PARACHUTING MARINES . . . Page 3

SCIENTIFIC AMERICAN

JANUARY · 1942

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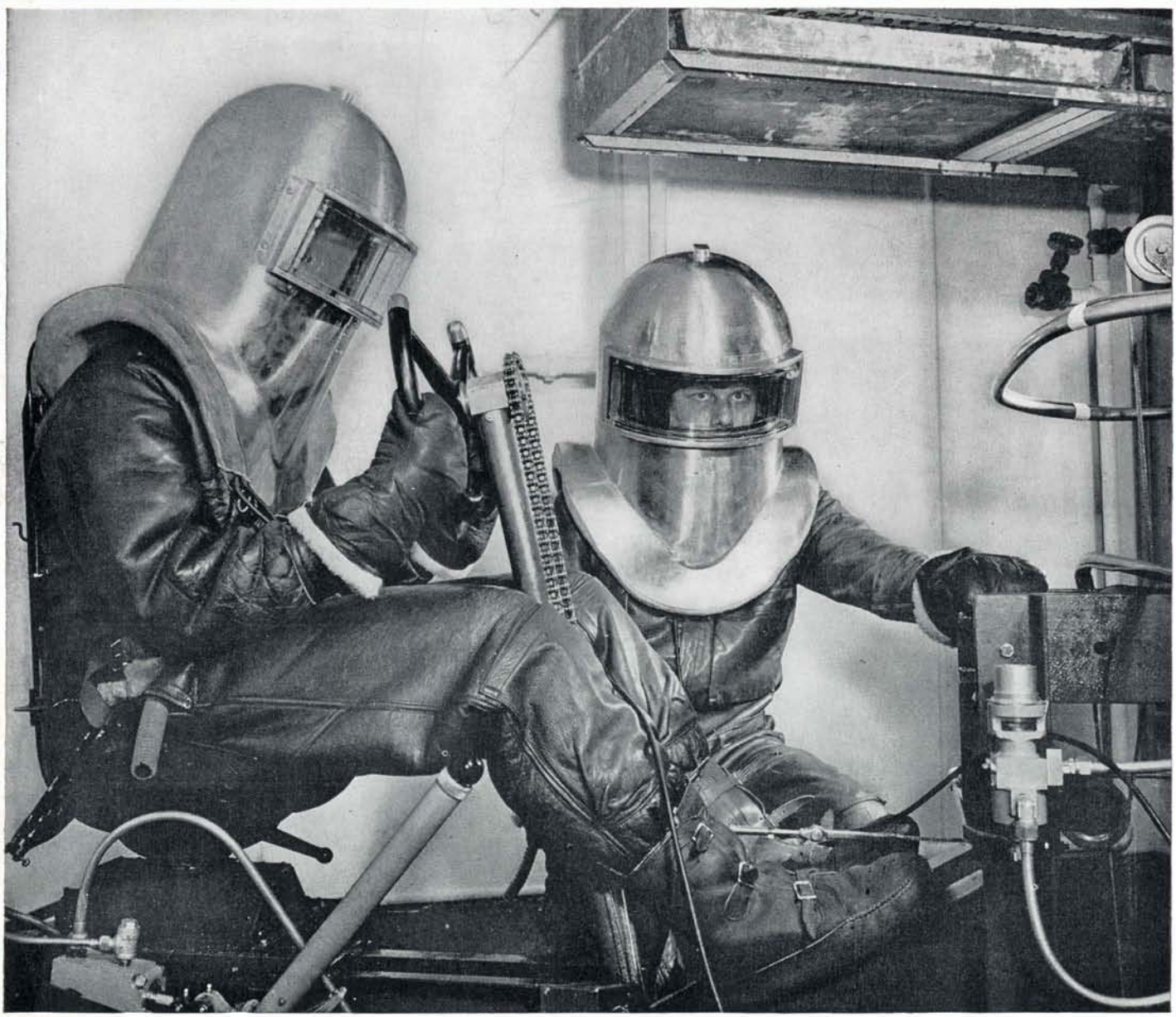
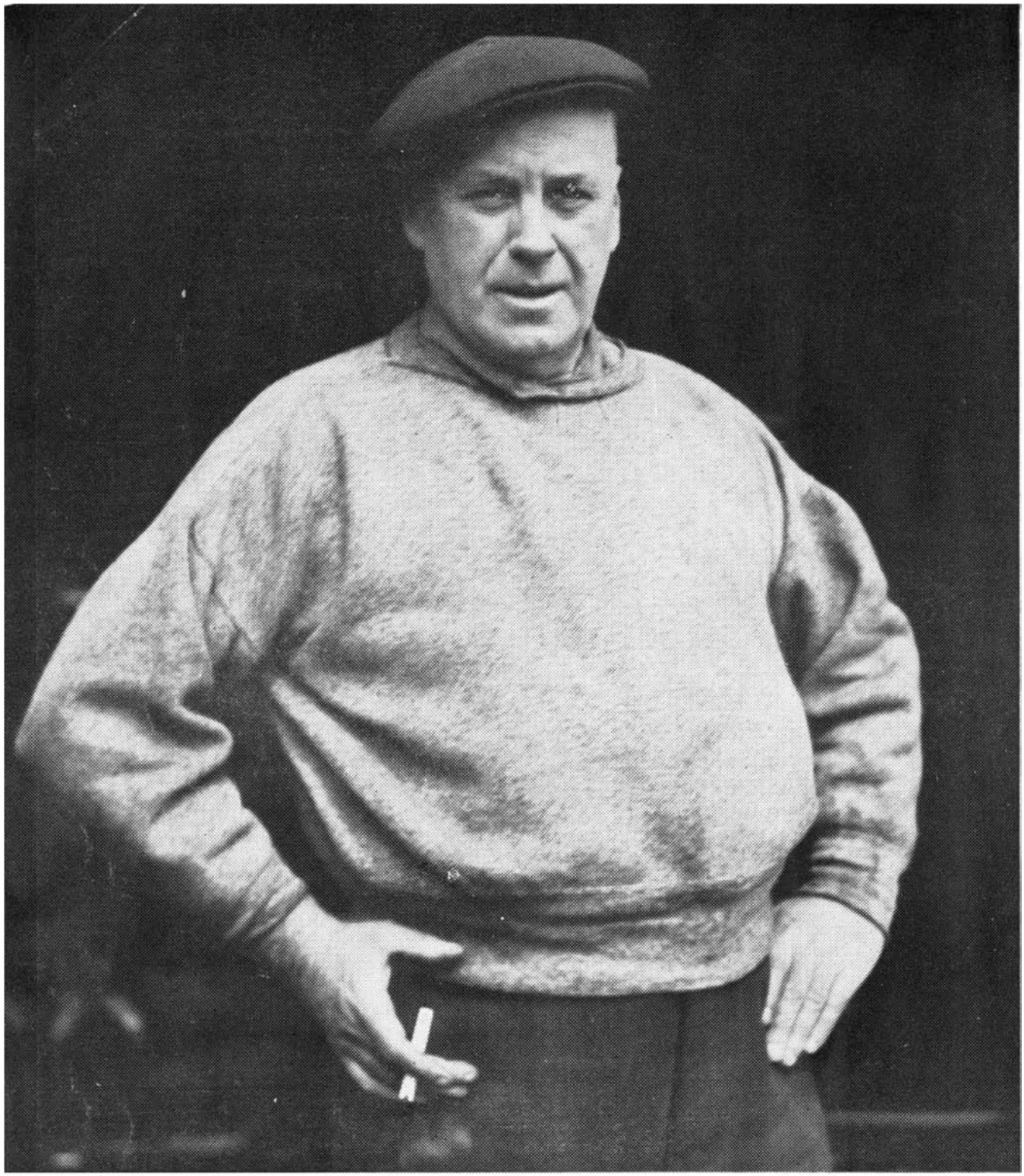


"High-Altitude Flight" at Ground Level



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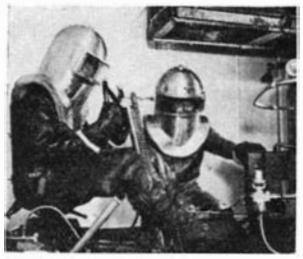

IN THE "cold room" used for aeronautical research at the Douglas Aircraft Company's plant in Southern California, these strangely dressed engineers are conducting research on high-altitude flying equipment. In this room, described in more detail on page 27, the conditions and effects of extremely low temperatures can be studied at leisure under controlled conditions.

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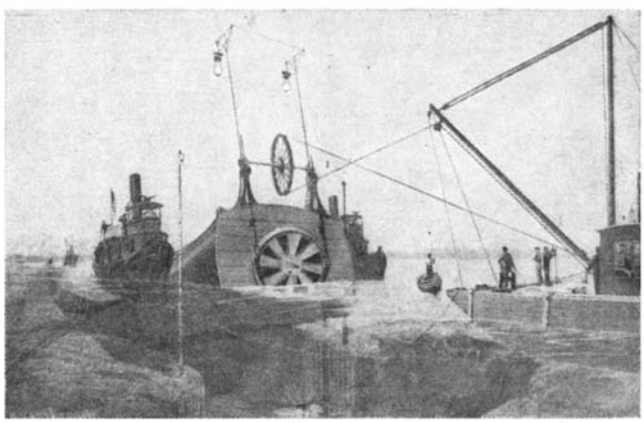
50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of January, 1892)

NAVY—"Our navy, as regards material, ships, armor, and ordnance, today is in the first rank among nations. All that is now needed is more ships and proper crews. The ships are being rapidly built. Congress might supplement the work so well in progress by providing for the improvement of the status of recruits, thereby securing intelligent and superior men for the naval service."

TUNNELING—"A method of constructing tunnels under rivers whose beds are of mud, clay, silt, or sand is shown in the illustration. A sectional iron tube is sunk in a cut dredged for it, leveled, topped with clay or concrete in



bags, the cut filled in and working shafts built around the ends. The tunnel tube is then pumped out and bricked up by sections, a roadbed made and junction effected with approaches."

FLEXIBLE GLASS—"Herr Eckstein, an Austrian engineer, claims to have discovered a strong and flexible substance, as transparent as the ordinary brittle glass. . . The material obtained is said to resist the action of salts, alkalies, and acids, and besides being transparent is odorless. It is flexible, and almost unbreakable. . . Any color or shade may be imparted to the new glass."

POWER—"After the completion of the great tunnel works now in progress at Niagara Falls, there will be nothing to hinder the rapid rise and growth of that interesting town into a great and wonderful city. Its dwellings and factories will be supplied with light, heat, and motive power at an extremely low cost, and useful industries of every kind ought there to flourish with unwonted vigor."

CABLE—"The Bahama Islands are soon to be connected with the general telegraphic system of Great Britain and the world. A submarine cable about 200 miles long will be laid from a point about five miles from Nassau, New Providence, to a point about the same distance from Jupiter Inlet, on the southeast coast of Florida."

INSANE GENIUSES?—"Men of genius have not, as a rule, been mad, except with an insanity of a scientific and scholastic kind, such as the world really needs more of. The eccentricities, monomanias, and emotional exaltations of genius have been incidental, and were not the basis of their character and temperament. . . Insanity is a condition in which the power of adjusting one's self and one's conduct to the environment is lost. Surely there is no loss of this kind shown in the work or conduct of men of genius."

"TELETYPESETTING"—"The management of the *London Times* has utilized the telephone in a unique way. Telephone wires have been laid in the underground railway tunnel between the composing room in Printing House Square and the Parliamentary reporters' gallery in the House of Commons. A copy reader placed at the telephone reads the stenographic 'turns' from the note book as fast as it is possible for the compositors to take them on their typesetting machines in the Times building, a mile and a half away."

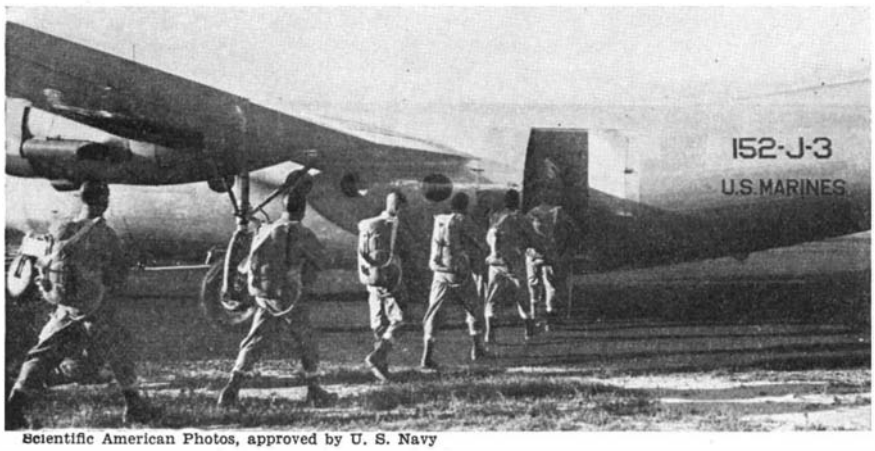
SAILING—"The demand for sailing vessels has, of late, shown a marked increase both here and abroad; in Great Britain, according to Lloyd's Registry, there being now 141 such craft with a total tonnage of 185,807 under construction against 76 with a tonnage of 80,000 this time last year. Here about the same tendency is manifest. The rate of steamer construction in Great Britain has seen a marked falling off during the year, and though in these waters the rate has largely increased, it may easily be traced to favorable legislation rather than to a further abandonment of the sailing type."

RAIN MAKING—"Nearly all the accounts of the recent rain making experiments in Texas appear to have emanated from, or to have been inspired by, persons who took part in the performances. These reports were, in most instances, grossly exaggerated, and, in some cases, wholly destitute of truth. . . It is understood that an attempt will be made to induce the present Congress to appropriate more money to carry out another series of these foolish fireworks."

CLOGS—"There is a considerable demand for wooden shoes in this country, especially in the Western States and Territories. They are worn by those who have become accustomed to the use of that kind of foot covering in the land of their birth and have not yet adopted the shoes generally worn here, and they are also used by persons who are employed in damp, sloppy places."

SPEED—"On a recent run by a Baldwin compound on the Baltimore & Ohio, hauling a 'Royal Blue' train from Philadelphia to Canton, on December 22, 1891, the time, including one stop at Wilmington and a slow-down at the Susquehanna bridge, requiring three minutes in crossing, was 101 minutes for 91.6 miles."

FORCE—"Man can neither create forces nor endow anything with properties. All that he can do is to convert and combine them into utilities. The man that does this with knowledge is spared the dismal failures of ignorance, but he that tries to use powers without understanding them is inevitably punished for his rash presumption. It is this presumption that causes the mortality and disease that follow in the wake of civilization. Natural law, like the civil, never admits ignorance as an excuse."



Scientific American Photos, approved by U. S. Navy

Fledgling Marine Paratroops about to make their first jump

rience. There was also a rigid physical examination in which the medico directed special emphasis toward freedom from organic heart disease, medical history of ankle, knee, or hip injury, if any, and systolic and diastolic blood pressure. In addition, there was a modified flight physical check-up on visual acuity, binocular vision, depth perception, and flight-ear examination as well as a test of equilibrium faculties.

IF, BY chance, you had grown a bit cocky over the physical perfection you had demonstrated for the benefit of the doctors, you would have had that nonsense knocked out of your system in an exceedingly "blitz" manner soon after reporting to Lakehurst Naval Air Station, along with other "perfect" lads from every state in the Union. Your six-week course of training, you would have found, had been arranged in three extremely strenuous periods of two weeks each. The first phase covered conditioning exercises—and were they "conditioning exercises!" They left you, at first, feeling as though you were a worn-out old rooster of 35 years, or so, who just couldn't take it any more. There was also an intensive course in parachute nomenclature and packing instructions; a study of landing methods, including harness training, platform jumping, and practice exits from dummy planes. You learned to roll and tumble around on the ground, like a circus acrobat, with muscles relaxed instead of tightly drawn.

The second two weeks covered more—bigger and better, you might say—conditioning exercises, with more rolls, more tumbles, more back somersaults. There was tower training, which meant utilizing an apparatus comparable to the New York World's Fair parachute jump, a drop of 125 feet in a 'chute guided by control cables. Then came more jumps from a similar apparatus, known as the "fly-away" tower, because the parachute you leaped with was pre-opened before the jump and was held that way by steel ribs, like an umbrella, but there were no guiding cables to direct you or control your landing. It was here, they told you, that a man really proves his readiness for the final phase of jumping from the 'plane. Along with these came parachute packing instructions and study of wind-drags, which included methods of controlling the 'chute through manipulation of the shroud lines.

The final, and most exciting two-week training period included a sort of post-graduate course in those ever-present conditioning exercises. By now they'd built you up from 20 to 45 minutes of exceedingly strenuous calisthenics early every morning except Sundays, with emphasis on leg and abdominal muscle development, capped by a brisk run, which was a half mile long to begin with and had gradually been extended to one and one-half miles. There was further training in parachute care and packing and, at long last, squad jumping from a plane in flight — which had resulted in your stepping off the edge of the plane's jumping port in the general direction of those Lilliputian pine trees and string-like roads, 1000 feet below.

The type of jump you've just begun is known as a "static line fall." Because of the mechanics of the static line, and in contrast to a "free fall" and a "delayed jump," this form of leap may be made from a plane as low as 250 feet in actual war-time operations. This short jump places men and equipment more closely together when they reach the ground, spots them nearer their objective than would a longer drop, and, falling at from 16 to 23 feet per second, offers the enemy far less time to attempt to make targets out of the landing force from the sky. As indicated by the terminology, the latter two types of jumps do not involve use of the static line, that stout, 13-foot strip of two-inch canvas webbing which is such an all-important factor in your present predicament.

YOUR fastidiously packed 'chute reposes in that canvas container strapped to your back. The static line is folded against itself several times and is held in place on the outside of the pack by two loops of elastic webbing. It terminates in a large, metal snap which, at that command, "Coming on the range!" you hooked onto the static cable that is strung lengthwise of the plane. The other terminus of the static line acts as the rip cord, tearing open the fastenings on the pack so the pilot 'chute can per-

Static cable fidgets

form its function of hastening the opening of your 28-foot troop 'chute. In other words, the static line is a mechanical rip cord which obviates the necessity of remembering to pull the rip-cord ring. If, for some reason, the static line doesn't perform, you grab the rip-cord ring of your reserve 'chute and—but why go into that? The static line has worked, the pack is ripped open, the pilot 'chute's released, and in a second or so you're going to receive the most severe yank or jerk your system probably has ever known.

POSSIBLY veteran jumpers can describe sensations and thoughts during the brief seconds that elapse between the leap from the plane and the teeth-loosening wallop that ensues when the 'chute opens and applies sudden brakes to a headlong earthward plunge, but to a neophyte that brief passage of time remains pretty much a blank. Although the parachute harness is designed to distribute the shock of opening to portions of the body best suited to absorb it, the come-uppance you receive when the 28-foot-diametered canopy abruptly goes to work is comparable to an almost instantaneous reduction of traveling speed from about 45 miles an hour to between 15 and 20 miles per hour. In an automobile, such a drastic change of pace might be preliminary to a swan dive through the windshield; in a parachute harness, you have a fleeting sensation that your skeleton is about to slide feet-first out of your body.

Despite the hours and hours of rigorous preparatory training for this bump in midair—training in which you were hooked into a practice harness, raised by block and tackle to the hangar roof rafters, and allowed to drop 'til the ropes caught you up short—you're surprised and slightly dazed at the short free fall and its sudden cessation. But in an eye's twinkling you're back to normal—as normal as can be expected when, for the first time in your life, you find yourself suspended some 900 feet above earth by 28 silken cords that funnel out from your body to the fluted edge of a gleaming white canopy which hides the sky and your fellow jumpers above you, but which is permitting you to float easily and gracefully downward. Actually, you have the sensation of being poised motionless, with a gentle breeze blowing up your nostrils and whistling past your ears, while the ground comes up to meet you. It's an exhilerating feeling to realize you've made your first parachute jump—that you've actually done it and that everything's under control. You feel like shouting or singing—and maybe you do both.

Now you begin to recall other instructions and more of your intensive training. You mustn't look up. Always look down! Keep your eyes on the ever-approaching ground. There may be rocks, trees, other protuberances that would contribute to an uncomfortable landing, but which may be avoided if you study the terrain below and manipulate your shroud lines properly. Those supporting ropes of braided silk, each with a tensile strength of 450 pounds, constitute the steering mechanism of your strange craft. If you want to drift further to the right, you reach up with both hands, grasp the shroud lines on your right side, and pull. This draws the gores of the 'chute downward, spills air out of the opposite side, and causes the 'chute to slide off to the right. The same procedure applied to the left, the front, the rear will motivate you in the desired direction, but don't slip too much air out—you might come down faster than good health dictates. All this, you know, you learned while practicing in a captive, stationary 'chute, suspended from the hangar rafters by wires, much like a gigantic umbrella.

Go! (Note static lines at jumping port)

Static lines are hooked to cable

THE ground's coming closer! Only a few seconds and you'll put practiced landing technique into operation. You recall the hundreds upon hundreds of training jumps you made from, first, the three-foot platform and, later, the eight-footer. The latter didn't prove much of a shock and you were told that, barring heavy winds or brutal ground conditions, your actual landing would be similar to such a jump. After all, you ruminate, an eight-foot jump, even onto hard ground, is kind of a sissy thing, so long as it's done correctly. You must land on the balls of your feet—never on your toes or flat on your heels. Let the legs spring naturally to take up the shock, and then pivot in the general direction of the wind. This puts you in a squatting-rotating position from which it is easy to follow through with that professional tumbler's back roll you practiced for so long. You simply ease down onto your buttocks, and with a continuous rolling motion in the general direction of the parachute, now falling onto the ground, you do the back somersault, and unless there's a strong wind, the 'chute will shortly collapse like a blown-up paper bag that has been smacked with the palm of the hand.

You're almost down! A couple of fellow Marines are running toward you to be ready with a helping

You're down—safely!

hand—just in case. You remember to reach up and grasp the shrouds on either side of you with both hands, for you're going to "break your fall" as much as possible by "chinning yourself" on the shrouds just before your specially clad feet hit old Mother Earth. Your toes wiggle anticipatorily in the soft leather of the rubber-soled, 10-inch high-tops. You recall having heard stories about broken ankles in the parachute training corps, and how the special shoes were reported to have steel braces for protection, but when your boots were issued to you, they were pliable, soft, and without the slightest trace of steel, and you learned that experiments had proved that the introduction of metal braces produced more injuries than occurred with normal shoes, equipped with rubber soles and the 10-inch uppers.

Ker-thump! You're down! You go into your roll—and, glory be!—it's a perfect landing! Your feet sting slightly and you whacked your head a bit as you rolled, but in the thrill of accomplishment you don't mind, and you scramble to your feet to greet the men who have been running to help you.

So, your first jump is over, and with more prosaic things to do there may come a mental let-down, for, whether you've realized it or not, you have been as carefully prepared psychologically for your initial leap as you were physically. There'll be other jumps, plenty of them, but meanwhile, your first job is to care for your 'chute. With the assistance of a qualified rigger, you collect the shroud lines—a process known as "chaining"—roll up the whole business and get it up to the loft above barracks. There it is suspended by its peak while you and a dozen helpers grasp the fluted edges and "whip silk"—shake and snap the silken expanse to free it of dirt and extraneous matter. If it's wet, it must stay hung up until dry, for a wet 'chute opens slowly. Next, you and your packer will secure the peak to one end of a long table; you'll draw the shroud lines to the other end, check all 28 of them for twists and turn-overs. Again you'll "whip silk" to straighten gores and panels, and fluff it up to remove air pockets. No gentleman's valet, not even the incomparable Jeeves, could fold his master's clothes with greater care than you lavish on the rest of the packing process, but eventually the 'chute is back in its container, the static line is once more folded and secured, and you're ready to jump again.

LATER, after more practice, there'll be squad-jumping in combat maneuvers, with preliminary study of terrain, objectives, imaginary location of enemy forces, airports, water systems, communication lines, and so on, to be demolished or taken over by a daring, fast-moving parachute force. Armed only with an automatic revolver, the squad will float earthward, followed by cargo 'chutes which will transport emergency rations, first-aid supplies, folding bicycles, radio equipment, ammunition, grenades, rifles, machine guns, and mortars. Each squad will practice landing as nearly as possible as a unit—the Marines have jumped 11 men from one plane in six seconds—and the instant each man is on his feet, he'll have his carefully rehearsed part to play in assembling attacking equipment. In an incredibly short time the squad is fully armed and is in action.

Yes, the United States Marine Corps is rapidly acquiring a new method of effectiveness. Shades of old Leathernecks "from the halls of Montezuma to the shores of Tripoli" may well be restless in their hallowed graves at sight of these super-youngsters carrying out the traditional Marine custom of being "first to fight for right and freedom" by dropping from the sky, but it merely will be the 20th Century equivalent of "The Marines have landed and have the situation well in hand"—this time, by parachute.

• • •

Meet the Jeep

The United States Army's Answer to Schicklegruber's Panzer Divisions

JO CHAMBERLIN

IT WAS the second day of the battle of Louisiana. The invaders' tanks roared to the attack near the Sabine River. But the defending forces didn't yield; they didn't even dig in and wait. Their lightning-fast jeeps, towing anti-tank guns, raced into strategic positions, harassed the enemy's advancing tanks, out-maneuvered them, flanked them, cut them off, and cut them down.

The tanks retreated; that particular blitzkrieg was ended. Over and over again the Louisiana maneuvers demonstrated the amazing abilities of Uncle Sam's newest invention, the rugged jeep or bantam car. General George Marshall, Army Chief of Staff, says that it is our main contribution to modern war. A buck private told me: "The blitzbuggy carries more fighting punch per pound than any other army vehicle." A post-maneuver War Department statement of mass-production plans calls the jeep "sensational."

Our army's youngest, smallest, toughest baby has many pet names: jeep, peep, blitzbuggy, jitterbug, beetlebug, iron pony, leaping Lena, panzer-killer. The names are all affectionate, for the jeep has made good. When it was only a year old, it stole the show in the vast Louisiana tank and anti-tank warfare.

I was standing in the hot Mississippi sun while Lieutenant Patrick Summerour, of Camp Shelby, explained the jeep. There were rows of them before us: American Bantam, Ford, and Willys auto makers are turning them out by the thou-

Photo by U. S. Army Signal Corps.

A 37 mm. anti-tank gun mounted on a jeep

lots of leg and arm room to spare!

"Plenty o' clearance," my driver remarked.

We crossed a small stream, water flowing over the floor. But we had no trouble, for electric units are placed so high that the 40-inch jeep can keep going through water 18 inches deep. We clawed our way up the 30-degree bank—twice as steep as you'll ever meet in a passenger car on the highway.

Rivers are an army's worst obstacle in enemy country, and raft or bridge builders offer splendid targets. It was enlightening, therefore, to see jeeps ferried across streams atop three rowboats, on rafts of empty oil cans, and on stray logs wired together. Latest plan is to lay a heavy tarpaulin on the ground, drive the bantam on it, fold up the sides, then drag it into the water where it will float with some support. Tacticians call this simplicity, plus.

Back in camp, in the warehouse section, Lieutenant Summerour gave me one more thrill. He drove the car up a narrow ramp to a railway loading platform, drove along the platform, steered through the open door of a boxcar, passed through the car to a ramp on the other side, and down to the street.

"Think we've got something here?" he asked, getting out of the bantam. I certainly did.

A heavier version of the jeep is the "swamp buggy," with bus-size tires for deep snow and mire. Most important, it's mounted anti-tank gun can be fired forward. It is not towed behind. This means quicker striking power.

In the Louisiana maneuvers, involving 400,000 troops, Army eyes were on its three new anti-tank battalions. All include jeeps and well-armed jeep-riding soldiers. Company A, of the 94th Anti-tank Battalion, for example, has 51 jeeps, some drawing anti-tank guns, others carrying ammunition.

THE jeep has helped mightily to lay the legend of tank invincibility. Brigadier General Ira T. Wyche, commanding the 1st Provisional Anti-tank Group, says cheerfully: "We might retire if attacked by heavy opposing infantry, but never from a tank outfit." Already the jeep has made major changes in army concepts of cross-country mobility. It also fits into the traditional American notion of individual action in war.

When war ends, jeeps can do useful work. An artillery officer told me they would aid certain kinds of farming which need practical "Model T Ford" type transportation. Or, with a few trimmings for looks and the spur of low gasoline consumption, the jeep might make good in cities. Lessons learned by jeep manufacturers surely will be put to practical use in improving your car and mine.

EDITOR'S NOTE: In the nomenclature of our Armored Divisions—which has reached almost the stage of a special argot—the term "jeep" is used to designate the one and one-half ton command car, while the miniature combat car, so often pictured in mid-air, is known as the "peep"—sometimes, "the son of a jeep." This is according to advices from the Bureau of Public Relations of the War Department, which explains that in other branches of the Army, however, "jeep" and the various names mentioned in the above article refer to a bantam car.

• • •

DECOY BLACKOUTS

Dummy Airfields, Deserted Roads, and Empty Areas

DUMMY airfields with dimly shining lights, wide open spaces illuminated to simulate crowded areas, and long lines of glowing street lamps on deserted roads are now being studied as a means of literally camouflaging whole cities in event enemy bombers reach America's shores.

"Tragic ineffectiveness of London and Berlin to protect themselves from night raiders with total darkness is forcing the United States government and commercial lighting experts to seek startling new blackout techniques, many of them secret," according to Samuel G. Hibben, Westinghouse blackout lighting engineer.

Since there appears to be no way of preventing bombers from dumping their lethal loads over the centers of blacked-out cities, engineers are now studying means of inducing them by camouflage to aim their bombs where direct hits will cause little or no damage, Mr. Hibben declares. He points out that in the camouflage version of the blackout, decoy airfields, highways and industrial centers could be changed for each raid. They would be located well out of the way of residential areas.

From the air, a string of partially concealed lights along a deserted stretch of road would appear to be a main artery leading into the city. Actually it might point in an entirely different direction. Anti-aircraft and searchlight batteries located several miles from a metropolitan center would be just as effective but would tend to draw pilots away from vulnerable areas. A broad rectangle of flood lights anywhere would serve as airfield decoys. Americans who drive cars with sleek, black tops probably will be obliged to swab their autos with some dull, removable finish in event of air raids. Even moonlight reflection on the tops of closely parked cars offers an ideal target from the air.

Insanity

Paranoia; Dementia Praecox, or Schizophrenia; Paresis; Senile Dementia; Toxic Insanity

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

PARANOIA was formerly believed to be a form of insanity in which the patient was insane on one subject only, and mentally normal on all other subjects. This is now known to be false, for the paranoid suffers from a general mental slowing and degeneration. The paranoid suffers from very definite and well systematized delusions. This definitely affects his judgment, especially in matters pertaining to his delusions. Paranoia usually follows a definite course of three stages. The condition may become arrested in any of the stages, and remain there for years. The stages may be reversed and the third stage may occur very early. The first stage usually begins in childhood, although it may not be recognized at that time. These patients are said to have been queer, taciturn, morose, avoiding other children and associating with older persons. The patient begins to feel that people are acting differently toward him. Older patients at this stage frequently complain that they fear they are losing their minds or their health. This gradually progresses into the second stage, ushered in by delusions of persecution and corresponding hallucinations, especially of hearing.

Up to this time the subject has suspected that people were cold and aloof to him, but now he knows it, and hears them saying unpleasant things about him. The voices are very apt to become vulgar and terrible, accusing him of crimes and sins. Other hallucinations substantiate this belief. People are poisoning his food, are trying to gas him or to injure him with electricity. He builds elaborate defenses against these dangers, sealing up all doors and windows, or setting his bed in saucers of water as insulation. After a time he begins to recognize the individual who persecutes him and instead of they who are persecuting him, it becomes he.

When the patient changes his ideas from *them* to *him*, he becomes dangerous. At first he flees from his persecutors, then he defends himself, and, finally, he strikes in retaliation. Having retained some of his mental faculties he is able to reason to some extent, and so is very dangerous. This stage may last for years before giving way to the third stage, the stage of ideas of self-importance. He begins to see that being such an object of persecution, he must be someone of great import. At this stage, the dual personalities or alterations of person appear. With this stage comes a more pronounced mental deterioration and enfeeblement even to an ultimate complete loss of mentality.

DEMENTIA praecox is a form of insanity in which there are delusions and hallucinations and various mental disorders. The mental deterioriation shows to a marked degree early in the disease, and the delusions are much more fleeting and changeable. Usually, dementia praecox is seen in younger persons, but this is not invariably so. Recently, the name schizophrenia has been suggested. This means splitting of the psyche, and refers to the fact that in these cases there are frequently two or more trains of thought traveling together simultaneously.

In general, dementia praecox also has its beginning in childhood with some oddity being apparent. These patients usually have been dull, but may have been unusually bright. They are frequently shut-in types, having no one with whom they can talk over their problems. Some of the exciting factors of insanity come along and set them off into a recognizable psychosis. It is impossible to guess the subject's reactions and answers. A question may bring a totally unrelated answer, a command may bring an opposite action, or no action at all. All this is due to his twin or double train of thought. This also accounts for the incoherence of speech found so regularly in these cases, and to the emotional deterioration. There are three types of dementia praecox, but these types may overlap or combine to give apparently more types.

Pure dementia praecox, or hebephrenia, is one type. A very mild form is sometimes called the simplex type or abortive form. This is a stationary form in which the disease has not progressed far enough to be called real insanity, when it becomes halted. The patient is able to lead a more or less normal existence except that his personality is greatly changed. It is from this class that hoboes, prostitutes, cranks, eccentrics, and criminals develop.

CATATONIA, or catatonic dementia praecox, a second type, has the usual onset and general symptom syndrome plus catatonia. Catatonia is an irregular alternation of excitement and stupor. In stupor we find negativism and muscular tension. These may be mild or severe, varying from being scarcely noticeable to so severe that the patient lies perfectly quiet in bed, refusing to speak, ignoring the calls of nature, holding the saliva till it putrifies and responding, if at all, to a command by an opposite action. A muscular rigidity resists all efforts to change the position of the body parts, and provides grotesque facial expressions held for long periods at a time. The condition may express itself in a waxy condition of the muscles and, while the limbs are easily moved by the examiner, they remain in the final position for long periods, dropping only from exhaustion. Catatonic excitement is just the opposite of the stupor, being shown in constant talking, tossing in bed, walking, and becoming maniacal. Talk has no goal, and is often completely incoherent. The patients are very impulsive, follow their impul-

Originally published in *The Journal-Lancet*, Minneapolis, Minnesota. 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. In a previous article in the December number, he discussed the general nature of insanity.

sions, and are unable to explain any reason for their violent acts.

The third form of dementia praecox is the paranoid form. This is a usual dementia praecox with considerable dementia and paranoid symptoms added. The paranoid symptoms differ from true paranoia in that the delusions are fleeting and changeable, and not well organized. They are usually persecutory in nature, but the type of persecution will vary from day to day. Such patients do not try to explain to their associates the reasonableness of their delusions as do the true paranoids.

A VERY frequent and most unhappy form of insanity is the manic - depressive, circular or cyclic insanity. The chief symptom of this disease is the recurrence of periodic phases of exaltation or mania alternated with phases of depression or melancholia. Usually accompanying these abnormal states are either corresponding or reversed expressions of motor activity. This means that a patient may be quite maniacal in his thoughts but quite normal or even subnormal in his physical activity, or the converse. Usually, however, the physical state corresponds to the mental state, the patient being agitated when in a mania and quiet when depressed. Some patients do not exhibit an alternation, but have cycles of mania or excitement only, and others have only cycles of melancholia, either being interspersed with apparently quite normal intervals. It is the recurrence of symptoms in a definite cycle that gives the disease the name of cyclic insanity.

The usual findings during a manic phase are a flight of ideas, emotional excitement and increased motor activity. Hallucinations and delusions may develop, and if they do, they are usually of a grandiose nature. The depression or melancholic phase is the exact opposite of the maniacal. It is characterized by difficulty of thinking, emotional depression and decreased motor activity. When normal or nearly so the patients have quite an insight into their condition, and will discuss it intelligently with their associates. This type of psychosis is explained on the basis that when excited the patient is trying to keep up with his problems and is, in his mind, doing so. When in a depression, the problems of adjustment have simply overwhelmed him with their multiplicity and magnitude.

The psychoses so far described are those in which there is no demonstrable physical change in the brain structure itself. They are pure psychoses, or alterations of thinking due to the inability of the patient to deal with the problems of environment and society. There are also insanities in which the mind would, perhaps, never have failed had it not been injured or diseased. Aside from actual injuries to the brain with actual loss of brain tissue, it may be due to scar formation, pressure atrophy of brain tissue due to tumors, abscess, meningitis, depressed skull fractures; or the injury may be the result of infection or toxin from within the body, or drugs. The manifestations are apt to vary, depending on the extent of the injury, the degree of toxicosis, the parts of the brain involved, and the thing causing the effect.

PARESIS is the first of this type of insanity to be discussed. It was a well defined disease entity long before it was learned that it is invariably caused by syphilis. Synonymous with the term paresis was the name "general paralysis of the insane," because it is more than just a psychosis. Before death, the patient invariably develops quite typical motor as well as mental symptoms. While every case of paresis is syphilitic in origin, not every case of syphilis develops paresis, nor does every case of neuro-syphilis have paresis. Locomotor ataxia, for example, is syphilis of the nerves of the spine, but not always is it found in a combination with insanity, and when it is so found, it is referred to as tabo-paresis. Early in the course of paresis, the only symptoms noticeable are a gradual deterioration of the intelligence, defects of judgment, memory loss and evidences of moral delinquencies. These things constitute the first stage of the disease.

The second stage usually presents physical changes added to the mental changes noted before and in addition more pronounced mental defects. The physical things easily noted are muscular tremors especially of the muscles of speech. These cause a peculiar quality of tremulousness in speaking certain words and phrases. A progressive general muscular weakness follows. Frequently, the patient is subject to seizures similar to apoplexy or epilepsy, which usually last longer than an epileptic fit, and disappear more quickly than an apoplectic insult. They leave very little or no motor paralysis, but it is very likely that there will be a very marked mental deterioration noticed after the spell, and the patient does not recover from this mental paralysis. The new level of mentality becomes his normal plane, and a new seizure will sink the mentality to a new low level. Memory fails more and more as the disease progresses, and all the mental defects of the first stage become more pronounced. Delirium develops, emotions are lost, speech becomes difficult, but not yet entirely lost.

AT THIS point in the disease, paresis usually follows one of four types, and little more than mention of them should serve to differentiate them. They are: the demented, in which loss of mentality is the chief symptom; the excited, in which there is terrific mental activity with expansive and grandiose ideas; the agitated, in which there is a great deal of motor excitement and the patient must be constantly on the go; and the depressed, in which one finds symptoms similar to those found in the depressed phase of a cyclic insanity, but with no alternation of the phases. It is usual that paretics are discovered in one of these four types of the second stage of their disease.

The third stage is the final curtain for the paretic. It is the final, eventual and complete breakdown of the mentality. The patient ceases to have any human reactions whatever, and exists like a vegetable, totally unable to care for himself in any manner, losing control of his sphincters, soiling himself and finally being unable even to feed himself. These things constitute the major and most easily recognized symptoms of paresis. The most constant and dependable are the speech difficulties and the positive Wassermann reaction in an insane person.

The senile dementias have one thing in common that allows grouping them together. That thing is that changes incident to age so lower the threshold of mental bal-

ance that complexes and conditions which have been previously handled or compensated satisfactorily, are now allowed to come to the surface, and so manifest themselves as psychoses. Involutional melancholias, various delusions, anxieties, and true senile dementias, with incident memory and judgment failures, egotism and paranoid ideas are examples of this condition. Arterio-sclerotic dementias are probably expressions similar to these, with the added insult of brain starvation and actual loss due to atrophy. To an appreciable extent, the psychosis will be manifested by and dependent upon the area of the brain altered by the sclerosis. One almost constant finding in all cases is an increasing forgetfulness for recent affairs and events, faces, names and places. This obtains in the arteriosclerotic types, chiefly, and accounts for the frequency with which this type gets lost when a very short distance from home, and indeed, even within the home itself.

The last group comprises the infection, exhaustion and toxic types of insanity. These, in addition to the deliria, may simulate more or less any of the types discussed before; but, in general, when the disease has been cured, the infection removed, the toxin eliminated, or the exhaustion corrected, the psychosis improves. It is just that the patient has a low threshold, and the waste products that have accumulated have weakened the defenses of the mentality, allowing some of the problems that have been compensated to decompensate. The patient gets out of adjustment with his environment until the body balance has been restored. Any of the symptoms expected in almost any of the other insanities mentioned may be found as well as some manifestations which are new and strange.

In conclusion, only the high-spots of the symptoms and signs of the common types of insanity have been discussed. There is, however, one thought which should be emphasized: The inability of persons to adjust themselves satisfactorily to their environments and problems, introduces a big field in preventive psychotherapy. Just as a weak rope will break when overloaded, so a mind breaks when it tries to carry a load too heavy for itself. Poorly adjusted individuals and those whose minds can be likened to weak ropes, should be helped to make a proper or a satisfactory adjustment, not by demanding more from them than they can carry mentally, but by finding for them a field of endeavor where the problems will not be more severe and heavy than they can carry.

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IMPAIRED SIGHT

Induced by Insulin Offset by Oxygen

ADMINISTRATION of doses of 100 percent oxygen will offset the impaired sight induced by insulin, according to Dr. Ernst Gellhorn, professor of physiology at the University of Illinois. This sight impairment takes place, he points out, as a result of the close relation between oxygen and blood sugar content. Administration of insulin in "shock" therapy, for example, decreases excess sugar in the blood, deprives the brain of some of the sugar which it burns, and thus produces visual disturbances including loss of the ability to see "after images."

"It was found," Dr. Gellhorn says, "that the effect of low blood sugar induced by insulin was alleviated by inhalation of 100 percent oxygen."

ASYLUMS

Some Mental Hospitals Are a "Disgrace"

"SOME mental hospitals are a disgrace!" This serious charge is made by the National Committee for Mental Hygiene in its annual report, just published.

A recent nation-wide survey conducted by the Committee reveals, the report states, a "dismal failure of state authorities in many parts of the country to provide adequately for the mentally ill.

"The depression has put in its deadly work, and standards of care in many institutions have fallen far below the requirements of modern psychiatric practice—in some places to such a point as to suggest a reversion to the conditions of the old asylum era."

Institutions in all parts of the nation are excessively crowded, the survey revealed. This is considered due partly to the fact that the average length of life has been extended 13 years in the last 40 years. Mental disease affects more individuals proportionately among old people than in the younger age groups. One person out of 20, it is estimated, will become a patient in a mental hospital some time during his lifetime.

In probably 12 or 13 states, the superintendent of a state hospital is a political appointee. He may be chosen, not because of his knowledge of mental illness, but because his cousin carried three districts in the south of the state. And he is subject to instant dismissal whenever the political regime changes. This condition makes the whole staff of the hospital, even when they are thoroughly competent professionally, feel insecure. The best men are apt to leave such a hospital and go into other work or to another state.

ATHLETE'S FOOT

Infection Reduced by New Flooring

THE danger of acquiring athlete's foot and warts on the soles of the feet from swimming pool runways, locker and shower rooms may be reduced by use of a copper cement flooring material called Hubbellite, Dr. W. L. Mallmann, of Michigan State College, reports in the *Journal of the American Medical Association,* according to *Science Service.*

When the fungus that causes athlete's foot was spread on blocks of glass plate, ordinary cement, and Hubbellite, Dr. Mallmann reports, the fungi multiplied on the glass plate and ordinary cement to double and triple the original number after four and eight hours. On the Hubbellite the fungi were reduced from 72,000 to 74 after eight hours.

Hubbellite was developed by D. S. Hubbell at the Mellon Institute for Industrial Research at Pittsburgh. It is said to owe its germ-killing property to the minute amounts of a copper compound which are released from the flooring when it is wet. It was effective not only when wet with water but when milk was smeared over it, Dr. Mallmann found, suggesting its usefulness on the floors of dairies and kitchens to help keep down germs.

Malodorous Mercaptans

Removal of Sulfur Compounds From Gasoline Gives Greater Susceptibility to Ethyl Fluid

H. W. FIELD

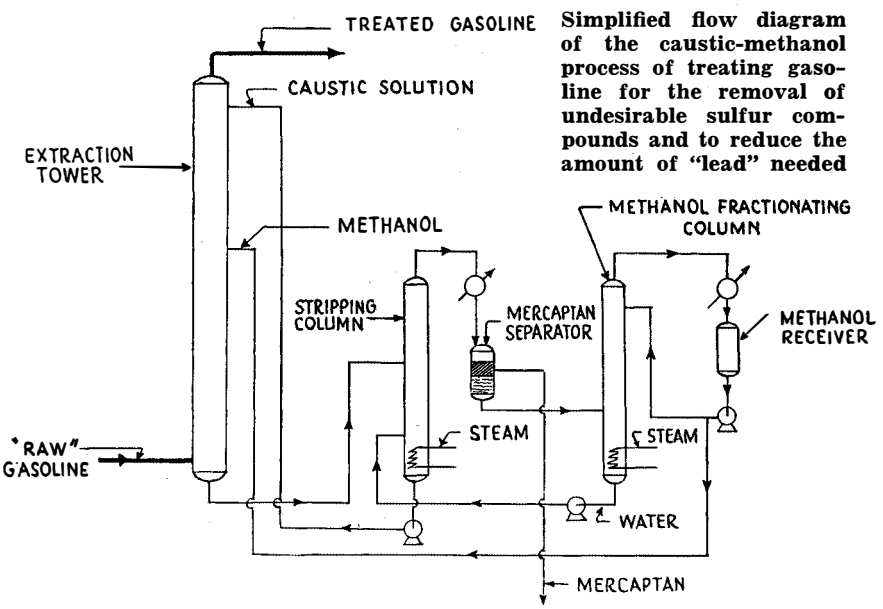
INDUSTRIAL pioneering in the petroleum field has led to the development of a new method of purifying "raw" gasoline and rendering it more susceptible to treatment to improve its anti-knock qualities. Raw, or unfinished, gasoline, as produced from crude petroleum, either by straight distillation or by the cracking process, contains malodorous compounds known to the chemist as mercaptans. These mercaptans are chemical compounds of sulfur, and are usually found in crude oil; they have such an obnoxious odor that practically all refiners have, in the past, resorted to treating operations involving the use of lead oxide and caustic soda—the so-called "Doctor Treating"—which converts these mercaptans to relatively odorless substances, hydrocarbon disulfides. This treating procedure was expensive; moreover, the mercaptans were simply converted into other sulfur compounds. The objectionable substances were not removed. Furthermore, both the mercaptans and the products into which they are converted have been known for several years to have a deleterious effect on the anti-knock value of gasoline and to interfere to a serious extent with the beneficial effect of substances such as tetraethyl lead, which are added to gasoline to improve its anti-knock value.

In spite of the rapid and widespread "face lifting" which has taken place in refinery processing methods in the last decade, the naptha-treating plant has undergone little basic change by the onslaught of new technique and, in many plants, stands as an expensive citadel which successfully has resisted all development efforts. It is true that various schemes of regenerative washing have eased the treating-cost burden in many places, but these have been only partial answers to the problem; mercaptan conversion, by doctor treating or otherwise, continues today to be the predominating means of improving gasoline odor, despite the fact that the processing methods are harmful both to a fuel's octane value and its susceptibility to tetraethyl lead treatment.

THESE deleterious effects have been known for several years. Naturally, the obvious answer to the problem has been the removal of the mercaptans. That much was easy, but how to do it was something else again. Petroleum research engineers have been attacking the problem for some years. In the first place, the mercaptans in the heavier parts of gasoline have objectionable odors, but are not sufficiently soluble in a cheap reagent, such as a solution of caustic soda in water. Moreover, organic solvents, such as the alcohols either alone or in caustic-soda solution, are excessively expensive, particularly if appreciable quantities are lost in the treated naptha. Further, any solvent which removes mercaptans, will, of necessity, gradually become fouled with other substances in the gasoline, such as sulfides, sulfates, thiosulfates, phenols, thiophenols, fatty acids, and so on, unless some mechanism is provided for discharging these materials from the recirculation system without incurring excessive cost in the loss of solutions.

This looked like a large order to expect any process to fill. Fortunately, gasoline is a large-volume product of the petroleum refinery, and if a way could be found to bring about fractional savings in tetraethyl lead and octane level, these savings in the course of a year would build up into large dollar returns. This furnished the incentive for much extensive research and development work and eventually resulted in the development of the caustic-methanol process, by research engineers of The Atlantic Refining Company. This new process meets the requirements imposed by the mercaptan-removal problem in an unusually satisfactory manner and, in addition, the commercialization of the process has disclosed that the unit manufacturing costs are considerably lower than had been anticipated at the beginning of the development. This fact increases the economic incentive for the installation of the process, and, as a result, large plant installations are now being designed.

Research in the development of the process involved almost endless studies of gasolines, the mercaptans, and other substances which contaminate motor fuels, both alone and in mixture with various strength solutions of caustic soda in water. Before the process could be perfected, the investigation was extended to include balancing the costs of the solvents which were

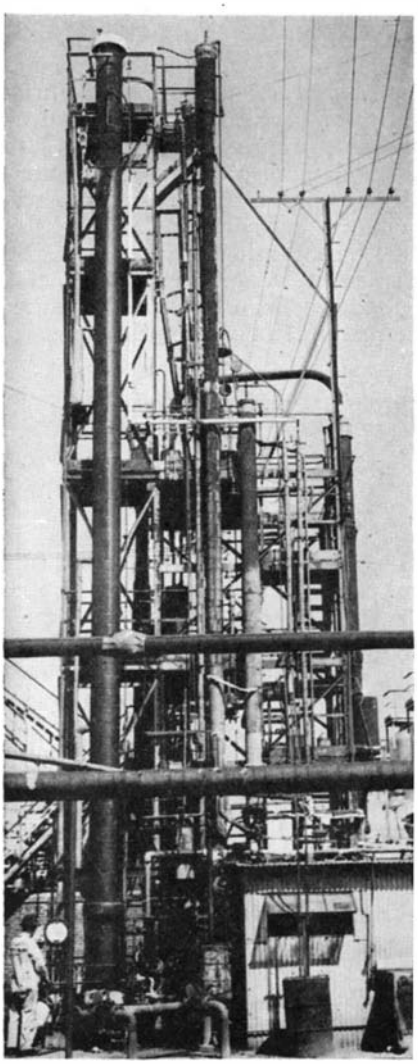


Simplified flow diagram of the caustic-methanol process of treating gasoline for the removal of undesirable sulfur compounds and to reduce the amount of "lead" needed

studied, ways and means to minimize losses in treated gasolines, the high solubility of the mercaptans, the ease with which the solvents used could be separated, and the overall flexibility of the process in treating a wide variety of raw gasolines.

Eventually, as a result of these studies, the researchers hit upon a single solution which was found to be most effective in treating the raw gasoline. It is a mixture of a solution of caustic soda in water, with methanol, or methyl alcohol. The combined solvent was found to be so effective that a substantially complete removal of the offensive mercaptans was obtained by recirculating in the plant an amount of "dry-cleaning" solvent which was less than 3 percent of the volume of the gasoline treated.

As soon as the research work was completed, the process was put into practical operation in a semi-commercial plant having a treating capacity up to 15,000 gallons per day. The operation of this plant is illustrated in simplified flow diagram in the accompanying drawing.



Semi-commercial treating plant

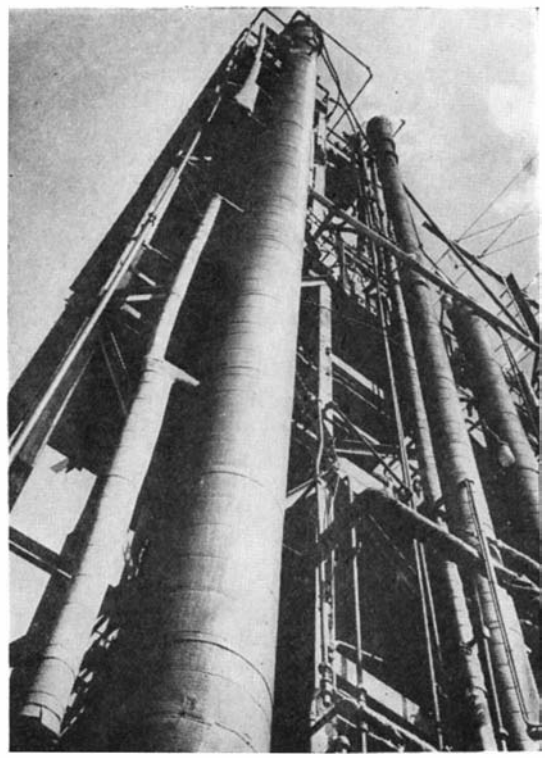
RAW gasoline is pumped into the base of the extraction tower at the left and flows upward. The methanol is introduced at the middle of the tower and flows along with the gasoline. The caustic soda is pumped in at the top of the tower. The combined solvents extract the objectionable mercaptans from the gasoline. The caustic soda solution, flowing down through the upper section of the tower, also removes practically all the methanol from the purified gasoline and settles at the bottom of the tower.

The "spent" solution is then pumped from the bottom of the extraction tower to a steam-stripping tower. This includes an internal steam distillation apparatus, which distills off the methanol, the mercaptans, and some steam, thus cleaning the caustic solution so it can be used again. This is withdrawn from the bottom of the stripping tower and returned to the top of the extraction tower.

The distillate from the stripper is condensed, and the condensate separates into two layers in the receiver. The mercaptans collect in the upper layer, and are withdrawn from the system, and sent to the power house to be burned as fuel. The lower layer is a water and methanol mixture kept relatively free of mercaptans by controlling the water-methanol ratio at a point where the mercaptans are least soluble.

The water-methanol mixture drawn from the bottom of the separator is then charged into a fractional distillation apparatus. The methanol passes over and is returned to the middle section of the extraction tower. The water which is left is pumped to the caustic stripper. One of the photographs gives a general idea of the size and scale of the semi-commercial plant used for the development work.

An outstanding feature of the caustic-methanol process is the separation of the two components of the solvent and the return of the two separately to the extraction tower. The charging of the caustic soda solution to the top of the extraction tower causes this section to function admirably in the recovery of methanol. As a result, the loss of the expensive methanol is negligible.



Close-up of the extraction tower

Another important advantage of the separation of the two solvents during their regeneration for use again in the "dry-cleaning" process is the ability to control other contaminating substances which creep into the solvents. This is accomplished by bleeding out small quantities of caustic soda solution from the bottom of the stripper tower so as to control the quantities of the substances which tend to build up and foul the solvent. Extensive operation of the present plant has shown that no foreign materials build up in the methanol. As a result, it can be used indefinitely.

IT WAS also found as a result of the study of a number of solvents that any solution capable of extracting mercaptans also will extract, to some degree, any phenols which occur naturally in gasolines. Since these substances usually are good stabilizers in controlling the tendency of gasoline to oxidize, their removal is not always desirable.

The caustic-methanol process offers considerable flexibility in handling gasolines of varying phenol contents. It will be recalled

that, in the regeneration step, the methanol and mercaptans are distilled from the caustic-soda solution. This regenerated caustic solution contains phenols and other acidic components extracted from the gasoline. If the stability characteristics of the gasoline being treated are such that the final product will be better because substantially all of the acidic bodies have been removed and because a synthetic inhibitor is used, the process can be controlled accordingly. This is accomplished by discarding a caustic solution when it becomes rich in phenols (50 percent by weight). The high ratio of phenol to caustic in this type of operation results in a low consumption of caustic soda.

If, on the other hand, the nature of the gasoline being treated permits the advantageous retention of the phenols, the process can be controlled to favor this retention. This is accomplished by permitting the phenols to build up in the recycled caustic-soda solution. The carrying power of the reagent for mercaptans is not impaired by this, but the extraction of phenols from the gasoline is substantially reduced.

The use of the caustic-methanol process results in a considerable improvement in the anti-knock value of the treated gasolines. In the older processes where the mercaptans are converted to other substances which remain in the gasoline, the octane values drop as much as 0.25 to 1.0 numbers. With the new method the octane numbers of the treated products are equal to or better than those of the raw gasoline. Furthermore, the treated gasoline is greatly more susceptible to treatment with tetraethyl lead to increase its anti-knock value, offering an attractive saving in ethyl fluid in all cases. This is highly important today, with lead shortages staring industry in the face.

EDITOR'S NOTE: While there are other means of achieving mercaptan removal from gasoline than that described in the foregoing article, the details of the Atlantic process are published because of the economic significance of the whole general problem. Further, the process described has advantages of low installation and operation costs, the latter largely through the use of solutions which can be regenerated and used indefinitely with little loss.

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PLASTICS PRIORITIES

Made Necessary Where Methanol is Needed

ALUMINUM, steel, zinc, copper, bronze, and so forth, and now plastics, have been placed on the priorities list—in particular those plastics which require formaldehyde or derivatives of methanol in their manufacture.

Formaldehyde comes from methanol. Methanol is secured in two ways—one, by the distillation of hardwood; two, from synthesis of carbon monoxide and hydrogen. It is from this latter source, synthetic methanol, that most formaldehyde used today in plastics is secured. It so happens that ammonia may also be made from methanol. Ammonia is valuable in the manufacture of explosives and many formaldehyde producers have necessarily had to change to ammonia production. In addition, it is said that methanol itself may now be used in making a super explosive. Consequently the market in formaldehyde is tight and this material is high up in the priorities list. To overcome this condition, new ammonia plants are being built and it is expected that within a short time the production of formaldehyde may return to a more normal status.—*Durez Plastic News.*

REPLACEMENTS

Developed in the Radio Manufacturing Field

AS A result of the search for alternate materials in radio sets, RCA Laboratories has developed more than 40 replacement materials; one item alone has saved 148,000 pounds of aluminum in the plants of the RCA Manufacturing Company.

Aluminum was one of the first items, essential to the radio industry, affected by priorities control. In every RCA Victor radio set, aluminum cans were employed to protect intermediate transformer coils. Four millions of these cans had been used in 1940; therefore, if they could be replaced by using an alternate, a tremendous saving in aluminum would result.

A fabricated cardboard tube, coated with a moisture-resisting substance and a sheet of copper foil, was tried instead of the aluminum can; marked success was achieved. The aluminum thus saved has so far amounted to 74 tons. Another important saving of aluminum was effected by using a plastic in the record changer control segment of radio-phonographs.

Plastics are under consideration to replace the metal housing that protects loudspeaker cones in radio receivers. They can also be used in making dial faces and a number of other parts in both radio and phonograph equipment. Their possible field of application is extremely wide. But even plastics are meeting curtailment.

Thereupon, the job of finding an alternate for an alternate was started. The answer was a felted substance made from shredded wood, cardboard paper scraps, and sulfite pulp. Moulded into required forms and treated with a moisture-resisting impregnant, it proved to be as tough as either wood or plastic. It can be covered with fabricoid or other surfacing. By the use of thermofusion, metals can be bonded to it. Perfection of this substance opens up new avenues of manufacturing development.

MOVIE TRAINING

Now Available For Lathe Operators

TO SPEED up the training of lathe operators, the South Bend Lathe Works has sponsored the production of a series of 16mm sound motion pictures in full color based on the book "How to Run a Lathe." Professionally filmed by Burton Holmes Films, Inc., at the South Bend Lathe Factory, these pictures show practical shop methods as practiced in modern industrial plants. Showing time for each of the two 800-foot reels now completed is approximately 20 minutes.

The first reel, entitled "The Lathe," clearly shows the apprentice what a lathe is, what a lathe is for, and how the various parts operate. Important lathe opera-

tions, including turning, facing, and thread cutting, are demonstrated. The second reel, "Plain Turning," shows in detail each operation performed in the machining of a straight cylindrical shaft between the lathe centers. Close-ups show locating and drilling of center holes, adjustment and setting of cutting tools, use of cross-feed graduations, use of calipers and micrometers, use of quick-change gear box, changing speeds, and operation of the lathe carriage and apron.

Factory apprentice schools, vocational schools, Army and Navy training schools, colleges and high schools teaching machine shop practice will find these films helpful in training lathe operators. Complete information on securing the use of these films can be had by writing to South Bend Lathe Works, Dept. S7, South Bend, Indiana.

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EYES—In round figures, eye accidents cost American industry at least $50,000,000 annually in lost time, medical expenses, and compensation. The average cost for an industrial eye injury is $343, as compared with $194 for all other types of occupational accidents.

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TRANSPARENT

Glass Building Block Provides Vision

A TRANSPARENT glass building block that affords almost window-like vision has been developed by the Pittsburgh Corning Corporation, a jointly owned subsidiary of the Pittsburgh Plate Glass Company and the Corning Glass Works.

The new block, called the "Vue" glass block, was developed for specific needs where some outside vision is desired through panels of non-transparent glass blocks. The new block permits sufficient general vision of large objects or movements beyond the panel to prevent a "shut-in" feeling, although the visibility of sharp detail is not possible under most conditions. The Vue block combines the high insulation properties of the usual glass block; it contains a partial vacuum, a dead air space, which results in the glass block panel having approximately the same insulation value as a solid masonry wall eight inches thick, and more than twice the insulation value of ordinary single-glazed windows.

In factories where non-transparent blocks have been used in exterior walls, a common custom has been to install several rows of transparent window glass panes. Several courses of Vue blocks might very well be combined with

New block provides vision panel

a selected conventional glass block pattern to achieve approximately the same light transmission and visional properties, but with the added advantage of better insulation.

In certain instances, workmen in factories where all light-transmitting areas are of obscure glass, or where plants are windowless, have indicated a mild feeling of claustrophobia. This shut-in feeling could be alleviated by the use of a few of the new blocks inserted in the center of the large glass block areas to provide a vision panel.

ROSIN

Increased Production and Use of Derivatives

ROSIN derivatives, now used in lacquers and paints, plastics, roofing, floor tile, and the box toes of men's and women's shoes—many of these being entirely new uses—are to be produced in large quantities in a new plant of the Hercules Powder Company, now in operation in Hattiesburg, Mississippi.

The new plant will use molten rosin delivered to it by pipeline from the adjoining Hercules naval stores plant, eliminating the packing, cooling, shipping, and remelting normally required in handling rosin. Another reason for locating the plant at Hattiesburg is that large supplies of hydrogen, used in the manufacture of the chemicals, can be obtained from natural gas available in the Louisiana and Mississippi oil fields.

"The series of rosin esters which this plant will produce will help diversify the rosin producer's market," a company report states, "for substantial quantities of these esters are already used by industries which have never used rosins before. An industry sending its products into many varied industries where they serve a multitude of purposes can only gain from technological progress. In fact, by furthering chemical research, it can both serve industrial needs and benefit by the greater use for its own products. This purpose has motivated the Hercules program of fundamental research on rosin derivatives."

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CHAINED: Defense workers are being chained to machines by the wrist—but as a safety measure. The wrist device, called the Posson guard, uses a pull cord attached to the machine which prevents the worker from getting his hands or arms into the mechanism when it is in operation.

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INDUSTRIAL AID

Supplied by Available Chemical Engineers

AN INCREASING number of manufacturers are finding it impossible to secure certain raw materials for the operation of civilian supply industries, and are attempting to turn to the production of usable merchandise made from raw materials that are not subject to priorities. In many such cases, however, technical problems arise which the manufacturers are unable to solve with available facilities. To meet this crisis these manufacturers have to avail themselves of independent consulting chemists and chemical engineers, often difficult to locate.

Manufacturers who find themselves in this predicament will be referred to an association where they can obtain free listings of consultants for such chemical problems, if they will address the Editor of Scientific American, stating their needs briefly.

INDUSTRIAL TRENDS

INDUSTRY LEARNS FROM DEFENSE

MANY of the lessons that American industry is learning under the forced draft of national defense production are going to have a very definite effect on the general trends of all industries in the immediate future as well as in the time of peace which will ensue. Any consideration of these lessons cannot stray far from the automobile and aviation fields, since it is in these industries that the greatest effort is being made to press production to the limit in providing the means for transporting huge numbers of men and vast quantities of materiel for military purposes. But, although consideration centers in these two closely linked industries, implications of developments accomplished and still in the formative stage are spreading and will continue to spread into all industries however remote from the centers of automotive production.

Outstanding example of technological progress in aircraft engine building, fostered by the laboratories of the automobile industry, is the production of cylinders from castings instead of forgings. When time was of little moment in airplane engine construction, the individual cylinders were machined from large forgings often weighing up to 100 pounds, for the production of a unit that, finished, would weigh only 15 pounds or so. Here was tremendous lost motion, lost time, inefficient use of material. Then came the contribution of centrifugal casting, by which were produced cylinder castings weighing only about 20 pounds and which needed only a minimum of machining to produce finished units. Time, material, machines, and manpower needed for the job were reduced, production was stepped up.

One word in the preceding paragraph holds the key to the success of cast cylinders—"centrifugal." Automobile engines have, of course, been made almost universally with cast cylinder blocks. But in a motor-car engine, low weight is of little consequence; in an aircraft engine it is essential that weight per horsepower be kept to the lowest minimum. Castings made by conventional processes cannot be machined to thin sections; to do so results in reduced strength. Thin sections in cylinders are required in aircraft engines to reduce weight; hence the use of forgings in the past. Automobile engineers, however, always unconventional, developed the centrifugal casting method to a point where it could produce cylinder units sufficiently strong to be machined to thin sections, and the problem was solved.

Obviously this casting method, which spells success for high-speed production of aircraft engines, will not be confined to the automotive field. There are many places in industry where it will find wide use in many applications, replacing forgings in some cases, developing new products in others. Together with powder metallurgy, **this latest trend in the development of methods of producing a variety of shapes from metal will undoubtedly take a place of outstanding importance in the industrial world.**

Another example of the effect which the automobile industry is having on the production of airplanes is to be found in the efficient utilization of multiple drill units for high-speed work. Where many hours were formerly spent in drilling holes in the main framework of a certain engine, the time required has been reduced to a few minutes more than one hour. Again, a number of machines labored for an hour to drill the required holes in an engine cylinder; time required on the job after automobile engineers tackled the problem was only three minutes—and this was accomplished with a smaller number of machines than was formerly used.

It stands to reason that these lessons of efficient machine utilization, just as in the case of centrifugal casting, are not going to be confined to any one or two industries. Engineers are finding that methods peculiar to one type of work can often be applied to other fields with equal success. And under present stimulus these applications are being ferreted out and developed to the benefit of all.

From what has been said above it must not be assumed that this automobile-airplane co-operation is all one sided. While motor-car engineers are contributing mightily to speeding-up aircraft production, they are also, in turn, learning lessons from the technicians of the aircraft industry. High-octane fuels, long used in airplanes, require special engine design of the sort that is meat for the aircraft men; automobile technicians are devouring the details of these designs and it is no shot in the dark to state that, beyond doubt, high-octane fuel will be used in the motor-cars of the future, with engines that will utilize it efficiently.

Then there are the techniques of using lightweight materials, special alloys, high-strength construction, and so on which have been brought to a fine point of perfection in aircraft work and can be applied to automobile design with decided advantages.

Such facts as have been set forth in the limited space available here give strength to the statement that there is certainly a bright industrial side to the grim business of preparing for national defense; the lessons learned by industry as a whole are leading rapidly toward more efficient use of available materials and the development of alternate materials to bolster or replace those of our natural resources which are limited in quantity or more urgently needed for other purposes.

SYNTHETICS NOT ALWAYS SUBSTITUTES

NOT all research in synthetic-rubber is being directed toward replacement of the natural product. In fact, many uses for materials that are emerging in a steady stream from the synthetic-rubber laboratories are being found where rubber had never been considered before. Thus a new non-metallic synthetic has been produced by the United States Rubber Company that is only one third as heavy as aluminum and will release much of that metal for other purposes. Upon impact of bullet or shell, it resists shattering, it does not fatigue as do some metals when subjected to vibration, it does not corrode. All these qualities point toward a promising future for this synthetic, so far known only as C-102. Industry will be quick to find use for a material of this kind.

—*The Editors*

OUR Point OF VIEW

TELESCOPTICAL CANFIELD

ELSEWHERE in this number is the first part of an article by the scientist in immediate charge of the 200-inch telescope mirror being built in California. Nowhere does he answer the one question which everyone asks: "When will the mirror be finished?"

A probable reason for this omission is that he doesn't know, and a still more categorical answer is that, literally, nobody does. Yet no inquirer—at least no real American United States Yankee—has ever accepted this answer lying down. All inquirers, when told that nobody knows, come straight back with something like: "But when?" Or, "If you don't, where can I find out?" Or, "When do they think it will be finished?" It is as if they suspected one knew all along, and determined that they would somehow mine it out of you.

It isn't the "grinding"—to use a term by which those who have never tried the work usually designate the whole process. It isn't even in the polishing that follows the grinding. It is the final operation called figuring, and which involves alterations seldom deeper than hundred thousandths of an inch and usually only millionths of an inch, that contains the real grief, the big headache.

Short of accidents, the concavity can be roughed out with coarse abrasive grains and smoothed to the satiny finish of fine-ground glass with finer and finer grains, working to a predictable time schedule. Polishing with rouge is similar in this respect.

In the next and final stage comes work that is art, not mechanics alone. Here and there millionths of an inch of glass thickness must be shaved off with local tools. Here predictability ends. Too much may be shaved off. Or some may be shaved off in the wrong place. The work must then be done over again. Often this going back is repeated over and over again. The object of the game is to do it times enough so that, ultimately, all the parts of the mirror's surface will come out right at the same time, with no areas too high or too low.

Seeking for a comparison that will "register" with the reader who never has tried this game even on a small mirror (where the principles are much the same) the game of Canfield comes to mind. You get almost through and find you can't come out. Start all over again. Maybe do this several times. This sort of thing largely gives the answer to the question, "Why can't they say when the mirror will be done." It's a game. A month? A year? Longer?—*A.G.I.*

RESEARCH AND LABOR

GREAT as have been the contributions of research—both pure and applied—to industrial development, there still appears to be wide-spread misunderstanding about the ultimate aims of the research laboratory. This is particularly true in the case of labor, where failure to appreciate the value of research results in a feeling of antagonism that frequently takes somewhat this form: "Those guys in the laboratory have it pretty soft. All they do is play around all day and draw good money. Me, I work like a dog and hardly get enough to live."

All of which goes back to the age-old battle between labor and so-called labor-saving machinery. For generations every mechanical development that resulted in apparent labor replacement has been bitterly opposed by just that group of workers which eventually reaped the greatest benefits. And the research laboratory of today is the birthplace of the fundamentals that are to become the mechanical improvements of tomorrow which, in turn, will benefit directly the man in the shop who may now be grumbling about "the guys in the laboratory."

As is perfectly obvious to anyone who follows even casually the course of science and industry, work in any sort of research laboratory cannot follow the well-defined lines of, for example, production operations on lathes or punch presses; on paper-making machines or in steel mills. The industrial workers have a carefully planned system of production that is followed throughout the working day; the laboratory technician conducting research is doing just what the name implies—searching for something, and that search, to the uninitiated, may very well appear to be aimless play. Hence there is a perfectly valid reason—in his own eyes—why the laborer should hold the research scientist in scorn.

Knowing full well that this state of affairs exists, it is indeed refreshing to hear of a representative of labor who has sufficient knowledge of the industrial world, and the right sort of intestinal fortitude, to make the following statement:

"The wages that workers in the pulp and paper industry now earn could not have been paid 25 or 30 years ago, no matter how strong the unions might have been, what their form of organization might have been (craft or industrial), or what labor legislation might have existed on the statute books.

"The pulp and paper industry is able to pay higher wages today because of improved methods of production which enable the mills to produce more paper at less cost than ever before. The contributions of enlightened management, engineers, technicians, and chemists in developing this great industry must not be overlooked or minimized as a factor responsible for the higher standard of living that the pulp and paper workers now enjoy." This quotation is from John P. Burke, president-secretary of the International Brotherhood of Pulp, Sulphite, and Paper Mill Workers.

Management, engineers, technicians, chemists—a complete research team: Labor receiving its share of the results of increased production and efficiency. Which is the way it happens in real life, despite any appearance of "play" on the part of the research worker.—*A.P.P.*

Molecular Spectra

More Complicated than the Spectra of Atoms, They Also Tell us More

HENRY NORRIS RUSSELL, Ph.D.

Head of the Department of Astronomy and Director of the Observatory at Princeton University. Research Associate of the Mount Wilson Observatory of the Carnegie Institution of Washington

SEVERAL interesting recent papers, dealing with the composition of bodies of astronomical interest, have this in common: they depend upon observations of molecular spectra.

Molecules are quite as capable as isolated atoms of emitting or absorbing spectra. These spectra are more complicated than those produced by atoms, but for that very reason, when they are well understood, they give us more information.

The lines of a given atom—such as iron—are usually scattered along the spectrum with apparent irregularity, though intricate and accurate relations between their positions are revealed by thorough analysis. But in a typical molecular spectrum, the very numerous lines are obviously arranged in groups. At certain places they crowd together so closely that spectroscopes of the highest power are required to separate them. On one side of such a "band head" the lines are sparse, while on the other they are numerous, gradually increasing in separation and growing fainter, and forming a "tail." Head and tail are parts of the same structure—the head being the region where the lines are most closely crowded. With spectroscopes of low power, the separate lines are not resolved and the band appears continuous, shading away gradually from a sharp edge on one side. Often the head of a second band is superposed on the tail of a first, and so on, producing very complicated patterns.

What happens in a molecule when such a spectrum is emitted, is now well understood. But, even in the simplest case of a molecule composed of only two atoms, the possibilities are much more varied than for a single atom. In the latter case, an electron can be shifted from its normal state in the atom to another state, or fall back again, with absorption or emission of radiation of a definite wavelength—a spectral line. There are many kinds of these electron-jumps, and so many lines in the spectrum. The same thing can happen in a molecule, but other things may, too. The two atoms (more precisely their heavy nuclei) will, in the normal state of the molecule, rest in stable equilibrium at a certain distance apart. If farther apart, they attract one another; if they are closer, they repel one another. Hence, if they are disturbed from the standard position, they will oscillate about it with distance alternately less and greater. Moreover, the molecule as a whole, whether the atoms are at their standard distance or oscillating, may be rotating about its center of gravity.

THESE motions, like all others that occur in structures of atomic dimensions, are governed by the quantum laws. There are a series of possible states of vibration which may be numbered 0, 1, 2, 3 . . . with amplitude increasing from each to the next, and a similar series of permitted states of rotation at increasing rates—usually very numerous.

The molecule can change from one to another of these states—according to certain rules. For example, the quantum-number defining the rotation changes by one unit. An electron-jump, a change in oscillation, and a change in rotation can all occur at once. No wonder the spectra are complicated! Changes in the rotation alone (which involve very little change in energy) give radiations in the remote infra-red. Changes in oscillation and rotation together usually produce bands in the nearer infra-red, and an electron-jump is usually required to get a big enough energy change to put the bands in the visible region.

With the same electron-jump and vibration-change, different changes in rotation (as for 0 to 1, 1 to 2, 2 to 3, and so on) produce lines very close together, the separate members of a band. A different change in vibration-numbers gives another band. The bands corresponding to such changes as 0 to 0, 1 to 1, 2 to 2, are often so close together that they tread on each others' tails, while 0 to 1, 1 to 2, and similar changes give another band-group, and so on. Thus we get a complicated band-system, which may fill a long range of the spectrum with thousands of lines, all from the same electron-jump. Another jump gives a different system of bands; —and finally, if the molecule is ionized, an entirely different set of systems of bands will result. Molecules containing three or more atoms give still more complex spectra.

BAND-SPECTRA are peculiarly characteristic of comets. The gases which form the head and tail escape from the solid particles of the nucleus and are set shining by absorption of energy from sunlight. The molecules C_2, CN, CH, CO^+, and N_2^+ have been recognized for many years. All five of them are fragments of the stabler molecules ordinarily known in the laboratory—the last two having lost an electron. Why the more familiar molecules do not show up is simple—their strong bands lie in the far ultra-violet, to which the Earth's atmosphere is opaque. We know, too, why the observed bands appear. They are all "resonance bands." A molecule of C_2, for example, in its normal state can absorb some line from sunlight, and become loaded with energy. Returning to normal, it emits this energy as light of the same wavelength. Other molecules, at the same moment, are working on other lines; so when we see the comet against a dark background, all the lines of the system appear bright. Once returned to the ground-state, the molecule can absorb again. Hence a relatively small number of molecules working steadily will give off a considerable amount of light.

Cunningham's Comet of last autumn, though not of the first rank, was bright enough to be observable with fairly high dispersion, and a long series of spec-

trograms were obtained by Swings, Elvey, and Babcock at the McDonald Observatory. These extend much farther toward the ultra-violet than any earlier observations, and thus reveal the presence of two more molecules, OH and NH, with bands near 3100 and 3360 angstroms. Like the others, these are fragmentary molecules, and the bands are resonance bands. From chemical considerations, we might expect these molecules to be present, since others containing hydrogen, oxygen, and nitrogen are. The strength of the bands indicates that they are abundant.

The cyanogen bands are extensively developed. Comparison of these bands with those produced in emission in the arc, or in absorption in the Sun, shows that the lines corresponding to the more slowly rotating states of the molecule are strong, while those produced by the rapidly rotating states are weak, or absent. That is, the average rate of rotation of a cyanogen molecule in the comet is very much smaller than in the arc or the Sun. The same is true of NH, OH, and CH.

In a gas of ordinary density, where the molecules collide with one another, very often the energy of rotation (of a diatomic molecule) will average two thirds as great as that of its forward motion, so that, at high temperatures, the high rotational states will be well populated. In a cool gas the slowly rotating states will be favored.

THE density in a comet, even in the head, is so low that practically no collisions between molecules occur, but we can still speak of a "rotation temperature," such that in a gas of ordinary density the average rotation of the molecules would have the known value. The cyanogen bands in this comet show a preference for the rotational states which correspond to a temperature of 300 degrees absolute (about room temperature), and also a second group of lines indicating a slower rotation, such as would be found at 50 degrees absolute—much colder than liquid air.

If the density were not so excessively low, it would be impossible for two groups of molecules rotating at such different average rates to remain distinct. As things are, the observers suggest that the molecules of CN may be produced by two different processes of dissociation of parent molecules (such as would originally escape from the solid particles of the head), and that one of these processes sets them in more rapid rotation than the other.

If these molecules were left entirely to themselves, their rotation would slow down to almost nothing; for a transition from one state of pure rotation to a slower one, with emission of radiation of very long wavelength, is possible under the quantum rules for any molecule composed of unlike atoms. What prevents this from happening appears to be the absorption of sunlight by the molecule. This tends, on the average, to increase the rotational energy, and may undo the first effect, or strike a balance where the two compensate one another.

This reasoning explains also what would otherwise be very puzzling. The carbon bands, produced by the C_2 molecule, show evidence of many rapidly rotating molecules, corresponding to a rotation temperature of 3000 degrees. But this molecule, being composed of two identical atoms, cannot unload its energy by the "pure rotational" transitions — they are forbidden by the quantum laws. Hence, the absorption of sunlight would gradually build up the average rate of rotation to a high level.

There remains a fairly conspicuous group of lines or narrow bands in the violet (between 3980 and 4130 A) which has not yet been identified and presents one of the last unsolved problems of astronomical spectroscopy.

While this remains a mystery, another important problem has just been solved. We have spoken before in these columns of the interstellar lines which are absorbed by atoms scattered with extreme sparseness in the depths of space remote from the stars. Besides atoms of sodium, potassium, calcium, titanium, and iron, the familiar molecules CN and CH have been identified — but by very curious-looking spectra. During the extremely long times of isolation in interstellar space, a rotating and oscillating molecule has time to make the transition, step by step, to lower states. Being free from stimulation by near-by stars, such molecules should practically all be in the rock-bottom ground-state of lowest energy, beyond which it is not possible to go. A molecule in such a state can absorb but one, or at most two or three, of the lines in the corresponding band — so that a whole complex band-system containing thousands of lines will be reduced to one line where each of a group of many-lined bands is normally found. These lines, moreover, correspond to a transition from the state of lowest possible rotation to the next, and are usually faint in comparison to other lines of the band, corresponding to more rapid rotation. A thorough analysis of the bands, however, points with certainty to the particular line in question.

AFTER these highly simplified spectra had been identified, four sharp interstellar lines remained. Discussion of these at a conference on interstellar molecules at the Yerkes Observatory led to the suggestion that three of them (with wavelengths 4232.58, 3957.72, and 3745.33), which were spaced about as the residual lines of three band-groups might be expected to be, might arise from some ionized molecule, such as CH^+ or C_2^+. Returning to the University of Saskatchewan, Dr. Herzberg, with his colleague, Dr. Douglas, proceeded to make molecules of this sort by the effective method of passing a discharge through helium containing a trace of the vapor of benzene, C_6H_6 — a heavy molecule which can be broken up into all sorts of pieces. Three new bands appeared in the spectrum, with heads at 4225, 3954, and 3743. The individual "rotational" lines in these bands were widely spaced, a proof that they come from some very light molecule — indeed, from one containing a hydrogen atom. Analysis of the structure served to identify the residual lines of the three bands, which were at 4232.57, 3957.71, 3745.30 — agreeing within the errors of measurement with all three interstellar lines. More detailed study of the bands showed that they were of a type which could be produced only by CH^+ among those molecules whose spectra were not already known.

As neutral CH molecules were already known in interstellar space, the presence of such molecules in the ionized state might have been anticipated. Only one sharp interstellar line at 3579.04 remains unidentified. The chance that it may turn out to belong to some other ionized molecule now looks good.— *Princeton University Observatory.*

How They Do It

By Prestidigitation, Dunninger Duplicates "Phenomena" that have Fooled the Public

ON THE evening of November 10, 1941, members of the Scientific American Committee for the investigation of Psychic Phenomena, their guests, and representatives of the press assembled in a room in the Waldorf-Astoria hotel, in New York City. The purpose of the meeting was educational, for Dunninger, Chairman of our Committee, proposed to produce some of the more noteworthy "phenomena" he has witnessed during his more than a score of years as researcher in the realm of the occult. In duplicating these so-called psychic spectacles, two purposes were accomplished. The extent to which modern conjuration may offer delusion and deception was demonstrated, and bogus mediums, who have presented — and who still present — "phenomena" which are demonstrably hocus-pocus, and by which the public is annually bilked of an estimated 50 million dollars, were exposed. That legerdemain, prestidigitation, and certain types of mechanical artifices performed by and in the hands of a clever operator can completely bemuse an audience of higher than average mental caliber was conclusively proved at this meeting.

Our Chairman, one must remember, has been practicing the arts of deception for many years; furthermore, in the course of his investigatory work into psychic matters, first with Houdini and later on his own behalf, he has witnessed over 1000 so-called occult demonstrations of physical nature, all of which must be accepted as pseudo, for Dunninger has successfully duplicated by trickery or explained by natural means all of the "phenomena" that have thus far been brought to his attention. However, this must not be taken as an indication that either the Chairman or the members of our Committee are engaged in a "witch hunt." Far from it. Since the advent of Spiritualism in its present form, about 1848, too many unexplainable incidents have come to public attention to dismiss lightly, and as pure hokum, the theory of return to earth after death. If our Committee, individually or collectively, were of that mind, there would have been no need or excuse for the original organization of that body. To the contrary, and notwithstanding all other claims, the inquiry of the Scientific American Committee in the field of the supernatural in no sense questions any form of religious belief, nor does it seek to cast aspersions on any individual or group who may lay claim to super-normal powers. The indisputable truth about psychic mat-

Dunninger; Miss Jane Schuele

ters is the aim of the Committee, but, by the same token, no credit or mercy can be extended to mediums or others whose practices are clearly shown to be nefarious and therefore not in accord with public welfare.

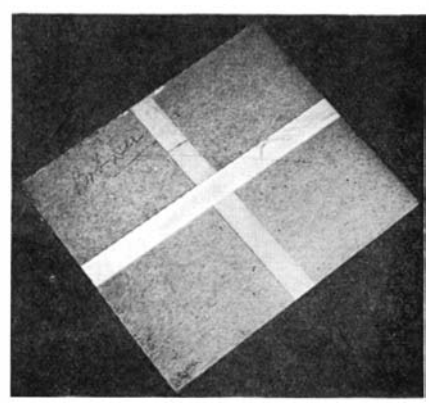
To emphasize how trickery can be utilized, Dunninger called two members of the audience to the platform and asked them to tie a number of simple knots simultaneously in two pieces of rope. While this was being done, he explained that Madame Stewart, a noted medium from Cleveland, Ohio, had based her claims to supernatural powers on ability to untie knots *in the dark,* while attendants at the seances held the four ends of the two ropes. In a room flooded with light, two men chosen at random from the audience each held two ends of the dual

These knots disappeared

ropes while the magician proceeded to untie them. Never once did the ends of the rope leave the hands of the witnesses.

TO ASSIST in his next demonstration, the Chairman requested a young lady, Miss Jane Schuele, to be seated at a small table opposite him on the platform, with her back to the audience. He displayed a stack of ten small slates, which were placed on the table. He then asked Miss Schuele to write on a slate the name of a deceased friend or relative and the date of the demise. This she did in such a manner that no one could see what had been written and then laid the slate, writing side down, on top of the pile. Dunninger picked up what he termed his "concentration slate," a larger edition of the one Miss Schuele had used, and placed it over the top of the stack of slates. Drawing a chalk line on the large slate, he termed this "the concentration line." Leaning back in his chair, he lifted his "concentration slate" from the pile of smaller ones and gazed at it, meanwhile requesting Miss Schuele to concentrate as intensely as possible on the chalk line. Without hesitation, he then gave the name that had been written on the smaller slate and the date of that person's death.

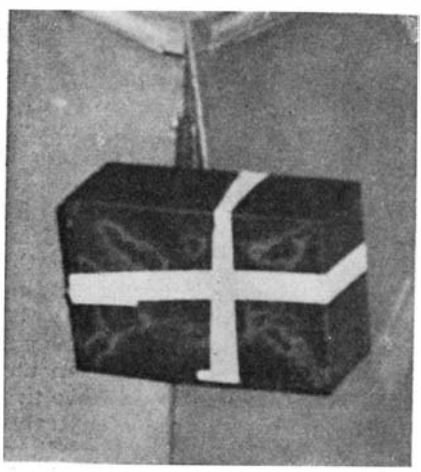
This was temporarily mystifying, but when the Chairman changed



The cards are tied together

places with Miss Schuele at the table and repeated the trick, asking the young lady for a different name and date, the audience saw clearly how the apparently amazing effect was so simply accomplished. As the magician leaned back in his chair and picked up the "concentration slate," he also picked up the top one of the smaller slates — the one with the message on it. This was easily done, for the inner edges of the frame of the "concentration slate" were made to fit perfectly around the outer edges of the slate which bore the message. As that slate had been placed message-side down on top of the pile, the writing appeared to the manipulator when picked up simultaneously with the "concentration slate," but not to Miss Schuele, nor, in the first instance, to the audience.

THE term "independent writing" has in modern times been applied to many forms of supposedly mysterious appearances of writing on a slate or a piece of paper, and various methods and rituals are used in the course of its production. (July and August 1941). To demonstrate one of these, Dunninger called two representatives of the press to the platform. They were Mr. Robert Dunn, of *King Features,* and Mr. Phil Hamburger, of *The New Yorker.* Handing each man a piece of ordinary cardboard about six by nine inches, he asked them to sign their names on one side of their cardboard. Then, to insure that the witnesses would see *both* sides of the cards before and after the trick was completed, he had them exchange cards and autograph the remaining blank sides, which left a Dunn and a Hamburger signature on either side of each card. After the cards were given to the two men for signature, Dunninger did not handle them. The witnesses placed the cards together, tied them with a ribbon and placed them in a strong box provided by a member of our Committee. They locked the box and retained the key. The strong box, without being touched by Dunninger, was securely taped, hooked to a rope which was thrown over the top of a 9-foot screen, and hauled up in plain view of the audience, where it remained for approximately an hour while other demonstrations were presented.



Suspended before all eyes

For the denouement of this trick, a New York telephone book for the borough of Manhattan was utilized. Dunninger asked a member of the audience to open the book at random. The magician held the book spread out at the designated page, requested another member of the audience to take pencil in hand and, by making a circular motion, to mark any name on the two open pages. The man revolved his pencil several times in mid-air, then brought the point down. It came to rest on the name of Alfred Sasha Gill. The name was read from the book by the witness and underscored so that others might corroborate his statement.

Messrs. Dunn and Hamburger examine the names, find Gill's

Messrs. Dunn and Hamburger were now recalled to the platform. Together they removed the strong box from the rope, tore off the tape, and unlocked the box, which at no time was touched by Dunninger. Somewhat gingerly, as though fearful of what they might find, the witnesses removed the cards, still fastened together by the ribbon, which they now untied. Each quickly looked at his card to determine whether the names were still there. Not only were the two

From 'phone book to card

names present, written in ink, but also, scrawled in heavy black pencil on one card was the name — Alfred Sasha Gill! For the sake of emphasis, it must once more be repeated that after handing the cards to Messrs. Dunn and Hamburger for their signatures at the beginning of the trick, Dunninger did not lay hands on them again, yet the name of Alfred Sasha Gill, chosen from the telephone book by a third and independent witness, after a fourth had blindly selected the page, was clearly apparent to all.

AS EVERYONE present knew, and as Dunninger forcefully stated, each of these "phenomena" had been accomplished solely by trickery, motivated by digital dexterity acquired through years of assiduous practice. Performed by a man who, among other accomplishments, is admittedly a magician, they were breath-taking, interesting, and entertaining. But, those identical feats of legerdemain, presented under the spell of darkness, or soft lighting — possibly with a subdued musical accompaniment and the intriguing odor of incense permeating the room — have been called "psychic manifestations" by the medium conducting the seance. With that sort of bogus performance, our Committee has no patience. We still, however, seek the truth concerning the physical type of psychic phenomena, and welcome all sincere offers of assistance and information.

● Scientific American, in collaboration with The Universal Council for Psychic Research, offers $15,000 to any medium who can produce a spiritistic effect or a supernatural manifestation under the rules and regulations published on page 210 of our April 1941 issue. ●

Dr. Carrel's Immortal Chicken Heart

Present, Authentic Facts about This Oft-Falsified Scientific "Celebrity"

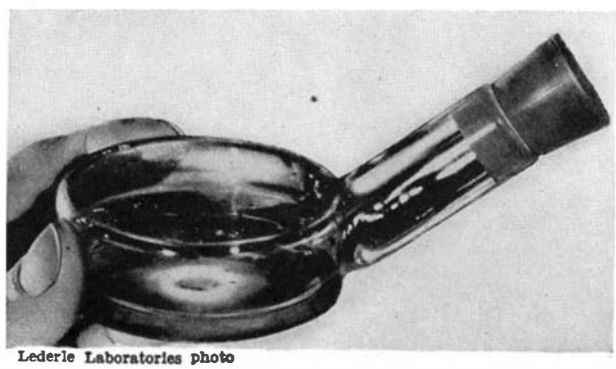
ALBERT H. EBELING, M.D.
Lederle Laboratories, Inc.

A TINY fragment, removed in 1912 from the heart of an unhatched chick embryo by the eminent Dr. Alexis Carrel, began then the most extraordinary career ever enjoyed by a chick or a part of a chick. It has attained potential immortality. The present descendants of the cells in this fragment, now spoken of as Carrel's immortal chicken tissue, or the "old strain," are in their 30th year of independent life in the wholly artificial environment of laboratory glassware. Their growth is independent of time. Under the established conditions, the cells do not grow old, and now, after practically three times the lifetime of a normal chicken, they are as young and healthy as ever.

The Carrel tissue, and others similarly cultivated, daily perform important services to advancing medical science. Independently growing cells, able to convert nutrients into new cells of their own kind, possess unique value as reagents for investigating biological problems. They are released from the natural defenses that protect organisms and hence respond freely to changes in their environment.

The scientifically important researches conducted with the "old strain" have filled volumes of reports. Among them, for example, have been studies of changes in environment on cell growth and cell characteristics. It has been found that blood plasma, included in the tissue culture medium, exerts an effect on the rate of growth of the cells varying with the age of the animal supplying it. Thus changes accompanying aging have been studied.

The history of the "old strain" is closely bound up with the progressive development of tissue culture technique as carried out in Dr. Carrel's laboratory. The procedures are used in the cultivation of numerous pure strains of cell types other than the original "immortal chicken tissue" of Carrel, such as, for example, various types of epithelial cells, cartilage, thyroid, liver, certain cell types from the blood as well as various strains of malignant cells (sarcoma and carcinoma), in a known condition of activity and on media of almost unvarying composition.



Lederle Laboratories photo

This is *it*—the famous culture as it is kept

One important use of tissue culture is in the study of the mysterious viruses, potent causes of many diseases—among others, influenza, measles, and poliomyelitis (infantile paralysis) in man, and distemper, rabies, and encephalomyelitis in animals. Viruses, so far as is now known, will grow only in the presence of living cells. In ordinary living tissue the native defenses of the organism against external harm affect the growth of viruses. Consequently a controlled environment must be created to permit their cultivation for study. That situation exists for certain viruses in tissue cultures. A few viruses will grow in the pure strain of the original Carrel tissue. Others require the favorable environment of cultures of other tissues grown by the technique developed by Carrel.

The many years the cells of the "old strain" have been under cultivation and the constant conditions under which they are maintained cause them to grow steadily, independent of time. They multiply—proliferate—at an unchanging rate, and their characteristics are well known and invariable. Their long pedigree and the mass of information accumulated about them in nearly 30 years make these cells the best possible material for testing the effects of a large number of substances of clinical and commercial value. For example, with them much can be learned about the action of drugs, such as those of the sulfanilamide family, upon living tissue. Similarly, they provide a unique way of studying the antiseptic action of germicidal compounds. To be a safe antiseptic, a substance must be more toxic to bacteria than to the healthy tissue of the wound to which it is to be applied. This is not true of many germicides. The all-important toxicity ratio—the dilution of a substance required to kill a standard bacterial culture, compared with the dilution that kills a culture of tissue cells—can be directly and accurately determined with this tissue. The standard strain is being widely used in tests of this sort at Lederle Laboratories and has already thus "earned its keep" over and over again.

Although this tissue's history is sufficiently impressive without embellishment, legends, some of them fantastic, have grown up about it. In these tales Dr. Carrel's original tiny fragment of chick embryo heart-tissue has grown into a large, pulsating chicken heart; or pieces have to be "snipped off" from time to time to hold it in bounds; or it is being kept in a glass jar or on a white marble slab, with the added setting of a group of scientists crowded around intently watching and tending it constantly, day and night!

YET, even though the simple facts lack some of the drama of the legends, they are important and no less interesting. On January 17, 1912, a minute piece of heart muscle was removed from an unhatched chick embryo. This tiny fragment, during repeated transfers into fresh nutrient medium, pulsated for a little over one hun-

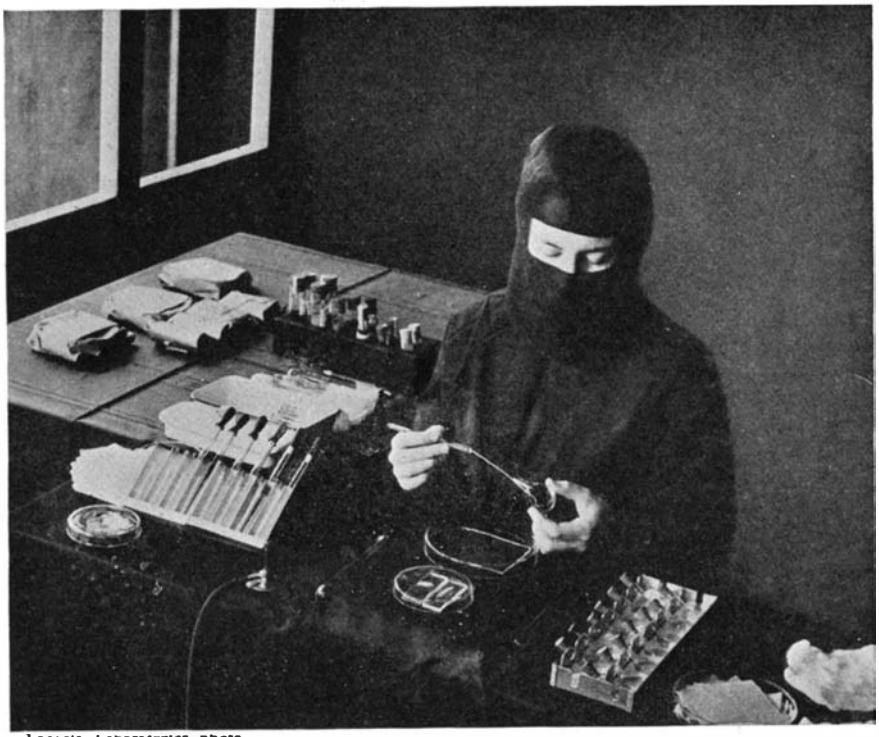
dred days after its separation from the orginal heart. By that time connective tissue cells—fibroblasts—which also were present in the original fragment, had gradually outgrown the muscle cells. The result therefore was ultimately a pure strain of fibroblasts, which pulsed no more. These cells have the property of continuing to form a network of tissue in a wholly artificial environment, not as part of a chick.

They multiply today as actively as they did at the beginning of their artificial life. The rate of growth has not diminished and they are constantly maintained under conditions favoring their optimum multiplication.

THE strain of cells is now in its 30th year of life outside of the organism from which it arose. In other words, it is potentially immortal. This is not a probability, but an irrefutable fact. In a few cases chickens have lived over 20 years, but the average lifetime of the barnyard fowl, if it can escape the axe, is not much over ten years. Hence, these cells derived from the chick embryonic heart muscle in 1912 have far outlived the chicken into which the embryo would have developed in the natural course of events.

If it had been feasible to keep, and nourish, every sub-culture that could have been derived from the original tiny fragment of heart, dividing each in turn *ad infinitum,* the mass of tissue would now be far larger than our whole solar system could contain. That, of course, sounds fantastic, yet it is mathematically demonstrable.

As the culture continually tends to form a more or less compact mass of tissue that doubles in size every 48 hours, each fragment must be subdivided, if its bulk is to be kept within practicable limits. Moreover, nutrition, respiration, and elimination of waste products are limited by the size and by the physical, physiochemical, and chemical conditions of the culture. For these services the cells depend upon the diffusion of substances through the semi-solid, jelly-like medium in which they are kept. Thus, if the culture were allowed to grow into compact masses, then those cells in the thickened portion would suffer from lack of proper nourishment, sufficient oxygen, and removal of waste products. Some cells would die, others would be poisoned, and total death of the culture might result.



Lederle Laboratories photo

This technician is transferring tissue cultures and giving them fresh medium in which to grow. Test tubes at left contain culture medium. Carrel flasks, in which tissue is artificially grown, are at the right. Black clothing and black surroundings reduce reflection of light and improve the technician's level of visibility in performing this exacting work

Actually, therefore, the average individual piece of tissue that is transferred to fresh medium is not larger than the head of a pin.

When the strain was started in 1912, it was necessary to transfer the tiny fragments every 48 hours, but later the method was modified and now transfer to new medium is less frequent.

The strain is ordinarily kept in small, flat, tightly-stoppered glass containers—Carrel flasks. The Carrel flask,developed for this type of cell culture, is made of Pyrex glass an inch and a half in diameter, about half an inch high, with an oblique neck. The amounts of nutrient medium and air in a flask are large in proportion to the total mass of tissue, so that several fragments (from two to four) can be kept in one flask, and transfer to a fresh medium need be made only every seven or eight days. The life processes—metabolism—of the tissue produce no dangerous variations in the condition of the medium during the length of its stay in a flask. Any surplus tissue is discarded at the time of transfer.

IN ALL the procedures involved in the cultivation of these cells, rigid aseptic precautions must be taken at all times; that is, the cultures must be kept completely free from bacterial contamination. The medium best suited to maintain the optimum multiplication of these cells is composed of chicken plasma, chick embryonic juice, and Tyrode's solution, mixed in certain proportions. Each of these constituents of the medium is especially prepared for the purpose.

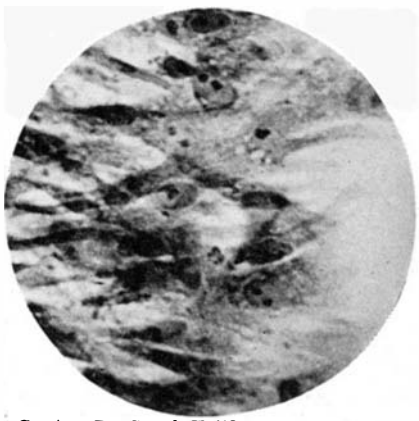
Plasma, the clear fluid part of blood, is obtained by bleeding an anesthetized chicken from a suitable artery under aseptic conditions and separating the cell elements—corpuscles—in a centrifugal machine. The clear fluid that constitutes the plasma is drawn off and preserved in a refrigerator.

Courtesy Dr. Carrel. X 412

Living old strain fibroblasts

Chicken plasma obtained under proper conditions will remain fluid for weeks, and thus can be stored for use at any time.

The embryonic juice is prepared by finely mincing the tissue of unhatched chick embryos and separating the fluid part. This juice also can be stored in the refrigerator for use. The embryonic juice contains most of the essential nutritive as well as growth-promoting substances required by the cells for their continuous multiplication. Some essentials, of



Courtesy Dr. Carrel. X 412
Stained old strain fibroblasts

course, are furnished by the constituents of the plasma.

Tyrode's solution is a solution of several salts and glucose. It acts as a diluent for the plasma and tissue juice, and supplies certain metals essential to cell growth.

When the medium is needed, plasma is combined with the tissue juice and salt solution. Soon after these constituents are mixed, coagulation — clotting — occurs. Hence, it is necessary to introduce the medium into the culture flask and, while still fluid, submerge the tissue fragments in it. Then, when the whole is left undisturbed, a soft, uniform clot quickly forms. This is firm enough to hold the tissue fragments in place and, at the same time, to furnish an invisible, fibrinous network in which the cells can multiply, and through which the fluid part of the medium and oxygen (from the air contained in the flask) can diffuse to reach the cells.

During their stay in the flasks, the cultures are bathed at intervals by introducing a quantity of Tyrode's solution, leaving it for a time, and then withdrawing the fluid by gentle suction in order not to disturb the coagulum. After this washing to remove waste products, fresh, diluted embryonic juice is added to replenish the food supply. Enough air enters the flask during the manipulations to renew the oxygen supply.

Microscopic observations of the cultures can be made at any time at moderate magnifications. For high magnification (1000 diameters or more), fragments of the tissue can be transferred to specially constructed containers—microflasks—which have paper-thin glass walls. Also, cell behavior in these flasks can be permanently recorded by micro motion pictures.

In July, 1939, Dr. Alexis Carrel retired from the Scientific Staff of the Rockefeller Institute for Medical Research. His department, the Division of Experimental Surgery, was discontinued and his organization dispersed. The writer, who was associated with Dr. Carrel for over 27 years, brought the "old strain" to the Division of Virus Research at the Lederle Laboratories in Pearl River, New York. Here, in a well equipped, modern tissue-culture laboratory, the strain continues to live uninterruptedly. Two former technical assistants of Dr. Carrel, Mrs. E. Hull and Miss D. Olmstead, are responsible for the important work of maintaining the stock cultures.

No other laboratory in the world possesses this strain under cultivation. Through the years, Dr. Carrel gave cultures of it to various individuals in research laboratories here and abroad. There is no record of any of them having survived. Hence these laboratories have the unique distinction of being the sole custodians of Dr. Carrel's original, potentially immortal strain of cells.

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IN BIG DEMAND: In the entire nation there are less than 5000 physicists, and of these between one third and one quarter are already engaged in defense work.

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CRYSTALS

Structure Demonstrated By Steel Balls

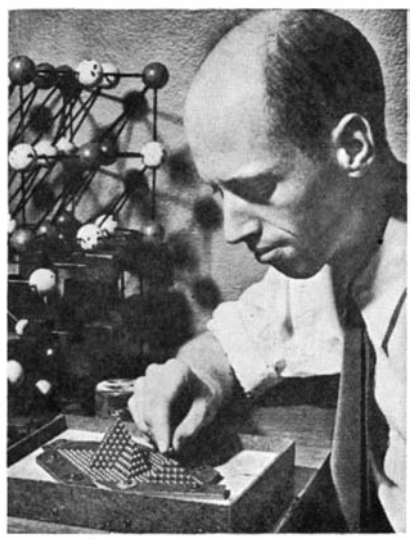
STEEL ball bearings are used by scientists to study the structure of all sorts of materials. Dr. Ralph P. Johnson, physicist in the General Electric Research Laboratory in Schenectady, is shown in one of our photographs, stacking up a model of a face-centered cubic crystal, such as is found in aluminum, silver, gold, calcium, copper, lead, and a number of other elements. Each steel ball represents one atom and is about 20,000,000 times the size of the real thing.

All crystalline substances have a specific geometrical arrangement of atoms which assists the physicist in identifying the material. The face-centered cubic type, as illustrated by the arrangement of the steel balls, is one in which each atom in a crystal is the center of a spherical cage formed by twelve surrounding atoms.

More than one material may have the same geometric arrangement of atoms. Once this type has been determined, usually by observing the pattern of diffraction of X-rays, the physicist distinguishes members of the group by the size of the atoms.

The arrangement of the steel balls shown in the picture is the densest that can be obtained. If a large number of similar balls were dropped at random into a pail, many would naturally fall into this arrangement. The group as a whole, though, would be more loosely packed than the balls arranged by Dr. Johnson.

In the background is shown the atomic arrangement of crystals of table salt, iron, and calcium carbonate. The square-block framework represents an iron crystal; the crystal of single-size spheres represents table salt; and the model containing spheres of two sizes represents a calcium carbonate crystal.



They represent atoms

Wheat Peeled For Better Bread

Process Developed by Mining Engineer Retains Grain Elements, Eliminates Fibrous Husks

H. T. RUTLEDGE

PEELING the wheat grain of its husk without cracking or injuring the kernel has been tried countless times, but each attempt to accomplish the feat in the last hundred years of milling in the United States has ended in failure. This peeling is desirable in order to produce flour from the wheat that retains all the desirable elements of the grain, without the splintery, indigestible husks, yet inventors and milling experts had reached a point where they were ready to declare that the task was impossible. They never dreamed that the job might be done by someone who did not have the remotest connection with milling or baking—but that is exactly what happened.

The wheat-peeling process was discovered in 1937 by Theodore Earle, of California, a mining engineer, who admittedly knew nothing of milling methods or milling machinery. Experimental tests continued and data on the process were checked for the next four years.

The Earle process was not originally aimed at wheat-peeling. Rather, it grew out of tests with seeds, made with mining machinery—flotation cells of the type used to separate precious metals from baser elements. After many experiments, Earle discovered that grain seeds classify themselves, when subjected to the flotation treatment, into "tails"—seeds that come to the top—and "concentrates"—grains that remain at the bottom of the flotation cells. Tails in wheat are found to be superior for milling purposes while concentrates are superior for planting because they yield the better crops.

IN A series of three tests of seeds so classified, conducted by the Kansas Wheat Improvement Association and the United States Department of Agriculture Bureau of Plant Industry at Hays, Kansas, the concentrates disclosed increased per acre yields of 22 percent, 7.1 percent, and 11 percent over those per acre yields of untreated wheat grain seeds. In the first two tests, the seed beds were cropped land; in the third test, the seed bed was fallow land. In all three tests, the same wheat grain variety was used.

Earle's chief interest, from the beginning of the experiments, was in the germination or fertility quality of seeds. He did not set out to find a way to peel wheat kernels of the fibrous, splintery, indigestible husk, or epidermis, that has been blamed for many gastric disturbances. Discovery of the peeling process occurred quite by accident.

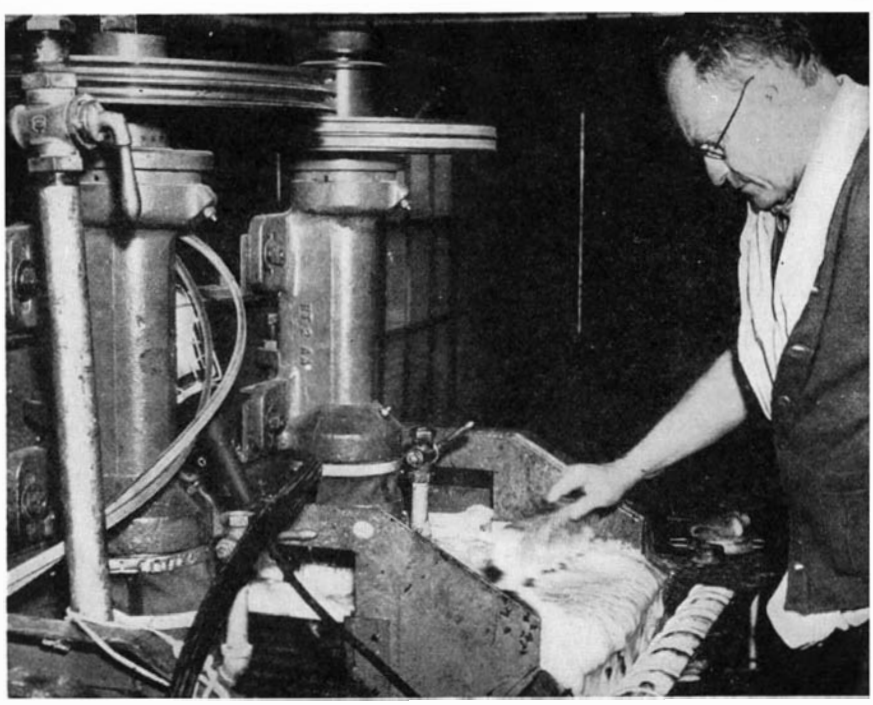
In one test, wheat grains were mixed with water in a single flotation cell. The mixture was placed in agitation and then—the telephone rang. Earle answered the call but talked longer than he anticipated. When he returned to the cell, he found slivers of wheat husks floating on top of the water. He examined the grains and they were free of husks. That started the ball rolling. Dozens of follow-up tests took place in the ensuing months and finally the peeling process was perfected.

M. Lee Marshall, President of the Continental Baking Company, became interested in the achievement because one feature of the process was of particular importance: it removed the husk without cracking the wheat kernel. That meant that all the vitamin, mineral, and protein content of the wheat grain was kept intact. It meant, too, that these deposits would be ground into flour just as nature had stored them in the wheat kernel.

HERE was big news to a baking executive who had been looking forward to the day when he might market a bread that contained the wheat vitamins, but not the scratchy husks which give whole wheat bread its bitter taste.

Preparation of the wheat for actual grinding under the Earle process combines many of the steps employed in ordinary modern milling. The flotation method unites with these steps to establish a smooth-running process that produces flour from which is baked *Staff*, a new, natural wheat bread.

The business of receiving, binning, and rough cleaning wheat under the Earle process is like that used by all good millers. Ten cells constitute the peeling machinery.



Mr. Earle combing the slurry from an experimental flotation cell

These are rubber-lined tanks, each equipped with a rubber-covered impeller. The grain is mixed with water in such proportions as to form a slurry that can be agitated by the cell impellers. The ten cells are linked at the bases by connecting pipes.

The slurry of wheat and water enters the first cell and undergoes agitation by an impeller. Then an edible re-agent is added to the slurry to form a froth which collects the feathery husks as they break away from the kernels. The slurry moves rapidly from cell to cell, the wheat husks, which millers call "bee-wings," amassing on top, the wheat kernels dropping to the bottom. The froth is skimmed from the tops of the cells as it thickens.

PASSAGE of the mixture from cell to cell occupies about nine minutes and the cleaned and peeled wheat leaves cell number ten to go to a vibrating screen that shakes much of the water from the kernel surfaces. The peeled grains then move into a whizzer, a continuous type of centrifuge, where more water is removed. From the whizzer, the kernels go to a dryer, through which flows a swift current of warm air. This dryer is a steel tube five feet in diameter and 30 feet long. It is fitted with a central flue and six concentric flues. Here the grains remain for about 12 minutes, moving at high speed and tumbling finally into the aspirator which takes out any specks of husks lodged in the kernel creases.

Still feeling moist to the touch, the grains flow to tempering tanks to remain several hours. When they emerge, they are externally dry. All moisture has been absorbed.

Now ready for grinding, the cleaned, peeled, dry wheat grains go to a battery of pulverizers of hammer-mill design and become flour containing the nutritive elements of the bran coats of the kernel, the vitamins (vitamin B_1, vitamin B_2, nicotinic acid), and the minerals and proteins of the berry, but free of the woody, outer coating.

The bread made from this flour contains 444 to 566 International Units of vitamin B_1 to the pound loaf, 1.02 milligrams of vitamin B_2 (riboflavin), and 12.7 milligrams of nicotinic acid. The methods used in these determinations were: (1) thiamin—biological, thiocrome, and fermentation: (2) riboflavin—microbiological; (3) nicotinic acid—colorimetric.

A typical freshly baked loaf of the bread reveals itself as follows in analysis:

Moisture	37.40%
Total Solids	62.60%
	100.00%

Composition of Solids

Protein	15.92%
Ash (less salt)	2.13
Salt (NaCl)	2.17
Crude Fiber	1.71
Crude Fat	6.31
Carbohydrates	71.76
	100.00%

A comparison of white bread, ordinary whole wheat bread, and the new peeled-wheat bread discloses that *Staff* contains 2.13 percent minerals as against 1.14 percent for whole wheat and 1.03 percent for white bread.

Dr. John R. Murlin, food authority, University of Rochester, New York, recently told the National Nutrition Conference for Defense that the only way to get all the nutritive elements of the wheat grain into bread is "by producing whole-wheat flour and making whole-wheat bread." He explained that his own experiments with a natural wheat bread disclosed the following story:

"The average per-capita consumption of wheat is four bushels, or 240 pounds. Deprived of its roughest constituent, 2 percent only, by weight, ground without sifting or bolting whatever, the amount will make 355 pounds of bread as compared with 221 pounds on a rich formula from 75 percent extraction of the grain.

"The 355 pounds of whole wheat, according to digestibility figures in a recent experiment in our own laboratory, on ten men, would yield 356,000 and some odd calories; compared with a white bread eaten by the same men, 240,000 and some odd calories, a saving of 116,000 calories, or enough to support the average man on our diet squad for 36 days. In other words, eating whole wheat bread would save over a year's supply of energy for yourself in the course of a year."

Thus, through the happenstance of a lengthy telephone call, a new type of bread that appears to hold promise of economy plus added nutrition has been made available. These factors, and the seed classifications made possible by the original flotation experiments, may mean much to the average bread consumer and to the farmer.

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Desert Alphabet

Strange Letters of Stone are Found in the Sand Wastes of South-western Arizona

JOSEPH C. COYLE

HIDDEN here and there in the mosaic of Yuma mesa, and buried in its topsoil, I find the letters of the alphabet. Some of them are scarce, but many letters are more or less plentiful and are remarkably perfect in shape. With the collection I have, I build many words, sentences, paragraphs.

One day an army plane roared just above my head. Involuntarily, I ducked. When I straightened up I held a perfect capital A in my hand. There were already a Y and a couple of Ls in my rock pile. I could now spell "Ally" with stone letters.

These stones range in color from light gray to nearly black, and most of them are so hard that they ring like cast iron when struck together. Some are shapeless and porous, but there are quantities of them, from the size of a straw to three inches in diameter, which closely resemble, in contour, fragments of petrified native wood. Nearly all are without a semblance of grain, however. The greater part are fairly straight and under 12 inches long, though I found one an inch in diameter and 64 inches long.

Cloudy days, though rare at Yuma, are best for rock hunting, since the sun's glare on the light-colored desert is then eliminated.

Second best is early morning or late afternoon, when shadows grow long and every pebble in the desert mosaic stands out against the drab background of gray sand.

My stone vocabulary grew by leaps and bounds, but it still centered around words requiring Ls, Ts, Ys, and so on. One day I parked my automobile and stepped out. There lay a perfect Q. I could now spell "quit," "quill." The letter O eluded me for a long time, but I now have several—some strikingly perfect. Although I wanted to spell out my name with the stone letters, the only Cs I found at first were imperfect, and E apparently was non-existent. Then one day I spied a very good capital E which a kangaroo rat had kicked out of his tunnel.

Many of the thick patches of specimens resemble closely in contour those of clumps of growing mesquite brush nearby. I was amazed to find a round stone about an inch in diameter and three feet long, with a groove cut by termites along one side; also logs, one of which is 30 inches in diameter and 20 feet long, outlined in porous stone and closely resembling cottonwood in shape. Stumps are outlined in the same porous rock, with stone roots radiating from them. Underground, as well as on the surface, are long stone roots.

A WELL-KNOWN geologist to whom I submitted the evidence stated that the specimens, when tested with acid, proved to be sand grains cemented by lime. Also that, judging from the photographs and the method of occurrence of the specimens, these undoubtedly were once plant roots and stems which,

Formerly a five-foot root

in decaying, left hollow spaces in the earth. Sand then filtered into the spaces and lime was added through the agency of percolating waters containing this mineral in solution. As the plant root fragments would have been branched in many cases, and later broken, the accidental resemblance of a few of the specimens to letters is expectable.

It is my own further hypothesis that the shape of many of these letters, as well as the other strange loops and crooks, has resulted from termites plastering the roots and stems of native wood and plants with their familiar tubes of sand, which then became consolidated into stone by the infiltration of water impregnated with lime, as just explained. The layers and folds of sand on the exterior of some specimens cannot be distinguished from fresh termite work, when the two are placed side by side. More than once I have picked up what I thought was a nice specimen, only to have the outside fall away, revealing a stick of wood which had been only *recently* plastered by the tiny insects. These specimens of termite work are often partially or wholly hollow, where the wood, covered with sand, rotted away before hardening took place. Crossed, branched, and crooked sections of these specimens later broke into sections resembling in some cases letters of the alphabet and various other things.

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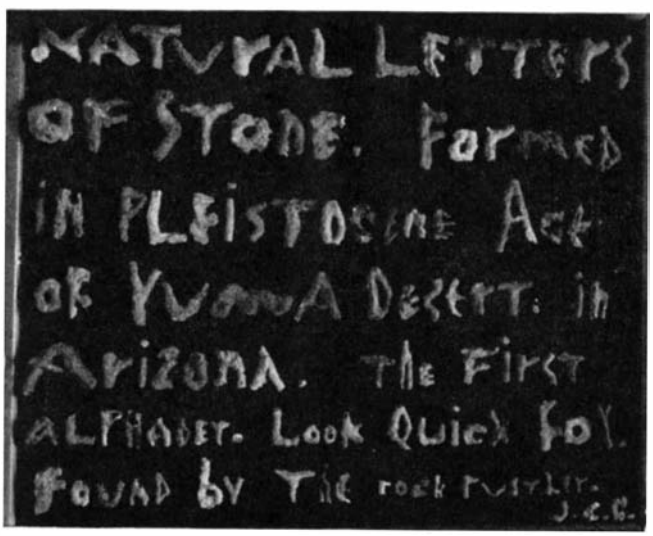
TROPOSPHERE

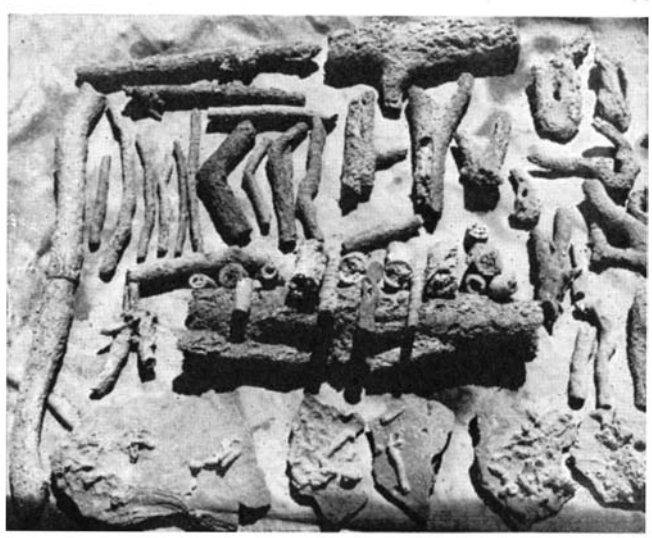
Studies Carried Out Near Sea-Level

COLDEST spot in the United States is not Havre, Montana, but in semi-tropical Santa Monica, in Southern California, where at one certain spot the average August temperature last summer was around *minus* 40 degrees, Fahrenheit, and frequently dropped to 104 degrees below zero! These temperatures were recorded in a scientific ice box located at the Douglas Aircraft factory where experiments for bombers operating in the frigid troposphere can be carried out at the more convenient ground level.

Function of the "cold room," say Douglas engineers, is to simulate the conditions and effects of extreme low temperatures on the various components of high-flying aircraft. Since, at 35,000 feet, the



Found by the "rock russler," near Yuma



Further specimens of the same kind

troposphere has a near-constant temperature of 67 degrees below zero, the men, motors, metals, alloys, plastics, and other materials used at such heights must be thoroughly pre-tested.

The trick is done with a combination of solid CO_2—dry ice—and methyl alcohol. Agitated together and pump-circulated through a heat-exchange unit, this mixture will reduce the temperature in the cold room from plus 80 degrees to minus 104 in two hours. This bit of Siberia in Southern California is contained in a space some 14 by 16 by 8 feet. The room is insulated with 12 inches of fire- and corrosion-proof spun glass.

"Our test program includes a study under polar conditions of fuel, oil, and hydraulic systems, controls, structural parts, insulation, heating, windshield de-icing devices, bearings, lubrication, tolerances, metal fatigue, and countless other subjects," explains the engineering department.

Despite extremely low temperatures, men are able to work in the room without too great discomfort. They wear sheepskin garments and wrap themselves into wool-lined leather suits surmounted by helmets equipped with earphones and a telephone mouth-piece. The helmet, greatly resembling a diving bell, is made of spun aluminum welded to padded shoulder pieces of the same material. It has a fixed vizor of laminated Plexiglas separated by air chambers and hermetically sealed after all moisture has been removed. This effectively prevents fogging. It is lined inside with orthopedic felt and soft chamois skin. Neither suit nor helmet is electrically heated.

Since a principal danger to workmen in the cold room is the possibility of pneumonia, the suits are valved so the wearer breathes air warmed by his own body, the large helmet providing ample storage space. The intake is near the floor; the exhaust is located in the helmet dome.

ANTI-FREEZE

Conserved With Cooling-System Sealer

CONSERVATION of automobile anti-freeze fluids, urged for this winter because of defense needs, gains an ally in a newly developed liquid cooling-system sealer announced by Du Pont.

Leakage and the subsequent

over-heating account for thousands of dollars worth of anti-freeze lost annually, radiator specialists point out. The new cooling-system sealer is an inexpensive "ounce of prevention," against such losses. It is said to be harmless to rubber, aluminum, and other metal engine parts, and to flow with water. It not only stops existing leaks without clogging, but prevents new leaks forming in the system. Before the sealer is used, the cooling system should be cleaned to rid it of rust and scale.

RADIUM DETECTOR

Protects Those Working With Radium Compounds

AN INSTRUMENT which sounds a warning signal and flashes a red light when the quantity of radium or radio-active materials in the vicinity is too great for workers' safety has been designed by the Geophysical Instrument Company. The instrument, which employs a Geiger-Muller counter tube and an auxiliary circuit including standard vacuum tubes, also indicates the concentration of radio-active materials on a dial. Furthermore, it is possible, with this instrument, to check the strength of radium compounds in order to determine whether or not any such material has been lost.

ICICLES

Movies Use Cellophane And Waterglass

CHEMICAL icicles are used on many of Hollywood's movie sets. The icicles are made of cellophane and waterglass — the substance used to preserve eggs. After being shaped they are dipped in alcohol, which solidifies them, and then in paraffin. The latter forms a coating which melts under the heat of the spotlights, giving a realistic effect.

PANELS

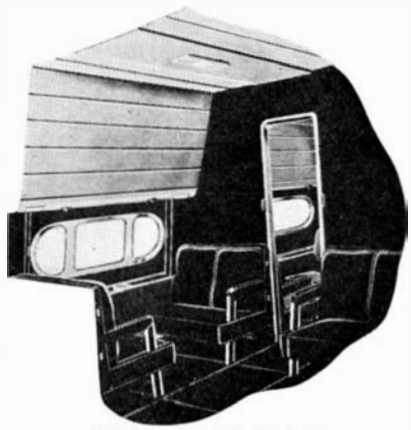
Of Light Weight For Transport Use

A MATERIAL which is establishing itself as being of particular interest to designers in the transportation field is Fybr-Tech, one type of which is being used as an interior lining for the huge flying boats which Vought-Sikorsky is building for the transatlantic service of American Export Airlines, Inc. The panels developed for this purpose weigh only one-fifth of a pound per square foot as compared with the average wall paneling weighing one to three pounds per square foot. This type of Fybr-Tech developed has a fiber face for strength, a balsa core for lightness, and a walnut face for beauty. This American walnut paneling is the key note of the decoration of the entire passenger accommodations in the new transatlantic flying boats.

This was, in a sense, an extreme and unusual form of Fybr-Tech; however, the principles involved in the material's construction are flexible, various factors being introduced to suit whatever application it is intended for. For surface transport use, a more orthodox construction of Fybr-Tech is used consisting of two faces of fiber with a birch or basswood core. With this a great increase in strength is gained with a certain sacrifice in weight, but both are present in sufficient proportions to make this form an efficient substitute for aluminum and other metal sheet in certain applications.

Greyhound buses alone, for example, have used over a quarter of a million feet for this purpose, while another manufacturer of buses will use large quantities of the material in their new models.

Among the advantages of this material for transport use is the fact that it is extremely easy to



Flying boat interior

work; it may be cut, drilled, die-punched, and bent to a radius of as little as one-half inch. It is resilient and will not dent easily; it has a tough, hard surface which will take a fine paint finish. It can be waterproofed, and used in conjunction with metal for unusual strength, asbestos for fire-resistant qualities, hollow-core construction for extra lightness, and with a veneer face for decorative trim.

VENTILATING

System Speeds Up Tunnel Boring

Six feet per day have been added to the push in the east portal of the 13-mile-long Continental Divide tunnel, being driven by the S. S. Magoffin Company at Estes Park, Colorado, since the recent installation of what is believed to be the most efficient and effective method of tunnel ventilation ever devised.

The ventilating system consists of heavy-duty blowers powered by General Electric 2200-volt, 100-horsepower motors, connected to the blowers by means of V belts. As the work progresses, the blowers are being installed every 9000 feet along the tunnel.

The installation of this ventilating system has cut twenty minutes from the time needed for each drilling cycle. So effective is the system that the men working in the heading can now return to their posts immediately after shots are fired, instead of waiting for the smoke of the explosion to clear.

In addition to removing smoke from the bore, the ventilating system can be regulated to overcome the fog usually prevalent in a tunnel because of the difference in the temperature of the air at the portal of the tunnel and at the heading.

After holes have been drilled by the crew in preparation for blasting, the fans are shut down while powder is placed in the holes. The charge is then fired electrically. Immediately after the shot is fired, the operator in the compressor house at the portal of the tunnel—from where the blowers are controlled—is notified by telephone and the fans are started to exhaust the bad air from the tunnel.

Twenty seconds after the blower in the heading of the tunnel starts, the next blower starts, and so on down the tunnel. This allows sufficient time for the air to reach each blower, thereby eliminating the possibility of a vacuum being created in the duct with a resulting inrush of air which might damage the blower or duct.

The fans exhaust for approximately 20 minutes, sucking all the powder smoke from the heading, and are then reversed to blow fresh air into the tunnel. After the "reverse" push-button is pressed, the motor in the portal of the tunnel delays one minute and then starts up in the opposite direction. This allows sufficient time for the motor to come to a rest before changing direction; plugging is thus prevented.

Twenty seconds later, the second blower picks up; the remaining motors start at 20-second intervals. The fans blow fresh air into the tunnel for about 30. minutes

Clear air, 9000 feet in

One of a series of blowers

and are then again reversed. Exhausting is continued until the heading crew is again ready to shoot, when the fans are shut off and the procedure repeated. This system requires only one pipe to supply fresh air and to exhaust bad air, and is much more economical than a double blower system.

Blowing and exhausting are timed to conform with outside temperature, to avoid fog collection in the tunnel. In this way, the heading of the tunnel as well as its complete length is always free from smoke and fog.

When completed, the fifty-million-dollar Continental Divide Tunnel will connect Estes Park and Grand Lake, Colorado, to bring water from the western slope of the Continental Divide to the eastern side, where it will be used for irrigation. In addition, immense quantities of power will be developed by the installation of turbo-generator units at strategic points. The project is under the direction of the United States Bureau of Reclamation.

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RAILROADS: Rails in present-day use on American railroads range in weight from 50 to 150 pounds per yard.

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PUTTY

Remains Plastic, With Hard Skin

A NEW putty for glazing, sealing, and caulking that remains soft and pliable on the inside yet hardens to a protective skin on the outside has been made available by the Tamms Silica Company. It is claimed that the material will expand and contract with temperature changes and will not crack, crumble or fall off.

Industrial Growth

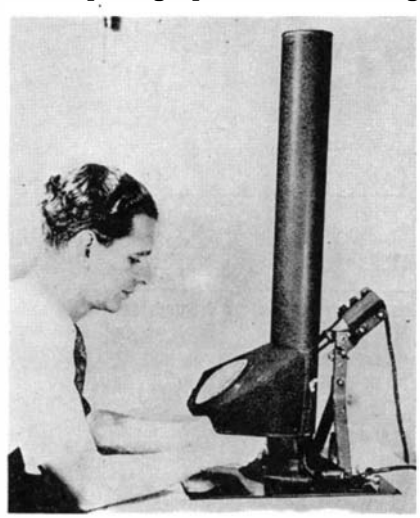
New Products and Processes That Reflect Applications of Research to Industrial Production

SOLDERING

Stand Holds Iron

And Magnifier

RAPID soldering operations on small parts can be carried on efficiently with a new soldering-iron stand produced by the Photobell Corporation and illustrated in one of our photographs. The soldering



Fumes are carried off

iron is held in an adjustable clamp, the 30-inch pipe acting as a chimney to carry off fumes. The hood is for the protection of the workmen and is provided with a magnifying glass of two, four, or six power or with ¼ inch plate glass, as desired. Under the hood are two lamps which illuminate the work.

In use the operator holds the work against the tip of the iron with one hand while solder is applied with the other, progress being watched through the lens.

INSULATION

Panels Can be Nailed

To Ceilings, Walls

ACOUSTIC material in 12 by 12 inch or 12 by 24 inch plates is now available for application by nailing to flat surfaces. Produced in three standard thicknesses, the new material, known as Cushiontone, presents a smooth surface that can be cleaned with a vacuum machine or with ordinary wallpaper cleaner when it becomes soiled. It is claimed that it can be painted without loss of acoustical properties and that its characteristics include glare-free light reflection, heat insulation, moisture resistance, and light weight.

MARKER

Hand Operated Press

For Nameplates, Badges, Parts

NAMEPLATES, tool checks, badges, metal or fiber tags, small production parts, and so on can be rapidly and economically marked with a new hand-operated marking tool recently placed on the market by the Acromark Corporation. Guide pins and holes in the table of this press-type machine are provided to locate work pieces accurately. A rack and pinion arrangement provide a leverage of 50 to 1 between handle and work.

POWDER METALLURGY

Reduces Machining Time,

Releases Other Tools

THE use of "powder metallurgy" to manufacture many metal parts ordinarily made by casting and machining, forging, stamping, and so on, is one important way in which industry can save machining time and release valuable machine tools for other work, according to an article by Fred P. Peters, in a symposium on "faster production" published in *"Metals and Alloys."*

"This production method—the molding of parts to finished dimensions by pressing metal powders in dies and then heat treating—has only recently risen to prominence as another (and often faster or better) way of making certain metal parts," he says.

"Powder metallurgy presses are available that can produce small parts at rates up to 500 per minute, although production rates are normally between 25 and 150 per

minute. In one plant 10 million flanged bushings a year are being produced by powder metallurgy at costs that compare with those for similar pieces made from flat strip stock."

Nevertheless, Mr. Peters warns that powder metallurgy is no panacea and has numerous limitations. "The fastest metal-part production is probably obtainable by die casting, the closest tolerances through screw-machining.

"Powder metallurgy involves the least waste of material, but its tool costs are likely to be among the highest. A process like cold-heading and forming may provide a better all 'round combination of low tool cost, high production rate, low material-cost, and design flexibility."

HAND CREAM

Invisible "Gloves"

Protect and Heal

A NEW water-soluble hand cream that is applied to the skin before starting work guards the hands of workmen from grease, paint, ink, and other materials which are ordinarily difficult to remove. Known as Mitts, this cream washes off easily with soap and water, taking all dirt with it.

According to the manufacturers, one of the ingredients of this cream exerts a therapeutic action, helping to heal cuts and sores during the time the cream is in contact with the skin.

ARC WELDER

For Use on Thin-

Gage Metal

FOR use in fabricating bright-surfaced, thin-gage metals, such as aircraft tubing (SAE-4130) which has a wall thickness of 35 mils, a new 150-ampere direct-current arc welder, the Strikeasy, has been

Portable welding current supply

announced by the General Electric Company. The design and characteristics of the new welder have been developed to help operators produce strong, uniform joints quickly and easily without spoilage.

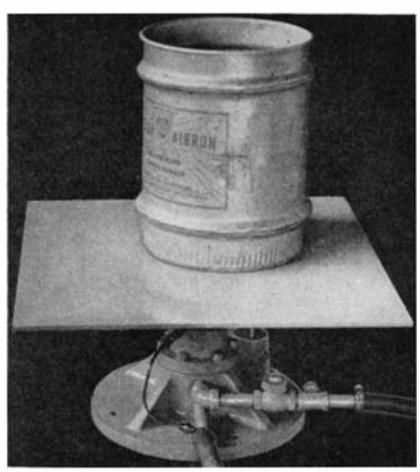
Chief among the features of the Strikeasy arc welder is its "pep" or extra high instantaneous recovery of voltage (40 to 60 volts) which helps the operator to strike the arc with ease under the difficulties presented by thin metals having a bright, polished surface. The wide welding range permits the use of shielded-arc electrodes as large as 3/16 of an inch in diameter and as small as 3/64 of an inch.

As a further aid to the operator in producing welds of uniform strength, the welder may be used with a remote-control device for reducing the current when the operator wants to fill a weld crater or when a reduction of heat is needed to avoid burn-through.

PACKING

Compacting Device For Settling Bulk Material

OPERATED by water pressure at approximately 50 pounds per square inch, a device is now available for settling light, powdered material in bulk containers. Materials such as soap chips, aluminum powder, and so on require this settling and compacting action in order to conserve space in containers.



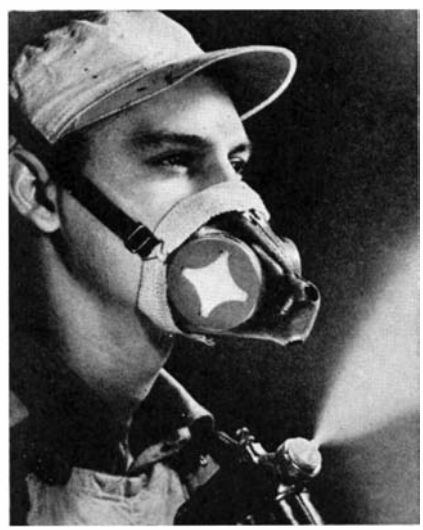
Material jolter

This new device, produced by the Syntron Company, is so arranged that the frequency and amount of lift can be readily controlled. The container of material is placed on the platform and a valve is operated. A cylinder then lifts the plate and drops it sharply about once a second. The equipment is available in a range of sizes and can be provided with a motor-driven pump to operate a closed hydraulic circuit.

MASKS

For Workmen, Use Plastic Pieces

PLASTICS are now being used in the construction of masks through which workmen may breathe without inhaling irritants suspended in the atmosphere. Made of shatterproof tenite, a plastic piece on each side of the respirator holds a felt filter which cleanses the air. It is lighter in weight and better in appearance than the aluminum part formerly used, according to the manufacturer.



Light-weight plastic side pieces are used in the respirator being worn by this spray-gun operator

The mask can be used in mines, breakers, granaries, and other places where dust threatens the health of workers. Painters using spray guns may also wear the device to protect themselves against fine particles of suspended paint. Air exhaled through the mask does not pass back through the tenite-held filter but it released by a valve in front of the respirator. The valve automatically closes when the wearer inhales.

The replacement of aluminum by tenite has lowered both labor and materials costs. The tenite parts come from the mold ready for assembly. They are molded by a process which turns out finished articles at the fastest speeds ever attained with plastics.

CURRENT BULLETIN BRIEFS

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

CAA FOR DEFENSE is a 16-page pamphlet on the work of the Civil Aeronautics Administration in civilian pilot training, airports, and airways, all aiming toward national defense and future peacetime safety and efficiency. Illustrated with photographs and charts. *Department of Commerce, Civil Aeronautics Administration, Washington, D. C.—Gratis.*

MINERALS YEARBOOK is a 1459-page authoritative reference work covering the whole broad field of minerals. Production, stocks, distribution, and consumption of metals, nonmetals, fuels, and mineral products are covered in a comprehensive manner with a large array of data. *Superintendent of Documents, Washington, D. C.—$2.00.*

ELASTIC STOP SELF-LOCKING NUTS is a four-page folder describing a relatively new type of lock nut and its various uses in a wide range of equipment where safe, vibration-proof fastenings are needed. *Elastic Stop Nut Corporation, 2330 Vauxhall Road, Union, New Jersey.—Gratis.*

THE CATERPILLAR CONDENSED CATALOG is a 36-page booklet, in two colors, devoted to track-type tractors, road machinery, Diesel engines, and so on. Each of the products is illustrated and brief specifications are given. Request Form 6425. *Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

THE OBSERVER'S HANDBOOK FOR 1942 contains data on the planets and other astronomical phenomena, month by month; also lists of double and multiple stars, variables, four star maps, an ephemeris of the Sun, and miscellaneous astronomical data to the extent of 80 very useful, practical pages. Most amateur astronomers obtain this booklet each year. *Royal Astronomical Society of Canada, 198 College Street, Toronto, Ontario, Canada.—25 cents.*

SURVEY OF ROOFING MATERIALS, by H. R. Snoke and L. J. Waldron, presents data on the weathering qualities and extent of use of various types of roofing materials on dwellings in the north-central states. 48 photographs illustrate the text. Request Report BMS75. *Superintendent of Documents, Washington, D. C.—15 cents.*

STRUCTURAL PLASTICS IN THE AVIATION INDUSTRY, by J. B. Johnson, is a copy of a paper, presented before the Society of the Plastics Industry, which surveys the various uses to which plastics are put in the construction of aircraft. Tables and drawings cover mechanical properties of plastics, tensile properties under varying temperatures, shear tests, and so on. *Society of the Plastics Industry, 295 Madison Avenue, New York, New York.—$1.00.*

PRECISION INSTRUMENTS FOR THE EXACTING INSPECTION OF INTERNAL SURFACES is a 12-page catalog describing and illustrating a series of industrial telescopes which are now finding wide use because of the increasing importance of visual inspection of internal surfaces, recesses, and hidden contours which cannot ordinarily be seen. *American Cystoscope Makers, Inc., 1241 Lafayette Avenue, New York, New York.—Gratis.*

PHOTOGRAPHY AS A VOCATION, by Andrew B. Hecht and George J. Berkowitz, is a 48-page paper-covered booklet which tells how the serious minded and talented camera hobbyist can prepare himself for a career in photography. Various photographic occupations are analyzed in a simple yet comprehensive manner. *Science Research Associates, 1700 Prairie Avenue, Chicago, Illinois.—50 cents.*

THE STORY OF VITAMIN A ESTERS is a descriptive pamphlet covering the process of molecular distillation whereby it is possible to produce concentrated vitamin products of high stability from fish oils. *Distillation Products, Inc., 755 Ridge Road West, Rochester, New York.—Gratis.*

PERFORMANCE OF PRESSURE-TYPE OIL BURNERS, by M. P. Cleghorn and R. J. Helfinstine, is a 32-page report of tests conducted primarily to provide information of assistance in the intelligent selection and operation of oil burners. Included is a tabulation of relative heating costs with coal and with oil. Request Bulletin 151. *The Director, Iowa Engineering Experiment Station, Ames, Iowa.—Gratis.*

A GREAT TEAM is a four-page illustrated circular that describes a new radio transmitter and receiver specifically designed for use by private fliers. The units are light in weight yet high in power and performance. *Lear Avia, Inc., Dayton, Ohio.—Gratis.*

WALKER-TURNER MACHINE TOOLS is a 56-page catalog illustrating and describing a standard line of metal-working and wood-working machine tools of all types. *Walker-Turner Company, Inc., Plainfield, New Jersey.—Gratis.*

TOOLING TURRET LATHES FOR SMALL LOT PRODUCTION is a four-page folder describing the use of Kenna-metal steel-cutting carbide tools for this particular purpose. Desirable economies are claimed. *McKenna Metals Company, 1000 Lloyd Avenue, Latrobe, Pennsylvania.—Gratis.*

Molded Plywood Planes

Plastics Plus Multi-Layered Veneer Used in Construction of New Two-Engined Ship

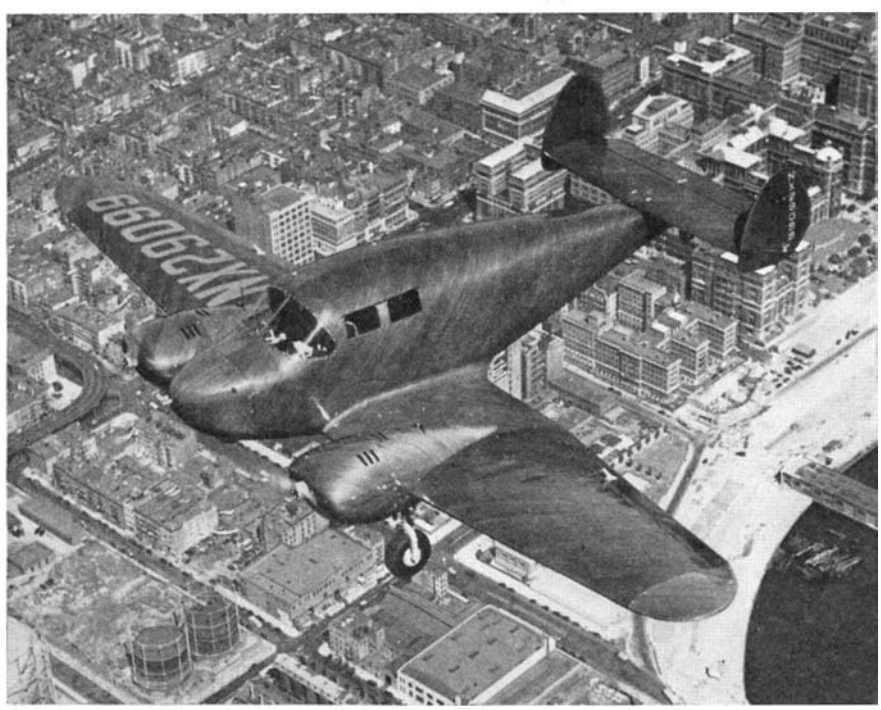
ALEXANDER KLEMIN
Aviation Editor, Scientific American. Research Professor, Daniel Guggenheim School of Aeronautics, New York University

A SMALL, twin-engined plane, the Langley, has attracted favorable attention by its looks and performance. But, and this is more important, the new plane is built entirely of molded plastic-treated plywood by a process which helps the aluminum shortage and which lends itself to mass-production methods. Since the exact methods employed by the manufacturers of the Langley plane are not entirely available for publication, we shall quote verbatim from the maker's description, with the sole comment that the process is known to us as really effective:

"The molded plastic plywood parts of the Langley ship are multiple layers of veneer, formed over a mold and permanently bonded together into a completed structure by plastic compositions which react in their characteristic manner to heat and pressure. Each of the integral members—fuselage, wings, control surfaces, and cowling—are joined together without any mechanical fastenings such as nuts, bolts, or screws. In place of mechanical dies, the Langley parts are made on relatively simple wooden forms or molds, prefabricated strips of veneer being placed over each other upon the forms while dry." Parts as big as half a fuselage are thus produced in one hour or less, under applied pressure and temperature. Cowls and fire walls are molded with an integral asbestos lining.

Simplicity of construction, resistance to corrosion and to temperature effects are features of the plywood plane. Real possibilities appear. With two 65-horsepower Franklin engines, and a gross weight of 2300 pounds, top speed is 142 miles per hour, ceiling is 15,000 feet and take-off distance is only 200 feet. The Langley should

The plywood plane with hatch open and, *below*, ship in the air



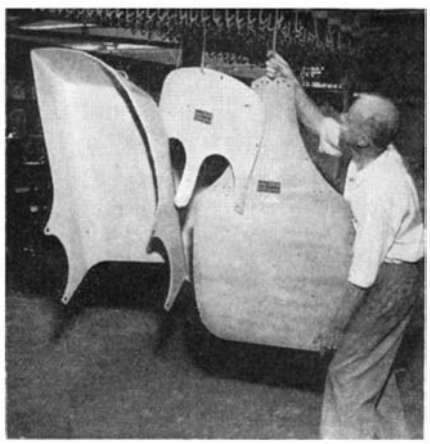
be a very useful training plane for pilots who are to fly fast twin-engined ships later.

Heading up the Langley Corporation is Caleb S. Bragg, an old war-time pilot. Working vice-presidents are Messrs. Draper and Jensen, with Smithline, a graduate of the Daniel Guggenheim School of Aeronautics of New York University, as the technical man of the group.

AIRPLANE ARMOR

Welding Produces Intricate Curved Sections

THERE are two types of armor plates, one known as face-hardened or carburized, in which carbon is added on one side of the plate for about a quarter of the thickness and the face becomes hard and capable of resisting even armor-piercing shells. The other type, called homogeneous armor plate, is uniformly hard throughout but is not so resistant to shell fire as the face-hardened type. Breeze Corporations inform us of an advance in the hitherto costly and tedious process of carburizing armor plate.



Three pieces of airplane armor

In the older process, the steel plates to be carburized are placed in metal boxes packed with carbon dust and wait for many hours before the heated steel can absorb the carbon on the chosen side. In the new Breeze process the plates are placed in large pots filled with liquid salts, heated electrically and accurately controlled. The result is closer control, more rapid and more uniform carburizing.

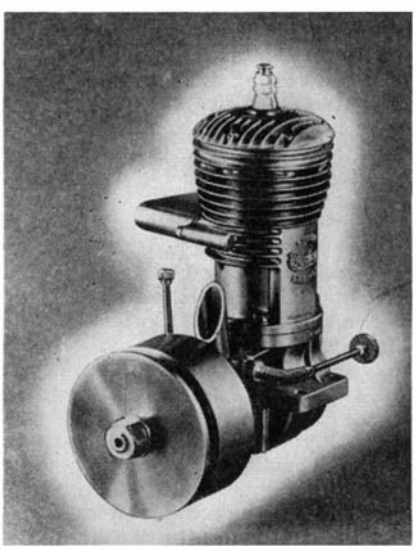
Another process which the ingenious Breeze engineers have developed is one of welding the finished armor plate together, making it possible to produce intricate curved sections such as, for example, the section of armor plate for shielding the pilot, is shown in one of our photographs. It looks like a small bathtub into which the pilot's seat is fitted. Other sections shown are gunner front shield in the center, and fighter pilot shield to the right.—*A. K.*

MIDGET ENGINE

For Gasoline-Powered Model Planes

THOUSANDS of American boys fly rubber-driven airplane models and do wonders with the primitive power plant of a few strands of rubber. Eventually they graduate to gas-driven models, and then the young engineers surpass themselves. Of course, even the most mechanical lad can hardly expect to build a perfect, tiny gasoline engine to power his model. That is where Aircraft Industries, Inc., help him out with a tiny "Super Cyclone Engine," which in its way is as fine as the giant Cyclones built by the Wright Aeronautical Corporation.

One of our photographs shows one of these fine little units, which operate splendidly without too much care by the boy engineers, and which are designed to stand a good deal of abuse since the models land themselves, at times, very roughly. The specifications are complete and thorough. Two-port, two-cycle, air-cooled. Fuel admission through rotary crank valve, Normal horsepower 1/4 to 1/5. Bore 15/16, stroke 15/16. Weight bare only 7¼ ounces. Propeller 13 inches diameter, revolving at between 6000 and 7000 revolutions per minute.—*A. K.*



7¼ ounces, 1/5 horsepower

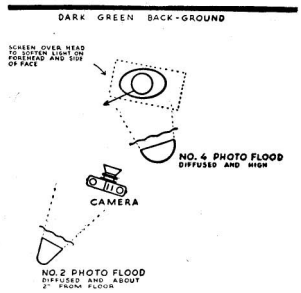
CAMERA ANGLES

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

The Professional On Portraiture

THE work of the professional portrait photographer is, in too many instances, so humdrum and lacking in imagination that when we have the opportunity of meeting one who still retains his amateur enthusiasm and a consciousness of fine technique, we never fail to listen. One such photographer is Maurice Carnes LaClaire,

Figure 1



whose exhibition of portraits made with the Contax recently attracted wide interest at the galleries of Carl Zeiss, Inc., in New York City.

We reproduce three examples from the show, together with lighting diagrams. Discussing Figure 1, Mr. LaClaire said that while the general rules for portrait lightings hold good for the average subject, it is sometimes advisable, and even necessary, to disregard accepted rules. Therefore, instead of using a broad lighting effect with this subject, he deliberately used a top front light which, he felt, brought out and emphasized the planes of the woman's face.

"This young lady has very small eyes," he continued. "Illuminated by the conventional 45-degree side light they appear very narrow and lack expression. By using the top light well forward, emphasizing all the planes of the face very strongly and by using the low point of view for the camera I have succeeded in giving this subject both dignity and expression. The subject has a mixture of large and small features which, taken from the normal viewpoint, would bring out none of that which is best pictorially, but these very features are *made* to dominate and carry the eye about in the picture area. Notice that the whole action of the head is carried out from the lines of the neck to the direction of the eyes."

The lighting arrangement is shown in the diagram. The No. 4 Photoflood is diffused with one thickness of tracing cloth placed near the camera and well above the subject. To soften the light on the forehead, a small screen was used. For illuminating the shadows, the No. 2 bulb was placed well back and close to the floor.

Figure 2 is one of the most difficult, yet among the most characteristic and agreeable shots in the baby photographer's repertoire. The problem lies in keeping the lighting general and soft, at the same time balancing the artificial light with the daylight illumination coming through the window.

"This picture was made in the nursery and was illuminated in such a way that the light, while ample, was not a hardship on the tiny eyes," Mr. LaClaire explains. "With a fast lens and the fast film available nowadays, it is possible to make excellent portraits with a very small volume of light. In this instance a No. 4 Photoflood was turned directly up so that the undiffused light struck the ceiling and filled the room with light. This gave an excellent and very soft gen-

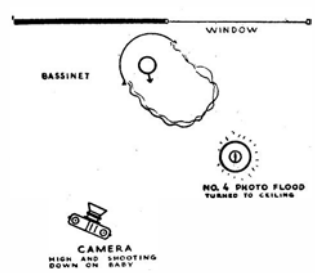


Figure 2

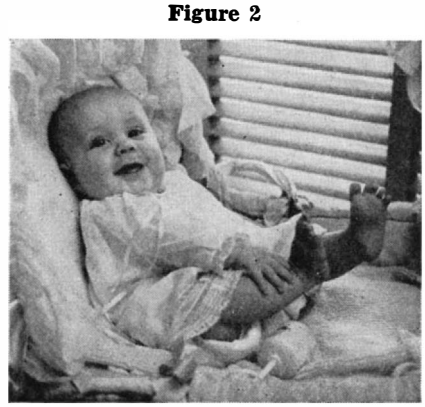
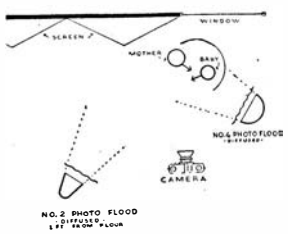


Figure 3



eral illumination. As you will note, the bassinet was placed close to the window and the accent light comes from the window, no other illumination being used."

An example of group portraits in the home is shown in Figure 3. The picture was made in a very small apartment. To prevent a black void in back of the subjects and to keep the tones of the picture harmonious, Mr. LaClaire used a light folding screen beside the window.

Mr. LaClaire suggests that should you have trouble having the mother hold the baby comfortably, you will find it helpful to crowd a small cushion or two between her elbow and the chair; this also helps support the weight of the child's head.

"Keep the light out of their eyes as much as possible," he advises baby photographers. "If they are lying down, have the light at such an angle that their eyelids shade their eyes, and by no means, when the baby is brought into the room, have the light turned on full. Reflect it against the opposite wall, gradually turning it so that the strength of it falls on the baby after his eyes have become accustomed to the more intense light.

"You will notice that while the window is in the picture, it is supplying none of the light that makes the picture. Had the light from the window been too strong, it would have outlined very disagreeably the baby's bald head and thrown too strong a light on the mother's face and far too much on the toys. And, speaking of the toys, I wish you to note that they are a number of shades lower in tone than the area surrounding the baby."

The lighting arrangement, as shown in the diagram, consists of a No. 4 Photoflood, diffused with one thickness of tracing cloth, in front and slightly to the right, and a No. 2 bulb in a clamp light fastened to the leg of a chair and some distance from the subjects.

Professional Aid

THE Professional Photographers' Association of Connecticut, in line with a newly formed policy to "bury the hatchet" and get together with amateurs "in an all-out movement for the advancement of photography," recently voted to offer, through the camera clubs of the state, a loving cup to be known as the "Professional Photographers' Cup, 1942." Other aids are part of the general program, including availability of the association's various departments to the amateur clubs in the state.

Scholastic Awards

THE Kalart Company announces its co-sponsorship, with *Scholastic Magazine,* of a nationwide competition among high-school students. This national magazine, the largest of its kind in this country, is used as a text in 8000 senior high schools. In connection with a division of photography, Scholastic awards have been made for 17 years. The 18th Annual Scholastic Awards, to be announced soon, will include a special Kalart Award "for the best pictures taken by high school students, using a synchronized flash."

New Reflector Material

DESIGNED for purposes of home insulation, a new material called Metallation, now on the market, is incidentally a very fine reflector for photographic use. The material is a composition similar to foil and is mounted on a thin but fairly stiff paper, which permits rolling up. One side is glossy, the other less glossy, almost semi-matt, thereby offering a double-purpose reflector, providing either the directional, strong reflection of the one, or the more diffuse reflection of the other. Bending the reflector in various ways will afford a selection of reflection angles. The material need not be mounted on a stiff cardboard but may be used as is, fixing the shape as circumstances dictate. The material is 25 inches wide and, in the quantity needed, very inexpensive.

Props for Effect

FAMOUS for his original ideas in portrait and fashion photography, George Platt Lynes is also notorious for collecting odds and ends of apparently nothing at all, for possible future use in out-of-the-ordinary portraiture. An example is the reproduction of a portrait he made of the ballet dancer,

Photo by George Platt Lynes

Tamara Toumanova

Tamara Toumanova. During a visit to Chinatown one day he noticed some Chinese painted kites on display, and purchased a few. These came in handy when he was arranging a shot of the dancer. One of the kites he pinned on the subject and a few others were pinned on a stretched white cloth behind her. The stretched cloth was then lighted from behind to give a luminous quality to the background.

Movie of Color Process

A 16mm motion picture film demonstrating, step by step, the processing of a color print by the Iso-Color Process, has been produced by the makers of the process, the Spectrum Products Co., Inc. This company offers to lend the film to camera clubs without charge. The film demonstrates how a color print can be obtained from a set of Kodachrome separation negatives in 40 minutes.

"Because there are only nine simple steps to the Iso-Color Process," says the announcement, "and because of its simplicity. . . it is possible for the first time to show the entire development of a color print in a film running only 15 minutes."

Guide Numbers

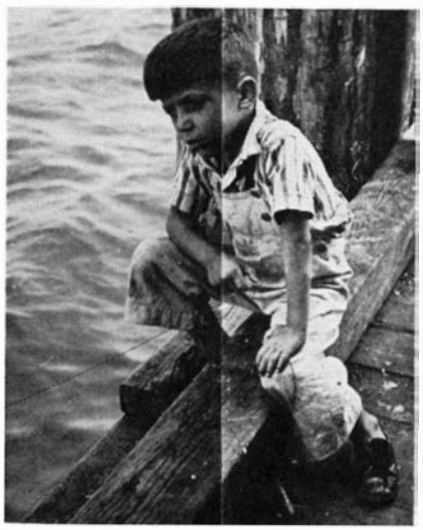
THE new system of exposure with Photoflash and Photoflood lamps, by which flash and flood bulbs of various sizes are assigned numbers for use as bases in determining the proper *f*/ stop to use, is one of the greatest conveniences to come the amateur's way in a long while. The system is simplicity itself, but since there are some who seem a bit puzzled, let us review it briefly here.

Guide numbers are assigned to individual bulbs according to the speed of the film being used (Weston or other film rating) and the shutter speed to be employed. The distance in feet of the lamp from the subject is then divided into the guide number, the result furnishing the *f*/ stop at which the diaphragm is to be set. Let us take a specific example. The Guide Number for a certain bulb at a given shutter speed is 160; the distance from lamp to subject is 10 feet. Divide 160 by 10—result 16, the *f*/ stop to be used. Could anything be simpler?

The system is now being applied to flood bulbs as well, but manufacturers generally recommend that exposure meters be used where possible.

New Tone Treatment

A NEW corrective treatment for negatives, prints, film and glass positives, and so on, is introduced in Supertone Clarifier, a two-solution formula designed to improve the quality of photographic images. The formula includes, in addition to the Clarifier, the Supertone Fixing Solution, and works equally well whether local or general treatment is desired. A few seconds immersion in the Clarifier is generally sufficient to effect the characteristic action of the

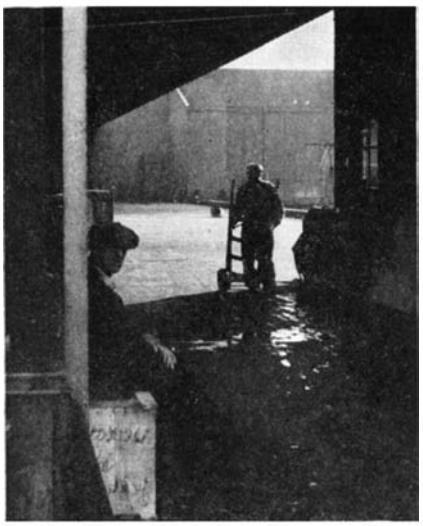


Untreated and treated

treatment, that is, to remove a thin veil of metallic silver density from the image, thereby rendering it more brilliant. Softness may also be obtained, if desired. The typical action of the solution is demonstrated in the illustration, which shows a print after half of it was treated with the Clarifier.

Entry Forbidden

AS YOU can readily see, the figure in the left foreground is both a blessing and a curse so far as good composition is concerned in this particular print. It helps arrangement by lending weight to the left part of the picture, thereby materially aiding balance of the several elements. Unfortunately, however, because of the distinctness of the man's face and hands and the fact that he is staring directly at the camera, attention is diverted, though temporarily, from the main object, which is the man wheeling the truck into the light. Entry of the eye into the picture is



"Morning Sunlight"

therefore done hesitatingly because it is stopped by the prominence of the figure in the foreground. The thing to have done, of course, was to have waited until the man had turned his face profile. In addition, it would still be necessary in printing to do some dodging to cut the tone of the hands and face, as well as that of the packing box on which the man is seated.

Military Uses of Photography

SEVERAL of the most important uses of photography in the Army were recently outlined by Colonel M. E. Gillette, Commanding Officer, Signal Corps, Fort Monmouth, before the Westinghouse Photographic Lighting Conference in Bloomfield, New Jersey. These included:

As an aid in military operations. Pictures from the air are made during reconnaissance flights and are used to study military operations where maps are inadequate and where ground crews cannot go.

As an aid to military training. Instruction by means of motion pictures saves a great deal of time and is much more effective than any other method.

In engineering work. By means of pictures, both still and moving, the Army learns what happens to equipment during tests.

Supplying news pictures to newspapers, magazines and other publications.

For record or historical purposes.

• • •

WHAT'S NEW

In Photographic Equipment

KING SLIDE FILE BOXES (100-slide capacity, $2.50; 200, $4.50): For storing 2-by-2-inch color slides. Two sizes, one holding 100 slides, the other 200 slides. Finished in imitation leather. French lapped rounded corners add strength.

MASKOID (2-oz. bottle, 85 cents; 4-oz., $1.55): New-type frisket for multiple toning and other uses. Called "the liquid mask"; of pre-vulcanized rubber composition (not rubber cement) dries quickly after application. Forms temporary protective film for local work in coloring, retouching, bleaching, and so on. May be applied with pen or brush, or sprayed on with airbrush. May be removed by stripping from surface. Thins with water; dyes and acids will not penetrate it.

LEWIS MULTIPLE SLIDE VIEWER ($3.25): Loads up to 36 color slides at one time for continuous, uninterrupted viewing. Shifting of lever changes slides. High power planoconvex lens. Viewer fits over both eyes, excluding outside light except through transparency. One screw adjustment changes for either ready-mounts or glass slides. Made of wood and solid black fiber covered with black leatherette.

LEWIS BULK FILM LOADER ($2.20): For loading bulk 35mm film. Darkroom needed only to transfer film from original wrapping. Cartridges wound by daylight. Loads for any number of exposures and holds up to 100 feet of film. Made of solid black fiber, leatherette covered. Holds two extra cartridges. Winding directions gold-stamped on lid.

AMATEUR PRESS PHOTOGRAPHER'S OUTFIT: Flash-camera outfit including: Agfa Cadet-Flash camera; flash unit with reflector; eight Mazda Photoflash lamps; adapter for lamps; two No. 915 Eveready batteries; two rolls Agfa 8 (127) Superpan Press film. Camera has fixed-focus lens. Flash unit easily attached to or detached from camera. Shutter automatically synchronized with flash mechanism.

SIGNAL (16-oz. bottle, 45 cents): Called the "indicating" shortstop. Colorless when fresh, turns rose-red when exhausted. Signal (undiluted) may be substituted for 28 percent acetic acid in same proportion as called for in regular photographic solution. Each pint bottle makes 20 one-pint baths.

LYONS SPEED GRAPHIC CASE ($19.50): Designed for the 4-by-5 Speed Graphic, to accommodate the camera, 12 holders, complete flash outfit, and extension flash unit. Special compartment in top of case for storing flash bulbs. Case can be carried by means of shoulder strap with bulb compartment open. Made of plywood, covered with black leatherette. Nickel finished hardware. Case measures 17½ by 8¾ by 13½ inches. Weighs 8 pounds, 12 ounces.

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.*

A Tyro Stocks a Rifle

Harry A. Groesbeck, Jr.

A FEW years ago I picked up a copy of *The American Rifleman* and was intrigued with an article on the re-stocking of a .45-70 Springfield. I have been burning powder and fondling guns for more than 50 years; I have some skill with tools, for working both wood and metal, but will you believe me when I confess I had never even thought of combining my two pet avocations? When I consider my present day enthusiasm for amateur gunsmithing, it is hard for me to believe I am the same man who once gave away his entire gun collection, considered himself washed up.

The amateur gunsmithing job started simply enough, with a new front sight; then followed some polishing and refurbishing of a few old cap-and-ball hand-guns. Harold F. Kent, of Lawrence, Massachusetts, is the man who really upset my peaceful apple-cart. He sent me a 1917 Enfield and dared me to re-stock it. When the hardware arrived, it was a pretty sad-looking outfit. Someone had already started to butcher it and I suppose it aroused my sympathy, especially as Kent sent with it a most complete description of how to proceed on such a job. (Remodeling Military Rifles—How to Transform a Military Rifle Into a Modern Sporter. Technical Bulletin 104, National Rifle Association.—*Ed.*)

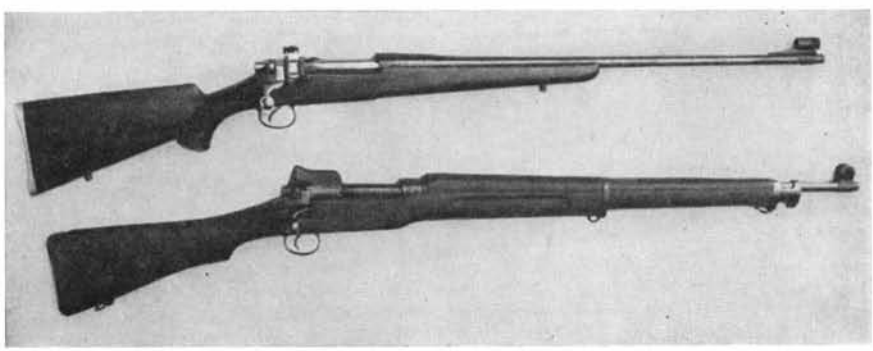
After reading this useful little article, I blew myself to Clyde Baker's book on gunsmithing, which I read from cover to cover before starting on my venture. Then I sailed in.

I should enjoy writing a most detailed account of every move I made in completing this job, but it would serve no good purpose. I came to the job as an absolute tyro in this particular field and I simply followed the books—as a good novice should. Did I say I followed the books? So I did, but I want to qualify that statement just a bit, because when I did *not* follow them, I sometimes found myself in hot water. It is about that punishment I feel I should write, lest others do as I did and then fail to have the good fortune that pulled me through.

The lads who have been doing this sort of work all their lives, both as amateurs and professionals, know what they are talking about. They have written guides to be followed by others, and they have planned these instructions in such a manner as to save their readers no end of trouble. Every time I got cocky and went off on some track of my own, I paid. How many times this happened is my secret, but my worst offense was impatience. Like all beginners, I yearned to see "how it would look."

When I shaped both the stock and the fore-end before thoroughly finishing the bedding-down of the action, I found I had nothing to hang on to while completing the work. I used more time finding a way to squirm out of that hole than the man who paints himself into a corner of his room. Anyhow, I finally finished the job, and despite my foolishness in some instances, the rifle came out well. The bedding-down is accurate; a full "blue" fit of wood to metal. The lines follow those prescribed by the authorities, with but slight deviations of my own. The finish turned out beautifully—and that baby groups the shots on the target to beat the band!

Frankly, while I am proud of the



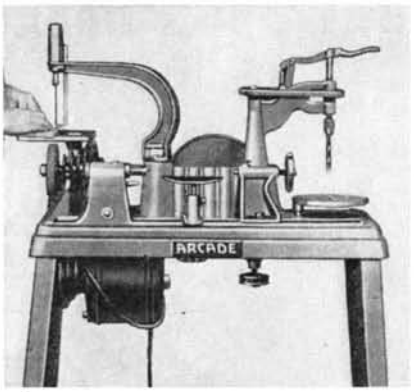
Above: **Remodeled Enfield. Note front sight, fashioned from steel block; metal recessed buttplate.** *Below:* **A 1917 Enfield rifle, as originally issued**

job, I seek neither publicity nor praise for the accomplishment. Rather, I tell the story to encourage others to go and do likewise, and I have many good reasons for so doing.

First, let me pay my little tribute to the National Rifle Association for, among other things, starting me off right. Then, consider how much one can learn of the most intimate "innerds" of firearms, if one has to reduce them to their individual components in order to work on them. Also, there is the fun of doing it and the utilizing of some very worthwhile "junk" which, in these troubled times, may turn out to be priceless. Finally, there will be the knowledge gained, to be passed on, perhaps, to some youngster who is facing the most serious times of his young career. Who knows but that a tip from some "old guy" who dabbles with guns, and who knows not only what to do with them, but what *not* to do, may stand some boy in good stead in a moment when things are happening fast. — (We've visited Harry Groesbeck's workshop in the basement of his home, seen his tools and equipment, and some of the rest of his accomplishments. For those who like to work with wood and metal, but who have been fearful of entering the field of firearms tinkering, his is a most encouraging example, for his gunsmithing activities have been going on only three years. Nevertheless, he is turning out masterly work, and at present is engaged in re-stocking an old Krag that saw service in the Philippine Insurrection of 1899. The gun was captured by Aguinaldo's native troops, later recaptured by Major Philip Eastwick, of our Army, and one day soon, dressed as a sporting rifle, it will demonstrate its inherent accuracy, doubtless enhanced by the work of the amateur gunsmith.—*Ed.*)

Complete and Compact

For the sportsman who would make his own gun cabinet, gun racks, pistol range shooting box, and other items, and whose workshop space is limited, "The Craftmaster," by Arcade Manufacturing Company, solves the small shop problem neatly and efficiently. Equipped with jig saw, drill press, disk sander, grinder, and a lathe which, through accessories, may be extended, this compact unit is operated by a single ¼ H.P. electric motor on adjustable mounting plate which permits operation of any



"The Craftmaster"

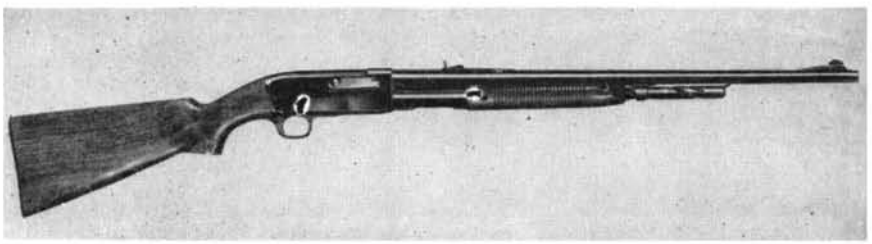
tool without interference from others by a simple change of the V-belt. Overall dimensions are: length, 29¾ inches; width, 20 inches; height, 44 inches. The cast iron base on which the five tools are mounted is 13 by 27 inches, and is 28¾ inches from the floor, supported by steel legs.

"Gamemaster" Gets New Sights

Back about 1910, Remington Arms Company brought out their original Model 14 slide- or pump-action rifle for big game hunters. It met with instantaneous acclaim for many sound reasons, but since then it has been re-designed and is now known as Model 141—"The Gamemaster." Still with slide-action, it is adapted to the .30, .32, and .35-caliber Remington cartridges, has 24-inch round barrel, pistol-grip stock, weighs about 7¾ pounds, has a five-cartridge capacity tubular magazine, and step adjustable rear sight with white bead front sight.

Never intended as a target rifle, it is, nevertheless, an extremely popular gun among the army of deer hunters because of its accuracy, ease of operation, and speed of fire, especially in wooded country. Another reason for this popularity is the similarity in general lines to the slide-action shotgun. Save for an annual week or two, many deer hunters are otherwise shotgun devotees, and the swing of "The Gamemaster," as it comes to the shoulder, is less foreign than would be either a bolt- or lever-action rifle.

Now comes the Marble Arms and Manufacturing Company with a flat-top sporting rear sight (No. 63H), sporting leaf sights (Nos. 69H, 70HH, 71HH), and an adjustable leaf sight (No. 95XH), all specially designed for the new Remington Model 141.



Remington's "Gamemaster"

Our Book Corner

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

FATIGUE OF WORKERS

By Committee on Work in Industry, National Research Council

NOTABLE report of a notable committee, concerning fatigue in relation to industrial production. Content: hearings; conclusions; heat and high altitude; industrial causes of illness; Western Electric researches; the interviewing method; self-expression and labor unions; extra-time allowances; study of organization. (165 pages, 6 by 9 inches, unillustrated.)—$2.60 postpaid.—*A. G. I.*

THE AMERICAN ANNUAL OF PHOTOGRAPHY 1942

Volume Fifty-Six

IT's here again—the cream of photographic endeavors for the past year, a series of articles on various aspects of photographic technique, the usual "Who's Who," the annual formulary, and all the rest of the features that have made this annual publication the standard in the field. (280 text pages, 44 ad. pages, 7½ by 10 inches, lavishly illustrated.)—$1.60 postpaid.—*A. P. P.*

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RETURN TO THE RIVER

By Roderick L. Haig-Brown

THIS book, by the author of "The Western Angler," presents the life cycle of a female chinook salmon from the moment she was spawned in a Columbia River tributary; her instinctive migration to the Pacific ocean; her return, years later, to native waters for her own spawning; and her death. An amazingly encyclopedic description of the life, habitat, food habits, migration, and other data on the salmon. Although brimming with ichthyological information, the data are so delectably wrapped in a fascinating narrative as to be easily digested by all readers. (250 pages, 5½ by 8½ inches, 17 full-page drawings by Charles DeFeo.)—$3.10 postpaid.—*A. D. R., IV.*

AMERICAN COTTON HANDBOOK

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MEMBER of the Harvard College Observatory staff presents authentic known facts on the planets, how the system holds together, the discoveries of Neptune and Pluto, determining the masses of the Earth and other bodies, the Earth as an abode of life, the Moon's influence on the Earth, observing the Moon, nature of the Moon; also on Jupiter, Saturn,

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AN ACTIVE member of the Massachusetts Safety Council, the author of this book has apparently made an exhaustive study of automobile design and its relation to highway safety. Briefly summarized, the aim of the book is to prove that safety on the highways of the United States cannot be increased, and the accident rate decreased, until automobile designers and stylists pay more specific attention to the safety phase of their work. (155 pages, 5½ by 8 inches, several drawings.)—$1.85 postpaid.—*A. P. P.*

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

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

JUST what is the present status of the 200" telescope mirror that is being made in California? What troubles have been encountered in the work, and how have these been dealt with?

From time to time the newspapers have stated a few facts—and some fancies. Three long articles in Scientific American (May 1936, November 1936, August 1938) stated many precise facts because they were written by the men who are making the telescope. Yet, even these did not fully satisfy those of this magazine's readers who are amateur telescope makers. This 10,000-sized minority of readers has wanted special, technical details not watered down for the general, non-telescope making reader.

This column therefore invited Dr. J. A. Anderson, who has lived with the actual work throughout, to describe the mirror part of it specifically for the amateur telescope maker, and in the lingo of the work. This is why the article presented is published in this department and not "up front."

The following is the first half of a two-part article by Dr. J. A. Anderson who, since 1916, has been chief optical expert at the Mt. Wilson Observatory and, since the start of the 200" telescope work, executive officer for it at the California Institute of Technology where the great mirror is being made.

"THE 200-inch mirror disk was cast at the Corning Glass Works in March, 1935, and arrived at Pasadena in April, 1936. The structure of the disk is indicated by the oblique photograph reproduced in Figure 1, showing the back and rim, and the diagram, Figure 2, showing a section along the line *AA* of Figure 1. In general it may be described as a continuous glass front supported by a system of glass ribs, so designed that when a concave curve is cut in the front surface (shown by the dashed line in Figure 2), the thickness of the glass shall be nearly the same everywhere. This construction was chosen in order to reduce the 'temperature inertia'[1] of the disk as a whole to a low value. It also makes it possible to bring the point of support of each supporting lever close to the center of gravity of the weight to be supported. For this purpose there are 36 circular openings in the rib system to accommodate the same number of supporting levers. Figure 3 shows one of the supporting units which is 'double-acting'; that is, it takes the place of both the ordinary back and edge supports.

"The work of shaping this disk into a finished mirror is not essentially different from that required for a smaller mirror familiar to all amateur telescope makers. Front and back must be ground flat and parallel to each other, and the edge ground to the form of a reasonably good circular cylinder. In addition, the 200-inch required that the 36 circular

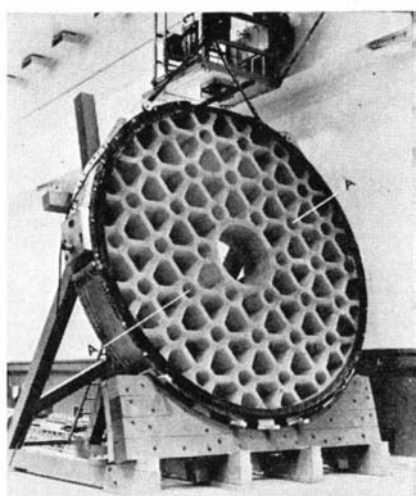

Figure 1: **Back of the big disk**

openings for the supporting levers be ground internally to very definite dimensions. An important difference arises from the great size and weight of the 200-inch; namely, that machinery is called for at every turn—and rather heavy and slow moving machinery at that.

"For the rough shaping a half-sized tool of cast iron was prepared. Its weight was about seven tons. It was made thick enough to be used first as a flat grinder and later on to be turned convex for roughing out the concave curve of the mirror. All other tools, including one of full size, were built up of thin sheet-steel plates welded together. These are much lighter than cast tools of the same size and they have also been found to be superior in rigidity. The working surfaces of these tools are covered with glass blocks which are used uncovered for grinding and covered with pitch substitute for polishing. The weight of the full-sized tool (shown on the floor to the left in Figure 4) is about five tons.

"In order to grind the back surface to a tolerably good plane, it was necessary to fill up the openings between the ribs. Little wooden tables were made and fitted into these openings in such a way that the tops of the tables lacked about 2" of being flush with the ribs. Plaster of Paris was then used to complete the filling. Only in this way was it possible to grind the surface to a true plane. This done, the cavities were cleaned of plaster and tables and the disk turned over in preparation for the next step, which was to grind the face plane and parallel to the back.

"Normally, this should have required a relatively short time, but actually it took many months, chiefly for the following reason: Corning had a considerable flood in 1935 while this disk was in the annealing oven. Water covered the floor of the room where the annealing was in progress to such a depth that it was necessary to shut off the current for about three days. A temperature drop of rather large amount was the result, but as soon as conditions permitted the temperature was slowly brought up to its normal value and held there constant for a time. Then the regular program of slow cooling was resumed. When, in late October 1935, the disk was examined, it was found quite successfully annealed, but there were some bad-looking fractures in the front surface. The immediate cause of these fractures was clear, for a couple of the chrome-iron I-beams of the cover had sagged enough to become partly imbedded in the hot glass and, as the cooling proceeded, strains due to the differential expansion of iron and glass did the trick. One has a feeling that this would not have happened if there had been no interruption in the cooling but, of course, this can now

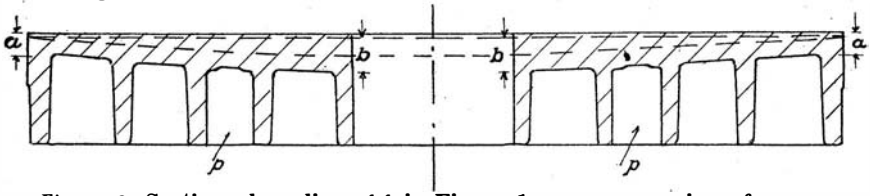

Figure 2: **Section along line *AA* in Figure 1. *p,p* are openings for supporting units. In the casting, thickness at *a,a* was 6", at *b,b* 9¾". In finished mirror (lower dashed line) thickness is approximately 4". Overall thickness at edge is 24". Finished weight, nearly 30,000 pounds**

[1] 'Temperature inertia' is a convenient term to indicate the length of time required for the temperature to reach equilibrium with the surroundings.

never be known with full certainty.

"The obvious thing to do was done; namely, to remove the fractures by sand blast and so find out whether sufficient thickness of glass remained to make a good mirror. The deepest excavation made in the sandblasting was over 5" deep but it was near the center of the disk, so it would still be possible to grind the concave curve and have a glass thickness of 4" left. If the disk had come out as planned, this thickness could readily have been 6" or a little more, which might have been an advantage if rigidity alone is considered. A thickness of 4" is, however, slightly better from the point of view of low temperature inertia, since all the ribs have about this thickness.

"It was decided that, instead of merely making the front surface into a true plane, the extra 2" of glass should be ground off before establishing the plane and making the disk parallel. This 2" of glass represented a weight of 2½ tons and used up five tons of coarse Carborundum. Later on, another 2½ tons of glass would have to be removed in cutting the concave curve.

"Grinding the edge was the next operation. This was done face down, with the face of the mirror raised some 8" above the turntable by inserting suitable timbers. The grinding was done with a rotating hollow cylinder of Carborundum fed with water and Carborundum powder. The 40" central hole was ground to size in this same set-up.

"The next step was grinding the 36 cylindrical holes designed to admit the supporting levers. The axes of these cylinders should be perpendicular to the parallel planes of the front and back already established, and, in addition, their spacing should be adjusted to form a regular geometrical pattern. A special 'pocket-grinder' had been prepared, carrying at its lower end a cast-iron hollow cylinder about 11" outside diameter. The rotating shaft carrying this cylinder could be given a slow motion in a circle having a radius variable slowly and accurately from nothing up to whatever the size required for the finished 'pocket.'

"The 36 pockets lie on five concentric circles, six on each circle except the fourth one (counting out from the center), which has 12. On circles 1, 2, 3, and 5 they are 60 degrees apart, while on the fourth circle they are spaced in six pairs 60 degrees apart, the members of a pair being separated by an angle a little less than 22 degrees. The whole operation of grinding these pockets was completed in about three months.

"Next the turntable of the grinding machine was covered with two layers of 1" sponge rubber and the mirror placed face-up on this bedding. In order to insure as uniform a support as possible the compression of each

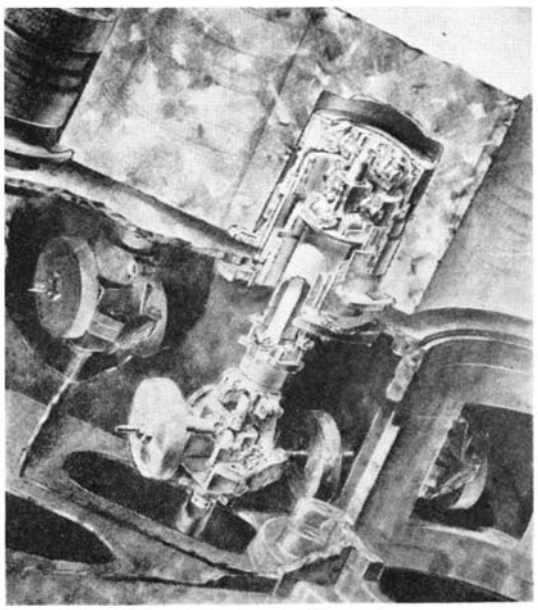

Figure 3: **Lever mirror support**

sheet of sponge rubber was carefully measured under a fixed load, and only those pieces whose compression was within a narrow range of being the same were applied to the table.

"The glass plug to fill up the 40" hole in the center of the mirror had been ground cylindrical to a suitable diameter, and it had to be inserted and fixed in place in such a way that, when the mirror is finished, it can be easily removed without any danger of harming the figure of the mirror. As the plug weighs about 1400 pounds, this did not look too easy. It was accomplished as follows: A wooden lifting clamp was applied to the upper half of the plug, leaving the lower ribbed section of about 15" projecting below the clamp. A cake of ice about a foot thick was placed on the table in the center of the hole. By means of the crane it was then possible to rest the plug on the cake of ice. The clamp was removed and the ice melted, thus lowering the plug gently into its proper position, after which it was fixed in place by means of plaster of Paris and waterproof cement.

"Before cutting the curve the support system was installed. This operation took approximately eight months. In preparation for it the weight to be carried by each of the 36 units had been calculated on the basis of careful measurements on the disk itself. Each support pocket was taken as the center of a hexagonal section of the disk. The hexagons around the central hole (Circle No. 1) and those adjoining the outer edge (Circle No. 5) are not complete, which fact complicated the calculations only slightly. The calculations furnished the weight to be carried by each unit and also located the center of gravity of each arbitrary section of the disk, thus giving the necessary data for each counterweight and for locating the internal points of application of the supporting force. Each support (Figure 3) was carefully adjusted and tested on a weight equal to that which it was intended to carry before it was attached to the mirror and its cell. Provision was made for temporarily disconnecting all the supports when work was in progress with large tools. They were, however, connected properly when an optical test was to be made.

"The curve was roughed out with cast-iron tools of about one third size, and brought to approximately correct form by means of the half-sized tool already mentioned, after which the glass-coated full-sized tool and the finer grades of Carborundum and emery finished the grinding. Measurements of curvature were made with a 36" spherometer. Next, the full-sized tool was changed to a polishing tool, as already explained, and the surface brought to a nearly full polish. It was found that the full-sized tool used up rouge at the rate of some 50 pounds per hour, mostly by simply splashing it over the edge, hence subsequent polishing and figuring was done with smaller tools—106" and down to about 12"."

Next month: Troubles. Tests. This part will explain the delays that puzzled the public: the disk developed a case of curable ptosis.

Figure 4: **Five-ton, full-sized steel tool. Grinding and polishing machine in rear**

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—CONTINUED FROM OTHER SIDE

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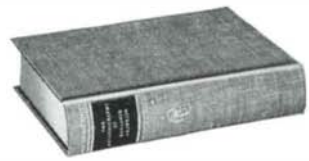

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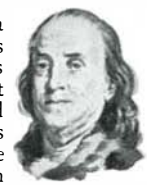

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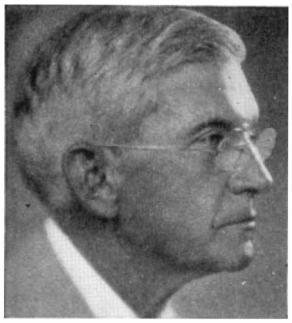

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