ts'ai Lun.

The lead pencil was used for making notes in classrooms as early as the 2nd Century, A.D., and probably was invented earlier.

"BIG-INCH" WELDING
Speeds Construction of Largest Oil Line

WELDING operations used in constructing the "Big Inch," largest oil line ever built, are speeding up construction through all kinds of terrain.

The line, which has a capacity of 300,000 barrels of oil per day and is made of 24-inch seamless pipe of 3/8-inch wall thickness, runs from Longview, Texas, to Norris City, Illinois, and is being extended to the Atlantic seaboard.

After a section of pipe has been brought up to the end of the line, and pulled into position by tractors, men of the tie-in crew stand on the pipe to bring the ends into alignment. Then the tacking crews of the firing-line gang go to work. The pipes, mounted on dollies, are lined up, clamped, and tack welded ready for the roll welders, who complete the job of the tackers and join lengths of pipe into one section. First

Along the "Big Inch." *Upper left:* Men of the tie-in crew stand on pipe to bring the ends into line. *Above:* Lining up and clamping a section of pipe to the end of the line. *Below:* Putting the last pass of a roll weld on one section of the "Big Inch"

Illustrations courtesy Lincoln Electric Company

pass is made with 3/16-inch "Fleetweld 5" electrodes at 200 amperes. Second pass is made with 1/4-inch electrodes with 325 amperes. Third pass is made with 5/16-inch rods with 375 to 400 amperes. When completed, the weld is "penny wide" and "nickel high." Each roll welder marks his weld with a stencil. Careful inspection discloses any pin holes and these are rewelded by the roll welder before he leaves that section of pipe.

OIL ROCKS
Now Classified to Aid the Hunt for Petroleum

THROUGH finding the essential microscopic characteristics of various types of rocks, Dr. Paul D. Krynine, assistant professor of petrology and sedimentation at the Pennsylvania State College, has been able to formulate a classification of sedimentary rocks, based on their evolution, which it is believed may be of value in discovering new oil fields. Where a particular rock or sand fits into the classification indicates where and what type of oil may probably be found.

This is the first systematic petrographic classification of sedimentary rocks ever made, though igneous rocks have long been classified.

The characteristic composition and texture of the rock is intimately related to the movement of the earth's crust many million years ago, Dr. Krynine believes. The texture or appearance as well as the chemical and mineral composition of different sand types indicate the geologic changes they have been through in the earth's evolution.

Oil in California comes from sand or rock reservoirs produced during mountain-making motions of the earth. Through the microscope the pattern of these rocks looks different from the oil bearing sands of the eastern United States and most of the Gulf coast, which have been formed during milder motions of the earth. When the earth is relatively quiet, a third type of rock is formed which becomes the reservoir from which the oil of most of the mid-continent and east Texas is derived.

Since most of the so-called "anticline" fields in the United States have now been discovered, the future of oil production rests on finding new fields, or on stepping up the production of the fields now in use. It is believed that Dr. Krynine's classification may be an important factor in the discovery of new fields. With the scientist's blueprint to guide him, the engineer can drill with greater assurance of finding oil.

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CURVATURE—The actual curvature of the earth for any distance can be worked out simply by multiplying the square of the distance in miles by .67 and the answer —in feet—tells how far the earth has "curved under" at that point. Ten miles from the point where an observer is standing, for example, the surface of the earth is actually 67 feet "lower" than the observer.

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FLEXIBLE TUBING
Made of Plastic as Rubber Replacement

PLASTIC tubing with all the flexibility of rubber and adapted especially for use in breweries and creameries is now being produced from materials far lower on the critical list than rubber, thus making it available for a wide range of purposes for which manufacture of rubber tubing is prohibited under present conditions.

Exhaustive tests which Goodyear Tire and Rubber Company made of its new plastic tubing before announcing its availability disclosed that it has practically the same resistance as rubber tubing to extremes of temperature.

In addition, it is stated that the new plastic tubing will resist pressures up to 40 pounds per inch when unbraided—approximately the same strength as rub-

ber tubing—and up to more than 200 pounds per square inch when braided.

Unbraided, Goodyear's new plastic tubing is transparent to disclose immediately any obstructions which might occur. It also can be produced in an opaque finish or in colors. Tests likewise have shown that the new plastic tubing in some applications is less prone to pick up odors than rubber tubing.

POWDER METALLURGY

Round-Up of Important Industrial Factors

THE SUBCOMMITTEE on Powder Metallurgy of the American Society for Metals defines powder metallurgy as follows: "Powder Metallurgy is the art of producing metal powders and shaped objects from individual, mixed, or alloyed metal powders, with or without the inclusion of non-metallic constituents, by pressing or forming objects which are simultaneously or subsequently heated to produce a coalesced, sintered, alloyed, brazed, or welded mass, characterized by the absence of fusion, or the fusion of a minor component only."

While the art of using metal powders goes back hundreds of years B.C., powder metallurgy as we now know it obtained a large-scale commercial application as soon as tungsten became the useful metal for electric lamps.

The melting point of tungsten is so high that it is uneconomical, if not impossible (due to the absence of suitable refractories), to melt and refine the metal by orthodox methods; hence tungsten was prepared by the reduction of the finely divided tungstic oxides in the solid state. This reduction left tungsten as a powder which was compressed originally by the use of binders (later without binders), sintered, and subsequently after going through various steps of preparation, drawn to the fine wire now familiar to all.

The same procedure of reducing the oxides to metal in the solid state, particularly with a gaseous reducing agent, has been adopted for a large portion of the metal powders now used; but electrolysis and atomization are other methods also used. Iron and copper powders are produced by reduction of the oxide by the use of hydrogen, coal, gas, or by electrolysis. The light metal powders, such as aluminum powders, are produced by atomizing; so also, generally, are lead and tin.

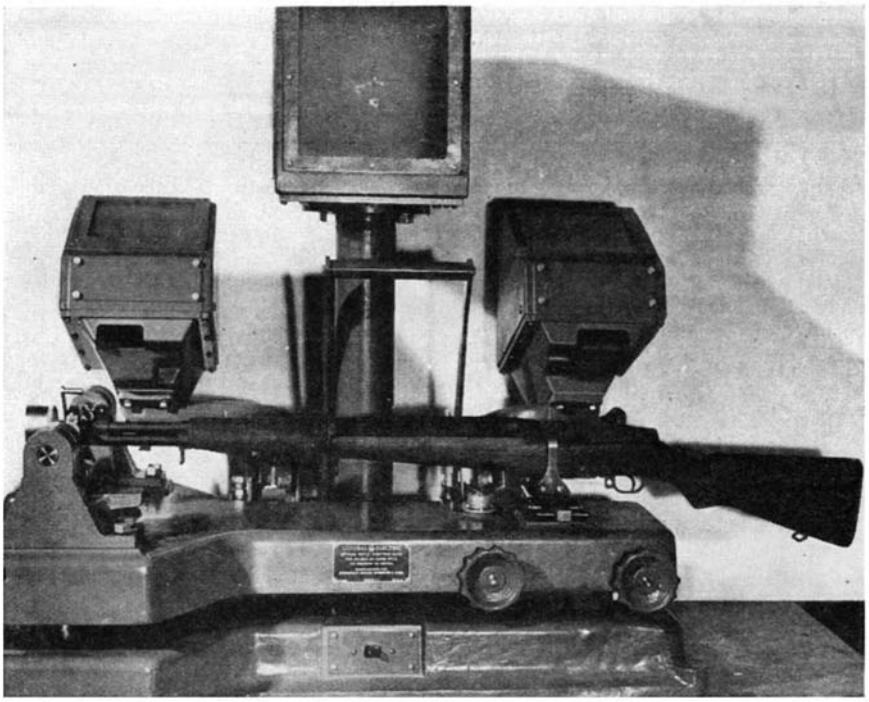
In preparing either the straight metal powder or the alloy powders, the features which should be most carefully watched are purity of the metals and the shape of the metal particles. Only clean surfaces of the metal particles will give a continuous cohesive surface in compression, thus assuring subsequent strength in the finished part.

The shape of the particles of metal powder should be angular, not globular, as globular powders do not compress well, though for certain applications, such as filters, globular powders may be used advantageously. Globular powders compact without pressure and, therefore, do not lend themselves well for parts which have intricate configurations. Angular particles will deform under pressure, interlock, and give strength of cohesion to the compact sufficient to permit handling of the compacted piece even before sintering. Where clean surfaces of the powder particles are assured, the heat created by pressure and friction is sufficient to create a molecular weld.

Metal powders are available of practically all known metals, but in addition a number of pre-alloyed powders such as brass powder, bronze powder, and ferro-alloy powders, have been produced. In the case of some of the age-hardening alloys, however, it has been determined that these alloys are best created during the process of sintering. The age-hardened powders are generally too hard to compact easily, and even when they do compact, the resulting part is generally brittle and of low physical properties; whereas if the compact is formed from the copper, aluminum, magnesium or in the case of ferrous metals, iron, nickel, or chrome, the metals can be annealed before compression and the softness of the powders allows excellent compression conditions. The alloys are then formed during the sintering operation.

The next step of importance is the mixing of the powders, their compression in dies, and subsequent sintering. Since compounds of from two to six different metals are frequently required, it is important not to mix light and heavy metals as they will tend to segregate and will not compact into a homogenous mixture. Even if the mixing or blending of the different metals takes place immediately prior to their use, the mixing must continue from a few hours to 24 hours or longer—depending upon the nature of the mixture—to insure an absolutely even distribution of the various particles.

Pressures to form a compact vary from a few tons to a hundred tons per square inch and of late Dr. Clarence W.



The Garand rifle sighting equipment, with sight projectors raised

Balke of Fansteel Metallurgical Corporation has increased his pressure to 160 tons per square inch to obtain high physical properties in iron parts recently prepared. The selection of the desired pressure is governed entirely by the physicals expected in the finished part, how close such part is to come to the full density of the metal, or alloy made by orthodox methods, or how much porosity is expected.

The advantages of powder metallurgy lie in the fact that production can be assured at a very rapid pace, and to very close tolerances, eliminating practically all need for machining and subsequent loss of raw material.

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LAMINATED—To preserve and protect the huge laminated arches and beams used in airplane hangars, recreation centers, and so on, some manufacturers are now dipping them in tanks containing synthetic resin preservative and sealer before erecting them on the job.

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GLASS TANKS
Now Made of Heat- and Chemical-Resistant Sheets

GLASS TANKS for industrial or commercial applications requiring a non-corrosive, shock-resisting material, and using a minimum of critical material have been developed by the Pittsburgh Plate Glass Company. They are not just glass lined, but are actually tanks made of glass, made by building up the required shape and size of heavy tempered glass plates. The result is a rigid, permanent, sturdy tank, free from maintenance or wear.

Mills, factories, plants have heretofore experienced difficulty in holding acids or chemicals in tanks that would at the same time be free from attack. The new glass tanks eliminate practically all the former difficulties.

The new method of heat treating gives to the tank material a physical strength four to five times greater than ordinary glass. Furthermore, the glass has a high resistance to thermal shock. It will withstand continuous operating temperatures of 650 degrees, Fahrenheit, and an instantaneous thermal shock of 400 to 500 degrees.

The joining problem is comparatively simple since the glass is made in large sheets; on all tanks of medium size nothing but the corners are involved. All joints are accurately ground so that they resemble, in a sense, the ground stopper of a chemist's bottle. In addition, use is made of a joining material developed especially for this purpose. The entire tank is usually surrounded by a wooden frame work filled with a compound. This frame serves both as insurance against leaks and as protection against severe physical blows.

Tanks of glass have already proved their ability to take it and continue to give service in one of the most severe of all tank applications—pickling tanks for steel and other metals. Their successful initiation here has caused a demand for them in other industries, such as the rubber, synthetic rubber, chemical, textile, paper, photographic, electroplating, and many other fields.

RIFLE SIGHTING
Done With Mirrors, Saves Time and Ammunition

PRECISION sighting of Garand semi-automatic rifles in quantity production for the United States Armed Forces can now be done with mirrors and without firing a shot, through the use of new equipment developed by the General Electric Company.

Officially known as an "Optical Rifle Sighting Gage," the equipment will save up to 13 rounds of ammunition formerly used in sighting each gun, and will permit a girl to do the job in less than two minutes per rifle—about half the time it took two men by the old method. Moreover, the optical equipment requires less room than the average domestic kitchen, whereas sighting by firing requires a 100-yard rifle range.

When sighted by the optical gage, all the rifle "fires" is a light ray at a mirrored taget approximately six feet in front of it. The ray is caught by another mirror on the gage equipment at the operator's eye level and is thrown onto a ground-glass screen in the image of a cross. Superimposing this image upon another cross on the ground glass correctly positions the rifle, and the gun is then sighted by adjusting its rear sight so that its shadow, magnified 25 times on the screen of a projector directly above it, is in the same relative position as the shadow of the front sight, similarly magnified on another projector above it.

Although the optical sighting gage was built specially for the Garand rifle, it can be adapted to sight other types of rifles.

What the gage actually does is to transfer the sight setting from a "master" rifle, correctly sighted by firing, to rifles subsequently sighted in the equipment.

Inserting the Garand bore plug

The gage is set for accurate use by placing the master rifle in it, and adjusting the equipment to conform to the bore direction and sight positions of the master rifle. When other rifles placed in the gage are aligned with the target optical system, and their sights moved to the proper position as designated by the sight projectors, they are given the line-of-sight to line-of-bore relationship established by the master rifle.

The target optical system consists of a light source and condensing lens, a cross-shaped aperture, a concave mirror mounted on the end of a four-inch bore plug, an adjustable mirror mounted above the light source, and a mirror and ground

glass screen on the main fixture. The light bulb, lens, aperture, and adjustable mirror are contained in the separate target unit which is mounted approximately six feet in front of the main fixture and facing it.

The concave mirror is mounted on a bore plug. The plug is inserted in the muzzle of the rifle for each sighting, its mirror facing the separate target unit.

Light leaves the bulb in the target unit, passes through the lens and the aperture, and is focused on the concave mirror on the plug in the shape of the bulb filament. It reflects to the adjustable mirror mounted above the bulb in the target unit, and then back to the mirror on the main fixture which throws the cross image on the viewing screen. Focal length of the concave mirror on the plug is such that it focuses the image of the cross aperture on the screen.

The two sight projectors are optical systems designed to magnify the images of the sights approximately 25 times and focus them on viewing screens. They are mounted on separate arms so that they may be lifted to permit inserting and removing the rifle. The two arms rotate about a common shaft, and are raised by a handle attached to the shaft. The arms and projectors are held in the up position by an automatic latch. Each projector has a dash pot which prevents it from being jarred when dropped into position, and individual stops to limit the downward position.

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EXPLOSIVE—Cyclonite, a new explosive for bombs and shells, explodes even faster than TNT.

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FATTY ACIDS
Hold Promise for New Industrial Synthetics

A NEW family of synthetics using fats as a basis is predicted by Dr. A. W. Ralston in "Chemical and Engineering News," the available supply of these fats in vegetable, animal, and marine life being essentially unlimited.

"A study of the structures of various fatty acids combined with a realization of their ready availability shows that they present an exceptional opportunity for synthetic work," Dr. Ralston says. Fats are one of the greatest sources of compounds for chemical synthesis known to mankind. It is now clearly apparent that many of the compounds which can be synthesized from fatty acids are destined to become important chemicals in the future.

Fats are comparatively simple compounds, which are structurally similar and which can be easily separated into their major components—glycerol and fatty acids. Many of the fatty acids can now either be separted from one another or can be segregated into groups of acids which possess similar chemical properties.

"The glycerol part amounts to about 5 percent of the weight of most fats so that the fatty acids comprise by far the greater portion of the fatty molecule," Dr. Ralston continues. "Glycerol is a compound for which many uses have been found, both in peace and in war. The problem of chemicals from fats, therefore, is centered about the major component, the fatty acids. . . .

"Recently, quite a number of fatty acid derivatives have been developed, some of which are now available commercially. They can be roughly divided into two classes. The first comprises the simple derivatives in which the hydrocarbon group retains its identity, and the second, those in which this group is a part of a very complex molecule.

"Examples of the simple derivatives are the alcohols, aldehydes, acid chlorides, ketones, esters, amides, nitriles, amines, and the many compounds which can be prepared from them. The complex derivatives are represented by plastics, polymers, elastomers, and similar substances.

"Amides are formed by the removal of one molecule of water from an ammonium soap. They are relatively high-melting solids which are useful as waterproofing agents, protective coatings, and chemical intermediates. The amines and their salts

have an ever-increasing number of industrial applications. They have been found to be useful in many fields such as flotation, water treatment, and textile finishing. They are strongly adsorbed upon glass, pigments, silicates, clays, limes and metals and decidedly modify the surface properties of such substances.

"The amines possess bactericidal properties and certain of them act as insecticides. They are the starting point for many types of derivatives of commercial interest. We can easily visualize that the nitrogen derivatives of the fatty acids present a field for investigation which can well occupy the attention of chemists for many years to come."

SILVER BEARINGS
Plating Speeded Up by Potassium Cyanide

IN THE production of silver-plated bearings for airplane motors, the rate of plating is more than trebled by use of potassium cyanide, formerly imported from Europe but now made in this country by the Electrochemicals Department of E. I. du Pont de Nemours & Company.

Literally tons of silver are used each week in the fabrication of bearings which will withstand the high loads and terrific speeds demanded in modern wartime operations. According to some authorities, air speeds would be reduced as much as 75 miles an hour and loads would be cut substantially if silver-plated bearings were not available.

Potassium salts now are recovered by re-crystallization from vast salt deposits in desert areas of California. These salts provide the basic material from which potassium cyanide is manufactured. In an electroplating bath, potassium cyanide not only increases the rate at which silver plate is deposited on the motor bearings, but also gives required heavier coatings that are smooth, firmly adherent, fine grained, and easily machined or burnished. Coatings of silver deposited on the bearings, some of which are three to four inches in diameter, range from three to five one-hundredths of an inch in thickness, whereas silver electro-deposits usually are measured in thousandths of an inch.

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SHAMPOO—First-aid kits on many American ships now include a supply of a liquid soapless shampoo. Experiments have shown that the shampoo is of value in removing fuel oil and similar substances from sailors rescued at sea.

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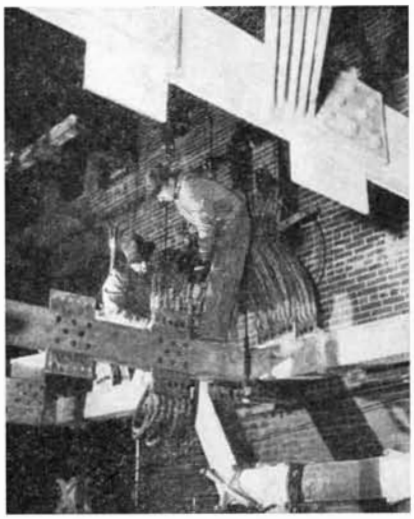
SILVER BUS BARS
Conduct Electricity in New Magnesium Plant

ELECTRIC current flowing through huge bus bars of solid silver recently brought another great magnesium plant into production, when Dow Magnesium Corporation poured its first metal in the fifth Dow-process plant built by The Austin



Starter cables to the silver bars

Company for the Defense Plant Corporation, to meet the wartime demand for this lightest of all structural metals.

The silver almost completely replaces copper in the power distribution lines required for large-scale production of magnesium, and was loaned by the government for this use to release copper for shells, ordnance equipment, and other war needs. The silver is even more efficient as a conductor of electricity but would not normally be used because of its excessive cost.

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PESTS—Millions of two-ounce cans of body dusting powder for the U. S. Army protect overseas personnel against typhus-carrying pests.

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EMERGENCY LIGHT Turns on Automatically When Power Fails

REQUIRING no fixtures or wiring other than plug-in connections to the A.C. supply, a new emergency lighting unit has been designed to meet the need for a source of emergency light in war plants, arsenals, ordnance plants, shipyards, factories, and other places where war-time activity has increased the potential dangers resulting from power-line failure, fires, and sabotage. It throws a beam of light 50 feet wide a distance of 150 to 200 feet, covering an area of 7500 square feet.

With power lines loaded to capacity, plant feeders are in many cases overloaded, needing only a slight upsetting load condition to produce a lighting failure. When the lights go out and machinery continues to run on momentum, the Exide Lightguard, by automatically switching on a broad beam of light, helps to reduce the accident hazard, particularly in those plants where men and women unfamiliar with machinery are working. It is especially useful in windowless plants, many of which have been built recently.

The Exide Lightguard has been designed for use where workers are em-

ployed at night on machines, particularly in crowded spaces; for emergency lighting at control equipment, electrical or mechanical, such as power switchboards, telephone switchboards, pumps and valves; in boiler and engine rooms for reading gages and operating valves; in plant gate houses, entrance and exit locations, first-aid stations, and dispensaries.

Because it is a self-contained unit weighing only 47 pounds, this new light

For use when power fails

can easily be moved from its customary position during a fire, accident, explosion or air-raid, for use in rescue work.

The new unit operates instantly and automatically without a hand touching a switch. The only maintenance required is the occasional adding of water to the storage cells. Recharging is done automatically by trickle charge, state of charge being clearly indicated by pilot balls.

ENGINEERING WILL WIN
By Making Best Use of Skill and Materials

BECAUSE of the importance of making the fullest possible use of available resources, the side with the best engineering will win the war, according to L. A. Umansky, Assistant Manager of General Electric's Industrial Engineering Department.

"The real meaning of the word 'engineering' is making the most skilful and efficient use of the available materials and of human effort," Mr. Umansky says. "The foremost job of engineers is, therefore, to conserve our critical materials, which can be done in the following three ways: By use of alternate materials more readily available; by working available materials harder; and by using available materials more skilfully. All three methods or a combination of them is being actually used by engineers in furthering the war effort.

"For instance, since the aircraft industry has first call on all aluminum production, other industries had to use steel, zinc, and other materials and had to modify their designs so as to make the use of these materials possible without impairing the performance of their equipment. One electrical manufacturer alone is saving in this manner up to 8,000,000 pounds of aluminum per year."

Many other substitutions of this kind have been made but no good substitute has been yet found for copper as a current-carrying material, he pointed out. True enough, on some large electrochemical installations, silver busbars have been employed, the silver being withdrawn from the government vaults and put to work. Such an application, spectacular as it is, cannot be used universally since the amount of silver available in the world is a small percentage of the copper requirements. The electrical industry and other industries manufacturing combat equipment have their just claim for copper, he added. Any ton of copper saved by skilful engineering does not mean merely that a few hundred dollars are saved but that this copper can be used to manufacture some 80,000 machine gun cartridge cases. Even if only one percent of these rounds of ammunition reach their goal, there will be 800 fewer enemies facing us, and the end of the war will be that much nearer.

"Electric equipment can and should be worked harder during the war just as the men and women in the services are doing and as the men and women on the homefront are expected to do," Mr. Umansky declares. "Overloading a motor may shorten its life from 20 years to 10 but this span will cover the expected duration of the war. Of course, this method is not always applicable to an older machine, since the aged insulation may fail and the failure may cripple industrial production."

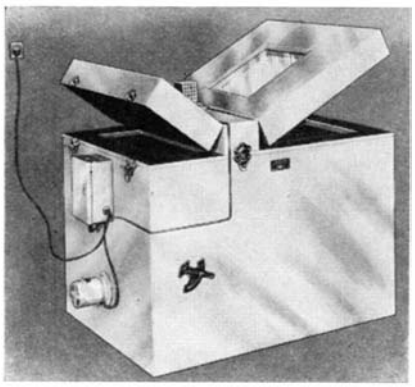
As an example of skilful engineering, intended to conserve our natural resources, Mr. Umansky cited the method of connecting airplane engines under test to a generator and pumping energy which would otherwise be wasted back into the power system. At several engine factories, up to 60 percent of the energy required to operate the entire plant is thus obtained and if all airplane engines were tested in this way, approximately 750,000 tons less coal would have to be mined and transported annually, he added.

"No effort should be wasted on anything that will not help to win this war," he says. "However, this does not mean that engineering developments and investigations should be stopped during the war. On the contrary, they should be stimulated, since this war, more than any other in history, is a war of machines, of engineering. With the nation at war, the engineering profession must do double duty in blazing new trails, in trying new ideas, in venturing into the unknown. Co-operative effort is needed as never before."

DRY-ICE CABINET
Holds Temperature Within Close Limits

WHEREVER reliable, convenient, trouble-free, and speedy refrigeration is required in the laboratory, a new cabinet developed by the American Instrument Company will be found useful. It provides temperatures from minus 90 degrees, Fahrenheit, up to 220 degrees, Fahrenheit, with a

constancy of plus or minus ½ degree and is intended for use where expensive mechanical refrigeration would not be justified. Two temperature ranges are available: From zero to minus 90 degrees



Dry-ice cools the cabinet

and from 220 degrees to minus 90 degrees.

Temperatures can be held at minus 40 degrees and minus 90 degrees in an ambient temperature of 85 degrees for 24 hours with 40 and 60 pounds of dry-ice respectively.

The cabinet is portable and ready for operation after packing with dry-ice and plugging the cord into the current supply. Once packed with dry-ice it requires no further attention until a new charge of dry-ice is required.

In the low-temperature model, close temperature control is made possible by means of a thermo-regulator, which, through a solenoid and an electronic relay (time-delay), operates a damper that allows air to be passed over the dry-ice when cooling is needed, or to be by-passed when cooling is not needed. The temperature control system requires only natural heat leakage for its operation. No electric heaters are used in this model to control the temperature.

In the high-and-low-temperature model, the control described above is augmented by electric heaters operated through a relay.

The working chamber (24 by 24 by 24 inches) has a hinged removable cover in which is incorporated a five-ply vacuum-sealed plate glass window. Another hinged cover is provided for access to the dry-ice compartment. Air is circulated constantly through the cabinet by means of a fan located beneath the dry-ice compartment, the fan being driven by a motor mounted outside the cabinet.

MINE GAS
Reduced By Drawing
Off Through Pipes

DEFINITE economy in ventilation costs, by freeing coal mines of dangerous gas before a seam is worked, is being accomplished by sinking pipes into the ground ahead of the workings and pumping the gas out, according to the Compressed Air Institute.

This is being practiced at a mining operation near Bluefield, West Virginia, where holes for the pipes are drilled to

depths ranging from 100 to 1000 feet, depending upon the thickness of the overburden between the coal and the surface. The pipes are sent a short distance through the collar of the holes and then connected to blowers which exhaust the gas.

Some of the mines where this is being done are extremely gassy, the Institute reports. One liberates as much as 12,000,000 cubic feet of gas a day—enough to supply a large city.

Although the amount of inflammable methane must be kept to a maximum of 0.5 percent in the mine atmosphere, it is the aim of this new gas-evacuating process to reduce the amount of methane in the mine atmosphere 50 percent before a coal seam is opened.

An idea of the economy of this method can be gained by considering that to get out 12,000,000 cubic feet of gas from the mine and bring the methane content of the atmosphere to the required maximum would mean the circulation of 300,000,000 cubic feet of air a minute by the usual means of ventilation.

POWER LINES

Can be Made to Carry Increased Power

ELECTRICITY zipping through a midget power line has demonstrated that existing transmission systems can be stepped up to carry 65 percent more power by adding one generator and thousands of small steel boxes crammed with sheets of aluminum and paper. R. D. Evans, consulting transmission engineer at Westinghouse Electric & Manufacturing Company, conducted the laboratory experiment to prove a theory he developed.

By using 7200 of the small steel boxes, called capacitors, together with the necessary generating equipment, Evans says, a 250-mile-long power line with a capacity of 175,000 kilowatts could be stepped up to carry 290,000 kilowatts. This 115,000-kilowatt increase would be sufficient to supply all the electrical needs of a city of 350,000 population.

The capacitors which would make possible this power increase are steel boxes the size of overnight bags, filled with layers of aluminum foil and paper which permit more power to flow through the wires.

These devices "tune the circuit like a condenser does in a radio," the engineer says. "Use of capacitors to increase a power line's effectiveness not only is efficient but also is the most economical way," Evans reports. Heretofore, the most common method of boosting a power line's capacity was by adding extra transmission wires, since additional electricity could not be "forced through" the old lines without the help of capacitors. The cost of an additional power line and auxiliary equipment to step up a 250-mile transmission system's capacity 65 percent would be about $4,500,000. With the 7200 capacitors necessary to step up a 250-mile-long line's capacity 65 percent, the cost would be about $1,200,000. This, it should be added, does not include a generator which would be necessary in either case.

New Products

THREE-LIQUID PUMP

A SPECIAL-PURPOSE step-valve pump, developed for use in a new war process which cannot be discussed here, is a typical example of how industrial pumps are engineered to meet specific requirements and, as in this case, can often be built from units used in standard pump design.

This new Milton Roy pump, although driven by one motor, delivers three liquids—one heavy, viscous material and two very light materials—at various required rates of flow to control accurately the volume of each in a compounding operation. Features of the pump include three step-valves, one with a single coverplate. All valves have self-cleaning double ball-checks on both inlet and discharge sides.

COMMUTATOR CLEANER

MANUFACTURED of a nonconducting abrasive compounded with soft rubber, a new hand-held commutator cleaner

A hand-held commutator cleaner that does not remove polish from brush faces

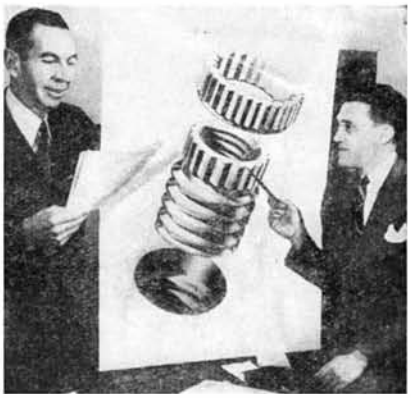
is now available. This cleaner, adaptable to use on either commutators or slip rings, will not, it is claimed, scratch or score, but leaves a clean polished surface which adds to the life of both the commutator and brushes.

STUD LOCKING SYSTEM

ENGINEERS have used threaded inserts and studs for fastening two parts together for many years but this practice has always fallen short of being entirely satisfactory. Under vibration the inserts or studs would back out or loosen, and, if a nut became frozen on a stud, the torque necessary to disengage the frozen nut invariably unscrewed the stud.

The difficult problem of permanent installation for these fastenings can now be solved by the use of the Rosán Locking System for inserts and studs.

The principle of the locking system is very simple. A locking ring, serrated both inside and out, engages its inner teeth with a serrated collar on the insert or stud. The outer teeth of the locking ring broach their way into the material when struck with a hammer or a drive tool. Thus, the insert or stud becomes an integral part of the softer material, and since the inside serrations on the locking ring prevent the insert or stud from turning, and the outside serrations prevent the ring itself from turning, the whole installation becomes completely permanent. The sharp leading edges of



Demonstration of stud locking system

the serrations on the locking ring broach the material effectively, but the crests of the serrations or splines are rounded to prevent any sharp corners which might create possible points of failure in the soft material. The locking ring has a special pilot on the lower edge and its inner serrations are so designed that they easily engage with the serrations on the insert collar. When fully driven into place, the ring closes in on the insert and makes a completely solid unit of the whole.

CORROSION PROOFING

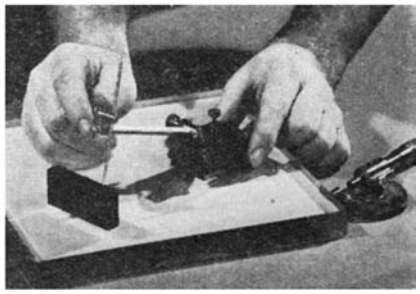
Two coatings for ferrous metal surfaces which are ordinarily exposed to corrosion have recently been developed. One of these, known as Silco, resembles a vitreous enamel. It is applied to such surfaces as engine exhaust manifolds, mufflers, and so on, by spraying after the metal has been cleaned, pickled, rinsed, and dried. The sprayed surface is first dried and then baked, after which the finished coating will not burn off at temperatures up to 1000 degrees, Fahrenheit.

The second corrosion proofing material is known as Armor-Vit. It may be applied

either by spraying or dipping and, after baking, may be heated to 1200 degrees, Fahrenheit, without failure of the coating film.

GLASS SURFACE PLATES

SURFACE plates in heavy glass are now available in degrees of accuracy from .0002 to .0005 of an inch and in standard sizes of 8 by 8, 8 by 12, 10 by 10 and 12 by 12 inches. The use of these glass



A glass surface plate in use

surface plates is releasing, for other uses, materials that are urgently needed in war industries.

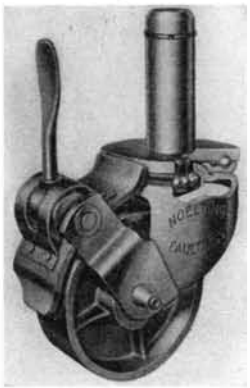
Wear, negligible since the surface of glass is very hard, is indicated by scratches and, unless they are grouped closely and densely, they do not affect the accuracy of the plate. As scratches do not burr, they will not cause surface errors. The low co-efficient of expansion of glass indicates very little change due to variations in temperature.

Glass surface plates are non-conductors of electricity and will never require demagnetizing. They require no oiling of the surface as they will not corrode. The fact that they are of glass will induce greater care on the part of those who use them.

As these plates are clear, drawings or data to be referred to frequently may be placed beneath them, thus providing protection for the prints and making the data readily available. Where required, permanent records may be etched on the lower surface of the glass.

LOCKING CASTER

FREEDOM of movement is provided for scaffolding, portable work benches, and so on, by the caster shown in one of our illustrations, yet complete immovability can be obtained whenever desired through the application of the self-contained lever-operated brake. The caster shown includes a double enclosed ball swivel, a steel fork, a roller bearing semi-steel wheel, and a cam operated brake which bears against the caster wheel when the lever is operated.



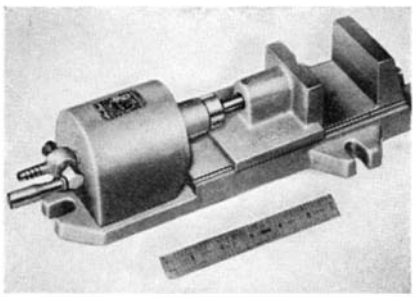
Simple lever motion locks the caster wheel

AIR VISE

THE USE of long dove-tail ways for the sliding jaw of a new air-operated vise gives an exceptionally smooth action which is free from play in all directions. The long ways keep the jaws parallel, even where work is held off center, and prevent any binding action from absorbing part of the holding power. The sliding jaw can not "lift" as it closes on a cylindrical piece held horizontally.

A simple but useful feature of the Mead Air Vise is the collar provided on the ram by which the length of the stroke may be controlled to any desired length. On many types of work a stroke of no more than 1/16 of an inch is needed and minimum strokes are recommended in all cases. Three reasons are evident: Low air consumption; quick action; and minimum danger of pinched fingers. The adjustment is easily made with a screw driver.

In cases where a drill plate is attached to the stationary jaw, a long stroke is



May be foot- or hand-operated

sometimes needed to facilitate inserting and removing work. The two inch stroke of the vise will be found adequate to handle work of this type within the capacity of the vise.

This air vise can be furnished with either hand valve, as shown, or with one of two types of foot control valves. Model ON foot control releases work when the button is pressed and holds it at all other times. Model OFF foot control holds work while the button is held down, but leaves the jaws open at all other times. Either model ON or model OFF may be set up to be operated automatically by functional parts of the machine on which the vise is used.

REFRIGERATED WELDING

A DEVELOPMENT in resistance welding electrode design which makes possible full utilization of refrigerated welding has been announced by Frostrode Products, originators of refrigeration for resistance welding.

Aircraft manufacturers who have adopted the new "Frostpoint" as an integral part of the "Frostrode" electrode refrigerating process have already reported increases from 600 to 1000 percent

over refrigeration of conventional electrodes in the number of spot welds which can be made before the tips require "dressing."

A 90 percent saving in the copper normally required for resistance welding electrodes is forecast by the fact that the only part that needs replacing in the new "Frostpoint" is the "Frostcap," a quick-replaceable tip on the end of the welding electrode.

Other features of the new electrode include: Machine and hand dressing of points is completely eliminated; if a cap does mushroom, it is removed and replaced by another in about one minute's time. The life of a cap without any dressing except polishing is estimated to be about equal to that of a conventional electrode re-dressed until no longer useable. The cap seals the electrode against leakage. Greater cooling area is obtained by internal integral finning of the cap. The electrodes are so constructed as to provide absolute accuracy of coolant flow control, thus insuring operation at maximum cooling efficiency at all times.

WATER LEVEL SIGNAL

A PASTE-LIKE material which is applied in a thin film to a gage stick makes possible accurate determination of the amount of water present in the bottom of a gasoline or oil storage tank. The paste is of such character that it changes from gray to deep red when in contact with water but not when it is touched only by gasoline or oil. When the treated gage stick is inserted into a tank and removed, the dividing line between water and other liquid is sharp. This material, known as Detex Water Finder, is packed in 2½ ounce and 1 pint jars, the smaller jar containing sufficient material for about 500 tests.

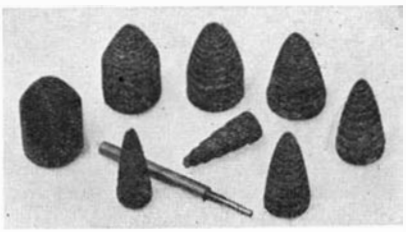
HAND NIBBLER

DOUBLE crank construction of the hand nibbler illustrated in this column makes possible easy and rapid operation. With this device, developed by the National Machine Tool Company, templates and trial blanks may be quickly cut to any desired size, thus saving costly hand operations at the bench. It is also possible to cut drill rods with the same machine or to punch holes up to ½ inch in diameter through ⅛ inch flat stock.

Nibbler and hole puncher

SPIRAL ABRASIVES

SPECIALIZED abrading and polishing jobs can be accomplished with a new abrasive strip material formed into the shapes shown in the accompanying illustration.



Abrasive strips in spiral form

As shown, some of these are produced in tapered shape for their entire length while others have a base that is cylindrical in form. This coated abrasive strip material is designed for application on a mandrel in stationary or portable machines.

MOLDING PLASTIC

BOILING water and food stains have but little effect on a new plastic molding material known as Melmac 1077. This melamine plastic, filled with alpha cellulose, is designed for the production of tableware and similar forms. The molding powder or granule is available in a range of colors.

HYDRAULIC OIL SOLVENT

A CONCENTRATED liquid known as Gum Solvent B has been developed for use in hydraulic installations. When 3 to 5 percent of the concentrate is added to the oil before draining, it is claimed that all accumulated gums and sludge will be dissolved. Thus when the system is drained, the hydraulic lines, valves, and other parts of the mechanism are found to be clean without the necessity for a flushing operation.

SAW-GUN

AN ATTACHMENT for electric drills, flexible shafts, or air operated drills, which has recently been developed, makes it possible to convert such tools into portable power saws or files.

The conversion is accomplished by chucking a reciprocating attachment into the drill or other power source. This attachment, which is prevented from rotating by being held in one of the operator's hands, converts the rotary motion of the primary tool into reciprocating motion of the saw blade or file secured in a holder. It is claimed that this unit will save hours of work on panel notching, slotting, or other fabricating operations in metals, plastics, plywoods, and other materials.

Helicopter Progress

Present Orders and Future Possibilities Point Toward a Fertile Field for Rotating Wing Aircraft

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

THERE IS immense interest in the helicopter. Both American and British naval authorities have announced that the helicopter will be used for protecting freighters against the submarine, and an order for 250 helicopters has been placed with Sikorsky Aircraft Corporation. The use of rotating wing aircraft for anti-submarine work was suggested in many quarters years ago, and it is pleasing to note that the cautious conservatism of naval authorities has now been overcome. In some respects a helicopter is better equipped to fight the submarine than an airplane because it can hover over the U-boat and drop depth charges with 100 percent accuracy, and certainly the helicopter is an aircraft which can utilize the landing facilities of the deck of a 10,000-ton freighter with ease.

Then we learn that Cargoes, Inc., a subsidiary of the Lend-Lease Administration, has placed an order for two helicopters for the British Government (also for use with merchant ships) with Fleetwings, Inc., a plant which Henry J. Kaiser took over last winter. It is understood that the Kaiser helicopter will be ready in a few months and that, if it is successful, a contract for large-scale production will follow.

But it is not only for war purposes that the helicopter is likely to be useful. There is an optimistic prediction by Mr. Sikorsky who thinks that speeds in excess of 120 miles an hour can be obtained by the helicopter.

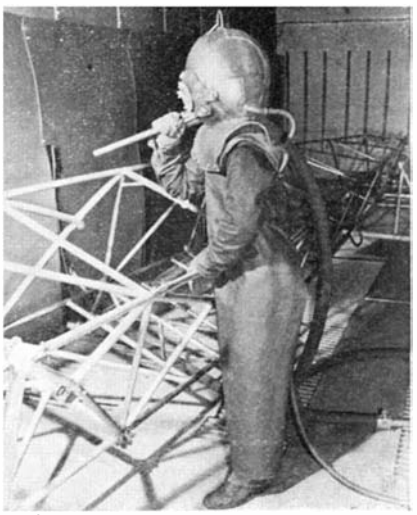
"The helicopter well may be expected to become a very popular type of aircraft extensively used by private individuals in a way similar to the automobile, and also by individuals and organizations for a great variety of business and commercial assignments," Mr. Sikorsky says. "The helicopter may be a vital factor in the period of demobilization of the aircraft industry after the war, permitting the utilization of facilities and the employment of a gradually increasing part of the trained personnel which will become available. It will make possible broader and better use of the territory of this country by opening for residence, recreation, prospecting, and development areas that now remain practically idle because of transportation difficulties. All this may be foreseen with confidence and I am convinced that within a decade after the war there will be hundreds of thousands, possibly a million, helicopters in actual use in this country."

But there is a still more encouraging item of news in regard to the postwar utilization of the helicopter. Samuel J. Solomon, President of Northeast Airlines, one of the most energetic and far-sighted of the air transport operators has filed an application with the Civil Aeronautics Authority for permission to start a helicopter service. This service would carry airmail and air express to and from the rooftops of over 400 post offices and railroad stations in the six New England States and New York. The Northeast Helicopter System would augment the regular operations, and fly express not only between cities and towns, but from congested areas to the airports. Mr. Solomon became convinced of the enormous potentialities of the Sikorsky helicopter after witnessing several demonstrations, and is certain that his plan will be followed by every important airline in the country.

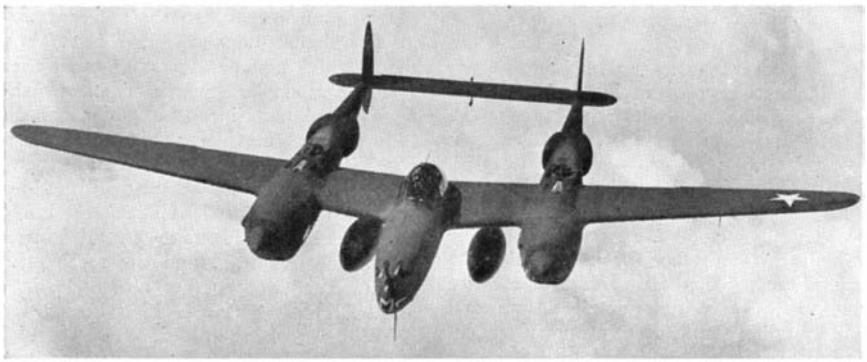
FUSELAGE SANDBLASTING Used in Fabrication of Primary Training Plane

NOT A deep sea diver, but a mechanic of the Boeing Airplane Company, who is sandblasting foreign particles from the hollow steel tubing which forms the fuselage of a Boeing primary trainer, is shown in the accompanying photograph.

This biplane trainer, known to the Army as the PT-17 Kaydet, and to the Navy as the N2S-3, has made quite a name for itself in World War II, in which it occupies a position akin to that



Sandblasting foreign particles from fuselage frame of a training plane



Auxiliary gasoline tanks are suspended under the Lightning's wing

of the Curtiss "Jenny" in the First World War.

The 7000th Kaydet recently was turned over to distinguished A.A.F. officers by a Boeing Company official. For primary training where low wing loading, sturdiness, and stability are more important than speed, the biplane has much to commend it.—*A.K.*

FLIGHT TRAINING
Speeded Up by New and Simple Method

AN INTERESTING idea is being tried out for training students to fly the exceedingly fast Lockheed Lightning; the single-seater fighter with two engines and two booms to support the tail. By removing a good deal of the radio equipment, the student is able to sit in "pickaback" fashion behind the pilot's seat; he is enclosed in the pilot's cockpit, his head coming close to the pilot's shoulder where he can see all instruments and controls. The Lockheed is fast and controllable and can be put through some wonderful maneuvers. It can even be maneuvered on just one engine, but it takes experience and skill to secure complete command of the Lockheed. The student flying immediately behind the instructor can learn in one hour what might take ten hours to absorb when practicing solo.—*A.K.*

GASOLINE TANKS
Increase Plane Range, Decrease Speed Only Slightly

THE STREAMLINED gasoline tanks, which are shown mounted under the wing of the Lockheed Lightning P-38 in one of our illustrations, carry enough gasoline to double the normal range of this remarkable fighter. Yet, thanks to skilled aerodynamics, there is a loss of only 4 percent in the top speed. Doubling the range has obvious advantages when ferrying across the ocean, and in extending the range of the fighter when protecting bombers. The addition of the tanks does not hinder the fighting characteristics of the P-38, since these auxiliaries can be dropped prior to combat.

Each tank carries 165 gallons of gasoline, or 1000 pounds when full, but the weight of the tank itself is only 90 pounds in spite of the fact that it is beautifully streamlined and that a streamlined shape does not have the maximum capacity for a given weight. Hours of wind tunnel and static vibration tests went into the design. The tanks are very simply built in two half shells of "1010" body steel, .024 inches thick. The rate of production is quite remarkable, as one tank is turned out every four minutes, and the cost is now under one hundred dollars. Clever spot and seam welding equipment, and conveyor methods in welding and assembly have facilitated production, with a regular sequence of operation on the conveyor line. Although space does not permit a description of the fabrication process, conveyor lines and production methods, once generally the prerogative of the automobile industry, have now been adopted, and even improved, in the aircraft industry. A recent visit to an airplane plant has convinced us that miracles of production are being achieved by our aviation men.—*A.K.*

WOODEN AIRCRAFT PROBLEMS
Are Completely Different from Metal Problems

A GREAT deal has been heard by the public on the replacement of aluminum by wood, of the success of the Mosquito bombers (built of wood) flying over Germany, and the like. Yet, at the same time, wood structures have in the past year acquired somewhat of a poor reputation in static strength tests. Is this because wood is unsuitable for large aircraft construction?

At a meeting of The Society of Automotive Engineers, Ivar C. Peterson faced the problem squarely, and discussed the various difficulties that have arisen.

Wood is not an inorganic material like steel, but an organic one whose properties vary from log to log. Its strength properties also vary with moisture, and this sometimes is not properly taken into account. Moisture causes variation in strength, and also produces shrinking and swelling. Metals, of course, present no such difficulty.

Glued joints naturally play a large part in aircraft construction and here there must be a sufficient spread of glue on smooth wood surfaces, and just the correct temperature, pressure, and glue consistency at the time pressure is applied in the glue joint. The gluing operations require more skill and thought than riveting or welding in metal construction. Sometimes is it very tempting to use high and low density woods in combination, particu-

larly in highly stressed points of the airplane. But the elastic properties of high and low strength woods are different and troubles arise accordingly, owing to the elastic incompatability of the two woods. Other difficulties arise when there is a great stress concentration in the wood.

Mr. Peterson's conclusion, and it is one with which we thoroughly agree, is that wood and plywood are perfectly suitable for aircraft construction; if their use has caused any difficulties of late, these are due to the fact that detail design and handling have not been properly understood, and because wooden aircraft have been constructed by factories new to the airplane art.

With all due precautions, and when construction is in the hands of skilled or well trained new workers in wood, these difficulties will largely disappear.—*A. K.*

TIRE REMOVAL
Made Easy by
New Device

OUR AIRLINES are beautifully organized and splendidly run, some of the success in this direction being due to the fact that conferences by mechanics are greatly encouraged. A mechanic employed by

Safety in airplane tire removal

United Airlines, W. H. Pitts, was awarded several war bonds by the United Airlines Suggestion Committee for the device illustrated in one of our photographs. This is a tire-removing tool which has become standard equipment throughout the United system. The device, which consists of a steel frame and a hydraulic jack, facilitates the removal of tires without damage to either tire or wheel.—*A. K.*

GLIDERS
Proposed to
Assist Take-Off

WORD comes from Washington of a patent granted to Vladimir S. Makaroff in which it is proposed that a heavily loaded bomber or transport should be assisted off the ground by means of a glider fastened to its back. We have been asked whether the idea is sound.

It is plausible. When the powered airplane and the glider are hitched together, they form a biplane of greater wing area than the monoplane which constitutes the powered plane. Since the glider can be light in construction for this specific purpose, it is clear that the average wing loading of the combined craft will be low, and with low wing loading there should be a quicker, easier take-off. Of course, the glider has drag, and the mechanism locking the two together also adds drag and weight. Therefore, in spite of the plausibility of the idea, very careful analysis would have to be carried out before it could be accepted completely.

Readers may remember the composite airplane invented and tried out by Major Mayo in England; there is a certain resemblance beteeen the two ideas. But Major Mayo had a small, heavily loaded airplane mounted on top of a large one, so that the large airplane could help the overloaded smaller airplane get into the air. Of course, Major Mayo was also experimenting with assisted take-off, but in his device each craft had its own power-plants.

Assisted take-off has been suggested again and again in a variety of forms: compressed air catapult, powder catapult, winches and cables hauling a plane along, rocket or jet propulsion, have all been discussed as possible means. But none of them has been generally adopted, because the growing power of our engines has reached such a figure as to make assisted take-off unnecessary. Only for launching airplanes off the deck of a ship have catapults remained. But that does not mean that assisted take-off will not be with us sooner or later, at least for specialized purposes.—*A. K.*

DESIGN DETAIL
Needed to Keep Fighting
Planes in Trim

IN A RECENT paper presented before the Society of Automotive Engineers, N. L. Kearney, Service Manager of Curtiss-Wright Corporation, reminds us that only those airplanes can fight which are properly maintained and repaired. Mr. Kearney expressed hope that the designers of our fighter airplanes will give greater thought to ease of maintenance, and to the problems of those men whose job it is to keep airplanes in flying and fighting condition. When the Army field mechanic finds that before he can remove and service a propeller speed governor, he has to remove the propeller itself at the cost of two or three hours extra time, his explosive language may well be forgiven. A great deal of progress has been made from a maintenance point of view in recent years—fewer disconnections in removing a unit, fewer cowl fasteners, more quickly replaceable wing tips, and so on, have been introduced.

Another important matter is the thorough training of field personnel in the proper servicing and handling of aircraft. Tools and spare parts are of the utmost importance and a lack of spares can keep a tremendous number of airplanes on the ground.—*A. K.*

CURRENT BULLETIN BRIEFS

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

THE FIVE COMMERCIAL TYPES OF SYNTHETIC RUBBER is a 40-page illustrated booklet designed to present a relatively brief resume of a comprehensive subject. The data presented will serve as background material for understanding the general possibilities of various synthetics. *United States Rubber Company, 1230 Sixth Avenue, New York, New York.—Gratis.*

FLUORESCENT MAINTENANCE is a 20-page pocket-size pamphlet which shows, in illustration and text, how to get the best performance out of industrial lighting systems which employ fluorescent tubes. Hints are given on trouble shooting and on checking lamps and equipment. *Sylvania Electric Products Inc., Salem, Massachusetts.—Gratis.*

BETTER BRUSH SPRINGS is a ten-page illustrated catalog which describes the advantages of beryllium copper brush springs and their effect on small motor performance. *Instrument Specialties Company, Inc., Little Falls, New Jersey.—Gratis.*

INDUSTRIAL FORMS is a 12-page booklet illustrating and describing a number of forms which have been specifically designed to aid in recording data obtained as a result of time and motion studies, operation analyses, production control, and so on. *Methods Engineering Council, Wood and Franklin Streets, Pittsburgh, (21), Pennsylvania.—Gratis.*

VARIABLE SPEED TRANSMISSION is a 16-page illustrated catalog describing a variable speed mechanism and gear reducer built in a single compact unit. These transmissions meet the many important requirements for accurate variable speed control of industrial machines. Request Catalog TR-432. *Reeves Pulley Company, Inc., Columbus, Indiana.—Gratis.*

BATTLENECKS is an elaborately produced pamphlet printed in many colors—including metallic inks—which tells the story of materials, machines, and men in their relation to industrial production for war. Designed to encourage and speed operations on the production front. *Major General T. J. Hayes, Jr., Chief of Industrial Division, Ordnance Department, Pentagon Building, Washington, D. C.—Gratis.*

LUCITE MANUAL is a 126-page pocket size book describing various general methods of fabricating Lucite methyl methacrylate resin which have been found satisfactory in industrial operation. Information is given on the chemical, physical, and mechanical characteristics of Lucite, care and handling, machining, shaping, finishing, and so on. *E. I. du Pont de Nemours, 624 Schuyler Avenue, Arlington, New Jersey.—Gratis. Request this book on your business letterhead.*

TIMBER CONNECTORS is a four-page folder which describes a type of split-ring timber joint connector now being satisfactorily applied in various types of structures. Specifications are given on the kinds and on methods of application. *Carlson Building Specialties, 3234 West 31st Street, Chicago, Illinois.—Gratis.*

SOUTH BEND LATHES (Catalog 100-C) is a 48-page brochure illustrating and describing in detail the entire line of engine lathes, toolroom lathes, and turret lathes manufactured by this one company. Specifications are tabulated to facilitate consideration of the lathe needed for any desired application. *South Bend Lathe Works, South Bend, Indiana.—Gratis.*

HOW "CATERPILLAR" HELPS FIGHT WORLD WAR II is a 56-page story, mostly in pictures, of the work which this type of prime mover is doing in all phases of wartime operations, from the construction of airports and other engineering projects to the actual movement of men and materiel. *Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

CALIFORNIA REDWOOD—ITS PROPERTIES AND USES is a colorful four-page circular discussing the physical, mechanical, and chemical properties of this wood. *California Redwood Association, 407 Montgomery Street, San Francisco, California.—Gratis.*

SPECIAL COATINGS AND CEMENTS is a folder describing a number of adhesives and coatings which have been satisfactorily tested for actual production requirements. Uses for these materials range from barrage balloon cementing to shoe lace tips, jungle tents, and rubber mats. *Union Bay State Company, 50 Harvard Street, Cambridge, Massachusetts.—Gratis.*

THE STORY OF STEINMETZ is a short illustrated biography of Charles Proteus Steinmetz, the great mathematical wizard of electrical engineering whose work helped to make possible a great industry of today. Bulletin GEB-104B. *Publicity Department, General Electric Company, Schenectady, New York.—Gratis.*

PLASTIC PARTS FOR WAR PRODUCTION is a folded sheet showing examples of plastic parts made to order and to close tolerances through new fabricating techniques which eliminate the use of expensive molds. *Creative Plastics Corporation, 963 Kent Avenue, Brooklyn, New York.—Gratis.*

TUBE PICTURE BOOK consists of 16 large (17 by 22 inches) pages containing eight charts which show structural details of representative receiving, transmitting, cathode ray, and special vacuum tubes. Distribution limited to United States and Canada. *RCA Victor Division of Radio Corporation of America, Harrison, New Jersey.—Ten Cents.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

THIS MONTH, let's turn over the meeting to the math sharks. For the rest of us, what follows may have to be taken in low gear.

In this department in September, 1942, Capt. Alan E. Gee described his solution of the old problem of testing a Cassegrainian secondary. He proposed to grind and fine-grind the convex mirror to a sphere; then set it aside and polish, or partly polish, the concave tool; next, figure this concave tool to the required hyperboloid, using the formula at the top in Figure 1 with the Foucault test. Finally, figure and test the convex against this prepared concave by means of interference fringes.

Commenting on this proposal, F. A. Lucy, 3427 W. Penn St., Philadelphia, Pa., writes: "Capt. Gee's method of figuring a Cassegrainian secondary, appears to be the best yet offered, and deserves all the emphasis that can be given it.

"Hindle's test for an hyperboloid ('A.T.M.' Part X) has advantages over Ritchey's autocollimation method: it shows more of the mirror surface and is less troubled by diffraction effects. Further, there is only one auxiliary surface instead of two. Gee's test has the same advantages more strongly: it shows *all* the mirror surface, is still less troubled by diffraction, and uses no auxiliary surfaces, except insofar as the test-plate is considered one.

"It is true that the tests of Hindle and Ritchey employ a double reflection from the mirror, thus doubling the sensitivity, but a test-plate set up for Gee's test will be much closer to the knife-edge and, therefore, will have a larger apparent angular diameter.

"Geometrically, then, the tests are about equal in sensitivity but, as a matter of psychology, it is easier to judge contrasts in a large field.

"On the whole, finally, Gee's method appears to be capable of yielding the most accurate results of any.

"In like manner, an ellipsoidal mirror (for example, a Gregorian secondary) will appear more than twice as large when set up for c. of c. testing as when set up for the direct focal test—again with the least possible trouble from diffraction. Because of its greater speed, the direct focal method might be preferable for preliminary figuring, reserving the zonal survey for final work.

"With regard to the application of this test to convertible telescopes, a compound telescope is generally made with a paraboloidal primary of fairly large focal ratio, so that it may be used at the primary focus when desired. For looking at lunar or planetary detail, or for resolving close stars, the compound system is, however, preferable. The necessary high magnification can be obtained by using a short-focus paraboloid and a sufficiently small eyepiece; but if the latter has a Ramsden disk less than 2mm in diameter, the resolving power of the eye is reduced, and the use of still smaller eyepieces will give less detail rather than more in the image. It is better to use an objective of long focal length. If compactness is to be maintained, the Cassegrainian arrangement is generally considered the best way of doing this.

"While the classical Gregorian arrangement is less advantageous than the Cassegrainian, an off-axis Gregorian would be superior in at least one way to an off-axis Cassegrainian. In the Gregorian, the active part of the secondary will be below the axis when the active part of the primary is above. Thus the primary can lie very close to the axis with no shadowing at all by the secondary. An off-axis Gregorian, indeed, can be made even closer to the axis than can an analogous Newtonian; thus securing the advantages (A. A. Michelson, *Physical Review, 20,* 391 [1905]; N. J. Schell, Sci. Am. Telescoptics, April 1939, May, 1940) of this type (no shadowing, minimum diffraction) with the least extreme focal ratios and least difficulty in figuring. Incidentally, Gregory's original design has the eyepiece a considerable distance behind the primary, with a tube long enough and narrow enough so that direct sky light is kept from striking the eyepiece: the secondary shades it. This detail usually appears to be neglected in diagrams of the Gregorian construction.

"It follows that the convertible telescope of best performance would be an off-axis Gregorian with paraboloidal primary; although it would be easier to figure an on-axis Cassegrainian. In either case, the equations of Selby and Gee offer the best guide to the figuring (see below)."

When Capt. Gee first offered his data he included a mathematical proof, but this was not published—complicated formula matter is difficult to set correctly in type. Now comes Lucy with a condensed derivation, which follows. In it, the numbers in parenthesis refer to the numbered equations in Figure 1, written out by Lucy and reproduced by line-cut (one way to get around the above problem, mathematician-compositors apparently having all marched off to war). Lucy states:

"From a text on analytic geometry, one sees that, measured from the center of an hyperboloid, the x intercept of the normal is (1), where (x_2, y_2) is the zone on the test-glass through which the normal passes. The fundamental equation of the hyperbola is (2).

"Substituting (2) in (1) gives an equation for the intercept as a function of the zonal radius y_2. In discussions of mirrors, y_2 is usually called r, and will be below. As design constants, it is convenient to use, not the semi-axes a and b, but p and p', the latter two being respectively the distances from the secondary vertex to the primary focus and to the focus of the combined mirrors.

"By construction, (3) follows:

"Referring again to a text on analytic geometry, one sees that $a^2 + b^2$ is the square of the distance between the center and a focus. By construction, and with the use of (3), we have (4).

"With these substitutions, Capt. Gee obtains an equation for the radius of curvature (in the sense of the Foucault test). Going a step further, one may subtract $R_0 = 2p'p/(p' - p)$, the radius of curvature for the central zone. Reduction gives directly the knife-edge displacement for the zone of radius r (5).

$$R = \frac{p - p'}{2} + \frac{(p'+p)^2\sqrt{p'p + r^2}}{2(p'-p)\sqrt{p'p}}$$

$$x_0 = \frac{(a^2+b^2)x_2}{a^2} \qquad (1)$$

$$x_2 = \frac{a\sqrt{y_2^2+b^2}}{b} \qquad (2)$$

$$a = \frac{(p'-p)}{2} \qquad (3)$$

$$b = \sqrt{p'p} \qquad (4)$$

$$R - R_0 = \frac{(p'+p)^2[\sqrt{r^2+p'p} - \sqrt{p'p}]}{2(p'-p)\sqrt{p'p}} \qquad (5)$$

Figure 1: **Derivation formulas**

"This is for use with a testing set-up in which light source and knife-edge move together. If the knife-edge moves while the light source is stationary, the displacements are doubled, and the 2 in the denominator of (5) should be cancelled.

"H. H. Selby ('A.T.M.A.,' p. 134) has already given the corresponding equation for an ellipsoidal mirror. His equation may be derived by the process just described, using the ellipse analogues of (1), (2), and (3). The foregoing equations are all exact."

Subsequent to receipt of the above note by Lucy, there came from Captain (now Major) Gee, Corps of Engineers, AP 702, care of Postmaster, Seattle, Wash., the following communication.

"In the June, 1938, number of Scientific American, Kirkham furnished equations and dope concerning the construction of Cassegrainians with spherical secondaries and modified primaries of predetermined amount of spherical aberration to match. MacIntosh, Conner, and I applied this method to the 20½" telescope we made in Portland, also to a 12½" telescope now being completed there. On both of these telescopes I am interested in making high-

magnification secondaries to use alternately with the 3× secondaries for which both instruments were designed. With this in mind, I have worked out the necessary math to determine difference in radii of curvature of the zones of such a secondary, as measured by the King test or on the polished tool (for test of the convex by interference fringes). My equations are general and simple, so the dope may be of use to other ATMs who desire alternate secondaries for their modified Cassegrainians.

"Let a_1 be the spherical aberration of the primary (this would have been determined by Kirkham's equation when designing the original telescope); r_2 the radius of the new secondary to the margin of the area reached by light incident parallel to the axis; p' the distance from new secondary to secondary focus; and p the distance from new secondary to prime focus. Then

"$R = (2p'p)/(p'—p)$ = radius of curvature of new secondary (actually R of central zone) and $a_2 = [(R + p')^2/(R + 2p')^2]\, r_2^2\, R$. (The formulas are recast somewhat to permit them to be set on a linotype machine.—*Ed.*)

"Desired knife-edge movement between edge zone and central zone of new secondary then is $d' = \Delta a\, R^2/p^2$, where $\Delta a = a_1 — a_2$.

"The above equations are all derived for direct substitution of absolute values. In other words a_1, r, p', p, R, and a_2 are all positive values.

"If a_1 is greater than a_2, edge zone will have shorter R than center zone. If a_1 is less than a_2, edge zone will have longer R than center zone.

"Derivation assumes a stationary pinhole and moving knife-edge or grating.

"For intermediate zones, measured correction is proportional to square of the radius of the zone; that is, for a zone half way between center and edge, one fourth of the correction, $d'/4$, would be applied.

"The curve on these secondaries would approximate an oblate spheroid on secondaries smaller than the one for which the primary was designed, and a prolate spheroid for secondaries larger than the original.

"The above method could be applied to make a secondary for a Cass with spherical primary. In that case $a_1 = r^2/4R$, where r is the marginal radius of primary and R the radius of curvature of primary. Secondary would approximate an oblate spheroid.

"It is actually possible to make a properly corrected telescope with both primary and secondary spherical but, unfortunately, the proportions are highly impractical.

"Here is one more suggestion. Some ATMs who have conventional $f/8$ or $f/10$ Newtonians could convert them into RFTs by making a concave secondary for them to be placed inside focus. For a paraboloidal primary, the secondary hyperboloidal and the various knife-edge readings would be given by the equation I furnished in the September, 1942, number (first equation, Figure 1). For this special case, p' would be the distance from secondary to prime focus, and p the distance from secondary to secondary focus (just the reverse of the usual Ritchey notations). $R = (2p'p)/(p'—p)$ would still give the radius of curvature.

"If it were desired deliberately to introduce spherical aberration to correct for RFT eyepiece aberration, as suggested by Kirkman, my equation $d' = \Delta a\, R^2/p^2$ would give the change in zonal readings to be applied to the readings for the exact hyperboloid. This additional Δa would equal the desired aberration in that case. Care should be taken to see that the correction is applied in the right direction."

Maj. Gee's comments were next shown to Lucy, who then added:

"His equation for the hyperboloid to be used with a given paraboloid is exact; whereas the corrections in the modified cases are approximate. For that matter, Kirkham's equation is also approximate, as Kirkham himself made clear. The adequacy of the approximation depends on the size of the telescope, the focal ratio of the elements used, and on the severity of the selected tolerances. A modified telescope, made precisely to these equations, might require further correction by the aid of optical tests on the assembled instrument.

"I should be interested in hearing how these modified Cassegrainians actually perform when first assembled, especially when they are made to the extreme specifications of the Walkden RFT ("one-gallon" Cassegrainian)."

By accident, your scribe has just discovered that Lucy is the author of a two-part, eight-page article entitled "Exact and Approximate Computation of Schmidt Cameras," *Journal of the Optical Society of America,* June 1940 and May 1941. In this two-part article, the first half discusses the Schmidt design in a mathematical manner, while the second part discusses several modifications: a reversed plate Schmidt, solid Schmidt, thick-mirror Schmidt. Your scribe is collecting names of ATMs who go in for the math stuff. Such a group might become a sort of "Design Club," not formally organized but at least kept in closer mutual touch than at present, simply by being made known to each other.

ATMs HAVE asked this department about the content of some sets of salvaged lenses advertised elsewhere (page 275) in the June number. The Edmund Salvage Co. kindly gave us the requested data and a 70-lens set for inspection. The first set contains two lenses, 31mm diameter and 92mm f.l.; two 33 x 221 ditto; two 37 x 393 ditto; two 42 x 152 ditto; two 18 x 50 biconvex; two 17 x 58 plano-concave; two 14 x 35 ditto; and one 14 x 33 biconvex.

The second set contains all of the above, plus one each of: 9 x 36; 12 x 46; 16 x 238; 17 x 92; 24 x 92; 28 x 99; 28 x 136; 31 x 127; 31 x 152; 42 x 174; 42 x 201; 49 x 238; 54 x 201—all plano-convex. Also three biconvexes: 16 x 50; 22 x 45; 22 x 53; four plano-concaves: 12 x 148; 13 x 34; 13 x 55, and 24 x 148; two biconcaves: 19 x 30 and 19 x 50; and three menisci: 10 x 51; 28 x 120 and 33 x 120.

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 the names of available books, 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. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S.

FOR THE PERMANENT VICTORY
By Melvin M. Johnson, Jr. and Charles T. Haven

A DISCUSSION of the future, based on the past, from the standpoint of America, as the arsenal of peace. Not a complaint, but a constructive analysis on which a safer, better future can be built. After describing America's military strength and weaknesses in all her wars, a future plan is outlined. This emphasizes that, without becoming a militaristic nation, we should ever maintain a nucleus of modern war industries and a corps of trained men to operate them. Ably written by two men who know armament: The first is a Captain in the United States Marine Corps Reserve and inventor and producer of the Johnson light machine gun and Johnson Automatic Rifle; second is co-author of "History of the Colt Revolver" and other books on firearms. (246 pages, 5 by 8 inches, illustrated.) — $2.60 postpaid. — *A. D. R., IV.*

DICTIONARY OF SCIENCE AND TECHNOLOGY
By Maxim Newmark, Ph.D.

HELP for translators of scientific and technological English, French, German, and Spanish. Author is in the Department of Modern Languages at Brooklyn Technical High School, also does professional translating. Coverage embraces 45,000 terms in machine shop practice, foundry, electrical physics, radio, aeronautics, architecture, surveying, automobiles, meteorology, navigation, photography, and others, and each English term's equivalent is given in three other tongues including the American. There also are indexes for French, German, and Spanish technical terms. (386 pages, 6 by 9 inches.)—$6.10 postpaid.—*A.G.I.*

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