THE TRUTH ABOUT INSANITY . . . Page 330

SCIENTIFIC AMERICAN

DECEMBER • 1941

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How far can a gallon of gasoline fly?

HARDLY A DAY passes that we don't read of some new airplane that shatters all previous records for speed, size, cruising range or carrying capacity. Airlines, many of them stretching across oceans and impenetrable jungles, are constantly being expanded as ways are found to make a gallon of gasoline fly farther and faster.

Spurred on by the requirements of national defense, American engineers have redoubled their efforts to produce more power from each gallon of fuel and for each ounce of engine weight. Today, years of progress are being crowded into months and weeks . . . and few would venture to predict what tomorrow will bring.

For even today's most efficient engines can convert only a small portion of gasoline's potential power into useful work. There remains a vast reservoir of unused energy that stands as a constant challenge to the engineers of both the aviation and petroleum industries. Only when we know how far they can go in the practical development of fuels and engines can we tell how far or fast tomorrow's gallon of gasoline will fly.

Ethyl is privileged to help in this important progress through both product and service. Ethyl's products, anti-knock fluids containing tetraethyl lead, are used by oil refiners to improve gasoline. This, in turn, permits engine designers to increase the efficiency of engines—not only for airplanes but for all types of gasoline-powered equipment: automobiles, trucks, buses, tractors and military vehicles.

Since both engines and their fuels are inseparably related in their development, Ethyl research workers cooperate with both engine builders and fuel refiners in solving mutual problems. Our research laboratories at Detroit and San Bernardino function as a "clearing house" for technical information and help coordinate many individual research efforts. We also contribute the results of many of our own experiments with fuels and engines.

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A FEW OF THE MANY AUTHORS *Now Famous* WHOSE FIRST SUCCESSFUL BOOK WAS INTRODUCED TO THE PUBLIC BY THE BOOK-OF-THE-MONTH CLUB

The full list of authors who were first widely introduced to the public by having an excellent book chosen by our judges would be far longer than this. The few pictured below will be surprising to many people; they are included here to show how often you probably buy the book-of-the-month, because it is so widely popular. How sensible it is to buy these books from the Club direct since you receive a book-dividend with every two such books-of-the-month you buy.

Pearl Buck had had one novel published, *East Wind, West Wind,* which sold comparatively few copies when the judges chose **THE GOOD EARTH.**

The Club's choice of **KRISTIN LAVRANSDATTER,** by **Sigrid Undset,** in February 1929, was the real beginning of her fame in the United States.

Stephen Vincent Benét had attracted critical attention but had no wide public before his famous **JOHN BROWN'S BODY** was a choice of our judges in 1928.

ANTHONY ADVERSE was chosen as a book-of-the-month in July 1933. Prior to that, **Hervey Allen** was recognized as a poet, but was not nationally known.

Emil Ludwig was quite unknown to the American public, until his fascinating biography **NAPOLEON** was chosen as the book-of-the-month.

Victor Heiser, author of **AN AMERICAN DOCTOR'S ODYSSEY,** is one of the more recent authors whose fine work was first recognized by our judges.

Before our judges chose **LIFE WITH FATHER,** by **Clarence Day,** in August 1935, none of his books had sold more than ten thousand copies.

Margaret Mitchell's GONE WITH THE WIND, was a first novel; our judges immediately recognized its quality, sending it out as the book-of-the-month.

John Steinbeck had written several novels, when our judges chose **OF MICE AND MEN,** his first widely known book, in March 1937.

John Priestley is now well-known in this country; before our judges chose **THE GOOD COMPANIONS,** in 1929, few readers here had ever heard of him.

Marjorie Rawlings, author of **THE YEARLING,** is another comparatively recent "discovery." *South Moon Under,* her first novel, was also a choice of our judges.

Erich Maria Remarque's ALL QUIET ON THE WESTERN FRONT was the first of the successful war-novels; it was chosen by our judges in 1929.

Franz Werfel's books were called "noble worst sellers" by his publishers, until our judges' choice of **FORTY DAYS OF MUSA DAGH** introduced him to a national audience in 1934.

Stuart Chase, when he wrote **YOUR MONEY'S WORTH** with F. J. Schlink—a book chosen by our judges in 1927—was quite unknown to the general book-reading public.

Pierre van Paassen's reputation, won as a newspaper correspondent, became nation-wide only after the Club had selected his dramatic autobiography **DAYS OF OUR YEARS.**

Louis Adamic had written other books before **THE NATIVE'S RETURN,** which our judges chose in 1934, and which at once made him a national figure.

Arnold Zweig's European reputation was followed by renown in America only when the Club selected his famous novel, **THE CASE OF SERGEANT GRISCHA.**

Vicki Baum's GRAND HOTEL, chosen by the Club in 1931, set a new fashion in fiction and even in drama. It was her first book published in America.

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Jan Struther, with MRS. MINIVER, is a new author to Americans—instantly and widely introduced, as so many authors have been in the past, when her book was chosen in August.

Jan Valtin's OUT OF THE NIGHT became the leading best-seller three weeks after publication. This extraordinary autobiography of a young Communist was the February choice.

J. P. Marquand has been called "America's foremost satirist" for his novels of New England today. His latest book, H. M. PULHAM, ESQUIRE, is on the nation's best-seller lists.

every month from the Club. You receive a carefully written report about the book-of-the-month chosen by our four judges, *in advance of its publication.* If it is a book you really want, you let it come to you. If not, you merely sign and mail a slip, saying, "Don't want it."

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REVEILLE IN WASHINGTON, *Margaret Leech*
OUT OF THE NIGHT, *Jan Valtin*
FOR WHOM THE BELL TOLLS, *Ernest Hemingway*
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KABLOONA, *Gontran de Poncins*
SAPPHIRA AND THE SLAVE GIRL, *Willa Cather*
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Dr. A. J. Cronin's first novel since *The Citadel* four years ago — THE KEYS OF THE KINGDOM —has appealed so widely that over 300,000 copies were sold in a month. It is a study of a modern man of God.

Margaret Leech is the author of the September selection, REVEILLE IN WASHINGTON — a picture of the North during the Civil War as fascinating as that which *Gone With the Wind* gave of the South.

Winston Churchill's new book, BLOOD, SWEAT AND TEARS, was outselling all other books, fiction and non-fiction, six weeks after publication. It was the Club selection for May.

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CHRISTOPHER MORLEY is probably best known at present for his enormously popular novel, *Kitty Foyle*, one of the best selling books of recent years. But it was as a columnist and essayist of unusual charm and distinction that he first became familiar to his large audience. In this capacity, he has perhaps done more than any individual in the nation to revive the memory of old books and welcome new ones.

DOROTHY CANFIELD was educated partly in France and partly in the United States. Although her *Hillsboro People* and *The Bent Twig* in 1915 were widely read, it was her *Home Fires in France* that established her reputation as one of the outstanding writers of this period. Since then she has published a series of important novels, the latest of which is *Seasoned Timber*.

HENRY SEIDEL CANBY was one of the founders of *The Yale Review*. He also founded and was for many years editor of *The Saturday Review of Literature*, of which he is now a contributing editor. Widely known as scholar, editor and lecturer, Dr. Canby is the author of a number of important literary works, among the most recent being his notable *Thoreau* and his book on *The Brandywine*.

WILLIAM ALLEN WHITE is one of the most distinguished editors in America. He has stood especially for the independence and worth of the small-town newspaper, and has been a powerful voice speaking for the West. He is also the author of many books, ranging from his early novels such as *A Certain Rich Man*, to such notable biographies as his recent book on Calvin Coolidge.

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SCIENTIFIC AMERICAN

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NINETY-SEVENTH YEAR • **ORSON D. MUNN, Editor**

DECEMBER • 1941

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The National, State and Local Tuberculosis Associations in the United States

OUR *Point* OF VIEW

TRADE EDUCATION VERSUS CULTURE

WHY is it that in the United States, the greatest industrial nation on the face of the earth, there is a shortage of over a million skilled mechanics sorely needed to do the jobs necessary in our national defense program? Why is it that, when Congress recently appropriated 75 million dollars for the training of skilled workers in the public schools, it was found that there was no set-up for such training?

The answers to these two questions are not difficult to find, although they reveal an educational anomaly that is no credit to our much vaunted system of free public education. Then, too, the answers make one wonder whether our industrial system has not been built rather more in spite of public opinion—opinion held by those who are the greatest beneficiaries of the system—than because of it.

Answer to the first question is to be found in the fact that really skilled mechanics, those who bear the brunt of industrial production (and, incidentally, reap the rewards of this work), must be highly trained for their vocation, and that means of obtaining this training is not readily available. To attendance at the few so-called "trade schools" has been attached an odium that serves to repel those youngsters who would seek their futures in the industrial world. This has caused them to confine their formal education to the "academic" courses or to forego the benefits of advanced education completely. It has forced them to throw their lot on the industrial world with little or no preliminary training that would fit them to hold those positions which require mechanical skill.

Answer to the second question is to be found largely in that to the first, plus a bit of history in which those responsible for academic training do not play a very pretty part in the over-all picture. During World War I this nation was faced with an industrial problem similar to the one that now pertains. There was a dearth of skilled mechanics. There were no facilities for training the required personnel in the numbers needed. To remedy this the Smith-Hughes Act was passed, providing for federal appropriations for the creation and operation of trade schools all over the United States, coördinated with the industrial requirements of the localities in which they were located. These schools were to be no mere manual training set-ups, but were to be staffed with accredited mechanics who had been "through the ropes" and who had served a sufficient period in actual production work at their chosen vocations to be fully familiar with the problems that students would face when they finished their courses. The system worked and for awhile it looked as though the industrial requirements for skilled labor would be solved permanently.

But the trade schools were looked upon with disfavor by those academicians who, in final analysis, controlled the direction of our public school system. These men and women held the view that education should be cultural, that vocational training had no place in our educational scheme. Call it snobbery, if you will, but the feeling was there, and still is, and there appeared to be no permanently secured middle ground that would admit trade-school training to proceed side-by-side with cultural education.

Under the system set up by the Smith-Hughes Act, pupils of the trade schools spent half of their school time in cultural pursuits and half in study of the requirements of their chosen trade. For awhile things progressed favorably, but soon after World War I the snobbery of academic education gained the upper hand. By legal means it was decreed, in most of the industrial states, that no one could teach in secondary schools unless he or she had graduated from an accredited university. Death came to the trade schools. Cut off was their source of instruction material. Since 1925 no highly skilled trades have been taught in the public schools of the United States.

True enough, there are still so-called trade school classes in some sections of the nation, kept alive by that fraction of the public sentiment which saw the need of such education and which was sufficiently powerful to force its will on the opposition. But the opposition, being in control of education, saw to it that the trade education was reduced to the status of manual training, and that the cultural aspect continued in the ascendency. Then there are the vocational schools maintained by various industries in an endeavor to mold suitable material for their own purposes. And there are the private schools that offer special training in narrow corners of trades—automobile mechanics, Diesel engines, welding, and the like. But the combined output of these two sources of training is so small that it could hardly make an impression in the whole field of skilled labor needs, even if the training given were sufficient for the purpose.

There is only one educational source that can supply adequate numbers of skilled mechanics for present and future requirements—the public school.

Laws must be repealed that hamper the operations of the Smith-Hughes Act. Federal funds must be appropriated only for such trade educational programs as will fit present-day requirements. More public trade schools must be opened, with complete erasure of the odium that some have attached to attendance in such institutions of learning. The personnel of such schools must be composed of those who understand the needs of industry and can plan programs to meet those needs.

Only by such means can American industry continue to lead the world.

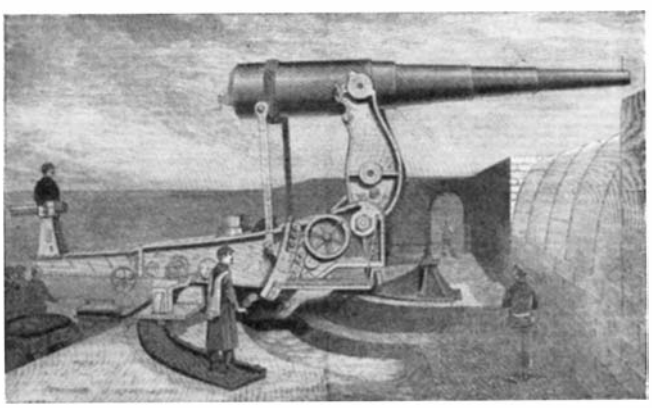
Here is no plea to side-track cultural education. Those responsible for this branch of learning have done creditable work that must not be allowed to lapse. Trade-school education must, however, go hand in hand with culture, to turn out graduates whose education is sufficiently many-sided to insure them places in our social scheme as well as in our industrial world. With such a balanced program our public-school system will reach that height of desirability to which it should rightly aspire.—*A. P. P.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of December, 1891)

DISAPPEARING GUN—"Trials have been made on the parapets of the old fortifications at Sandy Hook of a new disappearing gun carriage, the first of its kind ever built in this country for use with large guns. . . The gun is one of the new all-steel breech-loading rifles, and in its backward movement it is lowered eight feet, thus bringing it out of the direct range of an enemy's fire while being loaded and prepared for the next discharge. . . Steel of domestic manufacture is used exclusively in the carriage and its operation is automatic throughout. . . The gun is raised to firing position by means of compressed air acting



on a piston working in a cylinder beneath. . . As the gun falls back in the recoil the air in the receiver is again compressed, the air then acting as a cushion to take up the force of the recoil."

PENNIES—"There are 72,800 pounds of pennies encumbering the vaults of the Sub-Treasury. . . The accumulation is partly the result of the general establishment of the penny in the slot machines. The headquarters of the companies owning these machines is in this city, and all the pennies are therefore sent here when the agents make their returns. The companies thereupon unload them upon the Sub-Treasury."

OIL FUEL—"Though for a long time oil fuel has been used with success in forges for heating iron and steel, it is within comparatively a recent period that users have become convinced of its economy for use under boilers. Among its advantages are increased intensity of heat, lessening of labor and riddance to ashes."

PRESSURE—"An interesting experiment has been lately made by M. Chabry, of the Societe de Biologie, with regard to the pressure which can be produced by electrolytic generation of gas in a closed space. . . M. Chabry has succeeded in getting as high as 1,200 atmospheres, or about 18,000 pounds to the square inch; and the experiment was broken off merely because the manometer cracked (without explosion)."

SIGNALING—"The last of a series of demonstrations of a new method of signaling was lately given at the Naval Exhibition, London, by the inventor, Mr. W. B. Chalmers. The apparatus consists of a series of ten immensely powerful reeds, arranged to give a complete diatonic octave with a note on each side, by means of which it is, of course, possible to produce a virtually unlimited number of short groups of notes standing for letters, numerals, or whole sentences, such as are most likely to be required in a fog, or at night by two ships meeting. In many cases three notes suffice for a message that with the ordinary fog horn using the Morse code would take about half an hour to transmit."

PHOTOMICROGRAPHY—"The importance of modern photography as applied to microscopic objects is forcibly brought out by Prof. Robert Koch, the eminent bacteriologist, who employs photography with great success to bring out the most minute parts of organic and inorganic bodies. . . . 'The negative,' says Prof. Koch, 'frequently shows very fine bodies and parts, which are afterward discovered by the microscope on the object itself, but only after very hard work and under the most favorable conditions.' "

NAVY—"As the result of the efforts made during the last half dozen years, the position of the country as to means of offense and defense has been vastly improved. Not only have we the fine new vessels of the white squadron, with many other and more formidable ships approaching completion, but in the manufacture of heavy guns and armor we have about passed the experimental stage, and are now turning out both guns and armor believed to be equal to or better than any made heretofore in Europe."

POWDER—"The trials of smokeless powder are said to have resulted so satisfactorily that it is believed that within a very short time the use of gunpowder will be entirely abandoned in calibers of six inches and below, it being replaced by one of the smokeless powders."

TERMINAL—"The new terminal station of the Pennsylvania Railroad, Jersey City, N. J., opposite New York City, has the largest train shed in the world. . . It is 652 feet 6 inches long, 256 feet wide, 86 feet clear height at the center, and 110 feet from rail level to top of skylight. The structure consists of twelve pairs of main roof trusses, 252 feet 8 inches between centers of end pins, with the lower chord or tie rod running across under the platform."

SUGAR BEETS—"Among the new enterprises in Utah is the great beet sugar establishment at Lehi, with a capital of $1,000,000. . . Beets do not impoverish the land much. The constituents of the soil go largely into the leaves and crown of the beet, which are left on the ground after the harvest and subsequently plowed in. So that the farmer really returns to the soil in plowing the strength that has been drawn out of it by the growth of the beet."

ANCIENT MINERS—"A peninsula called Keweenaw Point, jutting into Lake Superior from the southern shore toward the northeast, is famous as the center of a vast copper mining industry. . . Numerous prehistoric mines have been found in this region. These ancient mines, judging from their extent, must have been worked for centuries. Who the workers were, no one can tell. They seem to have known nothing of the smelting of copper, for there are no traces of molten copper. What they sought were pieces that could be fashioned by cold hammering into useful articles and ornaments."

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BUILDERS FOR THE ARMY

The Engineers Put 'Em Up, Then Tear 'Em Down

DON WHARTON

THE Engineers run the greatest show in the Army. At Fort Belvoir, on the Potomac, next door to Mount Vernon, the drama, with a cast of more than 200, goes on twice every weekday except Monday.

It opens with a company of raw Engineer troops marching out on a road through the woods, halting at a defile, grabbing picks, shovels, saws, hammers, and mallets, and beginning to block a road. The troops have two hours, may use any materials at hand. They dig great holes, put in them logs two feet thick, rising upright six to seven feet, braced with other heavy logs and lashed together with steel wire.

In front of this and behind it they build other obstacles; one an odd-shaped platform to throw a tank off balance, another to tip it further, another still stronger to catch the swerving tank, stop it or turn it over, or snag it in the belly. For good measure they pile on some loose logs crazily—to roll with the tank and perhaps tangle in its track mechanism.

An officer blows a whistle—time is up—and the troops gather on the roadside to see their work tested. Not tested in theory, but by a real tank driven by a tank commander with but one ambition — to bust through what the Engineers have built. The three sergeants who are volunteers for this special duty, are altogether the most courageous men I've seen in our Army. For three months, they have seen the obstacles get more formidable each week, yet never have refused to tackle one.

Two have light tanks, one a medium. This afternoon it's the medium. Sergeant Cochrane, a Kentucky boy, has come down the road afoot to look the block over—the most terrifying thing you ever dreamed of driving into. Asked whether he can get through, he drawls: "I'm going to try like hell."

Now he's back with his tank, a quarter mile away, warming up his

NATIONAL DEFENSE

engine. Here at the block an officer is telling the troops that the tank may turn over, catch fire, injure the driver or kill him, but: "Understand, you are not to move." Now the tank is coming, all buttoned up with only the driver inside. The tank roars nearer, siren shrieking, making nearly 40 miles an hour and heading straight at the logs, any one of which would wreck the 20th Century Limited.

Cochrane hits the first block, swerves, plows on through the second, hits a third sloping mass, jumps toward the sky. Its belly nine feet off the ground, the 25-ton tank flies 30 feet through the air, crashes down, splinters oak and pine, thunders into the last obstacle—and stops. A tremendous happy cheer rises from the Engineers, and then silence, from them and from the tank. Its motor is dead and it doesn't move. The Engineers, remembering their orders, stand where they are.

A tank trooper races to the silent monster, climbs up, looks in—and everyone wonders whether the man he's looking at is dead or alive. Actually, he's unconscious but in a long moment he comes to, crawls out, lights a cigarette, and stands there rubbing his back. In a few hours he's in a hospital bed—wrenched back—and the Engineers are out on the field learning something more.

Next morning another Engineer company is building another road block and Sergeant Sims is hitting it with a light tank which is stopped upright on its tail, gas pouring from a broken line while the Engineers yell and a tank trooper runs up with a fire extinguisher. Then it's Sergeant Griffin's turn.

Out at Fort Knox, where the Armored Force trains its Engineers, you can see another good show. You drive a few miles to Salt River, park, stumble down a hill in the dark, and begin to glimpse black forms weaving back and forth. Here are Engineer troops who marched out from their barracks this afternoon, slipped across the river in assault boats, established a bridgehead and built two floating foot-bridges. Then they built a pontoon bridge for light tanks.

FIVE minutes after completing it they tore it down. That was in daylight. Now, stripped to their shorts, they are building it in a blackout — no cigarettes, flashlights, moon, or stars. They have been in the Army only eight weeks and the Germans reckon two years as the minimum for training Engineers. They have never built a pontoon bridge until today; their officers, reservists, are themselves a little green. Yet in the darkness they span 170 feet of river in two hours and 50 minutes—70 minutes faster than they did it in daytime, experience being more valuable than light.

Five minutes after finishing it

Photo by U. S. Army Signal Corps

The "Hairy Ears" strive to construct a sure-fire tank-wrecker

they begin tearing it down again. Then the Engineers in B Company come out of their tents nearby, build the bridge in the dark, tear it down in the dark, wait for dawn, build it again, tear it down again, and with A Company march back to barracks.

Thus our Engineers prepare for war. Except for the Air Corps, they are the Army's fastest expanding branch. They now number some 70,000 — nearly half the total strength of our Army when war began. Tanks, planes, and parachutes get the front page, but our Army, watching a single barometer, know that Engineers are playing just as big roles in this war. Their barometer is the German decorations list.

It was Engineers who forced the surrender of Belgium's great Fort Eben Emael, destroying the myth of impregnable fortifications. It was Engineers who constructed bridges on which German tanks crossed the Meuse, and thereby made possible the Sedan breakthrough. (Contrary to popular belief, the French *did* blow up the strategic Meuse bridges.)

British Engineers helped make the Dunkirk evacuation possible. Demolition accomplished by a relatively small group of them slowed the Germans down.

Mechanized warfare has doubled and re-doubled the importance of the Engineer. The tanks got armies out of the trenches, but it takes Engineers to get the tanks across streams. Bridging is their No. 1 job. The Engineers with a single German Army on the Western Front built 57 pontoon and 183 semi-permanent bridges in a few weeks. Not only must engineers in this war build more bridges, but also they must build them faster and stronger.

IN 1940 we had no pontoon bridge for the medium tank. Today we have one in use which some think is the best in the world. The wooden sleepers and flooring are made of selected Douglas fir; the boats are aluminum; all are carried on semi-trailers which can roll along at 45 miles an hour—twice as fast as the Germans can move their equipment.

But we haven't stopped there. Early this year Colonel Lunsford E. Oliver and Major Thomas H. Stanley challenged the military maxim that pontoon bridges should be made of parts small enough to be man-handled. Our Engineers, Germany's, Britain's—all believed this. But hadn't mechanized warfare made the axiom obsolete? Why not steel treadways instead of wood?

Colonel Oliver wrote to Washington. Washington at first said "No," but finally agreed and by August the new bridge was a reality: steel treadways supported by rubber boats. It is transported by special trucks, equipped with cranes. More than a thousand feet of the bridge is now being turned out.

At Fort Knox I watched them build a section of this bridge. I had seen crack Engineers put up our standard bridges; by comparison this one was amazing. A Canadian Engineer came up, so I checked with him. The Canadians, British, Russians, Germans—none of them, he said, had anything to touch it. To bridge 300 feet of river under average conditions takes 200 men some five or six hours; with this new bridge 25 men can do it in two hours—maybe in one. It will even carry the 60-ton (heavy) tank—something no German pontoon bridge will do.

A span of the new bridge makes an excellent ferry—to get a few tanks across quickly and into action while bridges are built for the main tank thrusts.

During the World War an American Engineer regiment marched afoot and worked by hand. Today each regular Army division has a

Photograph by Photo Section, 4th Armored Division

By pontoon ferry, engineers transport a tank across a river

battalion of 634 Engineer officers and men which moves entirely on wheels and works largely with power tools. One piece of its equipment is a motorized air-compressor unit which will do everything except whip up a salad. They hook a saw to it and cut standing timber for bridges and barriers; with another tool it drives railroad rails into the ground—more barriers; other appliances excavate, break pavement, build machine-gun emplacements, spray paint for camouflage. It has an automatic nail-driver for quick construction. It can pump water fast. At Fort Bragg, an Engineer platoon with this unit and a bull-dozer completed a crossing over a 120-foot swamp in 18 minutes.

The Engineers have mobile earth augers which race along at 50 miles an hour and can bore holes nearly two feet in diameter. The Engineers have the vital job of producing the maps for the army in the field; one small maneuver last year required 24,420 maps. They have mobile map units with high-speed printers which can operate a thousand miles from civilization. They also have a unit which can drive up to a muddy stream and in a few minutes be delivering enough clear, purified water for 4000 men. They have developed a portable overpass — invaluable when one column of troops must cross another's line of march. They have even developed a portable hot-water shower.

Photo by U. S. Army Signal Corps

Mobile water purification unit, with elevated storage tank, at right

To train men in handling themselves and equipment under difficult conditions they have developed an obstacle course that includes a hurdle, a ditch jump, a smooth wall, a four-foot breastwork, and a field of old auto tires. Besides, the human steeplechaser must swing by a long rope across a ravine, jump a fire trench, cross a stream on narrow stringers, climb over 12-foot ladders, and through barbed wire and long culverts. The men are sent through in groups of five. They make a game of it. Sometimes they compete as individuals and groups, sometimes run against the stopwatch. Gradually they build up to running in field uniform, under pack, carrying the rifle. Other camps have adopted this Engineer development, and at Pine Camp a medical unit raced through it carrying stretchers.

Photo by U. S. Army Signal Corps

Warm weather or cold, the Engineers must build pontoon bridges

Some officers say the Engineer's No. 2 job is laying anti-tank mines —the only portable obstacle which armored forces really fear. To develop the best pattern for laying mines, tanks were driven by remote control over live mines. The troops now use little smoke mines for practice, and see with their own eyes how good their work is when a tank tries to get through their pattern. Instead of practicing at night, the troops wear black goggles.

The "Hairy Ears," as the army song calls them, learn by doing. They have bought a 58-mile railroad in Louisiana to practice with. Come war, the Engineers may have to operate railroads—they did last time. Few experienced railroad men are of military age. On the practice line, green men are taught railroading. The Engineers are extending the line 20 miles—more practice. Regularly, they blow up part of it, to practice quick repairs. Also, they are testing in actual operation the light locomotives and cars the army has developed because World War I experience taught them that our standard equipment is too heavy for use near the front.

At Fort Belvoir, Engineer troops every day build crude shelters designed for troops near the front line. They are timed as they put up the shacks, timed as they tear them down again. The nails they use have two heads, one above the other. Driven in until the lower head is flush, they are easily pulled out by the upper projecting head. The lumber is used over and over.

Some months before we moved

into Iceland, one Engineer battalion practiced building "arctic" barracks out of prefabricated parts; the commanding officer had the men wear their barbed-wire gloves to simulate the all-thumbs effect of mittens. A few weeks ago a company commander at Belvoir found his men putting up barbed-wire sloppily—Monday morning apathy. He let them finish, called them to attention, told them it was such a

Photograph by Photo Section, 4th Armored Division

They're boatmen, too. Men in bow and stern are engineers

poor job he was going to tear it down with his bare hands. He did—then ordered them to put it up again. This time they went at it with pep and proficiency.

In Virginia they have built little Maginot Lines of pillboxes which they have scarred and blackened in practice assaults with flame-throwers, grenades, anti-tank guns, and explosives placed with poles. In southern Illinois, last spring, they found a stretch of old U.S. 13 which was to be flooded by the Crab Orchard Dam and practiced blowing craters in it. They used up three and one half tons of exposives, putting charges deep and shallow, close together and far apart, until finally they got a combination that blows craters with steep V-shaped sides which will stop a tank. Most craters will not. Since then the Engineers have tried this combination some 200 times on the varying soils of California, Georgia, Texas, Louisiana, and Panama—testing each crater with a tank.

They are also carrying on a great hunt for new ways of handling enemy mine fields, have experimented with rollers attached to the front of tanks, and are now working on a detecting machine, such as the Germans are supposed to have, which looks like an overgrown lawnmower.

Camouflage is another Engineer responsibility. They are not only working out techniques, but testing them. At Belvoir, they made models of two of our air bases so that from a high water tower they photographed the same as the bases themselves from 10,000 feet. As a result, they learned enough to halt the construction of one of our new bases, and have it completely redesigned. The Engineers are building their own new center near Belvoir—a $2,500,000 job—so that it will be virtually invisible to aerial observers.

In New England, they are camouflaging an air field in another great test; leaving tobacco barns and groups of trees in the field, building a parachute tower to look like a church steeple, putting in a false cemetery, eliminating the usual row of hangars, continuing a railroad siding far beyond its natural end, painting a dummy highway right across the landing strips, and even having sections of the field plowed at different angles and sown with different grasses to make it look like innocent farmland.

Meanwhile, they are carrying on the work they always have to do—the building for the Army. In ordinary times, that alone is considerable; just now it is a billion dollars' worth of construction—air bases from Alaska to Puerto Rico, sea-coast defenses, the new set of locks at Panama, these are items on the list.

Not having been at war, our Engineers have no Eben Emaels and Meuse River crossings to talk about. But thanks to the ingenuity of some Engineer officers, the troops are getting wide-awake training plus tools which will probably prove to be superior to those used by the Germans.

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BRITISH INGENUITY

Foreign Correspondent Tells Of War Aids

An interesting letter recently received from A. P. Luscombe Whyte, of England, outlines some of the constant research which is being carried on in England today. That the post-war world will benefit from the experiments of today is obvious from the following excerpts:

A suitcase radio transmitter for marine use has been developed which is compact, waterproof, and buoyant. When a ship is torpedoed or otherwise damaged and has to be abandoned, the unit can be thrown overboard where it will float until picked up by one of the ship's boats. The device is automatic.

A new type of life-saving "waistcoat," which can be worn day and night by passengers and crew members when the ship is in a danger zone, has been introduced and its use made compulsory. It is a sleeveless jacket containing 16 ounces of kapok. Although it is light and thin enough not to hinder ordinary work or to interfere with comfort, it will support the wearer and a comrade clinging to him.

Life boats themselves are now being equipped with one-man hand pumps which can rapidly empty a flooded boat. New types of concentrated foods and thirst quenchers have been developed for inclusion in the food stores to be carried by every boat.

By such means, and by similar applications of ingenuity, something of the dread can be removed from the order "Abandon Ship."

ANTI-AIRCRAFT

First Mount Built By Private Industry

Preliminary work has been accomplished and large-scale production is now starting on the first 90mm anti-aircraft gun mount to be built by private industry in United States. In this mount, shown in a photograph on this page and on our front cover, produced by the Allis - Chalmers Manufacturing Company, 3858 separate parts compose the delicate mechanisms on which the gun depends for its extreme accuracy and great mobility.

It is claimed that this new gun is capable of blasting planes out of the stratosphere nearly seven miles up. The units can be unlimbered from traveling position and put into firing position in six minutes.

New plane-blaster

Physics Scores an Assist

The Particle Detector, Teamed up with the Cyclotron, Gives Medicine a Powerful Tool

JANE V. SHEPPARD

PHYSIOLOGY teachers in grammar school used to combine instruction with entertainment by telling us that the food we ate did not retain its original structure once it got into the body, so that you could not expect to find a boiled potato floating serenely down the blood vessels in your arm or a pork chop wending its way through the muscles of your leg. We learned that digested food was broken down into different chemicals and distributed about the body; but just where each chemical went, and in what proportions, was rather difficult to determine by the direct chemical methods formerly employed. These methods required the administration of such large amounts of a given element that the abnormal dosage was likely itself to disturb the whole body metabolism and give false results for the experiment.

Today, modern physics has given biologists and medical research workers a remarkably versatile new tool with which to unravel the mysteries of metabolic processes, not only in man but in plants and insects as well. The knowledge made available through these new studies has vast implications for the improvement of human nutrition; for the treatment of abnormal states of body metabolism—notably malignant tumors and glandular disorders; and for increased control over the lives of plants and insects.

The first step in the new method for tracing the atoms of elements administered to plants and animals is to synthesize artificially radioactive elements into chemical compounds which can be taken into the living body, and followed to its parts by means of detecting apparatus. Irène Curie, daughter of the famous Madame Curie, and her husband, F. Joliot, were the first to discover, in 1934, the process of making stable elements into artificially radioactive isotopes. Transmutations of the atomic nucleus, brought about by bombarding atoms with high speed particles, will set up an unstable condition in the nucleus, with consequent emission of positive or negatively charged electrons, sometimes accompanied by gamma rays, depending on the particular element used, and the new cyclotron is already being used to good advantage to bring about these nuclear transmutations. Since a radioactive isotope is chemically identical with the stable element from which it is formed, it can replace the stable element in compounds which normally enter into the constitution of a living body, yet make itself known by its emissions.

Counter measures radio-iodine in the thyroid

In former experiments radium was used as a tracer, but this was not only dangerous but also limited in scope. Radium decays into other radioactive forms through a continuous series, so that any radium taken into the body will be giving off radiation for many years. Furthermore, radium is not a normal constituent of the body. In contrast, many of the new artificially radioactive elements do not emit radiation for a long period of time and they decay into stable elements which do not give off any radiation.

There are three ways of tracing the course of radio-elements in the body: tissue assay, autoradiography, and experiments in the living organism. These will be considered in order.

The radiations from radioactive substances can be detected by bringing the substance close to a Geiger counter, a physicist's instrument which records the impinging particles and gamma rays in a series of staccato clicks. If now you feed your pet mouse on some food containing a radio-element, and then dangle him in front of such a counter, it will emit a rapid stream of dot-dot clicks. Your pet has become a Super-mouse capable of throwing any near-by Geiger counter into a chattering panic.

NOW let us apply the process on a larger scale. If we give a dog some radio-element, and kill him after a few hours, we can disorganize him and test each separate organ and body fluid near a Geiger counter to see just which tissues have snatched the larger portions of the given element. This is known as tissue assaying. If the original substance, before being added to the canine menu, gave a count of 100 per minute, and the liver of the dog which has partaken of the tagged substance gives a count of 10 per minute, then we know that one tenth of that substance was commandeered by the liver.

Neat tricks like this are yielding valuable evidence as to just what becomes of the food we eat and what elements are most needed by the various tissues of our body, and these things are of fundamental value to medical science. For example, Dr. Borsook, at the California Institute of Technology, has

directed some significant studies on the disposal of vitamin B_1 by the body by preparing this vitamin, which contains sulfur normally, from radio-sulfur.

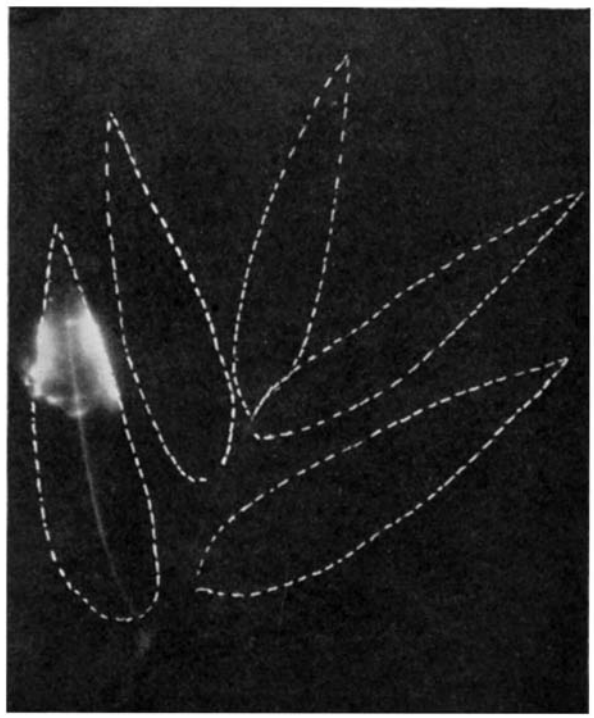
Another means of tracing the line of march and mass concentrations of radio-elements in an organism is to make auto-radiographs of tissue sections. After administration of the element, the animal is killed, and very thin sections of tissue are prepared from the organ to be examined. These sections are placed on a photographic plate and left an adequate time for exposure. Radiations from the tissue will act on the plate just as ordinary light does. The plate is then developed and the darkened areas indicate where the radio-element has been most concentrated.

Now the tissue section itself is stained to show up its cell structure. The film and the stained tissue are examined under a microscope to determine exactly which cells have taken up most of the radio-element.

This method is applicable to plants, animals, and insects. Metabolic studies of insects were formerly very difficult because of the minuteness of the experimental subjects. Now insects can be fed radioactive salts, thin sections of the entire insect prepared, and auto-radiographs made to find out just where the salts have accumulated. This method has important commercial applications for it can be used to test the effectiveness of insecticides.

Fortunately, we have still another method available for tracing the path of radio-elements in the human body without eviscerating the subject or making chipped-beef sections of his interior. This method is made possible by the gamma-ray emission of many radioactive salts. After administration of the salt, a Geiger counter is put over the region of the body where you want to detect an accumulation of tagged elements. It has been found that salts of sodium and calcium, when taken by mouth, appear in the tissues of the hand within two minutes. This is determined by having the subject grasp a counter tube in his hand, with the forearm enclosed in a lead box to shield the counter from radiations from other parts of the body.

The most extensive experiments using radio-elements have been conducted with phosphorus, iodine, calcium, strontium, carbon, and nitrogen. Radio-phosphorus administered to mice was found to be concentrated largely in the bones. K. G. Scott and S. F. Cook, working at the University of California, at Berkeley, were impressed by the implications of this experiment and reasoned that if radio-phosphorus tended to accumulate in the bones, large doses of it would irradiate just these tissues and affect them much as X-rays affect body cells. Using chicks as their experimental media, they confirmed their notion that radio-phosphorus would act on the bone-marrow, the chief blood-making tissue of the body, and would decrease the number of blood cells in the circulating blood.



Auto-radiographs of willow leaves (see text)

This seemingly innocent experiment may lead to the forging of new clinical weapons for combatting two mysterious blood diseases. The first of these, polycythemia vera, is a disorder of the blood in which red cells increase to an abnormal level for some unknown reason, and it now appears highly probable that radio-phosphorus can be used in such cases to irradiate the bone marrow and reduce the number of red corpuscles. The other disorder is a leukemia, in which white blood corpuscles increase to a dangerous level. It has already been found feasible to treat mouse leukemia—a disease in all ways similar to the human leukemia—with radio-phosphorus, and clinical procedures are now being conducted to explore the possibilities of using this treatment on human beings.

Radio-phosphorus has also been used to differentiate malignant tumors from normal tissue. The nuclei of tumor cells accumulate more labeled phosphorus than normal cell nuclei. In fact, many radio-elements are absorbed at a different rate and in different amounts by tumorous tissue than by normal tissue. It is to be hoped that these differences will lead to further knowledge of the origin and cure of tumors.

Biologists have made surprising discoveries about the movement of nutrients in plants by putting radioactive salts of phosphorus around the roots of plants and trees. It was found that both the anions and cations of salt were carried to the leafy part of a tree by means of the wood rather than the bark. The cells of the bark draw their nutrients from conducting vessels in the wood. Whereas it was formerly believed that nutrients could move only from the roots to the aerial portions of a plant, it has now been shown that they can also move from above downward. Radio-salts of phosphorus, painted over a limited area of a willow leaf were absorbed and spread to adjacent leaves. This process was observed by making auto-radiographs of the leaves. In the illustration the dotted lines indicate how the leaves were laid on the photographic plate. The bright area at the left is where the radio-phosphorus was painted on the leaf, and the faint central line proves how it traveled down the central vein of the leaf, through the stem and to adjacent leaves (very faint line, partly due to loss in reproduction). This proves that plant nutrients can spread from leaf to leaf as well as from roots to leaves.

Experiments using radioactive

iron salts have added to our knowledge of anemia. G. H. Whipple, at the University of Rochester, experimenting with normal and anemic dogs, found that the anemic animals absorbed far more iron than the controls, and that a larger proportion of the iron was concentrated in the blood cells. He also found that the absorption of iron depends on tissue depletion of iron and not on the existence of anemia alone. If dogs were bled freely and then fed iron salts, they absorbed iron at the same rate as normal dogs; but if a few days were allowed to elapse, during which the blood could draw on the iron reserves in the muscle tissue, then the anemic animals took up a large portion of iron to restore their tissue reserves.

AS MIGHT have been expected, experiments with calcium proved that it is largely concentrated in the bones and teeth. Since this element accumulates in the bones to such an extent, it would seem possible to use the radiations from radio-calcium in the treatment of bone diseases. But calcium remains radioactive for too long and it has weak beta-ray emission. Fortunately, strontium has the same distribution as calcium in the body and has the added advantage of rapid decay and strong beta-ray emission. Possibilities of clinical therapy using strontium are now under examination.

At the University of California, S. Ruben and M. D. Kamen, using radio-carbon in the synthesis of carbon dioxide, discovered that plants can assimilate small amounts of carbon dioxide from the air even in total darkness. However, the synthesis of plant nutrients does not proceed beyond a certain point in the dark, and requires sunlight for the reactions to go to completion. These new studies on photosynthesis suggest that simple sugars are not made directly in plants, but that they are split off from large molecules built on a plant enzyme whose chemical make-up has not yet been deciphered. These recent studies on plant metabolism will probably lead to improved methods of plant culture.

The use of radio-nitrogen in experiments on plants may yet upset some of our former views on nitrogen fixation. When barley plants were exposed to atmospheric radio-nitrogen, some of the labeled nitrogen atoms appeared in the plant tissues. Whether the plant merely exchanged some of its own nitrogen for the atmospheric nitrogen, or whether it actually succeeded in fixing some of the radio-nitrogen, remains to be determined. It would be quite a surprise if it were found that non-leguminous plants can fix nitrogen.

Radioactive iodine has so far proved to be the master detective in this brilliant new group of metabolic sleuths. The use of radio-iodine has led to some unusual revelations of the secret goings-on within the thyroid gland. Iodine is essential to the synthesis of the hormone, thyroxin, which regulates the oxidative processes of the body. The thyroid gland has an amazing ability to capture and concentrate iodine. Other tissues of the body contain less than 5/1000 the amount of iodine found in the thyroid. The concentration of radio-iodine in this gland is tested by placing a Geiger counter over the throat above the thyroid. The rate of accumulation of iodine varies considerably in normal people and those with thyroid disorders. In hypothyroidism the uptake is very slow, in non-toxic goiter it is quite rapid, and in hyperthyroidism iodine is quickly accumulated but is lost at an equally fast rate. It is still doubtful whether this technique of diagnosing thyroid disorders will replace those now in use. Auto-radiographs of thyroid tissue after administration of radio-iodine show that the iodine is evenly distributed in normal tissue but is distributed in a characteristic pattern for each type of thyroid disorder.

The use of biological tracers will doubtless be even more widely applied since the recent discovery of how to make radio-carbon 14. Since carbon enters into practically all organic compounds, the existence of artificially radio-active forms of carbon is most important. Formerly, physicists could make only carbon 11 in limited amounts, and it decayed so rapidly that the biologist had to be a track star to work with it. Now, with the aid of the cyclotron, carbon 14, which decays very slowly, is made available in generous amounts.

If physics has done a good turn for biology, the favor has not gone unrewarded. Not long ago, the physicists were casting around for some means of proving that a newly discovered element, element 85, was really eka-iodine. Since it was closely related to iodine it was reasonable to expect that it would be concentrated in the thyroid just as iodine is. Radioactive element 85 was fed to mice and was found to be strongly concentrated in the thyroid, proving that the new element was actually eka-iodine.

Thus, in the application of radioactivity to the solution of practical problems of biology, we come to another of the many instances in which pure science ultimately contributes, perhaps unintentionally but nonetheless beneficiently, to the progress and welfare of human life.

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THIN FILMS

Find Varied Applications In Scientific Research

FILMS of synthetic resins, some composed only of 10 to 15 layers of molecules, are proving a useful tool of science, according to Vincent J. Schaefer, of the General Electric Research Laboratory.

The thinnest films, he explains, are useful for mounting specimens in the electron microscope. Somewhat thicker films are valuable in studying characteristics of the resins themselves, as they react more quickly than larger amounts of the materials. For instance, Mr. Schaefer has found effects of ultraviolet light on films in a few minutes, where hours are required with thicker samples.

Pointing out another possible use, he says that, treated with zinc sulfide, the films make highly efficient "beamsplitters." These are used in optical instruments, where it is desired to divide a light beam, reflecting part to the side, and sending the rest on its original course. Partially silvered mirrors are usually employed, but these lose about a third of the total light. In contrast, only a twentieth of the light is lost with a film beam-splitter.

In making the films, Mr. Schaefer takes a clean glass slide and dips it into a solution of the resin. Then he withdraws it and lets the liquid dry, so the film forms on the slide. He scores with a needle point the part wanted, dips it in water, and the film floats off. The film is then perfectly dry, he points out, as the water slides off.

"Make-up" for Better Seeing

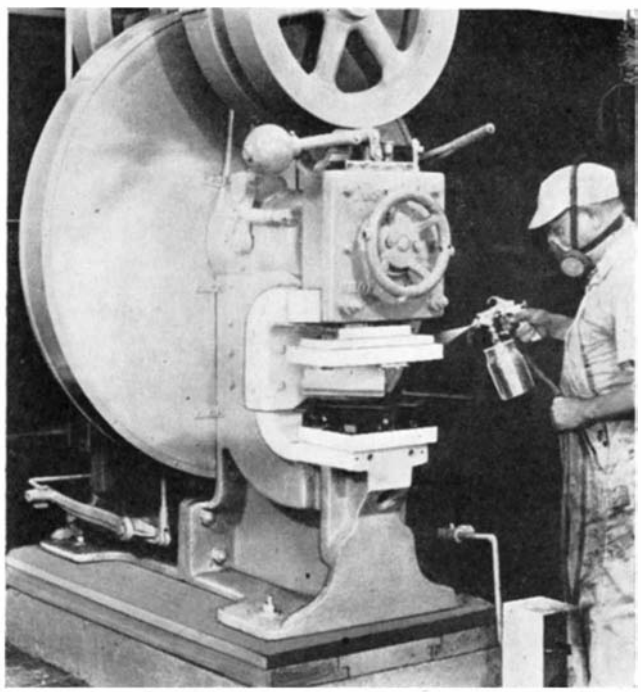
Studies Show that Safety can be Increased, Production Speeded, Workers Made Happier

A. P. PECK

AN ATTEMPT to improve seeing conditions for the operators of a huge press in an automobile-body fabricating plant pointed the way to research that is resulting in what may prove to be at least a small revolution in preconceived ideas regarding lighting in industrial plants in particular and in offices and other places of business in general. Piling up the illumination level at that press did not do the required job. After illumination reached a certain optimum, added wattage had no further desirable effect. Then light-colored paint was tried on the press itself. Immediately it was found that the newly introduced reflecting surfaces—the painted parts—so greatly supplemented the light source that the working parts of the press could be seen easily and accurately by the operator, in their correct relationship to the material being fabricated. Safety increased, production stepped up.

Here was something for lighting engineers to conjure with. It recalled the story of the New England shoe manufacturer who, a dozen years ago, was having a bit of labor trouble. His workers complained of frequent headaches, of spots before their eyes. Investigation showed that these men, working with black leather on black machinery, had to strain their eyes to distinguish their materials from a non-contrasting background. Paint the machinery a lighter color, any color, was the order. Accidents, so the story goes, fell off nearly 70 percent. The workers felt less fatigued, suffered less frequent headaches, saw fewer spots before their eyes.

Other examples of such hit-or-miss applications of color contrast to industrial jobs could undoubtedly be found, but it took the fine hand of research, intelligently applied, to bring forth an array of data upon which could be built a new corner of the science of seeing. Starting with the example of the painted press in the automobile-body plant, Arthur A. Brainerd, Director of Lighting Service of the Philadelphia Electric Company, decided to investigate the possibilities of improved seeing through the application of paints of various colors to surfaces which, in the past, had been painted in conventional colors selected with little or no thought to ultimate lighting utility.



"Spotlighting" the tool-working area of a punch press with light buff to produce better seeing

Engineers and laymen alike have known for many years that white walls and ceilings in a room will reflect light, will provide better illumination than when these same surfaces are dark in color. Little attention has been given, however, to color *contrast* in relation to ultimate seeing, and it is this contrast that has been found to be the key which opens many doors to better seeing.

As Mr. Brainerd progressed in his work, he found need for collaboration with experts in the surface-finish field. Such collaboration was obtained from E. I. du Pont de Nemours Company, the resulting research team working hand in hand to acquire the basic knowledge which has resulted in practical applications of what the researchers term "three-dimensional seeing."

Briefly stated, the basis of this new phase of the science of seeing depends on the fact that the eye is naturally attracted to the brightest area in the field of vision. Yet machine tools, such as the press previously mentioned, are generally painted over-all in solid, drab colors that do not attract the eye and that offer no color contrast to the material on which the operator is working.

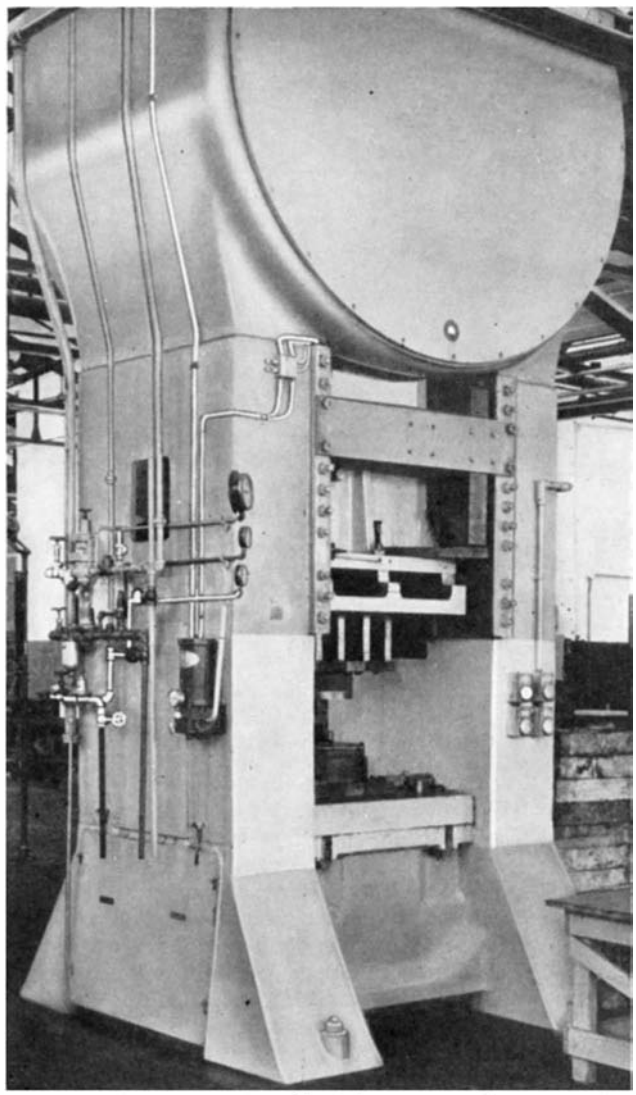
WITH these points in mind, the researchers selected two typical machine tools on which to conduct a series of intensive studies, the huge press that started it all being in constant production use and hence not available for continuous experimental work. A small punch press and a power shear, located in an active machine shop handling a wide variety of work, were the two units that became the guinea pigs of the research. In order to arrive at conclusions that could be applied under varying conditions, the two units were arranged so that they could be illuminated by either incandescent or mercury lighting equipment at will. Photometric records were made of each of the colors tested, the readings being taken of light falling on the working surface and of light reflected. The original color of the machines was a standard battleship gray, a color that reflects a relatively small amount of light falling on it. Periodically the machines were painted with different colors in semi-gloss, oil-resistant, washable machinery paints, a complete series

of tests being made with each color. These tests included light measurements, time studies, and psychological reactions of machine operators.*

When these experiments were started, the paint was applied to the entire machine. Included in the colors tested were battleship gray, aluminum, light green, light gray, yellow, light blue, light buff, and medium gray. These colors were accurately reproduced on a sample chart and liquid samples of each paint were kept for future reference and testing. As a further check on one of the minor but important problems involved, small metal samples were painted with each color and placed around the shop in rather dirty locations. Periodical examination of these samples enabled the engineers to determine the durability of the paints under shop conditions as well as their adaptability to maintenance.

When sufficient data had been accumulated regarding light-reflection characteristics of the various paints under operating conditions, it was found that, contrary to what might be expected, the aluminum finish rated very low under incandescent lighting. The researchers state that, thus far, they have no explanation for this fact. In any event, however, light buff showed up remarkably well under both incandescent and mercury lighting. Light gray and aluminum rated about equally well under mercury light but under incandescent the light gray far outstripped aluminum in reflection characteristics. Light green was high enough in its rating to warrant further consideration, and the other colors tagged along with values that put them out of the running.

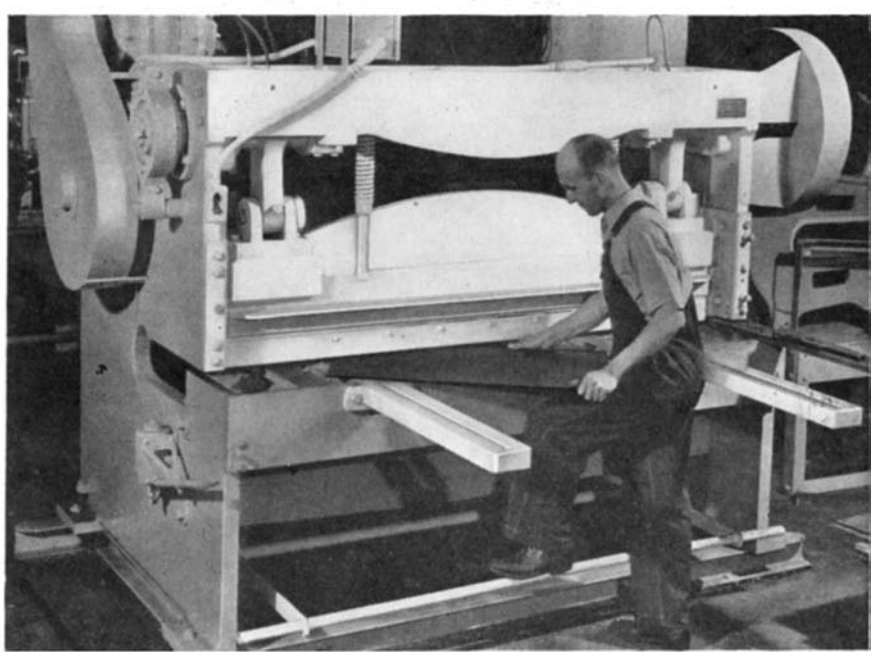
*Interested readers will be referred upon request to additional sources of information on this whole subject of "three-dimensional seeing," in which the tests are described in detail, with explanatory charts and tables.



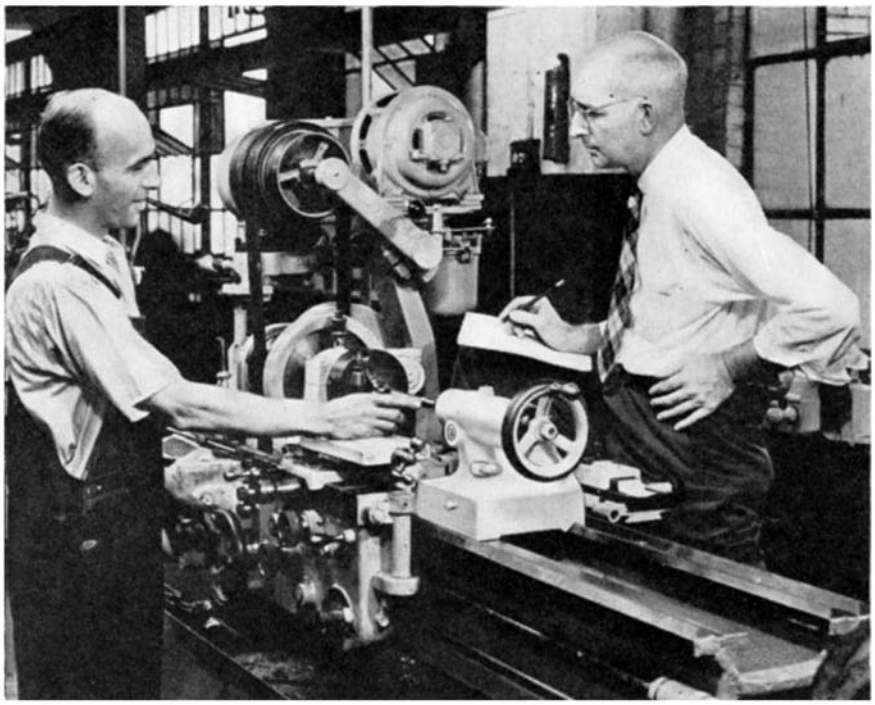
Dark areas are painted gray, light areas buff, giving "three-dimensional seeing" at this huge press

This brief summary of results is generally correct for both machines employed in the experiments, although the same colors sometimes reacted differently when applied to the punch press than to the shear. This fact alone indicates that additional investigation will undoubtedly reveal that this form of "three-dimensional seeing" will have to be varied somewhat to suit the immediate application. Basic rules can already be formulated, but the greatest benefits can be achieved only when these rules are varied for the job in hand.

Time studies with the two machines closely paralleled the light studies. Conducted with a group of workmen performing simple jobs under routine conditions, the light buff stood highest on the list. Jobs timed in seconds were accomplished more rapidly when the machinery was painted in this color than when other colors were used. This superiority held true under both types of lighting used. Oddly enough, however, medium gray showed up surprisingly well for certain tasks, in some cases leaving little to choose between this color and buff. Light green and light gray were also about equivalent, but lower on the time



The power shear that was one of the guinea pigs in the paint-and-light research for better seeing. Safety was increased, production stepped up



A machine-shop lathe painted in accordance with the findings of research. The stereoscopic effect so obtained is particularly noticeable here

scale than the other two colors mentioned. Again aluminum was low.

Psychological studies of the paints for various operations were made by the questionnaire method. A group of 15 men, including two foremen, were asked a series of questions about each color used. These questions included: Is the paint more or less tiring than original? Can you see better than with original? Can you work faster than with original? Is it easier to do better work than with original? Do you need more light? Do you think it's safer than before?

ONCE more a striking parallel was found. Light buff and light gray were voted less tiring than the original by all of the men, with the other colors ranging downward in popularity to yellow, which every worker considered more tiring. Buff, light blue, light gray, light green, and aluminum all received a 100-percent vote for better seeing than with the orginal color. Buff did not do so well with the third question, but light gray and aluminum stood high. About the same ratio held for the fourth question, while light buff and the grays were the outstanding colors with which the workmen did not feel that they needed more light to do their assigned tasks. All of the lighter colors received high safety ratings from the men, with medium gray and light green the lowest on the worker's safety scale.

With these three groups of data —reflection characteristics, time studies, and psychological reactions —in hand, the experimenters next compiled a composite rating for all the colors used. Thus it was possible to balance all factors and arrive at a result that should indicate which color gave the best all-around seeing. Under both mercury and incandescent lighting buff was rated at 100 percent, with light gray next under incandescent lighting and aluminum next under mercury.

Throughout the experiments it was necessary to make compromises, since the end-result sought was a practical one rather than theoretical perfection that could not be achieved in practice. Thus, the ideal reflecting surface for any color is a flat paint that gives a high degree of diffused light reflection, rather than a glossy surface that produces reflected glare. But flat paint is difficult to keep clean under field operating conditions and soon loses much of its reflecting qualities. Therefore a semi-gloss paint was selected as giving a minimum of maintenance problems, yet not producing sufficient glare to give trouble from this source.

Another compromise had to be made when the results of the experiments were laid before the supervisory force of the machine shop for criticism. The main comments were that, while the idea was good from a theoretical standpoint, it was not practical to paint machinery such a radical color as light buff. The machines would require too much maintenance, would have to be cleaned too often in order to keep the color effective. Accordingly, a group of machines were painted medium gray with light buff around the working areas. The purpose of this compromise was to retain the luminous possibilities of the lighter finish and still satisfy, at least partially, the requirements of maintenance.

HERE came the big surprise of the whole series of experiments. The combination performed better than any of the solid colors. Additionally, it has been found that mechanics who have been working for a long period of time with machines painted in this combination will keep the light area clean without immediate supervision.

Continuing studies of the problem of industrial lighting as affected by machine color have established the following facts: Soft color contrasts in parts of machines are easier on the eyes than abrupt changes in brightness. Making the working area of the tool slightly lighter definitely tends to concentrate the attention on the work. A favorable contrast between machine color and color of the work highlights danger zones and so makes for greater safety. A three-dimensional effect is secured by controlled color contrasts; the work in machines so treated stands out in stereoscopic clearness that cannot be achieved with brightness contrasts alone or by increasing the amount of light on the work above a certain effective level.

As a result of the work so far accomplished in this new field of better seeing, several industrial plants have adopted the so-called "spotlight buff" and "horizon gray" for some or all of their machinery. It must be pointed out, however, that the "spotlight" color most effective for a certain job is not always buff; other colors will have to be called into play where the color of the material being worked on is not satisfactorily spotlighted by buff.

As was hinted in the first paragraph of this article, industrial machinery is not the only type of equipment that will be benefited by this research. In one of the du Pont plants where color charts are made, the gray and buff com-

bination has been applied to almost everything in various departments, even to the uniforms worn by the girls. Other combinations have been tried by the color-conscious management with results that they state are highly satisfactory.

Similar work is being done in offices. Ceilings, sidewalls, and dados are being painted in colors that depart radically from the conventional. Some of these combinations give not only better seeing by reflecting more diffused light to the working surfaces but, by proper color contrasts, give an impression of depth and spaciousness so valuable to the psychological attitude of the desk worker.

And the end is not yet in sight. As with most research work, early results are merely indicative of what is to come. Field investigations are being conducted with a view to amassing an array of data on which to build a more complete analysis of the entire problem. Enough has been accomplished, however, to establish the fact that suitable attention to color contrasts and brightness is essential if the best results are to be secured from any lighting system. And sufficient practical work has been done to indicate that this system of "three-dimensional seeing" can be applied to many plants and offices to result in increased safety, increased production, better working conditions, and improved labor relations.

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SORTER

For Metal Parts of Like Appearance

A SIMPLE device for "unscrambling" metal fittings used in lighting systems was recently assembled in one afternoon by C. S. Williams, of the Westinghouse Research Laboratories. The sorter was developed after a manufacturer of malleable cast-iron conduit fittings appealed to the Laboratories for apparatus that would sort out a mixture of tough and brittle conduit parts. All of the parts looked alike, but some had been heat treated and some had not. The untreated fittings were brittle and would break in service.

Four pieces of standard laboratory electrical apparatus and two small hollow coils of fine wire were used in making the device. One piece of apparatus was an oscilloscope, a device which makes electrical waves trace a visible path on a glass screen. When a fitting was inserted into one of the hollow coils, a green line on the oscilloscope screen told whether or not it had been heat treated.

The test was based on the balancing of magnetic fields in the two coils. When the tough, treated

Parts "unscrambler"

iron was placed in a coil of wire carrying an electric current, the magnetic field was increased more than when the brittle, untreated iron was tested.

All kinds of small steel or iron parts which have different effects on a magnetic field can be sorted by this method.

SCRAP SHORTAGE

A Problem in Steel Operations

ONE of the most difficult problems facing the steel industry in its effort to maintain production at peak levels for national defense and other needs is the threat of a serious shortage of steel scrap material.

Currently, the industry is consuming scrap at the annual rate of 42,000,000 tons. Actual consumption in the first half of 1941 was 40 percent above the same period in 1940.

The present prospect that the amount of scrap available will fall short of the total needed is causing deep concern in the steel industry and various companies are adopting unusual measures in an effort to obtain scrap. Some of them have appealed to employees and the public at large in the communities of plants for help in collecting supplies.

About 55 percent of the tonnage of scrap consumed by the steel industry is produced within the steel works through the cutting of ingots, blooms, and billets, cutting and shearing of rolled products and through other forms of accumulation of scrap material. The remainder of the industry's requirements is searched for and purchased in what is usually termed the open market.

The present threat of shortage reflects not only the record rate of consumption, but also the fact that the available supply has been lessened in recent years by large tonnages of scrap exported. From 1935 through 1940, 20,000,000 tons of scrap were shipped abroad, chiefly to Japan and Italy.

Steps to meet the situation include:

1. Consideration of plans by the government for a nationwide drive for the collection of light iron and steel scrap, similar to the recent widespread drive for aluminum.
2. Consideration of plans to locate remote resources of scrap, such as old automobiles, structural steel, old railroad cars, and other bulk supplies throughout the country, and make it economically practical to ship it to steel producing centers.
3. Urging British purchasing authorities to confine their purchase in the United States so far as possible to finished steel products, and to limit their purchase of semi-finished steel products.

Nine-tenths of the steel ingots produced in this country are made in open hearth furnaces. In the production process, scrap and pig iron are charged into the furnaces in the proportion of about half and half on the average, although the proportion varies widely among individual steel companies throughout the country.

This mixture of cold scrap and newly made pig iron is more quickly refined into steel than a 100 percent charge of pig iron. The saving in time arises from the fact that scrap steel already has been refined once, and therefore contains fewer impurities than pig iron.

When charged into the open hearth furnace, pig iron contains about four percent carbon. Usually, most of this carbon must be eliminated, since a large propor-

tion of all steels contains no more than one-fifth to one-half of one percent of carbon.

Scrap steel used in open hearth furnaces has most of its carbon and other impurities removed when originally manufactured. A mixture of scrap steel and iron is more quickly brought to the proper analysis than iron alone without the addition of scrap. Aside from the saving in time thus achieved, the use of scrap results in a saving of large quantities of coal which serves as fuel, and of limestone which is used as a purifying agent.—*Steel Facts.*

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TORTURE: More than 20,000 electric light bulbs are deliberately destroyed annually by lighting engineers in order to determine weaknesses in construction. The lamps are bumped, pounded, dropped, beaten, and burned out to exaggerate the worst treatment that they might receive in service.

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TIN-CAN 'CAMERA'

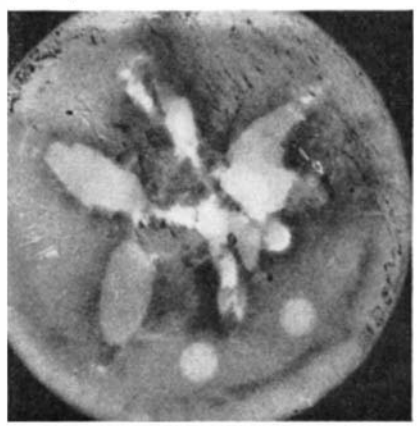
Photographs Location of Radioactive Atoms

A PHYSICIST recently demonstrated how he used a tin can, two small brass disks, and a screw clamp to devise a simple "camera" that sees into steel with the aid of radioactive atoms.

Although it has no lens, shutter, or other parts usually regarded as essential on cameras, the tin-can device records on photographic film the rays from artificially radioactive atoms of phosphorus, thus revealing their location in the steel.

Dr. William E. Shoupp, who improvised this "camera" at the Westinghouse Research Laboratories to find out if phosphorus is well mixed with iron in steel, or if it is bunched together in spots, tells the story as follows:

"To study the problem, we melted a sample batch of steel into which we put radioactive atoms, or tracers, of phosphorus. The phosphorus had been made artificially radioactive by bombardment in an atom-smasher, so it would send out invisible rays like those emitted by radium. These rays do not affect the action of the phosphorus, but they reveal



Above: **Clamping film on both sides of steel disk.** *Below:* **Light areas indicate phosphorus**

the location of the atoms from which they are sent out.

"Then we molded a small disk of steel containing the tracer atoms. In a darkroom, we laid a piece of photographic film on each side of the steel disk, placed two small brass plates outside the film, clamped the stack of film together, and placed the whole thing in a tin can to keep out all light.

"The next morning we unclamped the 'camera' and developed the film, which then revealed light and dark blotches caused by the rays from the tracer atoms. Our problem was solved, because the light areas corresponded with little air pockets, or blow-holes, in the steel disk, showing the phosphorus had concentrated on the surfaces of these holes.

"We were interested in this subject because too much phosphorus makes steel brittle, and the more we can find out about the way these two substances combine with each other, the better prepared we shall be to improve steel-making."

Dr. Shoupp said this simple method of taking pictures of radioactive atoms could be used to reveal the location of other substances besides phosphorus. For example, steel also contains small amounts of sulfur, carbon, manganese, and silicon. Any of these substances can be made into tracers with the assistance of an atom-smasher.

STANDARDS

For Household Equipment To Conserve Materials

IN an endeavor to bring about important economies in production and distribution, and thereby mitigate the effects of shortages of strategic materials, the American Standards Association has been requested to proceed with standardization work upon household mechanical refrigerators, domestic washing machines, and electric flat irons.

Not only will such standardization have the desirable effects mentioned, but it also should result in better service to consumers and in a continuation of availability of equipment even though materials shortages became stringent. The standardization program involves a limitation on the number of models to be produced, a standard method of size rating to insure the greatest possible value to the ultimate consumer, a method of comparing effectiveness of units of different manufacture, and minimum performance and construction standards for the protection of the buying public.

HEATING COMFORT

Promoted by Use Of Unit Heaters

FACTORY employees in the new plant of the Charles Bruning Company are able to control heating both in accordance with the requirements of their own comfort and with the requirements of the work they are doing. In addition to the general heating system, the plant is furnished with large, circular, fan-type heaters, especially designed to diffuse heat in all directions. Thermostats are provided in connection with these fan heaters, so that employees in various sections of the plant may regulate temperature. The general heating system, of course, functions entirely automatically.

INDUSTRIAL TRENDS

MOTOR CARS AFTER THE WAR

HIGHLY speculative today is the trend of the entire automotive industry, particularly the long-range trend reaching as far into the future as the end of the present emergency and the return, we hope, to normal industrial operation. At the time of writing, the motor-car manufacturers have completed their annual shift of models and are swinging into production of their allotted number of units, coincident with continued activity in producing or preparing to produce materials of war. Just what will be the final outcome of this many-sided operation by an industry that always has been geared to high-speed production of consumer goods in a highly competitive market?

Anyone who would try to give a definite answer to this question would also attempt to buck the parimutuels with hope of profit rather than for the pleasure of gambling. But there are certain known facts that can be considered and upon which may be based an estimate of the future, such estimate to be tagged "subject to change without notice."

First, the automobile manufacturers—nine of them—must be divided into the one privately owned company, Ford; the two "combines," General Motors and Chrysler; and the "independents," Hudson, Packard, Studebaker, and the rest. Then consider war orders. Most of these are being placed—to the tune of almost three billion dollars so far—on the basis of cost-plus contracts. In some cases the plus is as low as 5 percent, in others as high as 7 percent. OPM has indicated that the total orders placed so far will eventually be tripled.

Now the percentage of profit basis on which war orders are being taken is not too bad for some of the motor-car manufacturers, especially the independents. To some of these, at least, war orders may eventually prove more profitable than automobile production at the highly competitive prices that have prevailed for some time. To the combines and to Ford, however, the profits offered by government business are below those which they would realize under normal automobile business. Thus these profits will represent money in the bank for some and reduced earnings for others.

On the other hand, restriction of motor-car production is going to pile up a reserve of orders from new consumers and from those in the replacement field, so that by the end of the emergency there should be a substantial market for cars that were not bought for one reason or another during the period of curtailment. Add to this the fact that the automotive and aircraft manufacturing industries are being drawn closer together by wartime association, and the picture doesn't look too bad.

Then, too, motor-car manufacturers are learning many things by way of their participation in war goods production. They are learning that there are really no set rules for materials, that there are replacements or substitutes for things that were formerly considered irreplaceable. They are finding new ways of doing things faster, better, more economically. All of these factors are piling up in a bank of knowledge that can be drawn upon to the future benefit of all concerned. If good business management holds these companies together during the present period of stress, and if that bank of knowledge grows and is used, as there is every reason to believe it will, the trend of the industry in days to come should be toward a continuation of its activities as Number One among the industries of the United States.

WHAT ABOUT THE AIRLINES?

ON THIS page in our October 1941 number was discussed the position of aircraft manufacturers in relationship to present conditions and to the future. Now let's look at another phase of the aviation industry, closely linked with manufacturing, yet with problems peculiar to its own field. This is the industry of getting passengers, mail, express, and freight from one point to another by the fastest means yet devised by man—air transportation.

Some months ago a feature article in Scientific American dealt with the predicament in which the airlines find themselves by reason of diversion of commercial planes to Great Britain and Russia. This was the dark side of the picture. While it still holds true—over 120 planes have been transferred so far—there is another angle of this national defense business that will undoubtedly benefit the airlines in the long run. Already its effects are to be seen. New planes, slowly being acquired by the airlines for replacement purposes, are larger, faster, as a result of lessons learned in plane construction through wartime requirements. For example, in some cases transports carrying about 10 passengers are being replaced by ships with a capacity for 24. In this manner the airlines are able, to some extent, to meet the increasing demands for service, largely engendered by national defense programs and their call for more and faster transportation.

This is the sort of thing that will redound to the benefit of the airlines, and may be considered as a reliable guide to the future trend of the industry. Military planes capable of carrying huge loads for great distances are being built and put through grueling tests. From these ships will be spawned the transport planes of the future, planes that will serve the traveling public with air transportation on a scale never before seen.

FOOD PROTECTION

HARD hit, among others, by the diversion of aluminum from consumer fields to national defense requirements is the packaging industry, large users of aluminum foil for wrapping many commodities offered to the public, notably food. Now, however, comes the Reynolds Metals Company with a product of research that, it is claimed, is an ideal substitute for aluminum foil. Made of an alloy of lead and tin, the new foil opens the way for a trend in the packaging industry, being opaque, impervious to moisture, and reflecting about 95 percent of the radiant heat that strikes it. With these characteristics, it protects foods against many of the factors that can cause spoilage and other changes.

—The Editors

Who Threw Them?

Dunninger Plays the Role of Poltergeist By Dexterous Digital Manipulation

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

SO FAR as I know or have been able to find out, no one ever *sees* a poltergeist. One merely suffers varying degrees of annoyance from its prankish, often childish, antics. In "An Encyclopedia of Occultism," by Lewis Spence, poltergeist is defined as: "The name given to the supposed supernatural causes of outbreaks of rappings, inexplicable noises, and similar disturbances, which from time to time have mystified men of science as well as the general public. The term poltergeist (*i.e., Polter Geist, rattling ghost*) is sufficiently indicative of the character of these beings, whose manifestations are, at the best, puerile and purposeless tricks, and who not infrequently display an openly mischievous and destructive tendency."

From correspondence I have had with Mr. Harry Park, of Los Angeles, California, since last spring, it might be said that he is troubled with a poltergeist. Park, a man 71 years of age, runs a tiny printing establishment (the Clipper Printery) within a 15-foot-square ground floor space in the downtown section of that western metropolis. About half way up to the 12-foot ceiling is a miniature balcony, reached by a short flight of stairs. On the balcony are located a washroom and storage space. All windows are adequately barred, and there is positively no entrance, according to Mr. Park's letters, other than the front door. "The ceilings and floors are perfect," he wrote, "and we have offered five dollars to anyone who can find a hole big enough to push a marble through, to say nothing of throwing with considerable force articles three-by-three inches." During a period of two years both Park and his wife—who also works in the printery—have been pestered by having a total of over 200 articles thrown at them, apparently from nowhere, apparently by the hand of no living person. Many witnesses have observed these manifestations, and I have in my files the signed statements of several.

Whatever it is that motivates the pitching of the various articles about the shop isn't particular what it throws. In my possession

● The experience related in the accompanying article is not to be construed as part of the official proceedings of The Scientific American Committee for the Investigation of Psychic Phenomena. Although in no way concerning the Committee as a whole or the publishers of Scientific American, we believe the episode described to be of sufficient interest to warrant publication.—*Ed.* ●

are a number of bent nails, a dozen twisted, wire paper clips, several leads and slugs from type fonts (which I have been informed do not tally in size or style with any in the Park printery), a couple of small pieces of old, brown linoleum, a U-shaped piece of wire, an agate marble, and a machine nut, measuring three-quarters of an inch square, which, if it hit anybody on the head could cause an unpleasant bruise. All these and scores of additional articles have been thrown at one time or another during the past two years by this unseen force, most of them while witnesses were present.

Recently a man, whose name must be withheld, came to see me and stated he, too, had seen these amazing incidents occur. He had heard of the peculiar phenomena that were taking place at the Clipper Printery, and had visited Mr. Park a number of times, purely out of curiosity. Never had he been in the shop that something had not been thrown. My visitor brought me a manila envelope which contained the bent nails, paper clips, bits of linoleum, and the other mementos I have described. He stated he had seen several of these things land on the floor, on the type cases, on a table, At other times he had heard them land and had turned around to find they had struck the floor behind him.

At this point in my narrative it is imperative to note that thus far in the Park case no one connected with it is or has been associated with any phase of spiritualism. No one, not even Mr. or Mrs. Park, claims to be clairvoyant, psychic, or to possess any occult or supernatural powers. (In available histories of poltergeists, this situation is not unusual.) According to witnesses with whom I have discussed this case, however, the proprietor of the Clipper Printery can, more often than not, apparently cause the phenomena to recur. The witnesses have stated that sometimes an article will be thrown, that it will fall behind a piece of heavy furniture where it cannot easily be retrieved or seen. Under such conditions Mr. Park will say: "Please, Mr. Ghost, will you do that again? We couldn't see it that time." Within a moment or so, the performance is more often than not repeated.

When my necessarily anonymous visitor walked into my office with the avowed intention of presenting the facts of the matter as he had seen them with his own eyes, he graphically described his calls at the print shop and what he had seen. He was an enthusiastic man of 30-odd years, with that typical New England faculty for keeping both feet on the ground, and of scanning new acquaintances and new experiences with customary meticulous shrewdness and carefulness; not a man to let his imagination run away with him, but quite evidently what he had seen in the little Los Angeles print shop had impressed him to the core. As the whole thing was patently of sufficient interest to warrant it, I made an appointment with Dunninger, Chairman of the Scientific American Committee for the Investigation of Psychic Phenomena.

ARRIVED at Dunninger's apartment, I introduced the two men and we took seats. Dunninger, a big fellow, well built, threw himself carelessly down on the davenport, his arms stretched out along the back in complete relaxation. My companion chose a straight backed chair, while I slouched into an easy chair by a window where

I could observe both of them, and remarked: "Well, it's your story. Tell Dunninger what you told me."

In the course of his narrative, our friend arose, approached to within five feet of Dunninger so that both were in my direct line of vision. With exceeding emphasis and with his eyes intently on Dunninger, our visitor told about the amazement he had experienced when first a paper clip had fallen on the floor behind him at the Clipper Printery. There had been no one in back of him, he said, and he had neither seen nor sensed any movement on the part of either Mr. or Mrs. Park. He paused a moment to catch his breath, and in that instant of quiet, something hit the floor behind me with a minute clicking sound. I had been watching Dunninger's expression closely to obtain his reaction to this story of mysterious happenings and I could have sworn that he had not moved a muscle—but something had hit the floor behind my chair, and it sounded for all the world like a paper clip!

I know I opened my mouth, and I glanced at our visitor. His mouth was open, too—farther than mine, I'll wager. Our surprise must have been only too evident, for Dunninger laughed and said: "Don't bother to look for it, Rathbone. You won't find it."

Now I know Dunninger fairly well. I have seen his sleight-of-hand performances, his exhibitions of the magician's art, several times, so the first things I looked at were his hands and his arms. They still were completely relaxed along the top of the davenport, one on either side of him. Then I looked at our visitor and really was alarmed, for his face was as white as chalk. He was unsteady on his feet and there was a look of utter disbelief on his face such as I have never before seen on any man.

"Why!" he exclaimed, almost breathless with astonishment, "It's followed me here! That's exactly the same thing I saw at Park's!"

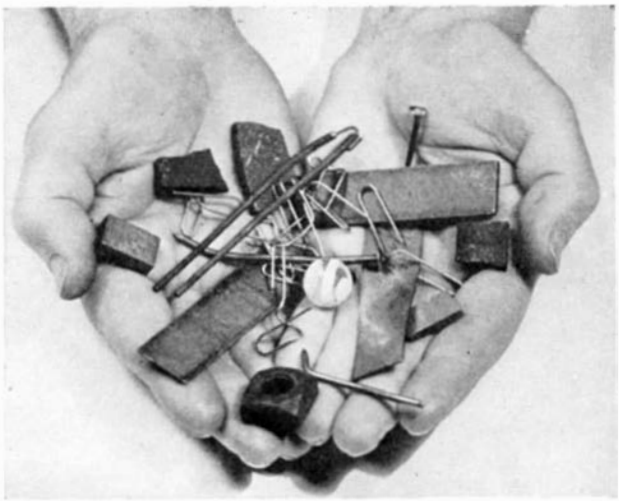
"You don't think *I* caused that, do you?" asked Dunninger.

"Why, no. You couldn't have. You didn't move. I was looking right at you."

"Did you see me move, Rathbone?" questioned the magician.

I shook my head, but I was extremely suspicious. I had seen Dunninger exhibit his digital dexterity many times.

Then an astounding thing happened. Now on my guard, I was watching Dunninger's hands most intently, and although there was no apparent motion, I saw something flash through the air and fall to the floor directly in front of our visitor. He saw it, too, and we both looked near his feet where it had landed. It was a pair of tiny tweezers.



Were these the weapons of a poltergeistic attack?

"You—you've done it!" he gasped.

"Done what?" queried Dunninger.

"Just what the ghost, or whatever, did to Mr. Park. But I didn't see you move," he added, doubt still pre-eminent in his voice.

Dunninger laughed, and, "Of course you didn't see me move. Why should you expect to observe movement? Now watch me closely. I'll do it again," and with that the small cover of a medicinal container landed on the floor between us, but again, I saw no movement of the magician's hands or fingers. It was the old story—the hand is quicker than the eye—plus a disarming and diverting personality and conversation.

But all the candor and pleasantries in the world weren't going to fetch our guest back to normal in an instant. He had visibly been too greatly affected. He had the appearance of a man who had come to tell us about a momentous incident, only to find that the incident had been duplicated at will before his eyes—and he couldn't make up his mind whether to believe that what he had previously seen had been a hoax, or that the poltergeist had followed him from California to New York. His dismay and perturbation were so pathetic that Dunninger took pity on him and explained that he had performed a sleight-of-hand trick, that there was nothing supernatural about the episode, and that there was nothing to fear.

Dunninger talked soothingly to our disturbed guest, and while he was discussing what had proved to be not a spiritistic demonstration, but merely a legerdemainic performance, the following items dropped, apparently of their own accord, and equally apparently from nowhere at all: another paper clip, a tiny nail, and a small stove-bolt nut.

During the entire time these odds and ends were dropping promiscuously in this or that part of the room, I only once saw a very slight movement of one of Dunninger's hands. It was so imperceptible that our befuddled guest missed it, but it was there and coincidentally I saw a paper clip fly through the air.

Now let me make one thing clear. I have never visited the Clipper Printery. I have not with my own eyes seen the things described to me by word of mouth and in detailed written form that are reported to have taken place in Harry Park's 15-foot-square printing establishment in Los Angeles. The evidence presented makes me believe they have happened and continue to happen, and I have no idea what causes these apparent phenomena. But I do know that when, for the first time, the performance of Park's "poltergeist" was described to Dunninger, he duplicated the exhibition to such perfection as to all but knock a hard-headed Yankee off his feet. And I can take oath that only once—just for a tiny instant—during his entire demonstration did I see his fingers or his hands move from their relaxed position on the back of the davenport. How it was done, I do not know—and magicians are not generally noted for being loquacious concerning the modus operandi which they employ. Confidentially, it was beyond my powers of observation—but then, perhaps Dunninger, too, is obsessed with a poltergeist!

93,000,000 Miles

After a Decade of Laborious Calculations, the Sun's Distance is Slightly Corrected

HENRY NORRIS RUSSELL, Ph.D.
Chairman of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of Carnegie Institution of Washington

THERE is an old saying that we do not understand a thing well until we can measure it. This obviously does not apply to everything —for example, the intensity of a toothache—nor would it be fair to claim that we understood something twice as well because we had learned to measure it with half the previous uncertainty. Precise measurement has led to many wholly unexpected discoveries—from that of Neptune to that of argon. But the chance of such good fortune is not the motive of the investigators who are still seeking to make our measures more accurate. Like true devotees of science, they do it for fun—they toil for months or even years in devising and applying methods of precision — as others rejoice in finding a new and more direct route to climb some beetling mountain peak. This challenge is peculiarly tempting when there is a weak link in a chain of related measurements. For example, the shapes of the orbits of the planets, their relative sizes, and the laws of motion of the planets along their orbits, can be determined with great precision.

In terms of the Earth's mean distance from the Sun—the "astronomical unit"—the dimensions of its orbit, and of those of the inner planets, can be found with an accuracy of about one part in a million, and comparable accuracy can be reached for Uranus, Neptune, and Pluto, when they have been observed over a sufficient number of revolutions.

We have specifications for a map of the solar system, incomparably more accurate than any drawing could possibly be made. But this map has no scale of miles.

To put one on it, we must first find the dimension of the Earth in miles—which has been done, by the combination of accurate surveys of large parts of its surface, with a precision of one part in 50,000. It will then suffice to find the distance of any planet at any time, in terms of the Earth's radius; for the relation of this distance to the astronomical unit can be calculated with great accuracy.

In principle, we have only to sight on the planet from two widely separated points on the Earth at the same time, and the intersection of the two lines of sight locates it. No single pair of observations can give a precise result, for the planet's distance is always thousands of times the Earth's diameter, and a very small error in determining the convergence of the two lines of sight will produce a serious one in the calculated distance.

BUT if we have found, in this way or any other, an approximate value, we may proceed to derive a very much more accurate one, by combining all the available observations — perhaps hundreds of them, made at many observatories.

If the planet's orbit is well known, the direction can be calculated in which the planet would appear at any given time as seen from the center of the Earth—or, more realistically, by an observer on the surface in line with the center and the planet. At this moment, observers elsewhere on the Earth will see the planet in different directions. This shift from the geocentric position—the parallax—is different for each observer, and changes as each one is carried around by the Earth's rotation. But its amount and direction can be calculated, for any place and time, by simple geometry, except for a scale factor to which it is proportional. This factor represents the radius of the Earth, in seconds of arc, as seen by an observer at the standard distance of one astronomical unit (or on the Sun at its average distance), and is called the solar parallax.

With our approximate value of this, we can calculate where the planet should have appeared among the stars each time it was observed. If our approximate values happened to be exactly right, if the elements used in calculating the planet's motion were entirely correct, and the observations free from error, these calculated positions would all agree perfectly with the observations. Of course, this will not happen in our imperfect world — there will be small outstanding discordances, or "residuals" for each observation — representing the combined effects of errors in the adopted values of the solar parallax, of the elements of the orbit, and of each individual observation.

TO separate these influences might seem hopeless; but if we have observations enough, made according to a properly planned program, it can be done. A correction to the assumed value of the solar parallax will affect each observation by an accurately calculable multiple of its own amount. The same is true for corrections to the orbital elements. From each observation we thus get an equation connecting the values of these corrections with the residual. All told, we may have hundreds of such equations, from which to find the values of half-a-dozen corrections. We cannot satisfy the equations exactly, for the errors of observation are still in them. But we can find a set of values of the corrections such that the outstanding residuals, after they have been applied, are as small as possible. Some of these residuals will be positive and some negative; so the rule is to take their squares, which are of course all positive, and reduce the sum of these to a minimum. When the algebra is carried through, it turns out that this "method of least squares" gives a definite answer to the complicated problem. If we know that some sets of observations are more accurate than others, this can be, and is, allowed for in making the solution.

The reader may have suspected that this process is laborious. It most certainly is; but it gives us results which represent the observations as well as can be done. These results will not be perfectly accurate; the errors in the obser-

vations will creep into them and produce small errors in the final values. These may make our calculated results too large or too small. We do not know which; but we can estimate the chance that this unavoidable error lies within certain limits.

From the final residuals we can find the "mean-square" discordance of an observation, and from this we can calculate the "probable error" of our final value of the parallax—that is, a quantity such that it is an even chance that the actual error is greater. The probability of large errors falls off rapidly. There is about one chance in six that an error is more than twice, and only one in 23 that it is three times, the probable error.

We can thus get a good idea of the trustworthiness of our results, provided that our observations have not been infested with the worst enemies of precise measurement—systematic errors. These are errors which repeat themselves every time that observations are made in the same way. The errors that may arise from sources which are understood—such as refraction—are of course carefully allowed for in working up the observations, or the program itself may be designed so that they are avoided or averaged out. Errors of unknown origin can be detected only by comparison with observations made with other instruments or by other methods. Some, but not all of them, can thus be detected and cleared out during the progress of a major piece of work.

So far, nothing has been said about the main question—which planet to observe. The asteroids, which appear on photographs as sharp, star-like images, are far preferable to the larger planets. Among these, the best to observe are obviously those which come nearest the Earth, and at times have large parallaxes. As soon as Eros was discovered in 1898, it was realized that it surpassed all other planets for this purpose. Its orbit, at perihelion, passes within 14,000,000 miles of the Earth's. It is very rarely that the two planets happen to come to the proper point at the same time. In 1901 they approached within a little less than 30,000,000 miles of one another, and extensive series of observations for parallax were made at many observatories. No better opportunity occurred till the winter of 1930-31, when Eros came within 16,200,000 miles of the Earth. No equally favorable approach will occur for a long time to come, and the planet was extensively observed.

In recent years, two or three tiny asteroids have been discovered which, at times, can come much nearer to the Earth than Eros ever does; but it is doubtful whether they will be more valuable for the determination of the solar parallax. To begin with, these very near approaches depend upon an even closer coincidence of the time of passage of the Earth and the planet through the right points on their orbits, so that they will be very rare. Just because the approach is so close, the planet stays near the Earth for only a few days, while Eros can be followed for months. Finally, the smaller bodies are so faint that, even when close, they can be photographed only with powerful instruments, while Eros, under such circumstances, is of about the same apparent magnitude as the stars which are used as reference points on the photographs, and good images can be obtained with short exposures.

The general discussion of the observations of Eros in 1931 was placed by general agreement in the hands of Dr. H. Spencer Jones—Astronomer Royal at Greenwich—who had proved his skill, thoroughness, and good judgment in handling masses of observations in several important investigations. The first announcement of the results was made to the Royal Astronomical Society last June — ten years after the observations were completed. For this apparently long delay, the War has at most a minor responsibility. The main reason is the great extent and laboriousness of the calculations. Part of this may be understood from the summary account given above; but this says nothing about the most time-consuming part of the work—the detailed reduction of every plate, or of each visual observation. Before this could be done, the positions of the reference stars had to be known. A long list had been carefully observed with meridian circles at various observatories, but to supplement it the places of nearly 6000 fainter stars were measured photographically—as a part of the work which was merely preliminary to the main investigation!

Other lengthy calculations were made to find the systematic errors peculiar to different instruments, the corrections due to peculiar conditions on individual nights, and the relative accuracy of the different series of observations. It was finally found possible to combine the observations with 16 different instruments into a single consistent mean value. For the solar parallax, this came out 8″.7900 ± 0″.0013. As appears from the probable error, the last figure is not significant—it is given to avoid error due to neglected decimals in the use of this value in future work. But it appears to be ten to one that the actual parallax is somewhere between the figures 8″.793 and 8″.787.

The results obtained from different methods of observation (visual and photographic), from right ascensions and declinations separately, and from observations with different instruments and at different places, are remarkably accordant — the extreme outside range given by them being from 8″.788 to 8″.791.

The finally adopted value corresponds to a mean distance of the Sun of 93,010,000 miles, with a probable error of 15,000 miles. The round number 93 million miles may be adopted for all purposes. This makes the Sun's diameter 865,400 miles, and its mass 333,400 times that of the Earth.

These values of the distance and diameter are greater by 0.15 percent than those which have previously been adopted, as the new value of the parallax is less in the same proportion. The new value of the mass is 0.45 percent greater, as it involves the cube of the parallax.

This change is rather larger than would have been expected. But the new set of observations, judged by the agreement of the different instruments, and so on, should be many times more accurate than the old, and there is every reason why it should be generally adopted. It seems probable that the older value, which depended largely upon the observations of Eros under less favorable conditions in 1901, was affected by some small, and effectively concealed, systematic error. But more work, as is usually the case, will be necessary before this question can be finally settled.—*Princeton University Observatory, October 2, 1941.*

Insulating "Blackout" Plants

Windowless Bomber Factories Will Contain More Glass Than "Daylight" Structures

H. T. RUTLEDGE

A NEW type of shatter-proof, non-combustible side wall and roof construction, combining three types of glass fiber with prefabricated steel panels, is being used to insure insulation and acoustical control for working efficiency in the twin 4000-foot-long Army bomber assembly plants being erected at Fort Worth, Texas, and Tulsa, Oklahoma.

Engineers of The Austin Company, who designed both plants, evolved the ingenious combination which utilizes products developed by Truscon Steel Company and Owens-Corning Fiberglas Corporation in a new approach to the task of insulating vast factory areas for economical year-'round air-conditioning. The plants are so large, however, that, even with this efficient type of construction, each requires 7000 tons of refrigeration—enough to operate more than a quarter million large household refrigerators—to insure year-'round working comfort and production efficiency in the two plants, where a total of 30,000 men soon will be assembling four-engined bombers on moving assembly lines.

With a total of 406 carloads of fiberglas required for these jobs—203 carloads for each plant—the buildings will probably contain more glass in their windowless steel side walls and roofs than the largest daylight factories ever built. Alternate layers of fiberglas and special vapor-seal paper, held together with asphalt, are being combined with steel channels, roofing sections, and metal lath to give the walls and roofs of all buildings maximum strength and the highest obtainable acoustical, insulating, and light-reflecting qualities.

Both plants are being built for the War Department under direction of the United States Corps of Engineers, who have a staff of 30 engineers and 238 inspectors, auditors, and clerks on the job at Fort Worth. The Austin Company has its own staff of 102 engineers and 20 clerks at work on plans, specifications, and the detailing of mechanical equipment and production layouts for the two plants in a downtown office building there, where Consolidated Aircraft Company, which will operate the Fort Worth plant, has its own consulting engineer. They all work seven days and three evenings a week, or a total of 65 hours.

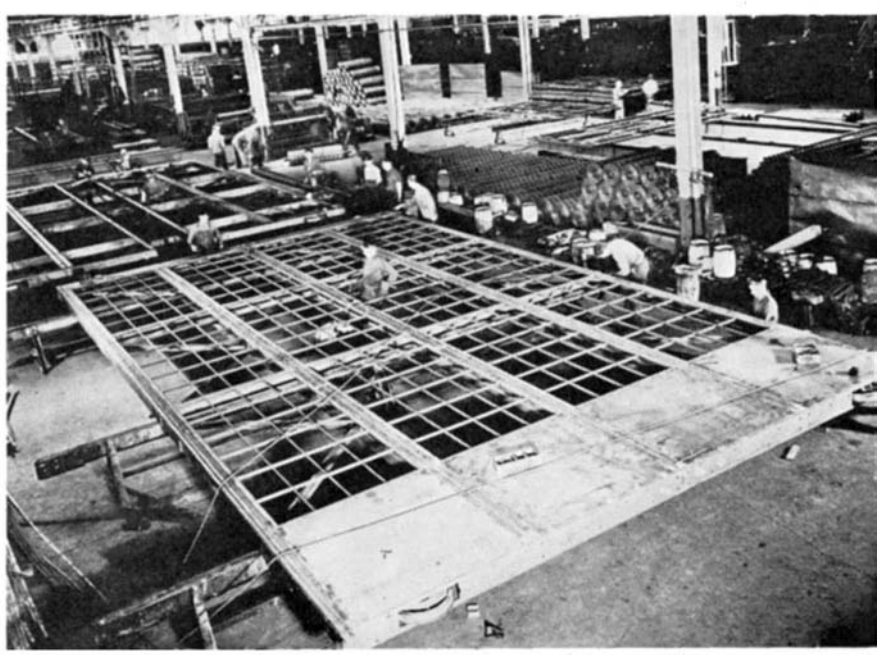
ANOTHER group of 147 engineers, superintendents, auditors, purchasing agents, and clerks are located in field offices on the 1450-acre bomber plant site overlooking Lake Worth, where 3500 construction workers are building the plant on a two-shift schedule that runs from 5 A.M. to midnight, seven days a week. This crew will soon reach 6000.

Manhattan - Long Construction Company, general contractors for the Tulsa plant, which will be operated by Douglas Aircraft Company, is using nearly a million dollars' worth of construction equipment, ranging from huge graders, trucks, cement mixers, hoists, and erecting cranes to wheelbarrows and small hand tools on the work at Tulsa. There is about the same amount on the ground at Fort Worth.

The 27,000 tons of structural steel required for each plant was more than any single steel mill or fabricating shop could deliver in the limited time allowed. The Bethlehem Steel Corporation has been able to meet the required schedule on steel for Fort Worth, however, by distributing this work among seven of its plants at different locations. Several companies have co-operated in production of the steel for Tulsa, which is being fabricated under a contract with the Midland Structural Steel Company of Chicago, in 17 shops throughout the Mississippi Valley and the Southwest.

Because all of the 171 200-foot trusses required for the main aisle of each plant are 25 feet deep and an equal number of 120-foot trusses for the side aisle are 16 feet deep—all too high for shipment of any completed segments by rail—they are being assembled entirely on the site. While these spans weigh 40 tons and 25 tons respectively and can be assembled on the ground and raised into place in one piece, 115-ton jack trusses of 200-foot span are being assembled in place with the aid of heavy false-work.

Only one 200-foot hangar door opening has been provided in each

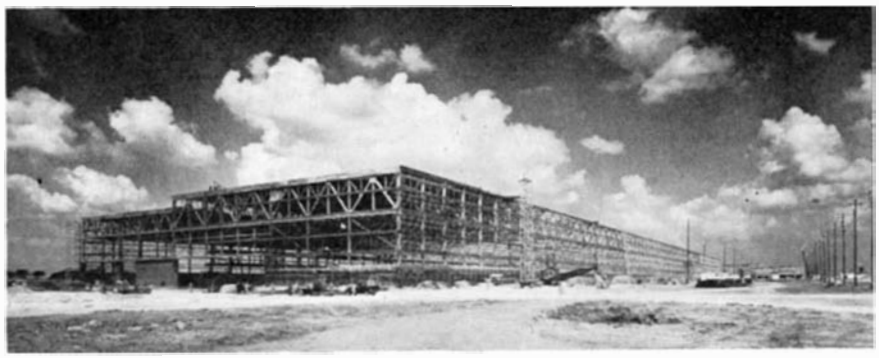


Assembling a leaf of a vertical-lift door of the type to be used in the twin bomber plants described. These units will be insulated, weatherproofed

plant, that being at the end of the assembly line. These doors, and eight 200-foot doors in the nearby hangar building, will be of the Truscon vertical lift type, installed in 100-foot-wide units to operate independently of each other. Four 150-foot single-unit doors of the same type will be used in the paint shop. All will be 40 feet high and insulated in a manner comparable with the side walls, with weather-proofing at jambs in keeping with the requirements of air-conditioned buildings.

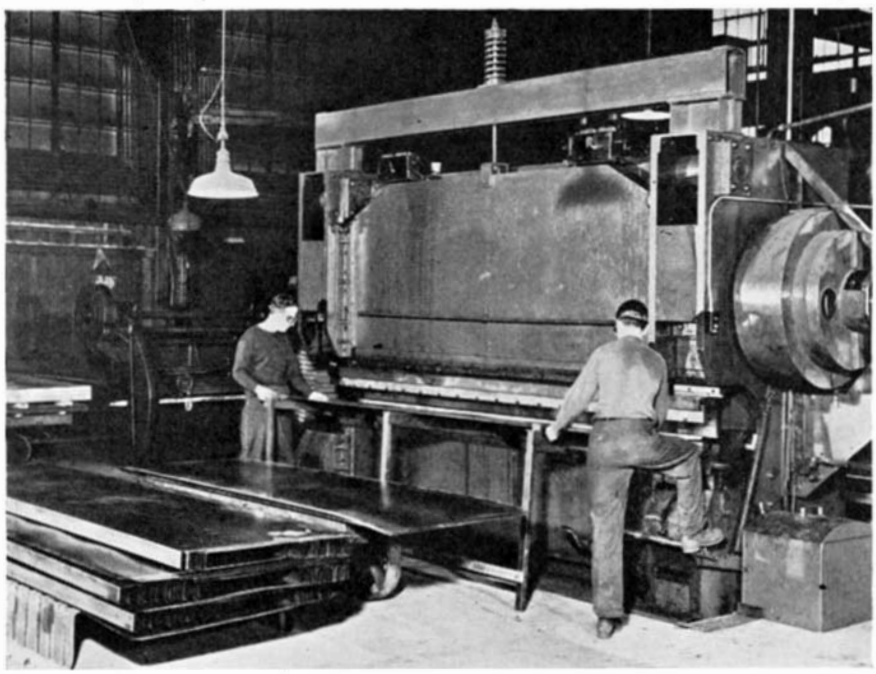
The assembly buildings and a majority of the auxiliary structures at each plant have an overall height of 65 feet. A 13-inch curtain wall of face brick and acoustic block, which is being specially reinforced with trussed rods to make it shatter-proof, rises to a height of 12 feet around the base of all buildings. The special insulated metal wall extends from that point to the roof. Fiberglas insulation board continues right down to the base of all walls through the masonry in order to insure absolute control of moisture condensation. Even the bolts used to anchor the upper walls are being insulated to prevent any continuous steel contact between exterior and interior.

The roof and wall construction will be uniform in all buildings at each site, including a two-story office building, a maintenance shop, and boiler house, all of which adjoin the 4000-foot-long assembly building, and a paint shop, hangar, and cafeteria buildings, which are separate structures.



Bomber assembly plant at Fort Worth under construction, with 11,000 tons of the ultimate 27,000 tons of structural-steel framework in place

BY BLANKETING the interior walls of each structure with white fiberglas, the engineers have not only provided for insulation and absorption of between 60 and 75 percent of all factory and office noises, but have also obtained a light-reflecting surface which will maintain brightness at a high level. Each assembly building will have 17,000 two-tube 200-watt fluorescent units recently developed by General Electric Company for high bays, to provide at least 35 foot-candles at the working plane in continuous service. A white cement floor will enhance the general lighting efficiency by reflecting light up to the underside of parts and planes on the assembly lines.



This machine is forming steel channel sections for the walls of the bomber plants, the channels to be filled with four inches of glass wool. Interior wall surfaces will be faced with white dust-resisting fiberglas

Each plant has been designed with two mezzanine levels alongside the assembly line, for storage of various parts and sub-assemblies convenient to the particular assembly station where they will be needed. These mezzanines are suspended from the 120-foot trusses spanning a secondary aisle beside the 200-foot-wide assembly aisle, and are supported on one side by the center columns.

It was necessary to provide some passage for monorails from aisle to aisle at intervals along the assembly line, and this need has been met by limiting the length of mezzanines to 450 feet so that there are seven 50-foot transfer aisles available for monorail crane connections. This has resulted in the creation of eight separate mezzanines at each level, 30 feet by 450 feet, and these are served by eight rotary lift hydraulic elevators large enough to handle all but the heaviest parts and bulkiest sub-assemblies, as they are received by truck or rail from automotive factories, engine manufacturers, or other plants participating in the bomber-building program.

With food wagons and first-aid stations, tool cribs, washrooms, and toilets all located directly below the mezzanines or on them, nothing will obstruct the free operation of the interconnecting monorail systems which will serve the entire area of each assembly building. They will be capable of carrying a fully assembled four-engine bomber the entire length of the 4000-foot assembly aisle where 40-foot clearance has been maintained, or transferring other overhead loads up to 20 tons between any two points in the 1,294,000-square-foot building area.

Bombers will progress through the final stages of assembly on parallel conveyors extending nearly 2000 feet through the buildings.

Just What is Insanity?

Essentially it is Simply a Lack of Proper Adjustment to Environment and Society

L. J. PANKOW, M.D., B.M., B.S.

INSANITY has been defined as a prolonged departure from the individual's normal reactions of living, thinking, and acting, and has also been called the result of a failure of adjustment of the individual to his environment. The environment is the situation in which the patient is found, which obviously differs with times and places. How the individual meets various demands and adjusts, or fails to adjust to them, determines what is called his sanity or insanity. This adjustment is a gradual affair from infancy to old age, the young child having few adjustment problems and the mature person having many.

The unborn child has no conscious wants. The instant he is born, however, he begins to have to do some things for himself, instinctively starting to breathe and nurse. But still, the problems are very minor, and very little adjustment is demanded. As the child grows older, he must ask for a drink of water when he feels something that experience has taught him is thirst, or for food when he feels something that experience tells him is hunger. The mind at this time works in a thirsty-drink and a hungry-eat manner. Still later, the individual finds that the idea changes to a hunger-work-money-purchase-prepare-eat idea. It is the matter of how well the individual responds and adjusts to these desire-effort-satisfaction demands of society that determines his normalcy.

There are certain desires that cannot be gratified, and it is the reaction of the individual to the thwarted desire that determines the normalcy of the individual. In any person the reaction to a thwarted desire will be one of three things: He will forget it entirely; substitute something else for that desire; or enter into a little world of his own, becoming obsessed with the idea that he *has* satisfied that desire. Adjustment, either by ignoring or forgetting, or by a substitute desire, is normalcy; and inability to adjust to the disappointment of one's environment, the abnormal or insane. Practically every case of insanity will be found to have some basis of similarity to this formula. Whether it be due to injury, toxin, drug, disease, degeneration or congenital weakness, it is an inability to cope with the environmental situation that constitutes insanity.

EVERYONE suffers disappointments and experiences thwarted desires. What elements, then, determine whether one shall be able to cope with these disappointments satisfactorily, or develop an insanity? Two elements enter into this determination; the predisposing and the exciting factors. Predisposing factors are chiefly heredity and such elements as the different epochs of life, such as puberty, marriage, involution, and senility. One might compare a person to a piece of wood to be carved by a whittler's knife. Some woods are naturally soft and respond well to carving. Others are normally hard to carve, but when softened by some process, lend themselves well to carving. Heredity determines what type of wood the individual is, and the physiological epochs of life may constitute a softening treatment that renders the hard wood more easy prey upon which the exciting causes work.

The actual exciting causes for insanity may be either physical or mental insults to the system. Physical insults are such things as toxins or poisons, which may arise from within the body or from ingested drugs or poisons. Other physical insults include injuries and diseases. Mental insults are such things as sudden severe problems. Heredity does not, in itself, have as great an influence on the production of an insanity in a given individual as might be supposed, nor as great as has been formerly believed. True, an heredity well sprinkled with insanity is more apt to produce an individual who is more easily unbalanced in an attempted adjustment to life and the environment, but this is not necessarily so. It is enough to say that certain hereditary characteristics and predisposing weaknesses may make the individual sufficiently impressionable so that social and environmental adjustments are too hard to make, and insanity results. Also, unless there *are* some predisposing weaknesses of the mentality due to heredity or some other weakness, few of the exciting causes alone are sufficiently strong or damaging to produce an insanity.

All symptoms of insanity are due to a derangement of the normal psychic or thinking reflex action. A reflex is the reception of a stimulus, the handling of that stimulus in the central nervous system, and resultant action. A reflex action may be either mental or physical. A simple physical reflex action is the knee jerk. A mental reflex is similar except that the stimulation, whatever it be, is carried up to a higher level of the nervous system, the consciousness, where the mental reaction results in a definite thought or action. Normally, this thought or action will always be the same in the same individual from the same stimulation. It is other accompanying stimulations that enter with it that appear to give varied reactions. When, however, a derangement of the mental faculties exists, odd mental reactions develop from these stimulations. Such disordered thought-actions and thought-reactions produce symptoms of insanity.

DISORDERS of perception mean there is some fault in the *reception* of a stimulus. These constitute the various types of illusions and hallucinations. An illusion is an improper interpretation of an actually seen object. An hallucination is the reception of a stimulus that never occurred. For the pur-

Originally published in *The Journal-Lancet*, Minneapolis, Minnesota, under the title, "What the General Practitioner Should Know about Insanity." The author, with a medical degree from the University of Minnesota, is a Sioux Falls, South Dakota, general practitioner who served on his county insanity board for 15 years, and the article is based on his studies and experiences during that time.

pose of this discussion, illusions will be separated from hallucinations only from a point of academic interest, and hereafter both phenomena will be considered as hallucinations. Hallucinations are of different forms, referable to and classified by their origin from one of the senses. Thus, auditory hallucinations are voices or sounds heard by the patient when, in fact, no sounds were actually made. Visual hallucinations consist of seeing things that did not exist in fact. Hallucinations of smell, taste, and feeling give rise to their respective false beliefs of the patient.

The dream states border very nearly on true hallucinations in that one imagines seeing, hearing, and perceiving things that do not exist. Clouding of the consciousness is also a form of hallucination, because, whether it be a mild clouding or a deep coma, the condition is an improper perception of the environment. Also in this class of improper perception is disorientation, whether it be disorientation of person, disorientation of time, or spatial disorientation. Hallucinations in general are the appearance to the individual of something which he has successfully repressed or covered up prior to a weakening of his consciousness. They may represent sexual desires, or the covering up of an inferiority by clothing himself in power. They may be either pleasant or unpleasant, and their true meaning is found only in psychoanalysis. The psychopathic dream states, disorientations, and cloudings of consciousness, are all very probably mild hallucinations, and probably represent the exclusion of or getting away from some unpleasant or intolerable situation or circumstance.

HALLUCINATIONS are disorders of ideas due to a faulty perception. There are other disorders of the content of thought due to stimulation, arising from within the mind itself. These are such things as delusions, fixed ideas, obsessions, and the like. False beliefs need not necessarily be delusions, but perfectly normal deductions from false bases. Examples of false beliefs which are not hallucinations are such things as believing it to be a Monday because the washing is seen on the line. So, again, the difference between a false idea and a true delusion is that there are supporting facts to prove the false idea, while a delusion needs no supporting facts whatever. A delusion may be fixed or changeable, systematized or unsystematized. A fixed delusion is one that the patient adheres to constantly, while the changeable delusion is rapidly and quickly replaced by others. A systematized delusion is one in which the individual believes something false, not supported by any facts, and as a result of which he acts, coloring his life by his delusion. Delusions, too, are frequently defense reactions to avoid unpleasantness. Fixed ideas and obsessions are mild delusions, and may be found in otherwise perfectly normal persons, as well as in the insane. A fixed idea is one firmly planted on the consciousness, which may or may not be entirely erroneous. The thing that makes it a fixed idea is the fact that the person governs his life by the idea.

An obsession is frequently accepted as and known to be false, and yet the subject is unable to act uninfluenced by his obsession. With an obsession, a person cannot rest until he has yielded to it, after which time he is comfortable and satisfied. Phobias are forms of obsessions that are pathological. Common ones are the fears, or phobias, of being in a narrow closed place, being in crowds, being alone, and so on. In themselves, the phobias are not very important symptoms, but when associated with others, they may indicate a failure of adjustment.

THESE disorders of perception, called various forms of hallucinations, and the disorders of thought content, called delusions, are single thought disorders. They may start a chain or train of thought, it is true, but in themselves, they are really single, individual, and more or less isolated thought entities. They may color the train of thoughts, but in themselves do not alter the *course* of thinking. Normal thinking progresses in a direct line to a definite goal. Even a person suffering from hallucinations and delusions may have a normal *process* of thinking. Normal thought, then, progresses toward a definite goal and all other thoughts and ideas fall into a proper position until the goal is attained. One disorder of the train of thought is called flight of ideas. In flight of ideas, there is no goal at all, or, if there ever was one, the train never arrives. The ideas are connected phonetically, or in the mind of the patient. Some sound of a word used in a statement he makes will remind him of another thing, and he jumps to a statement about that. The disconnected thought is as apt to be used as the connected. It is due to the extreme distractibility of the patient that this is so. Frequently an idea from outside the mind of the patient may distract him.

Circumstantiality appears similar to flight of ideas, but differs in the very important detail that the patient will eventually arrive at his goal. There is a definite relationship between the thoughts stated, but the patient is unable to differentiate between the important primary ideas and the secondary ideas, and so includes them all.

RETARDATION of the train of thought, or difficulty of thinking, is a limitation of the patient's stock of ideas. He will, if given enough time and encouragement, eventually arrive at the goal. More severe retardation is a complete paralysis of thinking, a total loss of all thought. If there be any response to a question or command at all, it may be nothing more than a repetition of the words just spoken to him.

These phenomena usually have a meaning. In the flight of ideas and the circumstantiality, the patient has some idea which he wants to hide. In the retardation and paralysis, the defense mechanism has failed, and the subject retreats into slowness or silence.

Disorders of feeling are also disorders of the thought content, but of those special thoughts called emotions. Exaltation is a feeling of elation not warranted by the environment. Depression is an unwarranted unhappiness, dejection, or melancholia. There may be a total loss or severe impairment of emotional feeling. Severe emotional impairment is usually found only in greatly deteriorated minds. Morbid anger, also an emotional instability, is found especially in the feeble-minded or mental defectives with mental deterioration. This condition is an insanity or psychosis superimposed on a feeble-mindedness. These patients frequently go about looking for something to get angry about. When encountered in one of the less feeble-minded, it becomes a very dangerous condition, for the patient is capable of some sustained

thought and can lay plans for revenge. The excessive emotional expression is usually a matter of the person getting into the emotional state that his various hallucinations and delusions may have placed him, or where he feels he deserved to be. Absence of the emotions usually denotes that the patient is living in his imagination entirely, where he is apart from everything else, and enjoying himself with no help from the world at all.

Amnesias or memory losses, which are severe forms of ordinary forgetfulness from which we all suffer to some extent, may be due to some toxic or traumatic injury to the brain structure itself. In such cases they are hardly symptoms of insanity. When not due to some insult to the brain tissue, however, they are usually an expression on the part of the person to forget some unpleasant experience. Paramnesias, or remembering things that never happened, are just the opposite of forgetting. They are expressions of the same sort, the wish to remember something that they wish had happened.

Rather peculiar to one form of insanity, the paranoid state, is the disturbance of personality. The symptom is usually due to a system of delusions becoming so complex and organized as to demand a change or transformation of the personality to fit the environment. This may result in the patient's believing that he is some figure of history. Or he may cease in his own belief to have any person at all. Occasionally, when more than one set of well systematized delusions occurs, several personalities are found in one person, and the one active at a given time will depend on which set of delusions is at the height at that particular time. There is usually a complete amnesia between the different personalities, no one remembering any of the acts or characteristics of the others. These are cases of dual or multiple personalities.

One more set of symptoms is rather important in that it refers to the effect of some of these mental symptoms on the motor volitional system. These are referred to as disorders of action. Usually a mental excitement results in physical activity increase, and mental depression results in decreased physical activity. These may be reversed. Other disorders of action are the impulsions and compulsions. An impulsion is the uncontrollable desire to perform an act. Common examples are pyromaniacs, kleptomaniacs, and dipsomaniacs. A compulsion is an urge to do something which the patient does not want to do, and frequently the act is very disgusting and abhorrent to him. In refusing to act when the compulsion develops, the patient suffers acutely.

IN A *subsequent article the author will deal specifically with the pure psychoses (paranoia, dementia praecox, or schizophrenia, and manic-depressive insanity); also with the injury- or disease-caused insanities (paresis, the senile dementias, toxic insanities).*

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VITALLIUM

Plates Used to Repair Skull Defects

MANY a soldier came home from the last World War with a metal plate in his head where a piece of skull had been shot away or so crushed that it had to be removed. Soldiers and civilians similarly injured in the present war will have their skull defects repaired with vitallium plates, it appears from a report by Dr. Fred W. Geib, of Rochester, New York, in the *Journal of the American Medical Association.*

Vitallium, an alloy of chromium, nickel, and cobalt, at first proposed for dental use, "makes the strongest and least complicated plastic repair of the skull known," Dr. Geib states in a *Science Service* report. "It is rigid, stronger than bone, non-corrosive and inexpensive and requires a much less complicated cranioplastic operation than any in use at the present time. The patient can be back at work on heavy duty within three weeks after the operation."

Dr. Geib's patients were not wounded soldiers; they were civilians, one of whom had osteomyelitis of the skull following industrial injury. The other two had brain hemorrhages which caused such pressure that pieces of skull had to be removed to save their lives. Grafts of bone from the patient's ribs and cartilage have recently been used to replace the missing skull piece in such cases.

The vitallium plate which Dr. Geib recommends is cast according to a pattern of the defect in the patient's skull. Slots are cut into it from the outer edge, so that it can be bent to fit the skull. Lugs extend over the edges of the skull, and the plate is screwed into the skull through holes in these lugs. The operation of inserting the plate and fastening it to the skull takes about one hour.

The soft tissues beneath the skull grow up around the vitallium plate and through the slots in it, completely incorporating it in a soft, gelatin-like covering. No harmful conditions in either skull, plate, or tissues under it have been found in any of the patients, the first of whom has now had his plate in place for two years. After the death of one of the patients from another condition, his skull was carefully examined and the findings showed how the tissue had incorporated the vitallium plate and was holding it firmly in position as if it were part of the tissue. Vitallium has been used within the last three years in other types of bone surgery by two other groups of surgeons.

BURNS

Announcement of New Treatment With Sulfadiazine

SPRAYING sulfadiazine, one of the new miracle sulfa drugs, directly on burns is being hailed as the most effective method of treating burns yet devised. At the Johns Hopkins Hospital, in Baltimore, 114 badly burned patients were swiftly healed by the new method announced by Dr. Kenneth L. Pickrell, of the hospital's surgical department, says *Science Service.*

Burned areas "healed more rapidly than with any form of treatment previously used at the Johns Hopkins Hospital," surgeons on the hospital staff declare. Some of them believe the sulfadiazine method will revolutionize the treatment of burns, eliminating the need for skin grafting and plastic surgery to efface scars and correct deformities.

No preliminary washing or cleaning of burned areas is needed. The nurse starts spraying the sulfadiazine while the surgeon is scrubbing his hands in preparation for removal of blisters and loose tissue. The sulfadiazine allays a great deal of the patient's pain and a narcotic may not be needed.

How to Make a Mastodon

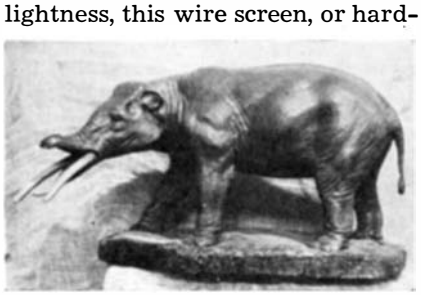
Students of Paleontology Reconstruct a Model of Amebelodon from Fossils

C. STUART JOHNSTON
Department of Paleontology, West Texas College

FOSSILS of an ancient, long-jawed mastodon named Amebelodon, that lived in Texas in the Pliocene Epoch of the geologist's Tertiary Period, have been used at the West Texas College as the basis of a life-size restoration of this little-known member of the large and widely variant mastodon family. The amebelodon was not so large as its more familiar relative of comparatively recent geological time. It had at the end of its lower jaw a pair of tusks prolonged and in near contact at the outer ends so that, together, they constituted a long, narrow scoop, prod, or "crowbar" for uprooting and digging out the plants on which it fed.

The first step in the restoration of this mammal, which lived about 5,000,000 years ago, was the modeling of a small figure seven inches in height. The fossil limb bones of the actual animal then were placed in position on the laboratory floor and full-size sketches were made of both the side and top views. From here on the actual fossils were not needed.

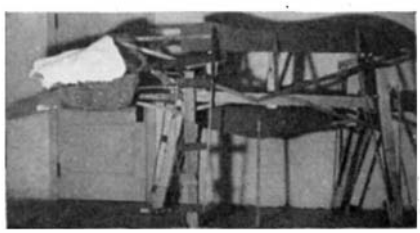
The sketches thus made served as a guide in constructing the framework. This was made as rigid as possible, with strong rollers at the end of each leg. The legs were constructed on two-by-four scantlings. The general surface of the animal was built of wire screen placed on the framework, stayed and made rigid by ordinary wooden laths. In order to obtain lightness, this wire screen, or hardware cloth, was placed as near the final surface as possible.



First a seven-inch model of the extinct mammal was made

After covering the framework with the screen, to approximately the general contours of the original animal, the structure was then covered again with a layer of burlap dipped in molding plaster. This served as a base upon which the final modeling could be done.

When this burlap base was finished and dry, it was sized with a thin solution of flake glue (colored, so that in putting it on it would be easy to note which parts had been thus sized, and which had not). In addition to sizing the plaster, the glue acted as a binder to the final layer which was to be placed upon it.



Next, a life-sized framework of common lumber was set up

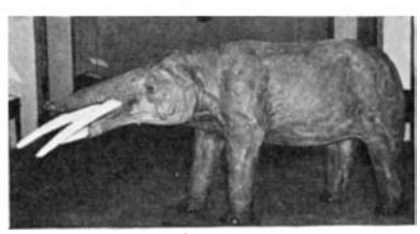
Framework covered with screen, ready for burlap and plaster

This final layer, into which the skin texture and surface detail were to be worked, was made of papier mâché, a strong, hard, yet very light, material. This was prepared by making a pulp of newspapers. This pulp was then mixed as needed with molding plaster, yellow dextrin, and glue. The mixture was prepared with equal parts of molding plaster and paper pulp, to which was added about one fifteenth by volume of yellow dextrin. To a gallon of this mixture a teaspoonful of glue was added to retard setting. By increasing the percentage of dextrin and plaster a harder material may be produced. A mixture such as this sets slowly, giving ample time for working in and modeling the details.

After the papier mâche was placed on in the desired position, it was covered with finely woven cheese cloth. This served the double purpose of helping to give skin texture, and at the same time hold the papier mâché in position until it had time to set. It is also much easier to model the papier mâché with the cheese cloth covering than without it—wrinkles are easily worked into the material, thus giving a life-like appearance.

Burlapped and plastered and ready for final papier mâché

Glass eyes about an inch in diameter, such as those used in commercial taxidermy for mounting antelope heads, were set in place. Heavy, black eyelashes were made from the bristles of a dust brush.



Papier mâché applied and skin modeled in it. All finished

Finally, the completely modeled animal was given a coat of flat gray paint, applied with a brush, so that high lights and shadows might be worked in where desired.

This animal was typical of the western plains about 5,000,000 years ago and is thought to have inhabited the forested region along the streams and water courses. The size of the ears and the length of the trunk are, of course, problematical, but otherwise the proportions are believed to be scientifically accurate.

EDITOR'S NOTE: Amebelodon, discussed above, was a mastodon, as stated, but was not *the* mastodon. What we commonly know as *the* mastodon was, however, only one of a whole family of mastodonts (correct plural spelling), and

its claim to fame as *the* mastodon rests merely on the circumstance that this rather recent animal, *Mastodon americanus,* is the one so often dug up from our swamps. Yet there were numerous other members of the family, each different, at different times in relatively recent earth history—say, the past 10,000,000 years—also different contemporary races at each time. The amebelodon was one of these, neither recent, like *the* mastodon, nor very early; it stood roughly midway in time. For illustrative comparison with motor car models: If the familiar mastodon was a recent model of about 1939, though no longer manufactured, then the amebelodon might have been one of the models of about 1915. The model did not long survive—maybe no more than a million years or so. It either wasn't altogether satisfactory on the road, or the conditions changed, causing better engineered models to forge ahead.

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"CRAZY DRIVERS"

May Actually Be Insane

THE "crazy driver" who whizzes by you at 70 miles an hour may be insane — literally. Probably the most vicious group of dangerous drivers on the highways are the mentally ill, according to Dr. Lowell S. Selling of the Psycopathic Clinic of Detroit's Recorder's Court, reports *Science Service.*

"Even in cities where there are a number of highly developed psychiatric and mental hygiene clinics," he said, "there are individuals who are suffering from mental diseases. Some of them have never been sent to a doctor and in many cases their own families do not know that they are insane. The average layman does not recognize symptoms of insanity unless the patient's behavior is extremely bizarre."

Some of the mentally ill have grandiose ideas. They think they are more important than other people and that they can pay for any amount of damage they might do to life or property with their cars. Some are nervous, unstable, and excitable so that in an emergency they do the wrong thing.

Sufferers from the mental disease dementia praecox, or schizophrenia, are likely to include the type of person with violent suspicions and false ideas that he is being persecuted by the police or mysterious organized groups. Such a person may interpret a gesture of a pedestrian as being a sign to some conspirator in a plot and deliberately run his car into the pedestrian to kill him in what is imagined to be "self protection."

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TIMBER: An all-time high from timber sales on national forest areas was reached at the end of the fiscal year of 1941. Receipts were $4,789,040, compared with $4,389,893 in 1930, the previous record.

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THE UNIVERSE

Pictured By A "Multiplication Table"

A NEW picture of the Universe from the smallest things to the greatest is given by a sort of multiplication table suggested by M. Davidson in the *Journal of the British Astronomical Association.* Taking his cue from Sir Arthur Eddington's famous lines in his book "The Expanding Universe,"

"A hundred thousand million
stars make one Galaxy;
"A hundred thousand million
Galaxies make one Universe"

Dr. Davidson proposed a series of things each of which multiplied by 100,000 would give the size of the next in the series, according to *Science Service.*

Beginning with the electron, as the smallest thing known in the Universe, the multiplication table of the Universe would run like this:

A hundred thousand electrons side by side stretch the width of an atom.

A hundred thousand atoms side by side stretch the width of a white blood corpuscle.

A hundred thousand white blood corpuscles side by side reach a length of 13 feet.

A hundred thousand times 13 feet is the radius of the minor planet Vesta.

A hundred thousand times the radius of Vesta will reach from the center of the Sun to one-third of the distance to Mercury—the planet nearest the Sun.

A hundred thousand times this distance is one-tenth of a light year or the distance that light, traveling 186,000 miles per second, would reach in the tenth part of a year.

A hundred thousand times a tenth of a light year is of course 10,000 light years, one time supposed to be about the size of our own Galaxy or Milky Way system, but now believed to be more than ten times as large.

A hundred thousand times 10,000 light years is a billion light years, a distance that would stretch across the whole Universe now visible to astronomers.

Here ends the table of M. Davidson, but not the Universe. With each increase in the size of telescopes, with each increase in the sensitiveness of photographic plates, the visible Universe is extended. And the number of stars coming in with each increase indicates that the end is still far away. Every theoretical model of the Universe, beginning with Einstein's, has made the radius of the Universe thousands of times greater than that of the part now visible.

BETTER PLYWOOD

Results from Improved Adhesives

THE plywood industry is on the threshold of a new production era, according to a statement to a Senate committee by Paul H. Appleby, Undersecretary of Agriculture. "Output," he said, "increased from 200 million square feet in 1932 to 700 million square feet in 1936 owing mainly to the inherently fine qualities of plywood as a structural material—high strength for its weight, for example. But now plywood far superior to that formerly used is available by virtue of improved plastic adhesives that are impervious to water. Furthermore the properties of wood and plywood alike can now be modified almost at will by impregnation with resin-forming materials followed by heat and pressure.

"This new type of plywood, waterproof and capable of being compressed and molded to form odd shapes and integral units, lends itself to almost unlimited development. In aircraft, for example, it can be used in the construction of wings, leading edges of wings, wing tips, fuselages, ailerons,

flooring, bomb-bay doors, instrument panels, and so on. Its use for such purposes would tend to relieve the aluminum alloy situation and at the same time would bring into the defense program an industry whose resources of labor and materials have not yet been tapped to the extent possible."

CUTS GLARE

Etching Glass Surfaces Reduces Reflection

RESEARCH in television in RCA Laboratories has led to a new chemical process to reduce extraneous reflections from glass. It now becomes possible virtually to eliminate the streaks that glare across show windows, framed pictures, ground-glass screens on cameras, and other glass surfaces or panels. For example, the glass faces of electric meters and the multiplicity of dials that confront airmen, as well as those of automobilists, now can be made reflection-proof, minimizing chance of error in reading.

Success in this conquest of reflections from large surfaces was achieved while striving to improve contrast on television cathode-ray tubes. Since the images are "painted" on the glass face of a cathode-ray tube, thence to be passed on through a thick glass protector plate to a glass mirror, the challenge of reflections was baffling. The experts, in their study, went back as far as 1900 to pick up an important clue dropped by Lord Rayleigh, the eminent English physicist.

He had jotted down in the record of his observations that hydrofluoric acid, diluted one part in 200 of water, removed a thickness of glass corresponding to about one-quarter wavelength of light each hour. Following up this clue, the research experts discovered further that an application such as Rayleigh used could impose on a glass surface an almost invisible film of low reflecting power.

Extending the investigation of the effects of hydrofluoric acid liquid and vapor on glass, new signposts were found for clearer vision in television and in the wide fields in which glass is used, whether in tiny lenses or big show windows. Of particular interest to the optical field is the fact that, as the amount of reflection is reduced, the light transmitting quality of the lens substantially increases and greater contrast results.

Dr. F. H. Nicoll, research scientist of RCA Laboratories, developed the new formula. His process is based upon the exposure of the glass surface to hydrofluoric acid vapor. The vapor etches away a small amount of surface, leaving a thin, transparent film of calcium fluoride measuring in thickness approximately one-quarter wavelength of light. Exhaustive tests show that the film withstands hard rubbing, that it can be washed with water, alcohol, and a number of other solutions, and can be subjected to relatively high temperatures without danger of serious impairment.

Half treated; half not

Major contributions to this same field, depending upon coatings added to the surface of the glass, have been made by Doctors John Strong, Katherine Blodgett, and C. H. Cartwright. These other methods, developed so far, have not been applicable to large sheets of glass, as is Dr. Nicoll's process, or, in some cases, they have been lacking in economy and in resistance to wear and weather.

TIN FINISH

Can Be Applied Rapidly, Easily

APPLICABLE to all copper and brass surfaces, a new material for producing a tin finish may be applied in ten seconds. In many instances this process can replace slow boiling methods of tin plating. The finishing solution is prepared by dissolving sixteen ounces of sodium cyanide and six ounces of Bon White paste, made by the Alrose Chemical Company, in a gallon of boiling water.

When cooled to room temperature, no further heating is necessary and no adjustment is required, as the material is completely plated from the solution. The life of the solution depends on the production volume. Enamel and glass containers are used and the work can be conveniently handled in baskets or on wire supports.

This new product, it is claimed, assures an inexpensive, highly effective white finish and, being pure tin, offers appreciable tarnish resistance. The new finish has already found wide acceptance in many industries.

POOR MILEAGE

Generally Ignition is to Blame

IF YOU'VE been wondering why your car doesn't give you better gasoline mileage, take the advice of an expert and look for the trouble where 85 percent of such difficulty lies—in a faulty ignition system.

This advice, based on Ford Motor Company experience with cars in the field, is offered at a time when the government is urging public support in conserving fuel, oil, and rubber.

Most people blame the carburetor when their cars seem to be using excessive amounts of fuel. In fact, a majority of car owners put the finger of blame on almost everything else but the ignition system. They usually start tinkering around with the delicate carburetor adjustments, or ask service men to change the adjustments.

But take it from the experienced automotive engineer, when you're having trouble with fuel economy, you'll find in four cases out of five that the ignition system is out of kilter.

If the timing is advanced too far, the fuel mixture in the cylinder fires too soon. This causes the pistons to work against (instead of with) each other and results in what is known as "piston ping." If the timing of the spark is retarded too much, combustion in the cylinder is not completed when the exhaust valve opens and the unburned fuel mixture is forced out

and burned in the exhaust manifold.

Findings show that poor spark also causes much of the gasoline mixture to be exhausted from the engine without burning. The sources of poor spark are numerous but here are a few of the more important: low battery charge; bad wiring connections; burned, pitted, or badly adjusted breaker points in the distributor; a "short" in the coil, rotor, spark plugs, or some other parts of the high-tension system; faulty coil; and dirty, badly spaced or worn spark plugs.

COLOR COILS

Modify Light From Fluorescent Tubes

PLASTIC coils have been developed which color fluorescent lights, control their brilliance, and correct color distortion. Made of tenite, a shatterproof plastic, the diffusing coils fit tightly over the tubes and can be used for their decorative effect alone.

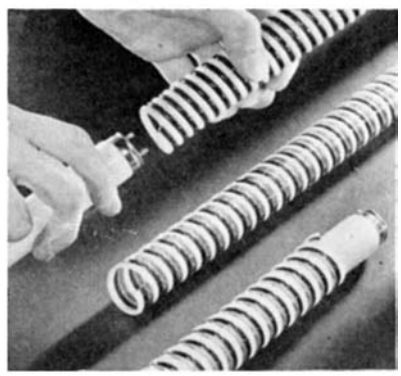
The diffusers are produced by winding thin, transparent, and translucent strands of tenite into tight, spring-like coils. Since the plastic has an unlimited color range, any shade or combination of shades is possible.

Color correction for white and daylight fluorescent light — both inherently deficient in red rays— can best be obtained with coils made of red and clear strands of tenite wound together. An insufficient amount of red rays in light can give a "cold" effect and make red and other colors containing red, such as brown, appear unnaturally dark. Pink coils not only serve as diffusers, transmitting more than 70 percent of the tube's light, but they also aid in correcting color distortion.

Illumination engineers and interior decorators can now obtain entirely new effects in lighting. The coils are virtually indestructible and will outlast many lamps. They are molded by extrusion. In this process, continuous lengths of the heated plastic are forced from a die much as toothpaste is squeezed from a tube. The plastic hardens when cool and is coiled in the desired lengths and diameters.

Although the size and wattage of fluorescent tubes may be changed in order to vary the amount of light available, the brightness of any single tube once installed is constant, it is pointed out. Tenite coils are a step towards solving the problem of varying this intensity. Since the plastic is manufactured in forms ranging from clear transparency to opacity, the amount of light shed by a tube sheathed in tenite depends upon the translucency of the coil.

The most outstanding result of tests so far made is the ability of



They remove glare, add color

the solid pink plasticoils to transmit a great amount of light. This ability, together with its high spectral transmission of red rays, and its cutting down of transmission of yellow rays, makes it an even better diffusion shield than the clear because a degree of color correction can be obtained.

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AUTOMOBILES: Over the years, more than 1500 different makes of automobiles, propelled by electricity, steam, or internal-combustion engines, have been built in the United States.

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EYE DEFECTS

Can Often Be Corrected

RECENT advances in eye-diagnostic and corrective techniques make it possible to rehabilitate many of the 123,000 men who have been rejected for military service because of defective eyes, according to Dr. R. J. Beitel, member of American Optical Company's bureau of visual science. In substantiation of his assertion, he referred to a Southbridge youth, Lionel Proulx, who, rejected by the Army Air Corps because of poor eye convergence, had his eyes brought to normal by eye-coördination training with the aid of prisms and the metronoscope, an instrument for correcting disabilities in connection with reading.

After this training, Proulx was able to pass the Royal Canadian Air Force physical examination and in the near future expects to use his reconditioned eyes in flights over Germany.

According to Dr. Beitel, many men with similar visual conditions, who have been rejected by Army doctors, can have their eye efficiency brought back to normal by such orthoptic or other corrective treatment.

BRUISED FRUIT

Cushions Reduce Spoilage Loss

TO prevent bruising of fruit while it is being graded, and thus decrease losses due to spoilage, one of the large Georgia peach growers now uses the new latex foam cushioning material on his grading and sorting tables, it is reported by The B. F. Goodrich Company. Similar use has also been made of the product by a large North Carolina potato grower.

LOST CIVILIZATION

Ivory Eyeballs, Jet Pupils, Carved Masks

FURTHER information about the strange lost civilization discovered at Point Hope, Alaska, last year, was reported by Dr. Harry L. Shapiro, associate curator of Physical Anthropology of the American Museum of Natural History, on his return after a season's work at this site.

This throws added light on the discoveries made in 1939 and 1940 by an American Museum-University of Alaska expedition under the direction of Dr. Froelich G. Rainey, which located the vast remains of a prehistoric town on the ancient migration route from Asia to America. Differences in the color of the vegetation disclosed five long avenues of some 600 buried dwellings that probably housed 3000 people on the barren gravel spit of Point Hope, 130 miles above the Arctic Circle. Subsequent excavations in the graves that led out from the town site uncovered remains and implements very dif-

ferent from those of the prehistoric and present-day Eskimo tribes of that region. This ancient culture has been labeled "Ipiutak" from the Eskimo name of a small spit of land near the site.

In log-walled tombs, constructed in rectangular shape, well-preserved skeletons were found with their implements for use in the after-world. The most exciting of the finds were those in which the skulls were equipped with large ivory eyeballs, inlaid with jet pupils, and fantastic ivory carvings evidently used for decoration. The graves also contained many arrowheads, fine flint tools, needles, and other artifacts of daily living. The carvings and implements made by these people were sufficiently different from the known Eskimo cultures to encourage the American Museum in a further search to trace the origin of the unknown race.

The Ipiutak culture is especially distinguished by a unique ivory art, an abundance of finely chipped flat tools, and by an emphasis on land hunting gear. Many implements widely distributed among all previousy known Eskimo people are absent. Moreover, in certain respects the Ipiutak culture, although the oldest in the area, is more complex and developed.

Dr. Shapiro and Dr. Rainey excavated 500 tombs in an area covering an extent of six miles leading out from the Ipiutak town. One of the most interesting discoveries is a beautifully carved ivory mask made in several sections, with the inset ivory eyes peculiar to the Ipiutak burials. The mask was found in a tomb enclosing the remains of a man, woman, and child. The body of the child was resting on the knees of the man and the huge ivory mask covered the body of the child. The sigificance of this, and other Ipiutak burials is unknown, and as strange to the living Eskimos on Point Hope as it is to anthropologists.

SHATTER-PROOF

Non-Bursting Oxygen

Tanks for Airmen

THAT steel tankful of breathing oxygen means life to a war-plane crew flying at 20,000 feet, but with stray bullets in the air it's like sitting on a time-bomb. When a machine-gun slug hits that vital oxygen cylinder, it's quite likely to explode with a roar and hurl deadly jagged pieces of steel through the cabin as the terrific internal pressure of as much as 1800 pounds per square inch is released.

Above: **One that can't burst and one that did.** *Right:* **Testing containers with .50-caliber armor - piercing ammunition**

Since the steel chunks could wreak more destruction than bullets, military air experts were quick to realize the danger of using ordinary oxygen cylinders in modern combat flying where an otherwise harmless stray bullet might knock out the entire crew and cripple the plane. This was the problem put up a few months ago to engineers of Walter Kidde & Company, maker of oxygen breathing cylinders, and it was solved by the development of a completely shatter-proof oxygen cylinder that would not burst when riddled by .50-caliber armor-piercing bullets. The nature of the metal used in the new tanks is kept secret. Bullets will penetrate it, as one of our pictures shows, but the pressure so released will not fracture the tank.

FOREST DAMAGE

In Michigan Caused

By Over-Cutting

FOREST resources in Michigan's Upper Peninsula are threatened with serious injury because of over-cutting in the area. Some 758 million board feet are being taken annually, although good management would allow not more than 589 million, if existing forests are to be maintained and a large group of industries supported on a permanent basis.

The Forest Service of the Department of Agriculture reports that the allowable yield could be increased within 40 years to 650 million board feet, and eventually to 1000 million feet a year, but the increased output, and even the maintenance of present production, depends upon the creation of sustained yield units and the elimination of timber "mining" or destructive methods of harvesting.

At the present annual rate of 758 million feet it will not be many years before usable forest resources are gone, says a new Forest Service report on the Upper Peninsula. Loss of resources would be followed by unemployment, lower standards of living, financial breakdown, and resultant distress. However, the foresters point out that these conditions can be avoided by good management of the remaining forests—proper cutting methods, close utilization of low grade timber, and careful protection of young growth.

A reduction in the present cutting rate, while producing temporary unfavorable conditions in a few cases, will result in the creation of permanently improved conditions for the area as a whole, says the report.

FIRE-PROOF

House Insulation Checks

Spread of Flames

A DRAMATIC demonstration of the fact that glass-wool insulation, in addition to helping keep homes warm in winter and cool in summer, serves effectively as a fire wall to check the spread of flames was recently provided by a fire in a home of wood frame construction with a shingle roof. Some years

ago the house was insulated with glass wool blown into the sidewalls and into the ceiling of the second story.

The fire started when sparks from the incinerator ignited the roof. The roof and roof rafters burned fiercely, but the insulation of the second floor ceiling acted as a fire wall and, although the heat of the flames was intense, the joists of the second floor ceiling burned very slowly.

The second floor ceiling finally gave in, but only under the weight of the fallen chimney which was constructed at an angle in order to pass through the ridgeway. Even after the cave-in of the second floor ceiling the insulation continued to protect the flooring of the second floor so effectively that in only one place was it sufficiently damaged to require replacement.

Due to the degree to which the insulation slowed the spread of the fire, the occupants of the house, with some outside assistance, were able to remove almost all clothing, bedding, and personal effects from the second floor before the ceiling fell.

STARTER SWITCH

A NEW "no-blink" starter switch which will end a fluorescent lamp's life when it has reached the stage where it blinks on and off, has just been announced by Westinghouse. Designed specifically for the 40-watt Mazda fluorescent lamp, the new switch will eliminate blinking and flickering of burned-out lamps. Starter switches will last longer because they will not be impaired by repeated attempts to start lamps. The "no blink" switch makes the group replacement idea feasible when lamps are installed in inaccessible places.

HEAT LAMP

Built-In Reflector, For Home Use

A NEW infra-red lamp bulb with self-contained reflector and two new fixtures, including a table and a floor model, have resulted from General Electric's solution to the problem of eliminating aluminum reflectors in home-type heat lamps. The new 250-watt, 115-volt lamp is mushroom shaped to accommodate the correctly designed reflector built in behind the filament. Reasonably uniform distribution

Uniform heat-ray distribution

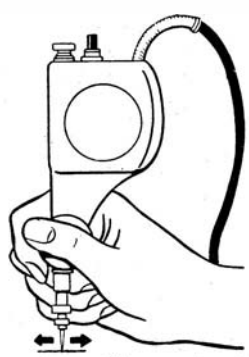
of the heat rays is provided by the finish and contour of the reflector. At close range, the energy is distributed over a small circle and at high intensity. Exposures taken at greater distances increase the area over which heat is distributed, but the intensity decreases with the square of the distance.

Because it is sealed within the bulb, the reflector is protected from the tarnishing effects of air, dust, and water; its original condition is preserved to provide maximum reflection efficiency for the life of the filament. The filament has been designed to operate at a cherry-red heat so that glare has been reduced to a minimum. The color is pleasing and comfortable to the eyes and is readily associated with infra-red radiation.

VIBRATING

Hand Tool Of Many Uses

BOTH home craftsmen and professional mechanics will find a wide variety of uses for a new vibrating hand tool recently announced by Burgess Handicraft Supplies. This tool, shown in an accompanying drawing, operates on any 110 volt, A.C., 60 cycle line.



Engraving with new hand tool

Delivering 7200 strokes per minute, the tool point can be used for engraving on jewelry, marking steel tools and parts (except tempered or hardened steel), marking glass and metal signs, and for other similar engraving on a wide variety of materials.

The tool comes equipped with interchangeable steel needle points, and several different types of attachments are available. These include knife blades, hammering tips, and special cutters, all of which are interchangeable in the tool chuck. With these attachments it is possible to do high-speed wood carving and a wide range of metal-tooling, leather working, and other pounding or pressing operations.

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SEA SAFETY: Asbestos shields on lifeboats of British oil tankers protect crews from torpedoed ships when surrounded by burning oil and can also be used as sails.

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OLDEST PLASTIC

Bitumen Still Can Be Improved

WHILE we talk glibly of the fact that bitumen, in which we include asphalt, is the oldest plastic, apparently having been used by a very old boatbuilder, it remains a fact that industrially bitumen became an important material only when the chemical industry demanded it as an anti-corrosion compound, when the electrical industry found it useful as a dielectric, when road building assumed importance because of the growth of the motor industry, and when this last found it useful as a molding material for holding acid accumulators.

Nevertheless, there is still much to learn about bitumen and there is still room for improvement. Certainly the road constructors are not too pleased with it, for it has poor adhesion to the mineral aggregate which it is presumed to bind. Recently Dr. C. Mack, of the Imperial Oil Company, Ontario, discussed this adhesion in a paper at the Chemical Society. There is no doubt that this property can be improved by the addition of certain agents. Among these copper sul-

fate and ferric chloride were mentioned as being useful; presumably in the latter case some oxidization or decomposition to more viscous and more adhesive compounds takes place.

It is interesting to note a recent patent by the Standard Oil Company which avoids direct admixture with bitumen, but induces adhesion to a road surface by covering the latter with a film of lead naphthanate, a material of great "stickiness," before finishing with bitumen.

There is little doubt that the adhesion of bitumen to mineral aggregate can be achieved very easily, but the chief deterrent of most methods lies in the fact that economically bitumen can stand little or no increase in price.

These notes carry sufficient interest for plastics generally, since their modification in one way or another grows apace. It is obvious that these problems are akin to plasticizing and that the road constructors can learn something from the plastics industry. The reverse is also obviously true. — *Plastics* (London).

CLOUD HEIGHT

Measured With Light in Daylight

A TINY, 1000-watt mercury lamp developed for searchlights and television studios has been used to solve a vital problem of aviation—the daylight measurement of the height of clouds from the ground.

Maurice K. Laufer and Laurence K. Foskett of the National Bureau of Standards discovered that by projecting the light from a General Electric high-intensity water-cooled quartz mercury lamp, and noting with a photoelectric cell the "splatter" of the light where it hits the cloud, the altitude can be calculated by triangulation.

"During the daytime," they explain in the *Journal of Research of the National Bureau of Standards,* "dark overcast clouds at an elevation of 9000 feet have been readily detected. For cumulus clouds illuminated by direct sunlight and having elevations up to 4000 feet, the detection is positive."

The projector consists of the lamp located at the focus of a 24-inch parabolic mirror having a 10-inch focal length. The detector consists of a vacuum-type phototube placed immediately behind a diaphragm with a slit opening 3/25 by 11/16 inch located at the focus of an eight-inch plano-convex condensing lens.

The narrow beam from the 1000-watt lamp is projected into the sky at a frequency of 120 flashes per second; the rays scatter when they hit the clouds. This light scattering is detected by the photoelectric cell located at a known distance from the lamp and adjusted for this flash frequency that will distinguish the beam from background light.

The cloud height then is determined by the solution of the triangle formed by the line of the beam to the clouds, the angle of the photoelectric cell sight upon the clouds, and the base line connecting the beam projector and the phototube.

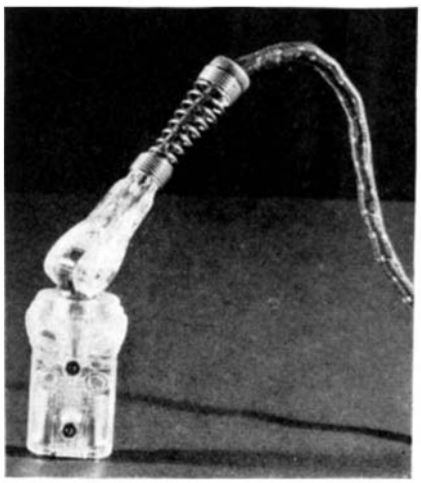
FLEXIBLE PLUG

Eliminates Broken Wires, Short Circuits

THE operation of "wrist action" electric plugs, designed to eliminate kinking and twisting of electrical appliance cords, is clearly shown by the "Lucite" demonstra-

tion model recently produced by the Davis Manufacturing Company and illustrated in one of our photographs.

Swinging freely in any direction, the swivel plug takes up practically



It spins around

all the bending and twisting which constantly occurs in attachment cords for irons, toasters, and other appliances. Thus the cord troubles which often come at the point where the cord enters the plug are eliminated in the wrist action plug; the swivel action prevents twisting of the cord. No wires enter the plug.

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LUMBER — Nearly 1,000,000,000,000 board feet of lumber have been cut from timber taken off American forest lands since 1909. This amount of lumber laid in a plank walk two feet wide would reach from the earth to the sun—a distance of 93,000,000 miles.

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DUST STORMS

Can Build Up As Well As Tear Down

IF DUST storms aren't up to one thing, apparently they are up to another. A few years ago they were awarded responsibility for digging out the "dust bowl." Now it appears that they also pile up bluffs.

Huge dust storms which swept the United States more than fifty thousand years ago created many of the large clay bluffs that line the highways of the Mississippi valley, according to Dr. Earl T. Apfel, professor of geology at Syracuse University.

Large drifts of wind-blown clay, found throughout the Central Plains of the United States and in small patches in Connecticut, Massachusetts, New York, and elsewhere, known as "loess," were deposited by huge "dust storms" which raged in North America during the Great Ice Age, more than fifty thousand years ago, Dr. Apfel says. The storms occurred in periods between successive intervals of glacial activity, and the loess deposits are usually classified according to the interglacial interval in which they were formed. For instance, the Loveland loess heaps, found from eastern Iowa to western Nebraska, are complex in origin and probably were built up from deposits laid down in several interglacial intervals

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ACCIDENTS: More than three out of every five traffic fatalities during 1940 resulted from accidents that occurred in rural areas.

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LIGHT, PLUS

Flexibility Featured In Illuminated Magnifier

FIRST described some months ago in these pages, a combined magnifying lens and light unit, particularly adapted to first-aid work, is now being produced in a new style, more compact, and with an improved mounting bracket. One of our accompanying photos shows both the old and new models; both give magnification and light wherever needed and both can be moved about with a minimum of effort, remaining in whatever position they are placed. Brackets available include a type that may be attached to the arm of a chair or table and one that is mounted on a pedestal.

CORYPHODON

Skeletons of Hippopotamus-Like Animal Discovered

SEVERAL skeletons of an ancient hippopotamus-like animal known as coryphodon, together with "spare parts" consisting of extra skulls, limb bones, jaws, and so on, have been found in Colorado by an expedition of the Field Museum of Natural History, under the leadership of Bryan Patterson, assistant curator of paleontology.

Since there are at present only three reasonably complete coryphodon skeletons in all the museums of the world, this new find constitutes a real scientific treasure trove.

Coryphodon was not closely related to the hippopotamus, despite its superficial resemblance. The evolutionary line to which it belonged has become totally extinct. The animal lived in the Eocene period, near the beginning of the Age of Mammals, reckoned at between 50 and 60 million years ago. —*Science Service.*

DECIPHERMENT

London Scientists Perfect Reading of Charred Documents

IMPROVEMENTS over older methods of preparing charred documents for decipherment have been worked out by two technicians at

Helps in removing particles from eyes and in other first-aid work

the Metropolitan Police Laboratory, W. D. Taylor and Henry J. Walls, who, in *Nature* (London), state that, "in spite of its topical interest, the subject is not a new one; but we have already obtained results which we think, taking into consideration the simplicity and general applicability of the method, mark a distinct advance on anything hitherto recorded.

"Briefly, the method consists in treating the document with chloral hydrate; this substance appears to exert an as yet unexplained 'clarifying' action on the burnt figures or letters. The chloral hydrate is applied in a 25 percent alcoholic solution; after several applications, the document being dried at 60 degrees, centigrade, between each, a mass of chloral hydrate crystals will form on the surface, and at this stage a similar solution containing 10 percent glycerine is applied and the document dried as before. It may then be photographed. The most suitable type of plate is a contrasty non-color-sensitive one.

"The method is equally satisfactory for typescript and for printing, and with certain modifications has been found to restore writing. Furthermore, the reading matter is restored equally on both sides of the paper.

"Certain distinct advantages which are possessed by this method are: (1) it appears to be applicable to any type of document; (2) it is fairly quick; (3) it has never yet in our hands failed to produce a readable result; (4) it requires no special apparatus other than a copying camera.

"It has so far eluded us to find a satisfactory explanation in physical or chemical terms of this action by chloral hydrate."

SUGAR

Identified by New Polarizing Instrument

IDENTIFYING and measuring sugar in baby's diet has been simplified by development of a new medical and research instrument which employs light-control polaroid film to determine if the sugar is the proper type.

Announced by the American Optical Company, the new polarimeter functions because sugar has the power of rotating the direction of polarized light, light vibrating in one plane only. Identification of sugars in diets is important because

only certain kinds pass as nutritional factors through the intestinal walls to be absorbed by the blood stream.

The new instrument enables the scientist to determine that honey, for example, is largely a left-hand

Checks on the sweets

sugar, a levulose, because it rotates polarized light counter-clockwise; also that corn syrup rotates polarized light clockwise, and is a right-hand, or dextrose, sugar.

In the new polarimeter, which resembles a small telescope, light from a sodium flame passes through a polaroid disk, a sample tube, another polaroid disk, a telescope objective, and an eyepiece. Crossing the polaroid disks darkens the tube. But if a sugar solution is placed in the tube, the field becomes light. Rotating one of the disks restores darkness. A scale and a drum on the instrument provide means for measuring the sugar in the solution.

ELECTRIC HEAT

Removes Paint, Putty, Without Damage

ELECTRICAL appliances for quick and safe removal of paint and putty have recently been designed by Tamms Silica Company. The paint remover, which plugs into any convenient electric outlet, is held against the surface from which the paint is to be scraped; quickly the paint softens, permitting easy removal with a putty knife. The handle of the appliance is well insulated to protect the operator against the heat generated. This paint softening appliance comes in two sizes, one for use on large painted areas and a small size for use on window frames, door jambs, furniture, and so on.

The putty softening unit operates on the same principle of applying electrical heat locally. The device is so shaped that, after plugging into an electric light socket, it can be held against the line of putty surrounding a window sash. The heat softens the putty quickly whereupon it may be removed with any suitable tool. It is claimed that the risk of glass breakage is practically eliminated.

GROWING AUTOS

Farm Crops and Animals Do Their Share

THE automobile industry is one of the farmer's best customers, according to a report based on the extensive use of farm products by the Ford Motor Company in building cars and trucks.

It is estimated that for each 1,000,000 units it manufactures, Ford needs from the American farmer the following agricultural items:

Cotton—69,300,000 pounds, or the annual output of 433,125 acres.

Wool—3,204,000 pounds, or the wool from approximately 801,000 sheep.

Wood—112,000,000 board feet, or 20,500 acres of forestlands.

Cattle—30,000 head to provide 1,500,000 square feet of leather.

Soybeans—600,000 bushels.

Flax—118,000 bushels, equivalent to 17,500 acres.

Tung oil—195,000 gallons.

Hogs—20,000 head, to provide 1,000,000 pounds of lard oil lubricant.

Corn—451,500 bushels, equivalent to 11,280 acres.

Wheat—120,000 pounds as flour used in foundry.

Goats—87,500 head, to provide 350,000 pounds of mohair material.

Jute—5,000,000 pounds.

Pine pitch—2,060,000 pounds.

Sugar Cane—enough to provide 2,500,000 gallons of molasses.

Honey bees—83,000,000 bees, to produce 6000 pounds of beeswax.

Castor oil—150,000 gallons.

Most of the cotton brought to the Ford Rouge plant is used in the form of upholstery cloth and in tire fabric. Wool is used in upholstery and for certain gaskets. The cow plays its part by providing leather upholstering, gasket material and glycerine.

Soybeans have many uses in the Ford industries. Chief among them are in the body finishes, molded electrical parts, and as core oil and bond in the foundry. Flax is utilized in paints, core oil, soft soaps, and

glycerine. Two chief uses for tung oil are in enamels and varnishes and in brake linings.

The hog contributes lard oil for rear axle lubricant and also provides bristles for brushes. Jute goes into carpet backing, and pine pitch is used for foundry resin, turpentine, adhesives, paints, and lacquers. Sugar cane provides alcohol for anti-freeze, shock absorber fluid, and various solvents. Castor oil is used for lacquer and artificial leather and hydraulic brake fluid.

Beeswax is utilized as electrical imbedding compound.

NO CURE-ALL

A Newly Developed Grass Sometimes Repels Some Insects

NUMEROUS reports of the discovery of a kind of grass that repels mosquitoes having been widely disseminated, apparently in rather glowing form, through the daily press, a number of our readers have written for information concerning the find. As is too usual, it turns out to be somewhat limited in value, though valuable — in the tropics.

The United States Department of Agriculture, when asked for data, replied as follows, and this may be taken to pin the account down to the facts even if it does greatly limit the hopes of those concerned:

"Apparently the grass referred to, *Melinis minutiflora*, commonly called molasses grass, has been given considerable publicity as to its repellent qualities against mosquitoes, ticks, and even snakes. There is some question as to its being toxic to insects such as mosquitoes, cattle ticks, and tsetse flies. Experiments conducted at the Puerto Rico Agriculture Experiment Station proved that molasses grass does not kill the common cattle tick. No doubt the oily substances secreted by the grass do act as a partial repellent and in a pure thick stand may tend to prevent development of certain insects.

"The grass is a native of Africa and has been introduced into South America where it has taken hold well. It has been introduced into Florida on several occasions but has never survived the winter there.

"Perhaps additional information regarding this plant and its insecticidal qualities can be obtained from Dr. H. Pittier, P. O. Box 255, Caracas, Venezuela. Dr. Pittier is a botanist who has worked in Venezuela for many years."

Industrial Growth

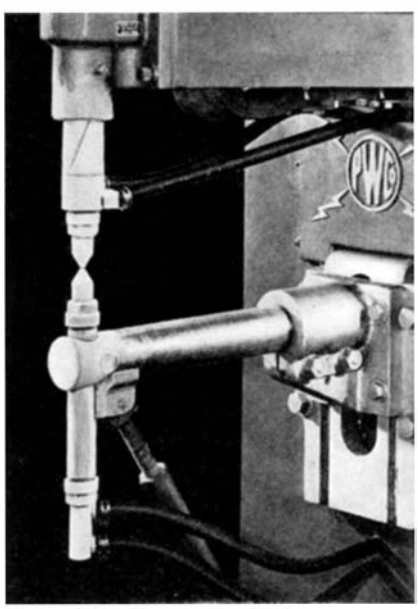
New Products and Processes That Reflect Applications of Research to Industrial Production

COOL WELDING

Refrigerated Points Last Longer, Weld Better

DESIGNED to increase productivity of resistance welding equipment, especially in welding of aluminum and stainless steel, a line of refrigerating units for many types of welding machines is announced by Progressive Welder Company.

Believed to be the first time "refrigerated welding" has been made commercially available, the unit



Frost on the electrodes

makes possible continuous welding of four to ten times as many spots in aluminum without requiring point dressing.

When used in combination with a spot welding machine, the unit reduces electrode temperature to a point where—in spite of the high heat necessary to produce a weld—electrodes will be continuously covered with frost. This reduction in temperature has so increased point life that 10 minute runs, continuously, at 100 welds per minute without point dressing are not unusual for the combination of a Progressive three-phase aluminum welder and the refrigerating unit.

The unit can also be used for welding other types of material besides aluminum and stainless, and may be applied to the cooling of industrial coolants, cutting oils, and so on.

The new units are available in a range of three sizes, designed respectively for use with (1) a single aluminum welder, (2) two welders, and (3) a bank of four such welding machines. The units are provided with automatic thermostatic control, all standard safety appliances, built-in dehydrator, heat exchanger, external indicating thermometer, highest efficiency pump with variable pressure.

Peculiarly enough, while the refrigerating unit absorbs a considerable amount of heat, experience indicates that welding machine settings are actually lower than when operating with water cooling. The lower setting of the heat control generally required is probably due in part to the higher conductivity of copper at the lower temperature.

Installation of the refrigerating unit is quite simple. Being self-contained, it is necessary in most cases only to disconnect the water-lines to the electrodes and couple the refrigerator unit inlet and outlet connections to the electrode water piping.

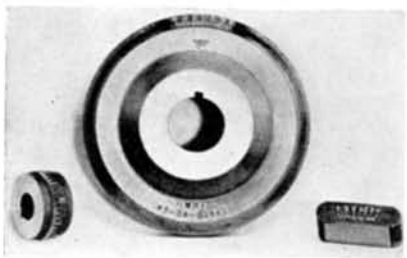
MARKERS

For a Wide Range of Machine Uses

A GREATLY expanded line of markers of various types suitable for cutting slots, notches, knurls, serrations, graduations, and calibration lines on machinery, ordnance, dials, indexing or calibrating collars or rings, bevelled disks, and so on, is now available through New Method Steel Stamps, Inc.

For use where the marks need not be precisely indexed around the circumference or periphery of the parts, markers of the roll type may be employed in any lathe. Where high production is demanded, they may be mounted in a turret lathe, screw machine, or other

high-production machine tool. The marking rolls are suitable for graduating or knurling on steel, bronze, brass, aluminum, or any other workable material. It is also possible for the calibration lines to be limited to a portion of the circumference or periphery, the roll



Types of markers

marker being equipped with stops that prevent repeating the design or markings even though the lathe or screw machine spindle on which the part is mounted continues to rotate.

These roll marking devices are also suitable for use where greater accuracy is required by gearing them to the parts to be marked in such a manner that the calibrations will be precisely located around the circumference. Proper registering devices to suit the design of the specific pieces on which the lines or serrations are to be cut may readily be obtained. The markers are available either with or without corresponding numerals. In some cases the numerals may be added by a separate marker after the calibration lines have been made on the part.

In addition to the more conventional cylindrical types with indexing lines or calibrations around the periphery, graduation markers are also available with bevelled edges, or may be of disk type for producing serrations on the sides of collars, ferrules, and so on. Sizes range from micrometer thimbles up to large calibrated hand wheels on machinery. Calibration lines can be varied in length, with any spacing desired. Similarly, the design of the markings may be varied.

Machine stamps for use in presses may also be obtained with any desired lines or markings.

ZINC PLATING

New Process Utilizes Waste Materials

CHEAP sources of zinc instead of the usual zinc anodes may be used in a new process of zinc plating in

which the zinc is dissolved from galvanizer's skimmings, organic reduction residues, or similar waste materials, by a solution of ammonium chloride and ammonia. Insoluble graphite anodes are used in the plating tank. The plating process reduces the zinc content of the solution.

This new method of zinc plating, known as the Hubbell-Weisberg Process, works at high current densities. This fact, combined with the high conductivity of the solution and careful design of the electrical equipment, makes the process highly economical of power.

Greatest economies with this process become evident when from 1½ to 2½ tons of zinc plating are required every 24 hours. From this point upward, savings become increasingly impressive as daily consumption increases.

FREEZING BOLTS

Shrinks Them For Easy Assembly

BOLTS weighing 205 pounds are shrunk a fraction of an inch by dry ice to insure good fit in the assembly of the great 150,000-horsepower hydroelectric turbine-generators at Grand Coulee Dam in Washington.

The bolts are nearly six inches in diameter and two feet or more long. Too heavy and too cold to be lifted by hand, the bolts are lowered into position by a small hoist. After placement, the bolts return to normal temperature and expand to a perfect fit. Before installation the bolts are placed in dry ice for 12 to 16 hours.

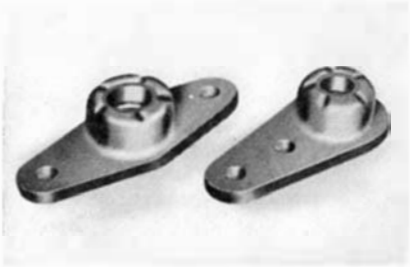
STOP NUTS

Now Available in Anchor Type

DESIGNED to provide vibration-proof fastenings for blind-mounting applications, as in removable plates used to cover hand holes, access and inspection openings, and for other blind-mount attachments, anchor nuts of the type manufactured by Elastic Stop Nut Corporation are permanently riveted to the inside of the structure. The bolts, which are inserted from the outside, pass first through the removable plate, thence through the structure into the stationary nuts.

These nuts are offered in a wide

range of size, material, and thread system, every nut incorporating the basic Elastic Stop self-locking feature, a fiber locking collar which is an integral part of each nut. This locking fiber prevents the bolt from becoming loose after it is installed in the nut, regardless of the severity of the vibration to which it is subjected. In such mountings, the bolts may be removed and replaced many times,



Vibration-proof—two types

the anchor nuts retaining their locking ability because of the resilient character of the fiber collar. It is claimed that the fiber of the collar, being softer than the metal of the screw, cannot damage the threads.

As with other Elastic Stop Nuts, when the end of the bolt enters the unthreaded collar, its passage is resisted, thus immediately and automatically eliminating all play between the threads of bolt and nut, and establishing contact of the load-carrying threads under pressure. Further turning and tightening of the bolt impresses a thread in the fiber collar, creating a moisture-tight seal around the bolt and maintaining the thread contact with a resilient grip. The braking action of the collar itself serves further to prevent any backing out of the screw.

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TOUGH: Industrial use shows bristles of nylon are at least three times as tough as those that grow on a hog.

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PRESSES

Hydraulically Operated, Smooth, Fast

To SIMPLIFY production problems, Colonial Broach Company's "Junior" presses have been designed to increase work-handling capacity. Smoother and faster than mechanically operated presses, the line of Junior presses designed for assembly, straightening, and so on, includes two hydraulically operated units rated at ½ and 1 ton capacities, both with 12 inch stroke.

The models are similar in design and construction with principal dimensions the same for both. Both are suitable for mounting in virtually any location—on benches or pedestals. While designed primarily for work on small parts, the large throat clearance (between ram and column) permits operations on large and bulky parts.

By the use of special coolant equipment, light broaching can be done on these machines. However, for such work Colonial "Senior" Presses are usually recommended since coolant equipment is a "built-in" feature of these units.

Control of the ram stroke is through a four-way valve, operated manually by a single-lever control, with the ram stopping at the bottom of the stroke or automatic return, and by the use of adjustable stops. The ram-operating cylinder is integral with the massive one-piece column of the machine for maximum rigidity. Ram speed down is 30 feet per minute, with return speed of 60 feet.

The hydraulic system includes an adjustable pressure relief valve so that the maximum ram pressure may be adjusted to any desired limit within the capacity of the machine. Thus ram pressures may be limited, if desired, to prevent damage of parts during assembly. Provision is made for the installation of a pressure gage on the column, for use in assembly work where exact press-fit tolerances are important. Thus equipped, the reading of the pressure gage during assembly will indicate the character of the fit, thereby serving as an inspection device.

Greater work-handling capacity

Autogiros Against Submarines

Convoy Duty Requires the Services of Aircraft With Peculiar Qualities for the Job in Hand

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

NEWSPAPER reports from London reveal what has been suspected for some time: the British are using catapult-launched single-seater fighters on board freighters as protection against air attack, employing small Hurricanes of relatively short range but with sufficient fire power successfully to attack a four-engined Focke-Wulf bomber. The pilots are specially trained and particularly courageous men. They need both qualities because the service is such a hazardous one. Suppose the pilot shoots off via the catapult and downs the enemy in the air, or the submarine by means of a depth charge. He cannot land on the deck of the freighter, so he has but two alternatives: To seek a land airport, hoping that his fuel supply will be sufficient, or else to "mush" into the water as near a ship as possible and save himself via life belt, as the airplane itself is sure to sink even if it does not turn over when alighting on the water. However skilled the pilots may be, however alert the surface vessels and air patrols of the British may be, casualties must occur. An airman bobbing about in the rough sea is a very small object to see, and the service must of necessity be hazardous, though thoroughly worth while.

Commander William A. Read, U.S.N.R., writing in the *United States Naval Institute Proceedings*, advocates another type of air escort for freighters or convoys; namely, the autogiro:

"If an aircraft type could be produced capable of operating from and to a short deck on the stern of a merchantman without requiring a catapult for take-off, or a stop for hoisting aboard by crane, and yet carry a military load of pilot, observer, radio, and depth charges, it would be possible to apply increasing offensive pressure against submarines. There is such a type in the rotary wing autogiro. . . . It should be possible today to build such a machine capable of fulfilling service requirements for convoy escort duty and capable of easily operating from and to a platform 100 by 50 feet or less."

Commander Read's suggestion has great merit. Of course an autogiro could not tackle a Focke-Wulf bomber as readily as a Hurricane, but it could put up an excellent fight, and against submarines it would be *more* effective than the Hurricane. It will be noted also that the Commander advocates the giro as an offensive weapon against submarines more than against bombers. At any rate, the suggestion is thoroughly worth prospecting both by the British and ourselves. [This suggestion brings to the fore once again the similar plan for using autogiros in convoy work, put forth by Scientific American, and fully described in our issue of December 1939.—*The Editor.*]

BALLOONS

Factors in Design of these Effective Defenses

THAT our own War Department is convinced of the utility of the balloon is indicated by orders for 3000 balloons, said to be under present consideration, and the hundreds that have already been ordered.

A convincing demonstration of

Small balloon, showing catenary curtain and the attached bridle

barrage-balloon operation was recently given by Goodyear Tire and Rubber Company, at its private air station at Wingfoot Lake, Ohio, which served as a training base during World War I for balloon and blimp pilots. In actual practice the captive balloons are capable of rising to 7000 feet or more, with

The number of fins corresponds to the number of dividing lobes

the height of ascent roughly dependent on the size. Thus, the relatively small model, the Goodyear D-5, has a capacity of 30,000 cubic feet and a ceiling of 7000 feet, while the Goodyear Strato-Sentinel model, with 68,000 cubic feet capacity, rises to 15,000 feet. The reason that larger balloons can rise to a greater height is that there is a certain amount of dead weight in connections, valves, and other mechanisms which every model has to lift, no matter how restricted in size. Then, the weight of the fabric has to be supported, and the reserve of the lifting capacity supports the steel cable, which may be of small diameter but is heavy when thousands of feet of its length are in the air.

The lobes dividing the balloons' skin are employed for ease of construction, and because they make maintenance of form, after inflation with helium, somewhat easier. An important problem in the design of the balloons is stability. The air resistance of the balloons depends on the attitude they take relative to the wind, and this attitude or angle of attack must not be too great or the cable may part or tear away from the fabric. Hence the provision of the large fins at the rear.

The air-drag of the balloon and the buoyancy which carries the weight of the cable create appreciable forces on the holding-down cable and these forces cannot be taken up at a single point on the surface of the bag. Hence the peculiar design of scalloped fabric, or curtain, sometimes referred to as a catenary curtain, on the sides of some of the balloons, from which the flying bridle is suspended.—*A. K.*

AIR SAFETY

Rules Laid Down By the CAB

THERE have been surprisingly few accidents in the Civilian Pilot Training Program, but instructors and students should always be on the alert and never relax vigilance or adherence to good flying practice. The Civil Aeronautics Board has just issued some splendid, concise safety rules. They are:

1. Know and Obey Civil Air Traffic Regulations.
2. Believe Your Instructor.
3. Fasten Your Seat Belt.
4. Check Fuel Supply before Taking-Off.
5. Check Controls Before Taking Off.
6. Be on the Alert for Other Traffic.
7. Climb Sensibly.
8. Land Straight Ahead if Engine Fails at Low Altitude.
9. Avoid Flat Turns.
10. Maintain More Than Just Enough Flying Speed.
11. Never Stretch Your Glide.
12. Turn Back or Land When Weather is Doubtful.
13. Go Round Again if Your Approach is too High.—*A. K.*

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FLIGHT: For every hundred miles flown by transoceanic Clippers on schedule with mail, passengers, and express, more than ten miles are flown in preparatory, test, and other non-schedule flights.

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PLANE CONDITIONING

Cools in Summer, Warms in Winter

A NEW type of air conditioner, which should make passenger cabins completely comfortable under either extreme of temperature, has been placed in service by United Air Lines. Built by the O. E. Wendt Company and Delco, of General Motors, the "comfortizer," as it has been called, is mounted as

a unit on a truck, and is used for air conditioning the plane while on the ground. In contrast with other means of cooling previously used on airplanes, the new unit employs ice. Water from the ice is atomized and air is drawn through the resultant vapor before being pumped into the cabin. With a capacity of 15,000 cubic feet of ice-cooled air per minute, the unit will reduce cabin temperature from 100 to 80 degrees in 20 minutes. For heating, a standard oil-burning furnace of the type used in a seven-room house—capacity 250,000 B.T.U's per hour—is employed.—*A. K.*

CO-OPERATION

Several Plants to Build One Type of Plane

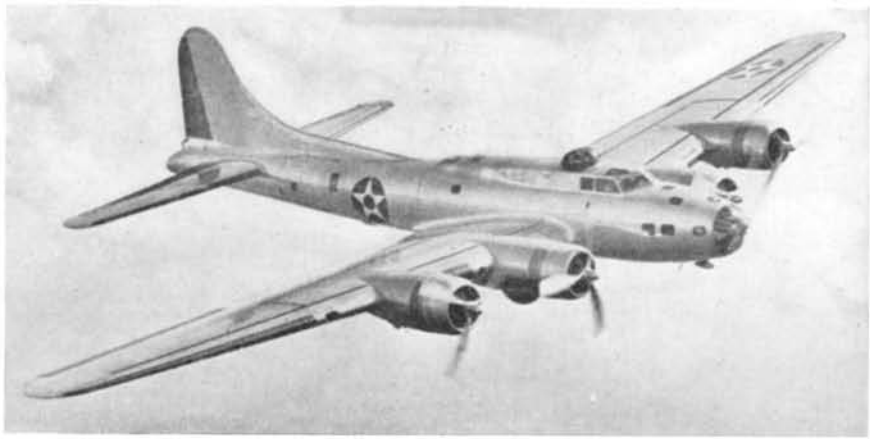
AGAIN and again we have heard well-informed opinion to the effect that, if the R.A.F. had 2000 or 3000 powerful, long-distance bombers, and the capacity to maintain them in operation, the potential devastating attacks then possible on Western Germany would shorten the war. As proof that this opinion is shared by the Army Air Corps, or whoever is responsible for our plane production, orders have been placed for manufacturing large quantities of the new four-engined Boeing B-17E shown in one of our illustrations. Aerodynamically, nothing could be more trim than this huge machine, described by the War Department as bigger and more deadly than any of its predecessors, with its machine guns, cannon, power-operated gun turrets, and enormous engines. While the B-17E was designed and built by Boeing Aircraft Company, it is encouraging to learn that a co-operative production program calls for large numbers of the ship to be built by Boeing, itself, in Seattle; Douglas Aircraft, at its new plant in Long Beach, California; and Vega Aircraft at Burbank, California. A special inter-plant committee is busily at work ironing out difficulties that are bound to occur, and exchanging wrinkles on speedy production methods.—*A. K.*

MOBILE

Surfaces Developed for Emergency Airports

THREE types of mobile landing fields have been developed by the U.S. Corps of Engineers for heavy bombers, light bombers, and pursuit ships, respectively. Experimental work was started late in 1939, with tests at Fort Belvoir and Langley Field, Virginia. The test program brought out certain characteristics which should be found in any "mat," as it is called, which is to be used for a mobile landing field. These include strength, continuity, speed of laying, speed of production and rehabilitation, low cost, ease of camouflage, skid-proofing, life, wear on tires, and so on.

Three materials found suitable for use as an emergency landing mat were steel plank, Irving grid with slip-ring connectors, and rod-and-bar grid with wedge connectors. While the steel plank presented a more satisfactory surface, it was slippery when muddy, and difficult to camouflage, but improvements have been made in coupling the planks, in camouflaging with paints, and raised buttons have eliminated skidding. Although some of the grids lacked continuity, a very promising grid type mat is now available, but it costs more than the steel planks and takes longer to produce. There is not the slightest doubt that American ingenuity will very



Bigger, more deadly than its predecessors

shortly produce a suitable mat, making the whole surface of the globe a conceivable flying field for our Air Corps—an immense tactical advantage.—*A. K.*

TRAILER-CRANE

Aids in Handling Aircraft Engines

AVIATION becomes less romantic, more practical, and stoops to labor-saving devices. The Boeing School of Aeronautics, for example, has developed a combination trailer-crane which is most useful around an airport for transporting and lifting heavy aircraft engines. The trailer has a capacity of two tons; the crane a capacity of one ton. Over-all length of the trailer is 12 feet; outside width is eight feet; over-all height is 14 feet. Vacuum booster-brakes in the trailer are controlled from the steering column of the towing car. When not in use, legs of the crane lie flat on the trailer.—*A. K.*

Boeing's aircraft crane

AERONAUTIC DECIBELS

A Handy Noise Meter for Aircraft Use

PHYSICAL measurements of electric current, flow of water, speed of air, and many other quantities have long lost their mysterious character but, when it comes to the measurement of noise, matters are somewhat less well understood. Noise is an air wave; the greater the noise, the greater the intensity or pressure of the wave. All that the decibel meter has to do is catch the pressure wave in a microphone not dissimilar to a telephone microphone, amplify the indication which is brought about by the fact that the pressure wave modulates an electric circuit so that a current is produced or modified, and transmit the amplified signal to an electrical indicating instrument.

Measuring airplane noise level

Of course, in actual application, there is a good deal more to the instrument than mere bare words indicate and, in the early days, measuring noise involved a whole laboratory! Now General Electric announces a very handy portable decibel meter which weighs only 19 pounds, has a decibel range of 24 to 120 decibels (roughly covering sounds from the rustle of leaves to the scream of a factory whistle), and is small enough to be carried easily—in the cockpit of a small airplane, for example, as shown in one of our photographs.—*A. K.*

TRAINING

Progress of the Civilian Pilot Program

AT THE Aeronautical Section Meeting of the National Safety Council a group of papers was devoted to the discussion of safety in the C.P.T. program. Early criticisms of the C.P.T. have disappeared because the system has given the nation a splendid source of Army and Navy pilots.

Today, between seven and eight thousand C.P.T. students and instructors are in the Army or Navy air services, or are training groups, and about 22 percent of the new cadets in Army or Navy air services are graduates of C.P.T. With courses offered in 709 colleges and 221 non-college units, more than 10,000 men have completed the primary training course, and several thousand the secondary course. Other valuable derivatives of the Civilian Pilot Training program have been the reduction in insurance premiums for private flying training, and a much better understanding of what constitutes safety in private flight training.—*A. K.*

CAMERA ANGLES

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

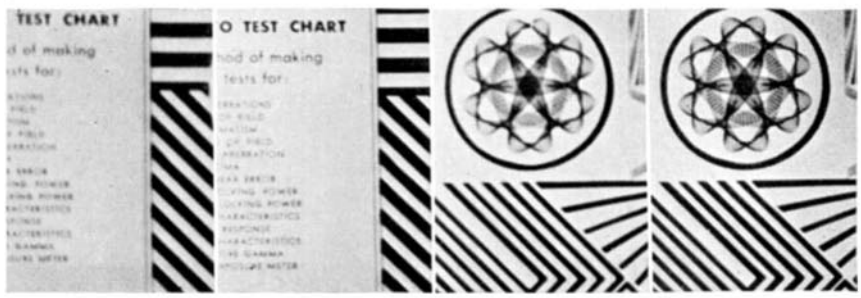
Image Sharpness

WHEN you say your camera does not make sharp pictures, you can mean any one or more of a number of different things. Let us check over the things that might interfere with getting consistently sharp images in your negatives and your prints. Only then, and this will be the case only if our tests have been accurate, may we say that the lens simply is not sharp; that is, its resolving power is so low that it is inherently incapable of rendering a sharp image.

First of all, we must set aside all factors of a mechanical nature, such as failure on the part of the photographer to focus the subject properly; inability to hold the camera steady during the exposure, thus causing camera shake or movement; the use of a shutter speed too slow to stop the motion of an active subject, and so on. We are to take all these things for granted.

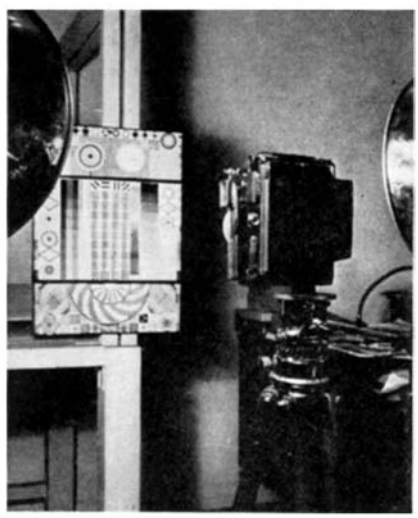
One of our readers recently wrote to say that his lens does not give a sharp picture even when he stops the diaphragm way down. Thereupon, he hit on one of the popular false notions, namely, that a very small stop will always give a sharper picture than a large one. However, this is too sweeping a statement to make concerning all lenses, because the situation differs with different lenses. With some lenses the very smallest stops will give an unsharp picture, at least not as sharp as one a stop or two larger. The best way to find out what your lens does at various stops is to give it a thorough test by setting up a test chart, or something similar, having fine lines and printing or writing on it, illuminating the chart evenly, as in copying, and then making a series of exposures at the different lens openings, compensating for exposure as you go along. After you have made the test and made prints from the several negatives, you will know which lens stops to favor and which to avoid, if you possibly can, under operating conditions.

In a recent test of two lenses, we found that in the case of a semi-telephoto lens, the largest stop of *f*/4.8 gave the poorest image sharpness, while the smallest stop of *f*/32 gave the sharpest. As a matter of fact, the only really sharp images were those taken at *f*/22 and *f*/32. The results are reproduced in Figure 1 (wide open, *f*/4.8) and Figure 2 (stop *f*/32). In the test of the other lens, the wide-open stop of *f*/2.9 was definitely soft or unsharp; satisfactory sharpness was not apparent until the stop *f*/8 was used. Equally good results were found at stops *f*/11, *f*/16 and *f*/22, but fell off again at stop *f*/32. When using this lens, therefore, we try to use only the stops from *f*/8 to *f*/22, employing the larger stops only when absolutely necessary.



Left to right: **Figure 1, wide open at *f*/4.8; Figure 2, at *f*/32, both semi-telephoto lens. Figure 3, wide open; Figure 4, at *f*/22, other lens**

In testing the results, we enlarged the test negatives 20 diameters. This was the supreme test, of course, and it may be argued that such large enlargements are not often made. However, the prints tell the story better than normal enlargements would have. In this connection, image sharpness may be relative, depending on how big an enlargement you intend to make. An enlargement of five diameters, for example, may be perfectly satisfactory as to sharpness even when some of the stops are used



Camera set-up for checking lens sharpness with chart

that were deemed unsatisfactory when "blown up" 20 times.

Unless fine-grain film is used and this developed in a fine-grain developer, another factor tending to unsharp results is coarse grain. This again will depend on the magnitude of the enlargement. A small enlargement of the full negative may not show it, but a greater one would. Other factors in this connection are over-exposure and over-development, both of which will cause grain in the enlargement and therefore image unsharpness.

How Much Diffusion?

THERE is diffusion . . . and diffusion. It is a method calling for an understanding of the fitness of things. What to diffuse and what not to diffuse depends on the subject and the effect wanted. But, aside from this, there is also the degree of diffusion that is, according to the majority opinion, permissible in any photograph.

As a lark the other day, we attempted to find what this maximum

Figure 1

of diffusion might be, and where it is best to stop for generally acceptable results. For the purpose, we employed a number of metal screens of various degrees of fineness, or coarseness. The screen was made up of many apertures in a regular, evenly spaced pattern, like an engraver's screen. After projecting the image on the easel, we interposed the coarsest of the screens between lens and easel, holding the screen fairly close to the lens during the total exposure. We then interposed for successive prints each of the other screens, the coarseness used being successively finer. The finer the screen, the greater was the diffusion.

The greater the diffusion, the more exposure was required because the intensity of the light became weaker in each case. In addition, the tone scale was spread out more and more, thereby necessitating the use of paper having a harder contrast. The maximum of diffusion, in our opinion not

Figure 2

desirable because it comes too near a simulation of an out-of-focus image, was obtained with a screen four times as fine as the coarsest. The result is shown in Figure 2; Figure 1 is the reproduction of a print made through the coarsest of the screens used.

To Retouch, or Not

"THE technique of portrait retouching," writes Mrs. K. C. Anderson, in a letter to *The Agfa Diamond*, publication of Agfa Ansco, "has got to change along with lighting, style, and general changes in photography. I personally think that the old school of retouching is passing and any photographer who insists on an 'overall' job is not keeping up with the modern trend. Such terms as blending, building, stippling, and modeling are only valuable in retouching amateur portrait work where there is poor, unbalanced lighting. . . . It is a fact that retouchers generally have been slow to see the new trend toward realism in portraiture and they still retouch negatives the way they did 12 years ago, removing lines of character and personality from the face."

Bravo, Mrs. Anderson! These are exactly our sentiments, too.

Slide Continuity

YOU'VE picked the 100 best Kodachrome slides in your collection. You've classified them according to type of subject: flowers, street scenes, beach scenes, landscapes, sunsets, and so on. Your family or a group of friends have come in great anticipation to see them projected. For a while, everyone "oh's" and "ah's" at some of the fine color impressions you have caught. After a time, there is only an occasional "oh" from some polite guest, and you sense a lag in interest. In the semi-darkness you may even have had the disheartening experience of spying someone dozing.

What is the matter? The slides seem to be good, the color reproduction fine. Well, for one thing, the attention of an audience—and it is still an audience, even if it consists of

Over $1100 in Prizes
36 Chances to Win

Sixth Annual
Scientific American
AMATEUR PHOTOGRAPHY CONTEST

POPULARITY of the divisional method of judging photographs in the Scientific American Annual Contests, as determined by the enthusiastic response in past years, has been so great that the method is once more being used for the Sixth Annual Contest. In each of the divisions listed below there will be awarded seven major prizes and five honorable mention awards, a total of 36 prizes in all.

Please read the rules carefully and abide by them. Note particularly Rule 6, under which any contestant may enter a total of six prints, but no more than two in any single division.

Divisions In Which Prints May Be Entered

Division 1. Human interest, including camera studies of people, animals and so on. Portraits will be grouped in this division.

Division 2. Landscapes, including all scenic views, sea scapes, and so on.

Division 3. Action, including all types of photographs in which action is the predominating feature.

THE PRIZES

1st. Three $125 LONGINES, Pres. Harrison Model, Solid Gold, Men's Wrist Watches.

2nd. Three $90 LONGINES, Presentation Model, Solid Gold, Men's Wrist Watches.

3rd. Three Intercontinental Marketing Corporation PHOTRIX "22" Enlargers, complete, less lens. (List price $54.)

4th. Three Burleigh Books FOTH-DERBY Cameras, with built-in coupled range finders. (List price $34.75.)

5th. Three WESTON No. 715 Exposure Meters. (List price $24.)

6th. Three ABBEY Vimo Flash Guns. (List price $13.75.)

7th. Three Raygram LEE Timers. (List price $12.50.)

Five Honorable Mention Awards, each to be a new or renewal subscription to Scientific American for one year.

Address all Entries to

Photograph Contest Editor, Scientific American
24 West 40th Street **New York, N. Y.**

Rules of the Contest

1. The groups will be judged independently on the basis of pictorial appeal and technical excellence. The decision of the judges will be final. In case of a tie for any prize, duplicate prizes will be awarded to the tying contestants.

2. Prints must not be smaller than 5 by 7 or larger than 11 by 14 inches. *All prints must be mounted,* otherwise they will be returned immediately.

3. Photographs must be packed properly to protect them during transportation.

4. Non-winning entries will be returned only if sufficient postage is included when the prints are submitted.

5. Each entry *must* have the following data written on the back of the mount: Name and address of contestant, type of camera, and film, enlarger, and paper used.

6. Contestants may submit no more than two prints in each group, but may enter any or all groups. In no case, however, will more than one award be given to any individual contestant.

7. Prints must be in black and white or monotone. Color photographs are not eligible.

8. Prize-winning photographs will become the property of Scientific American, to be used in any manner at the discretion of the publisher.

9. Scientific American reserves the right to purchase, at regular rates, any non-winning entry.

10. No entries will be considered from professional photographers.

11. All entries in this contest must be in the hands of the judges by December 1, 1941. Results will be announced in our issue dated February, 1942.

12. The contest is open to all residents of the Western Hemisphere who are not in the employ of Scientific American.

13. In fairness to all contestants, failure to comply with any of the above rules will result in automatic disqualification.

THE JUDGES:

McClelland Barclay
Artist

Ivan Dmitri
Artist and photographer

T. J. Maloney
Editor of **U. S. Camera**

Robert Yarnall Richie
Photographer

only two or three persons—has to be lured. Exhibiting a catalogue, however beautiful its individual parts may be, will not hold an audience for long. There must be some sort of interesting progression, or continuity, as the movie folk call it. If you can describe an incident with your slides, that is one good way. An easier method is to assemble a group of slides that describe a locale or a people. Even flowers can tell a story by grouping different specimens of the same flower, for example. Whatever plan you adopt, and this naturally will be governed by the type of slides in your collection, segregate the slides into small groups instead of projecting individual ones haphazardly. In addition, a line of chatter will help and record music to suit the subject, played softly, will supply a fine background of atmosphere. In short, since you're giving a show, make it a show and not a salesman's demonstration of his wares.

Adjusting Temperature

THE necessity for temperature accuracy in development is taken for granted, particularly in the case of fine-grain processing. The method often employed is to test the temperature in the bottle. For greatest accuracy, however, it is suggested that the solution be poured into the tank or developing tray and tested there. For adjustment up or down, place the tank in an empty tray, pour the developer into the tank and then allow water to run into the tray, hot or cold, whichever is required.

Let Them Pose Themselves

WE DIDN'T have very much to do with posing the lads on this old scow scaffold. "Mister, take our picture," they yelled, and up they went as we nodded assent. Two of them went straight to the top, the others preferred a midway position. The lad on the bottom really saved the day

"Mister, Take Our Picture?"

in the matter of composition. We asked him to come down two steps and as he did, he assumed the pose you see. It was a happily chosen pose because it brought the needed weight to the lower right hand corner of the frame.

In situations of this sort, with active children such as these, the more you fuss posing them the less success you have. Try letting them arrange themselves; rather frequently, the result will be better than you anticipated.

Color Horizon

EVEN a dull day, with sky heavily overcast, may offer a good subject for color photography. All late afternoon there gleamed on the horizon a long, thin ribbon of golden, gleam-

"Storm Brewing"

ing light, which grew more mellow as the afternoon wore on towards sunset. It was too beautiful to miss a color record, but you couldn't simply shoot the horizon; you had to have something to fill the predominant expanse of sky. Part of an old wrecked ship, therefore, was used as a frame to occupy the sky and bring the attention to the ribbon of light separating the horizon and the sea of heavy clouds. We took a number in black and white as well as in color, the illustration showing one of the arrangements. In color, the exposure was *f*/9 at 1/20.

Contest Prizes

WHEN the rules and prizes for the Sixth Annual Scientific American Amateur Photography Contest were first published, we had already placed orders for the prizes, had received many of them. First prize watches, however, were not delivered when ordered. Now we find that, due to war conditions, it is impossible to obtain the Longines Coronation Model watches originally offered. Hence we have substituted, as the first prize in each division, a Longines President Harrison Model man's wrist watch,

valued at $125. This watch is as high grade in every respect as the Coronation Model, lists at the same price.

We hope that this change in the prize offer, made necessary by conditions beyond our control, will be equally acceptable to all contestants.

Aid to Allies

FORMATION of the Photo Arts Committee for War Relief to the Allies, is announced by Albert Greenfield, of New York City, the committee's Executive Secretary. The committee, formed for the purpose of putting into immediate application President Roosevelt's appeal for all aid to the countries battling the Nazi war machine, is sponsored by many leaders in the photographic industry.

"In order to make the campaign as effective as possible," states Mr. Greenfield, "the photographic industry has been divided as follows, with representatives of each group on the sponsoring committee: photographic manufacturers, distributors, dealers, editors, publications, camera clubs, societies, press photographers, photo finishers, photographic schools, commercial photographers, and photographic models."

Readers of Scientific American who have suggestions to make, are urged to write to Mr. Greenfield at national headquarters of the committee, 331 Madison Avenue, New York City. Those wishing to send contributions may mail checks or money orders drawn to Photo Arts Committee for War Relief to the Allies; these should be sent to the national headquarters.

New Blackout Exposures

SINCE the publication of our article on the Wabash Blackout Superflash in the October issue, the company has made a change in the composition of the dye-lacquer solution with which the bulbs are coated. The resulting red glow is much weaker than was the case with the first bulbs, making it more useful than ever in the fields for which it was designed. The exposures are necessarily longer. Wabash suggests the following for "black" bulbs now on the market:

1/25th second, up to 15 feet..... *f*/5.6
1/50th second, up to 15 feet..... *f*/4.5
1/100th second, up to 12 feet..... *f*/3.5

• • •

WHAT'S NEW

In Photographic Equipment

PRECISION ENLARGER WITH POWER-COOLED LAMPHOUSE ASSEMBLY: B Assembly, for large negatives, now has Power-Cooled Lamphouse Assembly B designed so that stream of cool air is directed through lower portion of lamphouse to circulate between surfaces of heat absorbing glass and opal diffusing glass. Air current does not circulate directly above negative area, thereby eliminating possibility of dust being deposited on negative holder. Because of temperature control, user may substitute higher wattage No. 213 lamp for regularly supplied No. 212, increasing speed of enlarger about two and one-half times. Control Box, supplied with enlarger, arranged so that cooling mechanism and enlarger lamp may be operated independently of each other. Sheet film, film pack film, plates and individual frames of roll film up to and including 4 by 5½

inches accommodated in Combination Negative Carrier B. Adjustable Negative Mask B permits masking off any desired portion of negative. Prints 11 by 14 inches on baseboard; entire head may be turned 180 degrees around column for projecting on floor or swung and locked at any position from vertical to horizontal for projecting to wall.

MODEL "K" M.C.M. PHOTOMETER ($5.85): Combined photometer and densitometer. Third scale (logarithmic) added to read directly in absolute densities. New scale converts Haynes Photometer into projection densitometer; can be used to measure fog level of negatives, balance densities of color separation negatives, estimate gamma to which negatives are being developed, and so on.

PANATECH DARKROOM APRON: Available in black or white. Made of bombazine cloth, with heavy calendered rubber coating. Measures 36 inches long, 24 inches wide. Drip cuff at bottom held by snap-buttons, for draining. Neck strap, waist strap of heavier quality web.

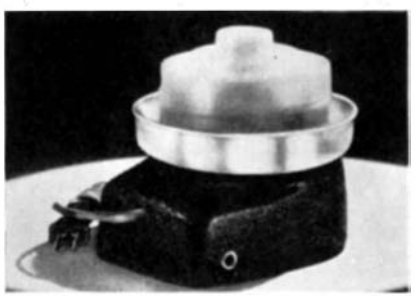
LEE STROBO SPEED LAMPS: Designed for ultra-high-speed photography. Speed approximately 1/30,000 of a second. Cool light. Allows maximum image detail, extreme penetration of light, complete subject control. Almost all camera shutters easily synchronized with lamp, no readjustment of shutter tripper necessary when changing from flash bulb to Lee

Speed Lamp. Will work independently of shutter action. Small apertures permissible with consequent increased depth of field. Consists of complete power supply unit which can readily be assembled by anyone with only a screwdriver, pliers, and soldering iron; complete plans and illustrations supplied. Offered in three models: A-1 consists of one lamp unit complete with one 15-foot special extension cord and one flash lamp tube for 115-volt, 60-cycle use ($125); B-1 consists of adapter unit in identical metal cabinet to A-1; converts A-1 unit to three-lamp unit, C-1, at any time ($150); C-1 consists of three-lamp unit complete with three 20-foot special extension cords and three flash lamp tubes, 115-volt, 60-cycle ($250).

NEW MIDGET FLASH PRICE: The price of the Wabash Superflash Midget bulb has been reduced from 15 cents to 11 cents, according to an announcement by the company.

BROWNIE REFLEX, SYNCHRO MODEL; BROWNIE FLASHOLDER: New model operates like old one when used outdoors, but is convertible to flash camera by attaching Brownie Flasholder (battery case, polished reflector, lamp socket). Flasholder designed for synchronized flash with Mazda SM (Speed Midget) Photoflash lamp. Ejector knob on back of reflector. Synchronizing switch within shutter preadjusted at factory so peak intensity of SM lamp occurs when shutter is fully opened. No further adjustments necessary.

C.S.I. FILM TANK AGITATOR ($3.35, complete): All-electric, featuring non-directional motion parallel to plane of rotation. Direction of circulatory motion changes every one



and one-half seconds, thus keeping fresh developer in contact with film at all times. Wertex plastic case. Tenite plastic pan. Capacity, two-quart tank, or less.

QUIXET: Magnetic movie titler, for black and white and Kodachrome titles. Made of plastic. "Alnico" magnets, requiring no adhesives or pins, hold firmly to any iron or steel surface through paint, lacquer, or enamel. Can "pull" through paper, cloth, photoprints, permitting use of unusual backgrounds. Can be arranged in curves, angles, circles, as well as in straight lines. Guaranteed to retain magnetic properties for ten years. Letters ⅝ of an inch high; also available in 1 and 1½-inch size letters. Come in sets of white letters with black panel and red letters with blue or green panel, in regular or deluxe sets.

KODASLIDE PROJECTOR, MODEL 2A: Available with either 5-inch, *f*/3.5 lens, or 7½-inch, *f*/4.5 lens. Replaces Model 2. Carries 150-watt lamp. New Projecto Case, in addition to Com-

bination Case for projector, lens, and file boxes, carries, in addition to latter features, folding leg stand which, when in use, provides convenient projection stand and extra shelf for 2 by 2-inch slide boxes.

KODAK ADVANCE ENLARGER, MODEL 2: Complete with baseboard and 98mm, *f*/11 projection lens mounted in removable lens board. Standard equipment includes friction-drive micro-focusing mechanism. New negative carrier designed to accept negatives in roll or uncut strip as well as individual negatives. Negative carrier of strong black molded material; frame holds two sheets of glass and one metal mask, latter making possible to enlarge 3 3/16 by 4½-inch sections of 3¼ by 5½-inch or 4 by 5-inch negatives. Set of metal masks, 35mm to 3¼ by 4¼ inches, available to fit negative carrier. Mask assembly held in close contact by two spring clips slipping over top sheet of glass. Removable plush-lined light guards clip into each end of negative holder. Film strip may be pulled through holder to selected negative without removing holder from enlarger.

MINICOLOR POCKET FOLDERS, CASES, ALBUM: Designed for display and storing of Minicolor prints size 2x (2¼ by 3¼ inches). Folder, of maroon leather-like material—for one, two or three prints—measures 2⅝ by 3½ inches closed, fitting into handbag or pocket. Prints held firmly in position by slipping corners under cellulose acetate corner pieces. Cases, holding one, two or three prints, similar in style to Pocket Folders, but designed with fold-over flap and glove-button fastener. Wire-bound Minicolor Print Protecto Album, holding up to 24 2x prints, has six transparent envelopes with gummed leaves inside to hold prints mounted back to back.

YOUR FIREARMS and FISHING TACKLE

Conducted by A. D. RATHBONE, IV

INTEREST IN FIREARMS *is traditional with American men; fishing tackle is a requisite of one of the world's oldest occupations. Scientific development of guns and tackle, in the use of which millions yearly find sport and recreation, fathers this monthly department which welcomes correspondence from readers.*

You Pull the Trigger . . .

WHEN YOU pull the trigger of your gun, you've started something—and in view of the enormity of the force you've set in motion, you will want to be sure that certain factors are properly under control—or else! It goes without saying that you'll have the gun pointed at something you *want* to hit. But how about other things? Is the barrel free from *all* obstructions, including a heavy coating of protective grease? Was your

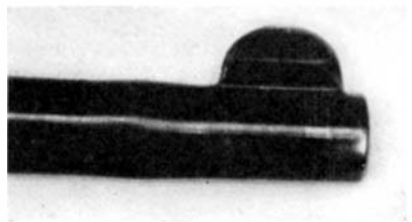


Photo by Lt. Kenneth Romaine
The shooter was lucky!

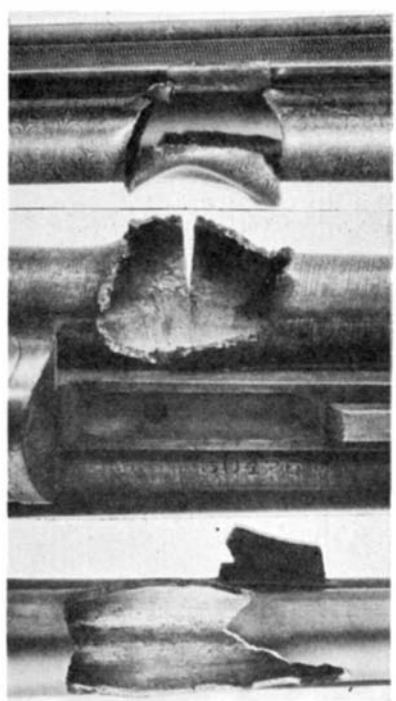
gun built to absorb the shock of the gas explosion that takes place when the fulminate of mercury in the primer ignites the gas-forming powder in the cartridge or shell?

Today's is a progressive-burning powder, which made possible the origin of high-velocity load development some 20 years ago, and it produces a gas that expands in volume to many times that of the charge of powder. In less than the flick of an eye-lash after ignition, this constantly increasing gas force tries to expand in all directions, and if the cartridge chamber of a gun were not strong enough, it would be blown to bits. Because the chamber is husky, because least resistance is offered by the light-weight bullet (or pellets, in a shotgun), the bullet is forced from its shell and into the barrel. Once the inertia of the bullet is overcome, and as this progressive-burning powder continues to burn and form more of the powerful gas, the slug—or scatter-gun shot—is boosted toward the muzzle and on its way.

As an example of variance in breech pressure derived from powder of former days and that of today, Damascus shotgun barrels were designed to handle shells that developed average pressures of about 5000 pounds per square inch. Modern high-velocity shot shell loads nearly double this pressure. The Remington Nitro Express load exerts its pressure at the terrific rate of about 36,000,000 pounds per square inch per second. Of course, this pressure build-up does not utilize much time—neither does the actual explosion of a one-ton demolition bomb—but it's long enough to raise hob with anything but a modern shotgun barrel, including the hand that is supporting it.

The standard .38 caliber S. & W. revolver cartridge develops approximately 16,000 pounds per square inch breech or chamber pressure. The cylinders of modern, well-known revolver barrels are constructed of chrome-nickel-steel alloy and specially heat-treated to resist such high pressure. In order to obtain workability, however, revolver *barrels* are not made of such alloy steel, nor are they heat-treated, for by the time the bullet enters the barrel, pressures are greatly reduced—that's how fast this whole process works!

The bulging of revolver barrels is invariably due to faulty ammunition. The cause can be either deterioration of the powder charge or priming charge, or the mere absence or near absence of powder in a cartridge. When one bullet stops in the barrel, and another is fired behind it (which is what happened to the gun in one of our illustrations), there is no leak-



They couldn't take it

age of air between them. Something must let go. Usually the barrel splits at its weakest point, often the point of stamping. Sometimes it doesn't split, but stretches sufficiently to allow the pressure between the two cartridges to escape one way or the other.

"Big-Time" stuff, this modern ammunition!

For Defense Training

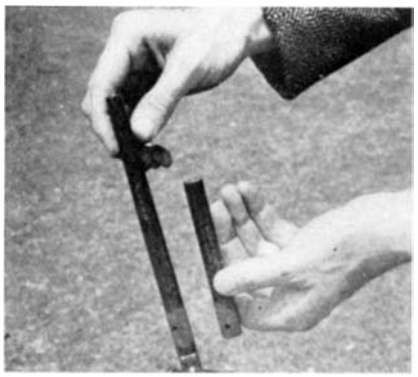
THOUSANDS of men have associated themselves with one or another form of civilian defense units. This influx of gunners and would-be gunners to the nation's revolver and rifle ranges, skeet and trap fields, has created an additional drain on the already limited supply of shotguns, small caliber rifles, revolvers, and

Targo gun

their respective ammunitions. Another problem is the expense of arms, shells, and cartridges.

In past issues we've pointed out possible solutions to this puzzle, and here's another. The Targo Gun, introduced by O. F. Mossberg & Sons, Inc., about a year ago, can be made to serve the dual purpose of providing .22-caliber rifle practice and aerial gunning practice on miniature clay targets, using .22-caliber shot shells for the latter operation.

The Targo gun is equipped with a 5-inch section of rifled .22-caliber barrel which is interchangeable with the Targo Tube, an 8-inch barrel section which is attached when firing the .22 scatter-shot shells. For this type of gunnery, the 14-ounce trap is fastened to the barrel ahead of the forearm so the gunner may release his own targets with his left fore-finger, or they may be thrown by another person with a Targo handtrap. Targets are one-half normal size, break on impact of the tiny shot pellets up to 50 feet.



Targo barrels

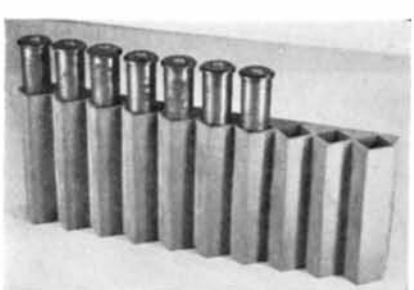
We've found the 5-inch rifled section of barrel provides remarkable accuracy in .22-caliber rifle fire. The inexpensiveness of ammunition and targets, the low cost of the gun itself, and the fact that it can be quickly adapted to either of two uses make the Targo outfit something to conjure with. Would you like a folder?

What of Sporting Arms?

A QUESTION that has doubtless come to the minds of many gun owners is: What effect have national defense efforts had on the production of sporting arms and ammunition? A recent survey, by correspondence, indicates that while price increases may be expected under present conditions, there will be little shortage of the more popular models of guns, shells, and cartridges for the next few months. Next year, however, may be different. The tooling up of arms and ammunition plants for defense requirements has necessitated utilization of every available machine unit, every ounce of man-power, and the temporary relegation to the background of less-widely-used sporting arms and ammunition. Adoption, months ago, of a far-sighted policy of heavy production and larger-than-normal stocking by manufacturers, distributors, and dealers will doubtless allay any serious shortages in the immediate future. Should present demands on American arms manufacturers increase, John Q. Huntsman and Aloysius X. Marksman can make up their minds that any resultant curtailment on their gunning activities will be just one more little sacrifice on their parts toward the furtherance of national defense.

Cartridge Carrier

A NEW shell pack, constructed of high quality rubber in red, black, and walnut-brown colors is offered by Mershon Company, Inc. The "Sure Grip" protects the lead, holds 10



cartridges of any high-powered caliber, fastens to belt with two-inch loop running full length of pack. Cartridges do not rattle or work loose; drain holes permit sand, dust, or other foreign elements to fall out of the bottom.

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 Maker—Advanced."

NO MACHINE is needed for grinding and polishing telescope mirrors, and only a minority of amateur telescope makers use machines, since one's two hands are a good machine. Nevertheless, among advanced mirror makers who finally tire of pushing glass by hand, or who, following Yankee tradition, need less than half an excuse to build a machine of any kind, machines are becoming more and more common. No machine has been copied so often as the one described by Hindle in the present (fourth) edition of "Amateur Telescope Making." This machine—now firmly established—is a pronounced success. Such a machine was built by Cyril G. Wates, 7718 Jasper Ave., Edmonton, Alberta, Canada, and described in the January, 1941, number of *The Journal of the Royal Astronomical Society of Canada*, 198 College St., Toronto, Ontario, a journal which, by the way, is entirely amateur even if "royal," and the following is a slight adaptation from that description.

"The machine shown in Figure 1 was constructed almost entirely of junk parts and the cost was surprisingly low. The framework is built of 2" x 2½" x ¼" angle-iron. The motor *F* is a second-hand washing-machine motor. The main flywheel came from an ancient treadle-drive dental engine.

"The main drive shaft *G* is ¾" steel shafting, but it would be better to use 1" shaft, as the lighter shaft has some tendency to whip at the center. The upright shaft *H* is driven by a worm gear from an old car. Shaft *J* is driven by a bevel-gear taken from a discarded differential.

"With regard to the bearings, of which there are six, it was found that standard pillow blocks would run into quite a sum of money, so a makeshift was devised consisting of short sections of 2" pipe welded to bases of heavy bar iron. The various shafts were centered in these pipes and babbitted, grease-cups being inserted in the four upright bearings, and oil-holes bored in the horizontal ones. All speeds being low, these bearings should run without appreciable wear for a very long time.

"The working platform *D* consists of two layers of ¾" board, glued and screwed and then given several coats of paint. It is fastened to a flange at the upper end of the 3" pipe *E*. At the lower end of *E* is a short bolt running in a plain bearing. This bolt is fastened into a plug of oak secured to *E* by means of wood-screws. The platform turns very slowly, being driven from the shaft *H* by means of a bicycle chain and sprockets.

"At the tops of the upright shafts are adjustable cranks, *K* and *L*, which control the motion of the 'alligator.' The elaborate construction of the right-hand crank is an unnecessary refinement. It can be seen that the crankpin *L* is controlled by a long screw with a ratchet-wheel *M* at one end. This ratchet encounters the double pawl *N* at each revolution, thus providing a continuous variation in the length of the swing.

"The alligator, *A*, is a framework of 1" x ½" channel-iron, welded together. The alligator is built around a square frame which embraces the mirror. Four lengths of ½" pipe are welded into holes in the corners of this frame. Sliding in these pipes are ½" steel rods, one of which is seen plainly at *B*. The rods are tipped with rubber buffers—carried by most hardware stores for walking sticks. The push-rods are locked in any positions by means of set-screws threaded into the alligator.

"The crankpin *K* drives the alligator from any one of several holes in the center brace of the framework, permitting adjustment for overhang, as in the Hindle design.

"Two adjustable guides are seen in the photograph at *P*, *P*. These prevent rocking of the alligator. Only one guide is necessary and the right-hand one has now been removed. The contact between the alligator and the guide is the one place where, in spite of lubrication, squeaking occurs. This was overcome by fastening a leather strap on top of the guide. The weight of the alligator should not rest on the guide but on the adjustable collars on the crankpins.

"Crankpin *L* works in a long slot formed by two facing angle-irons at that end of the alligator. Therefore, crankpin *K* provides the drive, while crankpin *L* gives the swing.

"On top of platform *D* is a simple drip-pan, made by soldering a strip of galvanized iron to a disk of the same material. The tool (or mirror) is held in place, slightly off center, by blocks secured to the platform by wood-screws. A sheet of paper under the blocks makes cleaning-up a very simple job.

"When in operation, the push-rods move the mirror in a series of elliptical strokes over the surface of the tool, these ellipses traveling from side to side under control of crankpin *L* in its slot. Obviously, the length of stroke and the swing can be changed as desired, from a very long stroke for roughing out the curve, to a short stroke for bringing the disks into spherical contact.

"The most important feature of the Hindle machine has not yet been mentioned: the method of rotating the mirror, *C*, between strokes. This motion is provided by adjusting the push-rods so that there is a clearance of about ¼" between the rubber buffers and the edge of the disk. This

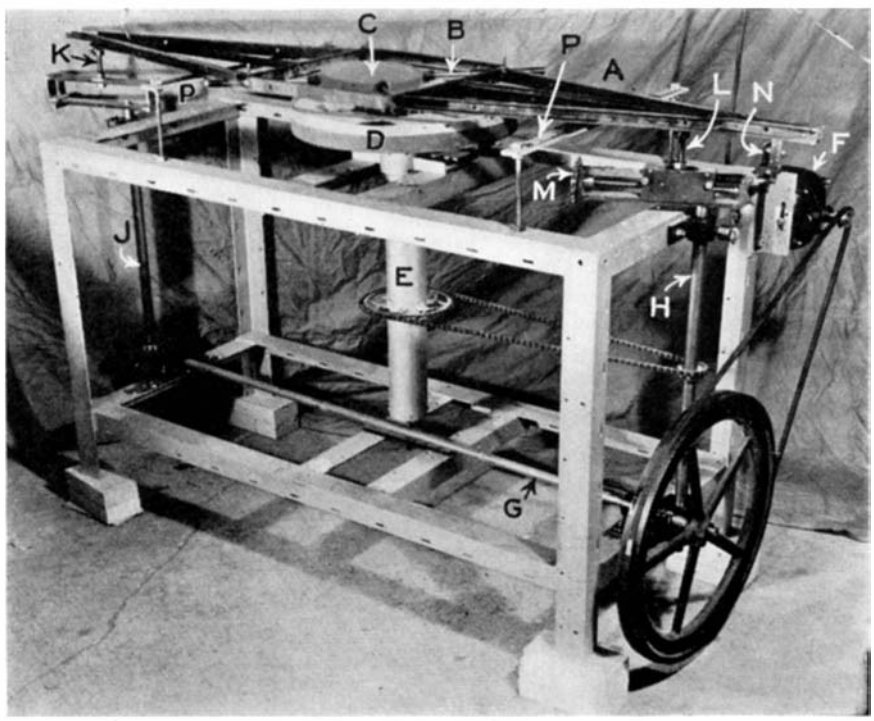


Figure 1: **The Hindle type machine, as built by Wates, of Canada**

clearance means that, at the commencement of each stroke, one of the buffers will touch the mirror before the other, thus giving it a slight turning movement. This action is similar to what mechanics call a continuous ratchet.

"I wish to call attention to an error in the construction of this machine as pictured. A study of the various gears shows that the mirror turns in the same direction as the tool. To correct this condition, the shaft *G* with its

Figure 2: Wates, 12½", & 4" RFT

worm should be placed on the other side of the shaft *H*. I have not considered it necessary to make this change since the mirror and tool move at quite different speeds. If they moved at the same speed, astigmatism would, of course, result.

"When roughing out the curve, the machine provides the overhang recommended by Everest in his article in 'Amateur Telescope Making—Advanced.' The stroke and swing should be as long as possible consistent with the avoidance of tipping. The machine should be operated by pulling the belt until the operator is quite sure that the mirror will not tip, before starting the motor.

"As Everest explains, the elliptical-overhang stroke results in the center of the mirror being hogged out, while the edge is scarcely touched. If, therefore, the rough grinding is continued until the center of the mirror is deep enough, the outside zone will be practically flat, giving a shape like the inside of a 'tin hat,' and it will be impossible to bring the curve out to the edge without deepening the center. To avoid this, grinding should be stopped when the center is about two thirds the correct depth, and the stroke and swing gradually shortened. With a little care the right depth can be reached just as the curve reaches the edge.

"The elliptical stroke pushes the abrasive off the edge. For this reason no paper is used on the platform during rough grinding, so that the mess may be scraped off and settled after each spell of grinding. Carborundum and water may be added from time to time as the machine operates, but the disks should be washed off about every 15 minutes. A weight of about 8 ounces per square inch is advised for rough grinding, tapering to 4 ounces for fine grinding and zero in

the last stages of the same process.

"The well-known practice of reversing mirror and tool between each stage of fine grinding is highly recommended as a sure method of bringing the disks to spherical contact. I can also recommend a minor discovery of my own for testing contact. Buy a tube of artists' 'Black Stumping Chalk.' Smear a little of this across a diameter of the clean, dry tool. Lower the mirror centrally into place and rub gently without pressure. When the mirror is removed its surface will show black streaks at all points of contact.

"Much may be done in reducing high zones by smearing abrasive on the zone to be operated on, and using a very short stroke. It should also be remembered that the greatest abrasive action takes place at the points where the edge of the tool comes at the end of a stroke. Repeated changes in the adjustment of the cranks is therefore the secret of avoiding gross zonal errors. This applies even more strongly in polishing.

"Polishing will be done with pitch, pitch with wax facets, or HCF, according to the taste of the operator. Long spells of polishing can be carried out by using HCF combined with rouge and soapy water. As Hindle points out, the use of soap obviates the necessity of scoring the facets. With regard to figuring, in spite of popular belief to the contrary, it is perfectly possible to complete this operation on the machine without any hand work at all.

"Crank shaft *J* rotates at 60 R.P.M. *H* at about 13 R.P.M. and the platform at about 2 R.P.M. These figures are reduced by one half during rough grinding by the use of a smaller pulley on the motor.

"The 12½" Pyrex mirror for the telescope shown in Figure 2 was ground by hand before the machine was built, but polishing and figuring were done on the machine, including the correction of a very bad hyperbola. The mounting of this telescope, which is designed for the University of Alberta, is a modification of the familiar double yoke, with the declination axis off-center to provide greater access to the polar regions. This necessitates a counterweight of about 125 pounds to balance the tube. The head of the tube moves on ball bearings, being turned by a handwheel (not seen) engaging with a circular rack.

"The entire telescope weighs about 750 pounds. The foundation and upright are, of course, temporary, as a concrete pier will be provided. The 24" wheel at the top of the polar axis provides means for the installation of a drive designed along the lines of the one invented and described by Mr. H. Boyd Brydon in a recent issue of the *Journal of the Royal Astronomical Society of Canada*. "Dignity and Impudence" are exemplified by the 4" Richest Field Telescope seen in the lower right hand corner of the picture.

"The Hindle machine is a labor-saving rather than a time-saving device. Rough grinding will take as long, possibly longer, than by hand, since we cannot increase the speed much beyond one stroke per second without nullifying the tendency for the upper disk to become concave, and changing abrasive is a slower job than in hand work. Some saving of time may be expected in fine grinding, and there is less temptation to skimp this vitally important item. Polishing is much faster than by hand, principally because long spells of work are possible without interruptions for rest.

"Perhaps the greatest advantage of machine-work lies in its perfect regularity. Despite popular opinion, there is no special virtue, *per se*, in the irregularity of hand polishing. The ideal lies in what may be called 'uniform irregularity.' With the Hindle machine the cranks are adjusted to give any desired stroke and, as long as the machine is running, this stroke is maintained with perfect uniformity, but never twice over the same area of the tool or mirror. The slightly eccentric relation of the disks, the movement of the swing-crank, the rotation of tool and mirror, all combine to give an almost infinitely varied distribution of abrasion within the limits set by the chosen adjustments. Since these adjustments may be changed at will, it will be seen that we have here the mirror-maker's ideal of complete flexibility combined with absolute accuracy."

JOBS. Amateur telescope makers who may think of getting jobs in the industries which now are making optical products for defense may obtain, gratis, from this department, "personal history forms" which, when filled out and returned, will become part of a roster available to these industries.

As a matter of fact, a number of the amateur telescope makers already have been working in such plants, and for some time past, and they have been successful.

One of the early crop of amateur telescope makers was Winston Juengst, whose photograph appears on page 402 of "A.T.M.," a photograph taken years ago when he was a youth. Juengst subsequently completed a full course in optometry at the University of Rochester and now is supervisor of the School of Mechanical Optics, at Montague and Henry Streets, Brooklyn, N. Y. A number of men, starting with little or no optical experience, have passed through this school and on into industry.

Other amateurs are in the game professionally, here and there, and every effort is being made by this department to direct the skills acquired by followers of the hobby into defense work.

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CARBOLOY GRINDER BULLETIN (GT-135) deals with cemented carbide tool grinders and presents illustrations on adjusting and using these grinders. Complete specifications are also given regarding recommended accessories. *Carboloy Company, Inc., Detroit, Michigan.—Gratis.*

RADIAL, PIVOT, AND SPECIAL BEARINGS IN MINIATURE PRECISION SIZES is an eight page illustrated catalog which describes these tiny bearings, their applications, the types available, and gives technical data on specifications of the various types. The bearings described are said to meet the rigid requirements of government services and are now being used by precision instrument makers and other manufacturers requiring bearings of unusually small sizes. *Miniature Precision Bearings, Keene, New Hampshire.—Gratis.*

THE SPECTROGRAPHIC ANALYSIS OF TIN-LEAD SOLDERS, by D. M. Smith, deals with the determination of aluminum, bismuth, cadmium, copper, and zinc in tin-lead solders, as revealed by their spark spectra. *Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio.—Gratis.*

THE STADIUM, by Myron W. Serby, is a 64-page bound book which presents technical details of stadia design of interest to all architects and engineers. *American Institute of Steel Construction, Inc., 101 Park Avenue, New York, New York.—$1.50.*

RADIOACTIVE EXPLORATION, by R. Burton Rose, M.A., is a 16-page reprint of an address delivered before the Colorado Mining Association. It discusses some of the fundamental phases of radioactivity as well as recent developments in gamma ray detection instruments and detecting technique as applied in geophysical prospecting for petroleum and ore. The use of a new type portable detecting unit for field prospecting for radioactive ores is demonstrated. *R. Burton Rose, M.A., 1255 Cristina Avenue, San Jose, California.—10 cents.*

TEXSTEEL TEXDRIVE SHEAVES is a 12-page bulletin describing steel and cast iron sheaves for Texrope drives from fractional to 25 horsepower. The illustrations show a variety of applications of this particular type of drive and tables give lists of available sizes and various dimensions. A section is also devoted to a description of a new type of V-belt. Request Bulletin B-6047. *Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.—Gratis.*

JESSOP MAGIC CHISEL STEEL is an eight-page folder describing a silicon-molybdenum bearing cold work steel for use where extreme toughness and resistance to fatigue are required. Information presented includes analysis of the steel, treating methods, physical properties, and typical uses. *Jessop Steel Company, Washington, Pennsylvania.—Gratis.*

RADIO FOTO LOG, edited by Samuel Kaufman, is a 28-page pamphlet presenting a listing of broadcast, short wave, and television stations. Included are feature articles and photographs covering many topical phases of radio programs. Published by *National Union Radio Corporation, Newark, New Jersey.—Available through radio dealers and servicemen.*

FILM SCANNER FOR USE IN TELEVISION TRANSMISSION TESTS, by Axel G. Jensen, is a 19-page monograph which describes the design and construction of a television film scanner primarily intended as a testing tool in designing circuits suitable for television program transmission. *Bell Telephone Laboratories, Inc., 463 West Street, New York, New York.—Limited free distribution.*

LESSONS IN ARC WELDING is an 184-page bound book which presents the fundamentals of arc welding in a series of 60 lessons with 170 illustrations. *Lincoln Electric Company, 12818 Coit Road, Cleveland, Ohio.—50 cents in United States, 75 cents elsewhere.*

HEAT TREATING BY ELECTROTHERMIC-PERMEATION is a technical treatise on the principles employed in a new type of salt bath furnace used in the hardening of certain high-speed steels. Furnaces are described and data are given on capacities, power requirements, and so on, of various types. These furnaces are applicable to virtually any heat-treating process requiring temperatures ranging from 300 to 2500 degrees, Fahrenheit. *Upton Electric Furnace Division, Commerce Pattern Foundry & Machine Company, 7450 Melville at Green, Detroit, Michigan.—Gratis.*

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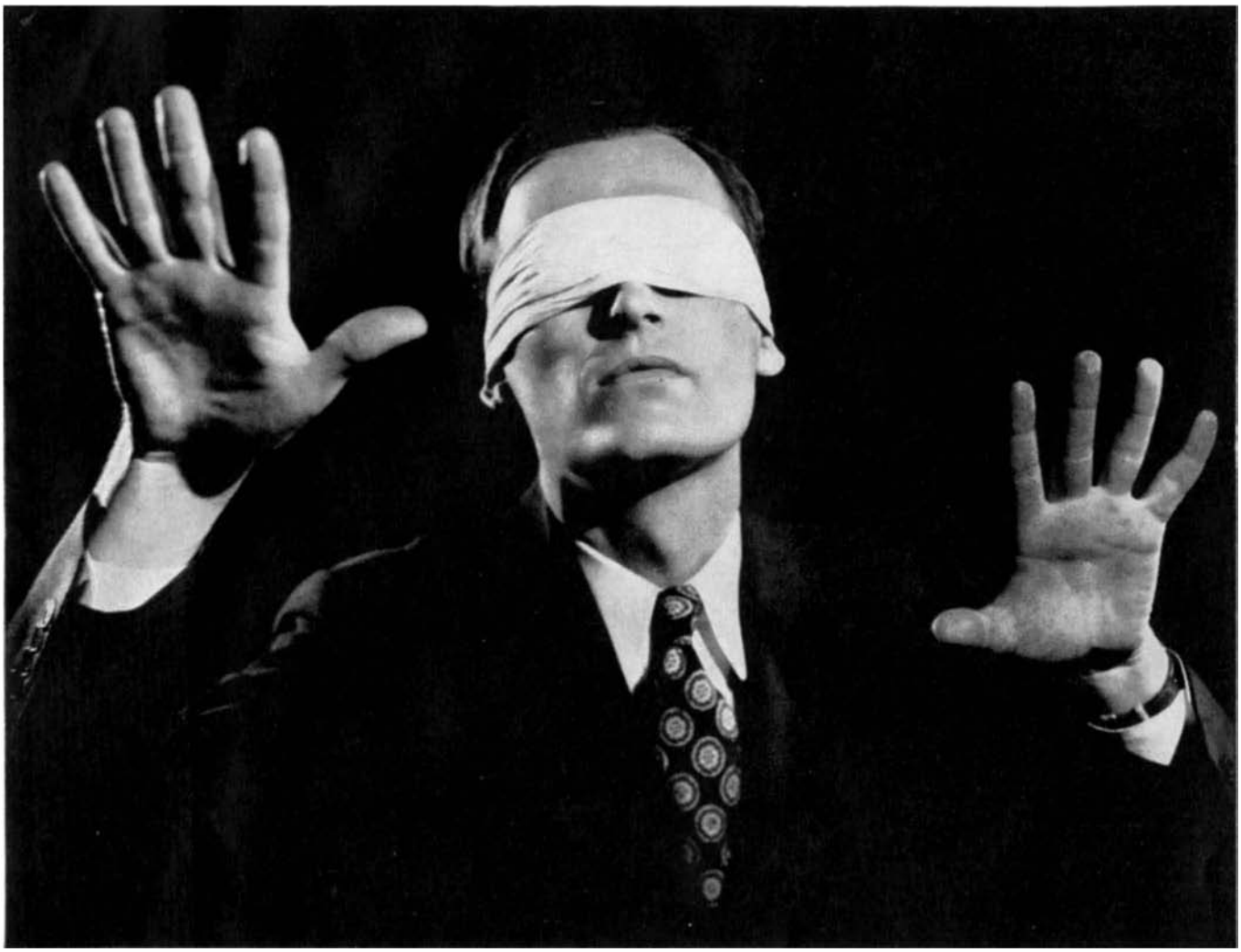

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