THRILLS OF A TANK RIDE . . . Page 183

SCIENTIFIC AMERICAN

OCTOBER • 1941

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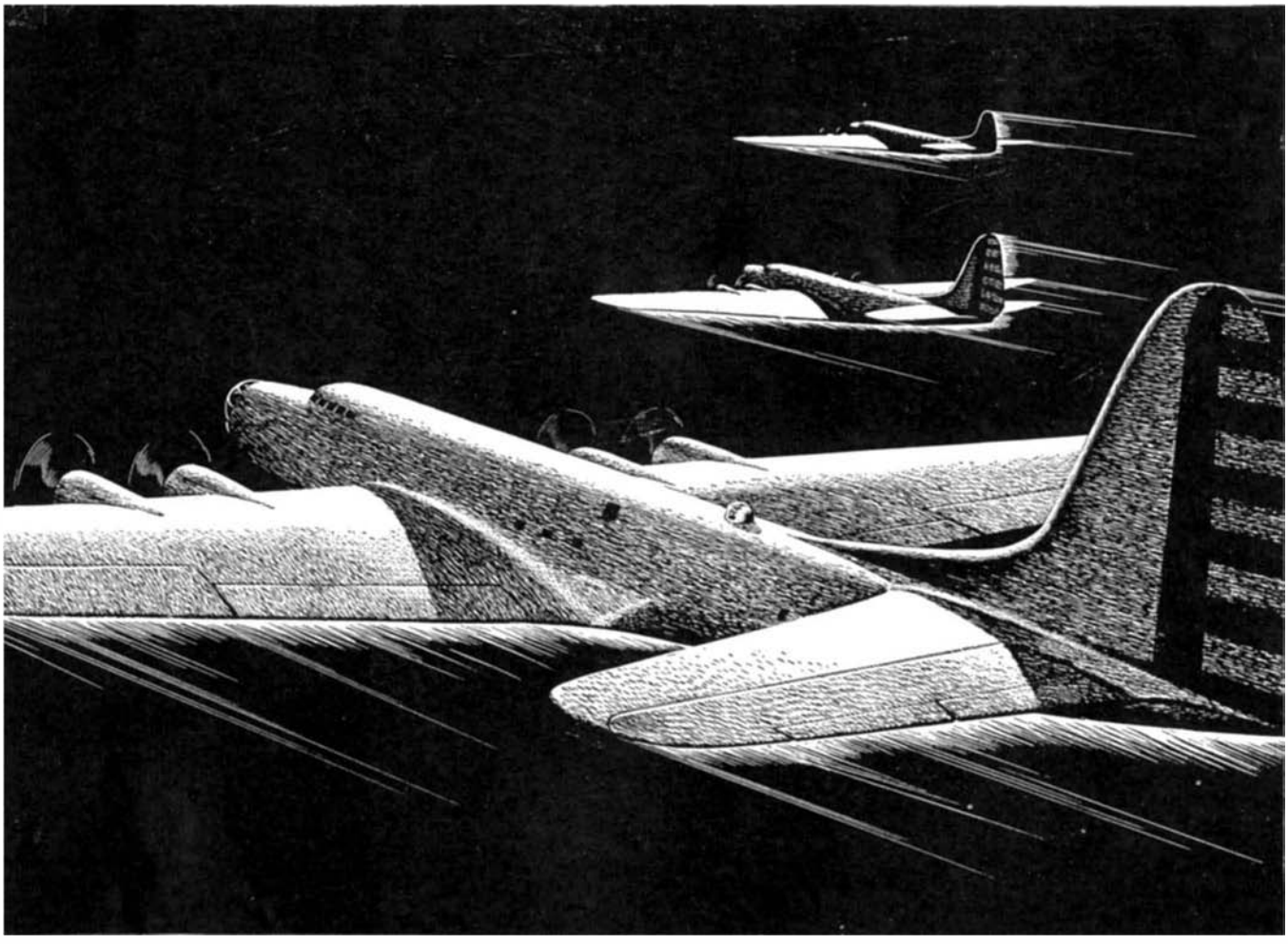
Photograph by Photo Section, 4th Armored Division

Looking Out of an Army Tank

ANOTHER WAY ELECTRICAL POWER IS SPEEDING PRODUCTION



40,000 HORSEPOWER HURRICANES

Test Tomorrow's Bombers

Wind, howling through a tunnel at 400 miles per hour, rushes at a model plane—and history is in the making.

There may be room in a footnote to history for mention of the 40,000 horsepower motor which powers the fans that drive the wind. This colossus among motors tips the scales at 125 tons. It's the largest wound rotor, induction motor ever built in the Westinghouse plant—the largest ever built anywhere in the world!

Thanks to the tremendous power built into this motor, engineers at Wright Field can actually see—through sealed windows in the test tunnel wall—what happens when an airplane encounters wind velocities of 400 miles per hour. New stresses are weighed and measured. Design faults are discovered and corrected on 15-foot scale models, not on costly Flying Fortresses.

Tomorrow's planes will be faster and stronger, because of today's tests in these man-made hurricanes. And in these times, our national existence may depend on the quantity and quality of planes we put into the air.

Ability to solve new problems in electrical engineering, facilities for building electrical equipment quickly and well—won for Westinghouse the privilege of building for national defense the largest motor of its type in the world. To put this ability, these facilities to work on your industrial problem, just phone our nearest office. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pennsylvania.

Westinghouse

Time-Saver For American Industry

ELECTRICAL POWER SPEEDS PRODUCTION

No American manufacturer can afford to overlook the modern methods and equipment offered by the electrical industry for speeding up production.

Recent Westinghouse developments include: a new furnace that clean-hardens motor parts without decarburization; a new drive that gives adjustable speed from a-c power; a new portable a-c welder for general utility work; a new transformer of smaller size and lighter weight. These and hundreds of other Westinghouse devices are available to help you facilitate production.

J-94449

"ABSENCE MAKES THE HEART GROW_____?"

Advertising Takes on Its Most Important Job In Building Public Good Will and Confidence

By H. A. BATTEN
President, N. W. Ayer & Son, Inc.

★

THE other day I attended the wedding of the happiest young fellow in the world. He had won a fine girl against tough competition, and his smile was almost big enough to turn upside down and use for a coat hanger. There was another young man attending the ceremony whose face would have worked in better at a funeral. I knew him, too, and he stopped me when we left the church.

"Harry," he mumbled, "I don't understand it. Wouldn't you have said, a few months ago, that Jack and I were pretty even as far as Mary was concerned?"

When I nodded, he went on, "I had to go away on a business trip, and Jack was away also. Mary liked us both just about the same when we left. But when we came back, she took him. What's the answer?"

"Of course you telephoned and wrote to her?" I asked.

"We-ell, Harry, you know I'm not much of a hand at that. . ."

American industry is going away on a business trip. It's the most important business of all: national defense. American industry won't be able to spend as much time as usual courting the public with products and services. In many cases, the needs of national defense will make it necessary for the public to get along with fewer products and services.

Let's make the parallel a little more definite. Company A goes away on the busines of national defense. It decides that it isn't much of a hand at writing back home to the public. Besides, Company A executives remind themselves, they told the public they loved it before they went away, and it's a shame to waste money by repetition. The public will be waiting faithfully after the emergency is over.

Of course the public won't be waiting . . . not if progressive Company B has, in the meantime, carried out its carefully-planned, sustained advertising program.

There are a lot of old sayings about what absence does to human emotions, and they happen to contradict each other. Distance lends enchantment. Absence makes the heart grow fonder. Out of sight, out of mind.

Perhaps the reason for these contradictions is that people sometimes think that absence and neglect are synonyms. Let's see how it sounds: Neglect makes the heart grow fonder. The answer is, of course, that absence makes the heart grow either fonder or colder, depending on the efforts made by the parties in question to overcome the barrier of physical separation.

The best representative a company can have with the public is a satisfactory product or service. When these products and services cannot be provided, this representation is lacking, and advertising must take over the increasingly important job of carrying on in its place.

At first glance, it might seem that the main job of advertising during the national defense emergency is to maintain the good will of the public toward a company, and its interest in the company's products and services, so that a profitable market will be insured when the emergency ends, defense contracts shrink, and supply again begins to approach civilian demands.

This is a big job, and every advertising program today should be planned with this purpose in view. But this is merely one of the responsibilities which advertising must assume. It is even one of the lesser responsibilities. A program planned for this purpose alone would be limited and static, whereas the times call for something much more dynamic.

One of the primary purposes of an advertising program today should be to create general public confidence in the future of this country. People are worried. One minute they hear that this country is all out for defense; the next minute, they hear that defense production is far below the mark, and that we cannot stand against totalitarian attacks no matter how great our efforts. France fell because a disillusioned, confused public had confidence in neither Frenchmen nor French institutions.

Advertising must build public morale by showing how the defense effort is progressing, and by demonstrating how industry is helping national defense through its productive facilities and its managerial experience. Obviously this will also create public confidence in the company carrying out such a program, and build up good will.

Business must explain to the public about changes in prices, and why certain products and services cannot be provided to meet unlimited demands from the consuming public.

It is not the responsibility of people in Washington to keep the public informed of these matters; it is the responsibility of business itself. Much of the confusion now existing in the mind of the public has been created by conflicting statements from Washington, in cases in which industries have ignored the responsibility of keeping the public informed as to facts.

Business has an opportunity now to tell the public about research, privately undertaken, to improve products and services. Business should keep people informed of long-range plans for meeting post-emergency problems of employment and of demands for goods and services.

One of the most important jobs of all is to hammer home the fact that our present gigantic defense effort was made possible because of the system of free enterprise developed in the United States. Various totalitarian nations began preparing for this war long ago. They concentrated production efforts on war material year after year. What these nations did in seven to twenty years, American industry has been asked to accomplish in two or three. And American industry is doing it!

This is a story which must be emphasized. The public has a right to know that the American system of free enterprise has made possible a defense effort without parallel in history. The public has an especial right to this knowledge in view of the fact that some people will undoubtedly use the emergency to further their agitation for state socialism, communism, fascism, and other un-American forms of government.

Business has a tremendous stake in the future, and it is the part of wisdom to guard that stake through the intelligent use of advertising—the most efficient and economical instrument which management has at is disposal. Many of our largest and most progressive businesses are already assigning jobs of this type to advertising, and it is reasonable to assume that many more will join the list as the emergency program continues. Advertising is being given its biggest job in history, and it has its greatest opportunity to prove its value to business and to the public.

OUR cover picture shows what the world looks like when you sit in the little seat beside the driver of a tank. The port in front of you is open, but when the tank goes into battle, the heavy piece of armor plate swings down, leaving only a slot for forward vision. What it feels like to ride in one of these modern juggernauts is described in the article beginning on page 183 of this issue.

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OCTOBER • 1941

Our Point of View—Editorials 179

50 Years Ago in Scientific American 180

Mechanized Power On The March—Frontispiece 182

Industrial Trends 195

NATIONAL DEFENSE

Bounce!—Bump!—Clank! ..... A. D. Rathbone, IV 183

Tank Headache 187

SCIENCE IN INDUSTRY

On They Roll ..... P. K. Korycinski, M. E. 188

Stored Energy for Welding ..... C. E. Smith 191

Back to Bessemer 192
Communication 193
Furnaces 193
Plastics Applications 194
Weight Saving 194
Clamp 218
Paint 218
Brazer 218
Heaters 219
Gloves 220
Goggles 220
Tools 221
Grinding Compound 221
Sander 222
Primary Battery 222
Magnifier 222

HEALTH SCIENCE

Cataract ..... Barclay Moon Newman 196

Prostate 197
Ridiculous? 198
Swimmers 198
Accidents 198

Supersonics 198

SCIENTIFIC RESEARCH

Whence Came Oil? ..... Randall Wright 199

Petrosnooping 200
Becoming Commonplace 200
Gold 200
Mutations 201
Outdoors Indoors 201
Viable 201

Gas Poisoning 201

ASTRONOMY

Star Stuff ..... Henry Norris Russell, Ph.D. 202

ENGINEERING

Curbing the Connecticut 204

MISCELLANY

Insulate to Aid Defense ..... Harland Manchester 208

Less Eyestrain 210
Touch-Up 210
Penalty 212
Gas Mileage 212
Glue Spreader 212
Desk 212
Psychic Research 212
Nylon Thread 212
Searchlight 212
Travel 213
Phonograph 213
Grass Study 214
Ink 214
It Reflects 214
Battery 214
Bomb Taxi 215
Money's Worth 215
Drawing Board 216
Fresh Fruit 216
Plaster Paint 216
Moistener 216
Inkless Recorder 217

AVIATION

Ocean Air Transport ..... Alexander Klemin 223

Soaring 224
Trainer 225

Private Flying 225

Camera Angles ..... Jacob Deschin 226

Firearms and Fishing Tackle ..... A. D. Rathbone, IV 232

Telescoptics ..... Albert G. Ingalls 234

Our Book Corner 237

Current Bulletin Briefs 240

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NOW IS THE TIME TO INVENT

AT NO time in the course of industrial development is it more propitious to turn attention to the possibilities of invention than during periods of stress. At such times as the present, when the whole world is topsy-turvy and every nerve is being strained in the effort toward self-protection and self-preservation, the inventor—whether he dwell in the garret of romance or in the busy laboratories of industry—has available for his talents broad fields which, under more peaceful conditions, might be ignored.

Two-fold, indeed, is the reason why now, more than ever, is the time to invent. First, there is the immediate industrial and defense emergency to consider. Second, there is looming in the distance the troublous times of readjustment after World War II.

Entirely too well known to detail here are the limitations which national defense preparations have placed on industrial production for civilian purposes. Yet these very limitations are the factors which offer to inventors opportunities unparalleled in history. Scarcity of materials which have always been accepted in the past as irreplacable opens new vistas for the discovery and development of satisfactory substitutes and new or improved processes. Plastics, glass, wood products for metals; lacquers and other surface coatings for tin and chromium plating; new methods of treatment to make smaller quantities of materials do a better job: the list could go on and on to cover every aspect of the present emergency.

Add to this the need for inventions in the immediate field of national defense and the picture becomes even brighter for the inventor. Armor plate of improved resistance to shell fire or made from new and plentiful alloying metals; more powerful or more controllable explosives and detonators; greater mobility and maneuverability of anti-tank and other guns; improvements in aircraft of all descriptions; again the list could be extended almost indefinitely to include virtually every item used in warfare.

Then must be considered the crucial period of economic rearrangement after the war. Production for military purposes will, of course, be greatly curtailed, although it is to be hoped there will be no such idealistic agitation for complete disarmament as resulted in the emasculation of our national defense forces after World War I. With military production reduced there will be available ample facilities for civilian production, and those facilities must be used to the fullest if we are not to face another disastrous era of unemployment and depression. But, in order to utilize this post-war advantage to its maximum, our industries must be ready not only to resume operations where they were abandoned for defense purposes, but also to proceed under full steam in the production of new consumer goods of various types. And these new consumer goods can be made possible only through the ingenuity of those individuals who have had the foresight to realize that inventions conceived and developed now will stand the greatest chance of contributing materially to the prosperous times that will follow the war, if only the industrial and economic lessons of the 1920's are not forgotten.

Brief analysis will show that the two phases of inventive possibilities just outlined actually dovetail neatly. In exploring little known or virgin territory in the search for solutions to immediate problems, inventors all over the nation will be constantly uncovering new data in their respective fields of investigation, thus adding immeasurably to the sum total of technical and scientific knowledge. From this pool will be drawn those inventions, discoveries, processes, needed for purposes of military importance; this same pool will, in many cases, provide the fundamentals for development of the consumer goods mentioned previously. Add to this the fact that many war-time inventions of military significance have equal or greater value in peace-time applications, and it is readily seen that this period in the development of our nation holds greater promise than ever for the inventor.

The frontiers of chemistry, physics, mechanics, optics, all the sciences, are being rapidly expanded. There appears to be no limit to present-day inventive possibilities, other than the limits of the human brain. Surely, now, more than ever before, is the time to invent.—*A. P. P.*

DEAD?

"WHAT has become of evolution? You don't publish articles about it any more." Several readers have asked this question.

Some 15 years ago the subject was at white heat, and everybody expected it to remain so. Anti-evolutionists predicted that evolution would be banned everywhere, and scientists trembled for fear they were correct. Some seemed to think that laws would cut off all knowledge of the theory from coming generations, as might be done in Germany.

But nothing has happened. The dispute is practically dead. Science hasn't won, since science doesn't yet understand the method of evolution. The other side hasn't won either, though at their behest the word evolution is omitted from most textbooks for the young. Yet nobody today wants to argue. One can't even pick a good fight about it. There's something odd.

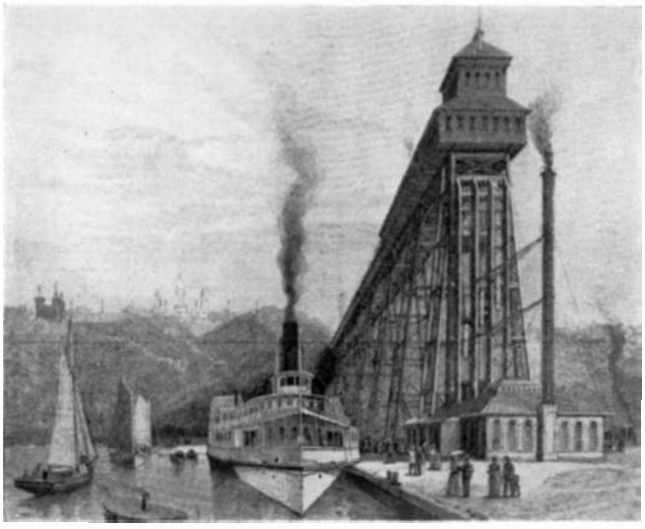
Certain tacit admissions on both sides seem to us to account best for the loss of scrappiness. Opponents evidently sense that they are fighting a retreating battle. On the other hand, we scientists, if candid, must admit that we haven't finally nailed down and riveted up proofs of evolution of the kind that convince opponents almost against their will. In moments when the more emotional, less intelligent, anti-evolutionary ranters desist, some of us realize this fact—such is human nature. Such an interval exists at present and it may be a good thing if both parties to the old fight keep it that way; it makes for more tolerance, open-mindedness.—*A. G. I.*

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of October, 1891)

ELEVATOR—"A passenger on one of the ferryboats leading to or from the upper portion of New York, or upon one of the numerous vessels passing up and down the Hudson, will notice on the Jersey shore, adjoining the West Shore Railroad station at Weehawken, a tall tower, communicating by a viaduct with the bluff, a few hundred feet distant. The tower is the passenger elevator of the North Hudson County Railway . . . The hydraulic elevator cylinders are 38 inches in diameter, and made in sections of 9 feet in length. The pistons of the hydraulic



cylinders are each provided with 2 steel rods 4¼ inches in diameter and 35 feet long. The pistons are geared by means of cables and sheaves in such a manner as to cause the car to move six feet for every foot of the travel of the piston."

YELLOW FEVER—"At a recent meeting of the Academy of Sciences, Paris, a paper was read on the preventive inoculations of yellow fever by M. Domingos Freire. The author has inoculated 10,881 persons with cultures of *Micrococcus amaril.* The mortality of those so vaccinated was 0.4 per cent, although the patients lived in districts infested with yellow fever, while the death rate of the uninoculated during the same period was from 30 to 40 per cent."

U. S., TOO—"The sun never sets on the soil of the United States. When it is 6 o'clock at Attoo Island, Alaska, it is 9:36 o'clock A. M. the next day on the eastern coast of Maine."

BLACK LIGHTING—"The report of the British Association Committee on Meteorological Photography, set forth, among other facts in relation to lighting: The so-called black flashes have been disposed of. The experiments described showed that the appearance is due to reversal produced by some form of diffused light having fallen upon the plate . . . After the flash had passed, the plate was left exposed for a few minutes, in the hope that a second flash might illuminate the same part of the sky. This happened, the lower part of the field of view being brightly lit up by a flash which was itself hidden in the clouds. Where the consequent glare crossed the undeveloped image of the flash, reversal has occurred, while no reversal can be detected in the other portion."

IT DIDN'T HAPPEN—"Use of electric roads for farms is destined, says the *Electrical Engineer,* to be enormous. At the present time the state of the vast majority of our rural highways is such as to render transportation a frightful tax upon production. But nothing is easier than to track and wire these roads, furnish them with motor trucks upon which the farm wagons can be run fully loaded, and then turn on the current at stated intervals from the power house in the nearest town or at the nearest water power . . . The bare possibility of getting promptly to market will stimulate the farmer to cultivate crops that now he dare not dream of. Moreover, the speed made will effect a most tremendous economy in the farmer's time . . . These electric roads will continue running through winter and spring months when ordinary dirt roads are utterly impassable."

RAIL SPEED—"Most experienced railroad men feel that the possibilities of steam practice are nearly reached, and that much greater speed is not practicable. A maximum of ninety miles an hour, with a running speed of sixty to seventy, is all that can be hoped for under the very best conditions . . . The maximum speed of which a locomotive is capable has not been materially increased in a number of years. The schedule time has been shortened, principally by improvements in detail and management which permit a higher speed on a more extended section of road because of greater safety and the greater degree of confidence inspired in the engine driver."

CHINESE LUCK—"The Chinese were very particular about lucky and unlucky colors. They liked Engish sewing needles, but would not buy many of them because they were wrapped up in black paper, black being an unlucky color. Another man developed a very good trade in printed Chinese calendars, and that trade continued good until he commenced printing his calendars on green paper, when his trade closed. He wondered why until he discovered that green was an unlucky color."

RUNAWAY STOPPER—"A successful trial of stopping a runaway team was witnessed by a large crowd on Michigan Avenue, Chicago, recently . . . By means of a small battery and coil in the carriage, a system of wiring through the harness, and the pressure of a conveniently located button, a mild shock is given the horses from the bit. The strange sensation induces them to back away from a seeming attack in front, and thereby causes them to immediately stop. The shock is not of sufficient strength to injure the animal in the least, but it is enough to check any horse."

RAIN MAKING—"The artificial production of rain is just now a topic of much interest. The government experiments carried on by Gen. Dyrenforth, at Midland, have not at all satisfied the public mind that rain can be produced on demand, but have aroused an interest which is intently waiting for further developments."

Never too busy to be Good Neighbors

THERE are a lot of workers in the Bell System — about 350,000 of them. That's a big family and it likes to be a friendly kind of family.

Whether it be the installer in the house, the people in our offices, the operators or the lineman on the roadside helping to rescue a stray kitten for a worried youngster, telephone workers are close to the public and the tradition of the job is helpfulness.

Even in these days when the needs of defense place sudden and increasing demands on telephone workers, they are never too busy to be good neighbors.

Bell Telephone System

"The Telephone Hour" is broadcast every Monday. (N.B.C. Red Network, 8 P.M., Eastern Daylight Saving Time.)

Photo by U. S. Army Signal Corps

MECHANIZED POWER ON THE MARCH

WHILE the terrific power and striking force of a modern armored division is best exemplified by its scores of tanks, these mechanized land "battle wagons" comprise but a small portion of the total number of vehicles necessary to transport and maintain such a division. No longer the slow, lumbering thing of crushing terror which accompanied advancing infantry in World War I, today's tank is a streamlined, fast-moving armored mechanism that forms the spearhead of modernized military offense and the bulwark of defense. To ride in one of these engines of destruction is to sense to the fullest their potential power, as related in the article beginning on the opposite page.

BOUNCE! — BUMP! — CLANK!

How It Feels to Ride in an Army Tank

A. D. RATHBONE, IV

YOU'RE in a tank—a clattering, crashing, speeding tank—in the gunner's bucket-like seat alongside driver Sergeant O'Rourke. You're dressed in fatigue clothes, your legs are stretched tensely out in front of you, your goggled eyes are bugging out of their sockets as you stare fixedly at the maze of pine trees and underbrush coming toward you at 25 miles an hour. A swirl of sand and dust cyclones up from under the thrashing Caterpillar tracks. It gets in your nose, your ears, and sharp particles of silica sting your cheeks. Those trees! They're closer every second. How will you get through them? Not even a 30-ton tank can knock 'em all over!

However, you've reckoned without Sergeant O'Rourke's driving ability. Crushing a growth of underbrush flat, the tank skims between two husky pines, whirls sharply left to avoid a third, then spins on its axis to the right. You're in the forest—you still don't know how you made it—and you smash ruthlessly on, flattening shrubs and small bushes, dodging, weaving, spinning like a big but fleet fullback running a broken field, avoiding heavy opposition and straight-arming the rest.

Suddenly there's a tree dead ahead. It's a man-sized tree, big enough to put an accordion pleat in the front end of any automobile —and this mechanized hullabaloo is heading straight for it! Involuntarily your lips open to shout a warning, but you get a mouthful of grit, and anyway O'Rourke couldn't hear you above the pandemonium. Like any well-regulated back-seat driver, you try to jam your feet through the steel floor plates, your whole body stiffens, and as the horrific crash becomes imminent, you close your eyes, duck your head, and hang on convulsively.

But there isn't any crash; not even a noticeable jar. A small shower of leaves and dead twigs comes through the open port in front of the gunner's seat, scatters itself harmlessly over your lap, and, amazed, you look up. The tree is gone and the tank is still racketing through the woods. A glance sideways at the driver brings a grin from him that says as plainly as spoken words, "Yes, I know how you feel"—and you *do* feel exactly that way.

NATIONAL DEFENSE

● Through courtesy of the United States Army, the writer of this article recently visited an Armored Division Camp. His personal experiences are described in these columns. ●

Like some mechanical behemoth gone berserk, the tank plows savagely on, smashing saplings like tooth-picks, turning underbrush into pulp as easily as you'd crush a tomato. Now and then a tree can't be avoided, so this monster of hubbub blandly smacks it flat, just as though it had never been there, but aside from an involuntary blink at the moment of contact, that doesn't bother you any more. You've had your first inoculation of armored division power and you've found it as exhilarating as a heady drug. Your puny little body of mere flesh and bones, scrooched down there in that gunner's seat, experiences a latent strength it has never before known and you feel that so long as you and Sergeant O'Rourke can keep that 30 tons of hell-let-loose under control, there's nothing you can't do.

A small clearing suddenly looms ahead and through it and into the woods on the other side winds one of those sandy, "snake-trail" roads. The sergeant wheels the tank into the trail and steps on the gas; the speedometer needle rises in tempo with the crescending clangor as all 25,000 parts of the tank are now strained for speed. You're doing 30, then 35; the needle hovers at the 40-mile mark; sand, dust, and the rich odor of hot, greasy metal assail your nostrils. While the sensation of speed in a tank is enhanced by the never-ending, ear-splitting racket, remember that you're doing 40 miles an hour in the belly of 30 tons—60,000 pounds —of steel, hurtling down a winding, twisting sand-trail—a demoniacal engine of destruction, if ever there was one.

AND now your imagination, needled with that sensation of tremendous power, begins to function, but it still has to work overtime to visualize what the entire tank brigade of an armored division would be like when on a punitive expedition against an enemy. Your recall there are five echelons to each division; command, reconnaissance, striking, support, and service. Command, or division headquarters, has sent out the reconnaissance battalion, consisting of two armored reconnaissance companies—the boys who ride the "peeps," "jeeps," and half-tracks —one light tank company, and one company of armored infantry, largely transported in half-track

Photo by U. S. Army Signal Corps

Banking on a sharp turn, a tank creates a miniature sandstorm

cars, to fan out ahead of the main striking force, locate the enemy, and radio back its information. In this they have been assisted by the radio-equipped observation planes that have scouted perhaps 150 miles in front and which have been protected by combat planes. Signal corps, responsible for the division's communications, including its more than 750 radios, has maintained excellent contact with the reconnaissance battalion. The ever-mobile division headquarters, armed with the desired data, has laid a plan of attack and you're in it.

You're part of the crew of just one of 108 medium tanks, assuming the brigade is striking in full force, and you're going into battle first to knock out enemy anti-tank guns and his strong points. Roaring and rattling along with you, sometimes ahead, sometimes behind—depending on the objectives—are 260 light tanks while, preliminary to the actual attack, and lifting as you advance, the motorized artillery regiment of the armored division has been laying down a barrage to cripple enemy defenses, prevent reinforcement, and disable his guns.

WELL up in the vanguard of this explosive thrust is the engineer battalion. It's their job to blow up anti-tank mines, to throw temporary bridges over the streams you'll come to, if you attain your objective, and to build road blocks, if necessary, to trap enemy mechanization. To perform these and a myriad of other jobs, the engineers lug along the tools of their trade on unbelievably powerful trucks and tractors. There are assault boats, utility power boats, and outboard motors; you'll find portable bridges and ferries, air compressors, portable cranes of tremendous lifting capacity; there'll be electric lighting sets, huge posthole diggers, and even a water-purification unit.

All these and many more are essential constituents of the armored division attack that your sorely tried imagination has striven to visualize as you rocketed down the snake-trail with the gleeful Sergeant O'Rourke in his bombilating tank. Suddenly that steel nightmare swerves from the trail, pulverizes a thicket, crashes through the woods for about 100 yards, and comes to an abrupt, pulse-quickening stop on the very verge of a deep, steep-sided ravine. "In the name of heaven!" you mentally mutter, "He isn't going down there?" and you glance apprehensively at the sergeant, but this time he doesn't look at you. He's studying the terrain, balancing the capabilities of his tank against nature's hazard.

Fortunately, there are many Sergeant O'Rourkes in our ever-growing armored divisions. They're all old army men who have been manipulating metal monsters since the Army first created a mechanized force in 1928, and, as today's instructors, when they finish grooming the newer and younger men, they will have infused them with an indefinable something that simultaneously radiates confident power and just the right amount of conservatism to utilize that power most efficiently. At least that's the impression you gain from Sergeant O'Rourke as you watch him maneuver his 30-ton ponderosity down into the ravine. At an angle that would appear impossible, you move slowly, clankingly down the hill; you splash through the tiny stream at the bottom and then, reversing the angle, you commence to climb. If that feeling of irresistible force was astounding during the earlier, smashing, crashing tactics on relatively level ground, it is overwhelming now, as the huge tank slowly but surely climbs up the steep incline. The engine emits a resonant roar as the Caterpillar tracks stubbornly and successfully fight off the law of gravity.

DESPITE the consumate faith that the tank's performance has generated, you heave a little sigh of relief as the machine teters gently forward over the brow of the ravine onto level ground. Once again you try to imagine 100 or 1000 tanks advancing against an enemy through country like this. Some, of course, will become disabled, by artillery fire or through mechanical difficulties. The latter may be minor, involving, for example, the mere replacement of a broken link in one of the tracks—an operation which, on a much larger scale, is comparable to replacing a drive-chain link back in boyhood bicycling days. If the trouble is serious, it's a job for the

Photo courtesy Chrysler Corporation

"Mechanized hullabaloo:" matchwood

service echelon. They'll be along soon, and with their enormous wreckers, tractors, cranes, winches, their mobile repair and machine shops, their motorized acetylene welding plants, there's little they can't salvage. Those fellows take a passionate delight in keeping every item of the armored division's rolling stock in first-class operating condition, and in doing it anywhere under all manner of conditions. As the commander of a service battalion said, "It's no good to us unless it's out of order."

BEFORE the service echelon arrives, however, the armored infantry regiment with its associated artillery battalion will have passed through in order to hold the ground won by the armored spear-thrust of the tanks and to repulse counter-attacks. Your ideal armored division infantryman is a tough, hard-bitten combination of dare-devil, mechanic, and expert marksman. He's imbued with that same spirit of unlimited power that hit you so forcefully after your first few minutes in the tank, but in his case he's been exposed to it ever since the beginning of his training. He has learned to shoot machine guns, "tommy-guns," pistols, Garand rifles, 37mm guns, and mortars. In numerous instances he's a "two-gun man," fighting with both pistol and machine gun, and although his training includes sufficient setting-up exercises, hikes, and overnight bivouacs to condition his body properly, his primary training has been toward shooting all manner of guns "on the run," in the mechanical mysteries of what makes an armored division click, and in communications of varying types.

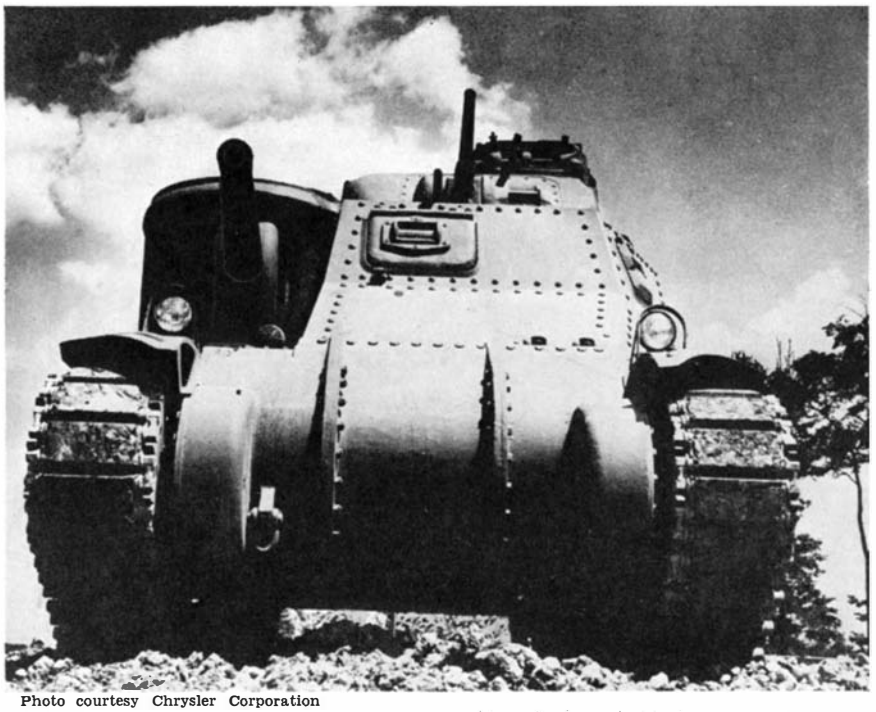


Photo courtesy Chrysler Corporation

A United States Army tank: brute force and heavy fire-power

In this attack you've been envisioning, the infantry regiment will be following the spear-head thrust of your medium tanks and the light tanks in half-track cars, of which the division has over 500; in "bantams," or "peeps," which total 400; on many of the 400 solo motorcycles, and in various other conveyances, practically all of which mount guns of one sort or another. Two-way radio maintains constant contact with the mobile regimental headquarters, wherever it may be. One thing certain, the infantry will not depend on its feet to follow the fast and furious advance of your medium tank regiment that opened the gap in enemy lines, a gap that was widened by the light tanks just in the rear. The motorized infantry has accompanied or closely followed these lighter units; it has organized and is holding the vital points thus won, while you and the rest of the advance tanks, reinforced by heavily armored scout cars, are now darting in against the enemy flanks and against his rear.

Photo by U. S. Army Signal Corps

Under simulated aerial anti-tank fire

In fact, if all phases of this theoretical maneuver have gone according to the time schedule, the entire operation has moved forward too rapidly for enemy counter-attacks to be effective against it. The flanks and rear of the spear-head have been guarded by the extreme speed and by the heavy, rapid fire-power of which an armored division is capable, rather than by formerly accepted methods which involved the sending out of flank and rear guard detachments and patrols. Your regiment of medium tanks and the rest of the vanguard have fanned out behind the enemy's pierced lines; you are playing havoc and raising hob with his communications, service lines, and any attempted reinforcements. Concurrently, perhaps, another armored division has duplicated your operations 100 miles or so from the point of your attack and ultimately, if all goes well, the fanned-out portions of the two divisions will complete a pincer movement, nipping off a large portion of enemy effectives and leaving a gaping hole in his defense.

THE past half hour's "practice spin" in a tank has vividly brought home to you the modus operandi of the armored force—a force calculated to operate independently against any kind of enemy under all imaginable conditions. You realize, too, that such vast and mobile power would be inestimably valuable in defense,

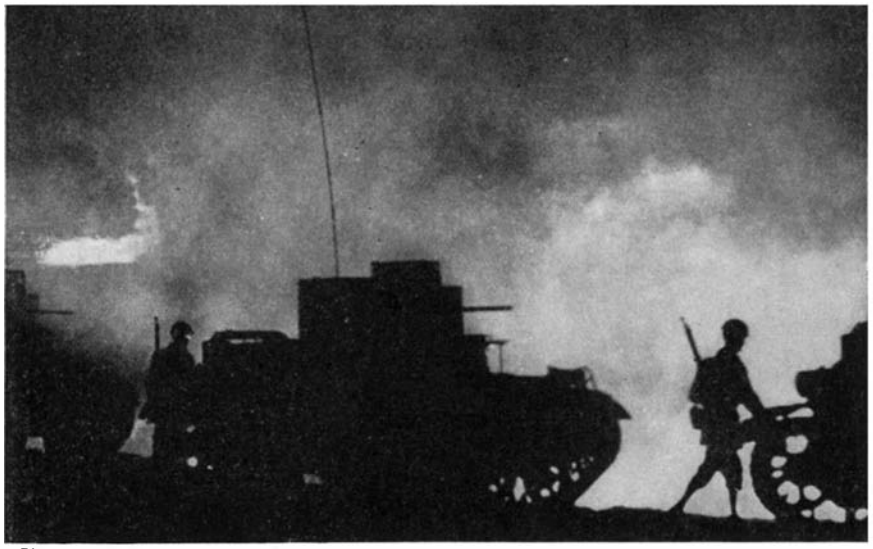


Photo by U. S. Army Signal Corps

Night practice maneuvers produce weird silhouettes

although you know full well that the American Army has not been one to take the defensive, and you can readily understand that fast and furious warfare of this type will tend to prevent conflicts from reaching an entrenched stalemate, as in 1917 and 1918. As Sergeant O'Rourke swings his metallic monster about and heads back toward the cantonment, you sense again and more fully that comforting feeling of latent strength. You're sort of a veteran now—in your own estimation—and you muse that if only you were 20 years younger, you'd like to join this man's army, this 20th Century version of Teddy Roosevelt's Rough Riders.

SUDDENLY, however, just as you're feeling a little over-confident in your ability to absorb the technique of life in a tank, you have the feeling that Sergeant O'Rourke has one more trick up his sleeve. The increased roar of the motor indicates a final spurt of speed down that gently rolling, sandy valley just ahead and the speedometer needle, at 35, at 40, at 45 confirms your suspicion that something is about to happen. That inquisitive side-glance at the sergeant begets nothing save a humorous quirk at the corner of his mouth and a mischievous twinkle in the crows' feet around his eyes. The sergeant is about to demonstrate something, but you can't figure out what it is.

The tank roars down the slope at a speed of nearly 50 miles an hour in the midst of a self-generated sand storm, and then you see what's ahead. There's an abrupt little rise of sand and a level surface beyond—a natural setting closely resembling the "jump-the-gap" constructions of circus days. You've seen it in pictures—a jeep, or maybe a tank completely off the ground as it tops a rise at high speed —and you've wondered how the men kept their teeth in when the machine jolted back to earth. Now you're going to find out.

There's a second of suspense as the tank catapults up the slope, a momentary racing of the motor as, front end still pointed skyward, this speeding mass of steel manages to leap free from solid traction. Before you can catch your breath there's a good, solid "kerplunk!" You're back on terra firma, you haven't lost any teeth, the jolt wasn't nearly as bad as might be expected, and you're left with one, all-pervading impression —*power!*

Sergeant O'Rourke is appreciative of expressions of gratitude for the ride. He had a good time, too, but when you intimate it wasn't as rough-and-tumble a trip as you had anticipated, he grins and says, "I'd like to take you out in really tough country. You'd know you'd been in a tank!"—so perhaps it's just as well the initiation took place over gentle, rolling terrain.

Of course, tanks and scout cars are not new to our Army. The Cavalry has had a mechanized force since 1931, and the infantry has been experimenting with tanks since the World War, but our scheme for employment of tank units was based largely on British and French concepts, which made such forces subordinate parts of larger, usually infantry, organizations. The latter were not mechanized and could move only about one-tenth as fast. Opposed to this was the German idea of a large, smashing battle force—a complete armored unit of all needed arms—which could penetrate enemy lines and hold the gains thus made, independently of other support. The crushing success of Nazi *schnell truppen* in 1939-40 left no doubt as to which of these two theories was correct, and the United States Army began to reorganize its mechanized units accordingly.

As has been stated, the first mechanized force was created in 1928, but it remained relatively inactive until the winter of 1930, when General Summerall, then Chief of Staff, assembled it at Fort Wallace, Virginia. It was split up on November 1, 1931, between Fort Knox, Kentucky, and Fort George G. Meade, Maryland. An Infantry Tank School was established at the latter post, but moved to Fort Benning, Georgia, the following year. When the directive of July 10, 1940, created the present armored corps, it was decided to base the 1st Division at Fort Knox, the 2nd at Fort Benning, with the door wisely left wide open for expansion. Today, the 3rd Armored Division has been organized at Camp Polk, Louisiana, the 4th Armored Division at Pine Camp, New York, and the 5th Armored Division will shortly be activated at Fort Knox, Kentucky. Some 7500 men who have trained with the armored forces at Fort Knox and Fort Benning are providing the backbone of the manpower for the 3rd and 4th Divisions, and all four will join in providing personnel for the 5th Division. They are being augmented by recruits and men chosen for service under the Selective Service Act. The War Department will increase the numerical and mechanical strength of its armored force as rapidly as practicable. Informed sources estimate that the total personnel of the armored force will reach 80,000 during 1942.

SOME concept of the detail involved in organizing and maintaining an armored division may be gained by realization that the armored brigade, or main striking force of each division, contains 1350 vehicles in addition to 270 light and a little over 100 medium tanks. The brigade would require 30 miles of road space on the

march, allowing 40 yards between vehicles for freedom of movement. A fully complemented armored division would stretch out to 110 miles on the march—more than the highway distance from New York City to Philadelphia, Pennsylvania.

As to armament, including weapons mounted on vehicles, each armored division of 12,697 officers and men is equipped with some 400 37mm guns; over 100 75mm guns; 3600 .30-caliber light and heavy machine guns; 800 .50-caliber machine guns; 2000 .45-caliber submachine guns; 36 105mm howitzers; 21 60mm mortars; 20 81mm mortars; 10,000 .45-caliber pistols; 2000 Garand rifles; and a dozen .30-caliber automatic rifles. In addition to tanks, the following amazing diversity of vehicles is included: around 100 scout cars; 500 half-track cars; 20 mortar carriers; 145 personnel carriers; 20 motor ambulances; light passenger cars; 400 solo motorcycles; 400 "bantams"; 100 half-ton command trucks; 100 half-ton pick-up trucks; 9 half-ton weapon carriers; 650 two-and-one-half-ton cargo trucks; 120 two-and-one-half-ton cargo trucks with winches, and a supporting complement of tractors with angle dozers and trailers; artillery repair trucks; automotive repair trucks; emergency repair trucks; instrument repair trucks; machine shop trucks; small arms repair trucks; spare parts trucks; tank maintenance trucks; 10-ton wrecker trucks; tool and bench trucks; welding trucks; radio trucks; a panel delivery truck; two-and-one-half-ton wrecker trucks; four-ton cargo trucks; four-ton tractor trucks; four-ton wrecker trucks; gas and oil trucks; crane trucks, and, for good measure, a few other miscellaneous trucks.

Photo by U. S. Army Signal Corps

Crashing through the woods from camouflage to open terrain

In April of this year the first 30-ton tank rolled off the production line, eight months ahead of schedule. This M-3, or medium tank, is the largest American tank now in production. While reliable reports place the weight of Germany's largest tank at 90 tons, the firing power of the M-3 is considered to equal or to surpass that of tanks in action abroad.

It is equipped with a 75mm gun which hurls a missile 15,000 yards. Included in its armament are an anti-aircraft gun and three machine guns, and the seven crash-helmeted crewmen can increase the deadliness of the tank by firing automatic weapons through ports. Although complete and exact production figures for tanks are naturally not available, it is public knowledge that they are coming off several different production lines at a rapidly increased pace. Early in August, for example, one manufacturer announced the completion of the 1000th tank constructed by that organization. Moreover, authentic reports indicate that production of the astounding variety of other armored vehicles required by our new fighting arm is progressing favorably. Meanwhile, the personnel is receiving its intensive basic training, it is practicing with such units as are available, and it is preparing itself to utilize to the fullest extent what has been proved to be the greatest factor in the succes of this new type of striking force—a factor epitomized by the one word—POWER.

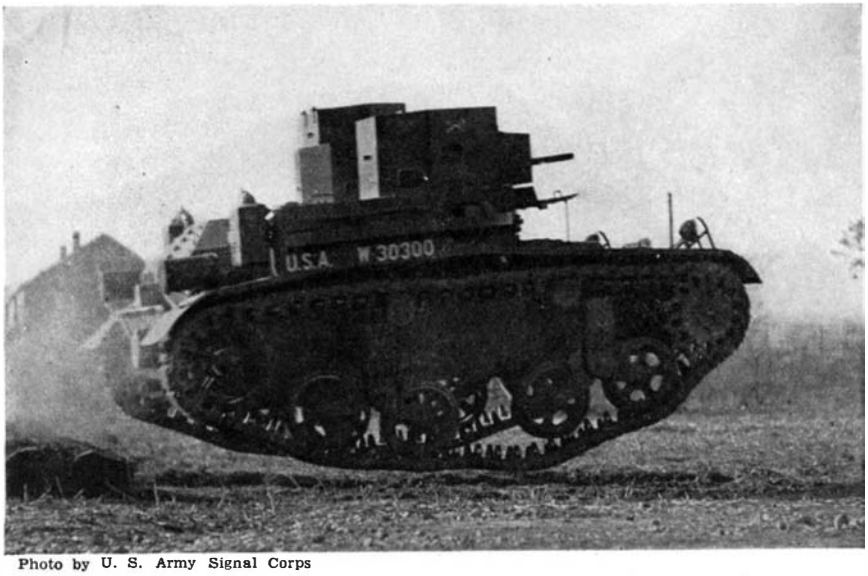


Photo by U. S. Army Signal Corps

Power enough to defy the law of gravity

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TANK HEADACHE

The design of a tank is evolved from compromises between conflicting military requirements. These are: armament, armor, mobility, weight, number of men in crew, and speed of production. To balance these and other factors, yet bring out a vehicle that most nearly fits all probable warfare situations, is the tank designer's headache.

On They Roll

Ball and Roller Bearings Have a Number of Properties of Importance to Industry

P. F. KORYCINSKI, M.E.*

THERE is historical evidence that the ancients knew that "nothing rolls like a ball" because they knew that heavy loads could be carried by riding them on balls. Because balls were seldom available, however, rollers were substituted and, in this manner, great stone slabs were transported from quarries to the ancient temples and tombs.

Ball bearings were first introduced into the United States from Germany by the bicycle manufacturers as recently as the end of the last century; roller bearings were developed in the United States at about the same time. Yet today these machine elements are of tremendous importance. Continuous progress in the metallurgy of steel, improved methods of precision manufacture, extensive research, and large-scale production are the factors which have contributed to their success and extensive use.

Though ball and roller bearings are commonly known as anti-friction bearings, they have other properties of equally great or even greater importance. One of their most valuable qualities is the high degree of reliability which attends their employment by the manufacturer in production and by the machine user in service.

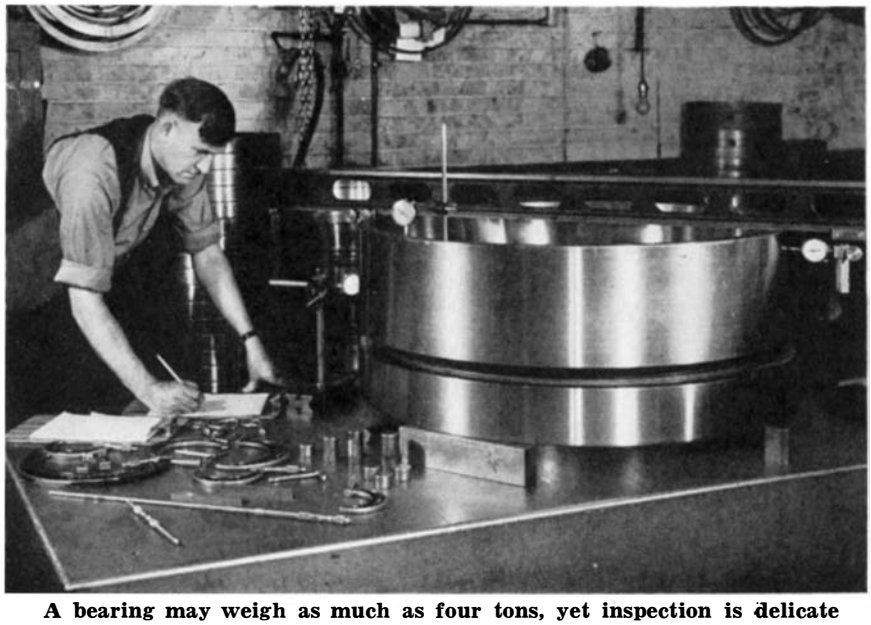
It is unnecessary to stress the obvious importance of bearings to the successful operation of any machine or equipment; only too frequently failure of this element serves to emphasize the fact and to jeopardize the success of an otherwise well-considered design. Unfortunately, the performance of a bearing in service is not entirely dependent on those conditions which can be analyzed in design. The design can anticipate load and speed conditions of normal operations or of heavy duty, but contingencies of operation play an almost equally important part and these involve many exceptional and unusual conditions as well as the hazard peculiar to the human element. It is not possible, however, to provide against every condition of abuse and neglect which may arise, although the owner or operator of the equipment will be quick to recognize the superiority of the machine which shows added stamina and reliability in meeting the demands he places upon it.

Precision is another property of great importance. Ball and roller bearings are manufactured to very close tolerances on both external and internal dimensions. The races and balls are ground to exceedingly close limits; the balls in standard bearings may be held within .000025 of an inch for sphericity and size.

Leading manufacturers also supply super-precision bearings for special purposes, the accuracy of which is even greater than that of standard. Thus the balls of the Fafnir super-precision bearings are selected to limits of five millionths (.000005) of an inch for size. The assembled bearing is checked for eccentricity to five decimal places. Each bearing is matched against another so carefully as to reduce variations between bearings to six decimal places.

Such super-precision ball bearings are not only very accurate, but also are pre-loaded. Pre-loading is the term applied to the rigidity that is attained by loading the bearings at assembly by forcing the faces of the bearing rings in or out of flushness. Thus additional loads from cutting tools, grinding wheels, and so on, result in extremely small deflections which, with the most precise measuring instruments, can be measured only in millionths. With such extreme precision a person can place his thumbnail against the spindle of a grinder turning at 60,000 r.p.m. and not feel motion.

ANOTHER important property of anti-friction bearings is that, in general, they require very little lubrication. Excessive lubrication, especially with oil, is not desirable, as such a condition promotes heated bearings and friction torque is increased. Theoretically, ball bearings can function without lubrication in the sense that plain bearings need lubrication, but oil or grease is applied for the following reasons: (a) to provide lubrication for the balls as they roll in the retainer pockets, (b) to dissipate the heat of metal deformation, (c) to prevent rusting or corrosion of the bearing surfaces, and (d) to protect the surfaces from water, acid, or any other foreign sub-



A bearing may weigh as much as four tons, yet inspection is delicate

*Original article by Mr. Korycinski appeared in the *Georgia Tech Engineer*. To this has been added, by the editorial staff of Scientific American, supplementary material.—*The Editor.*

stance. Grease, also, is very effective in sealing the housings.

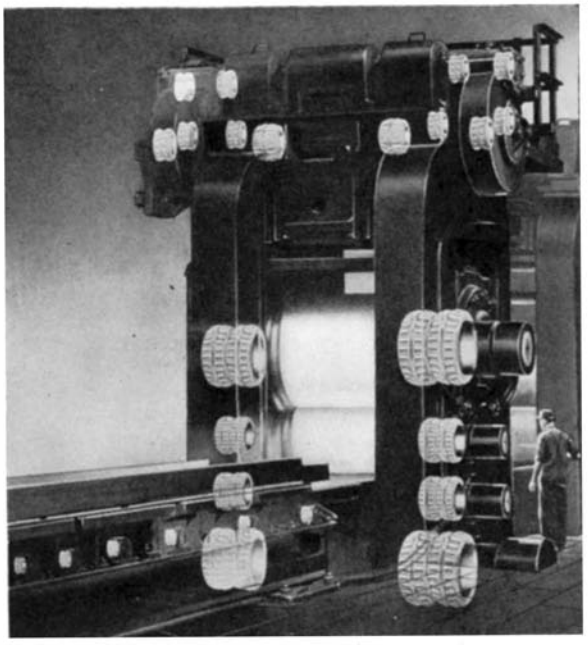
In selecting bearings the designer is generally concerned with the load-carrying capacity of the bearing. The manufacturers have listed in their catalogs data relative to the application of bearings in design. These data have been founded on scientific investigations first made by Hertz and Stribeck, of Germany. Although the basis for the data compiled by the manufacturers is the same, the load-carrying capacities of the same type of ball bearing made by two different manufacturers can vary. The reason for this variation is that the manufacturers use different life-ratings. Therefore, the manufacturer who bases the load-capacity of his bearing upon a short bearing life can have a high load-capacity. The following formula, as given by the SKF Industries, shows the relationship between the life of a bearing and speed and load:

$$\text{Hours life} = \frac{C}{(\text{speed}) \times (\text{load})^3}$$

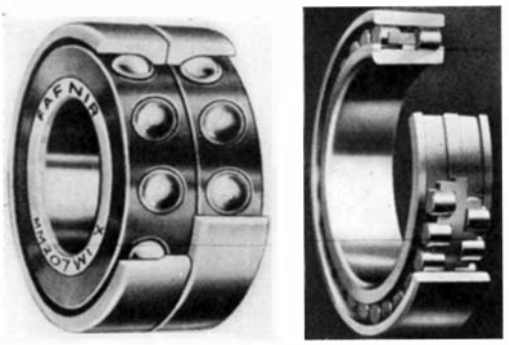
where C is a constant dependent on the type and size of the bearing. From the formula, it may be observed that when the speed is doubled the life is reduced to one-half; and when the load is doubled the life is reduced to one-eighth.

IN REGARD to friction, the SKF Industries assert that the low frictional characteristics of ball and roller bearings have been over-emphasized in the past, to the actual detriment of some of their most useful and valuable properties. This has been particularly true in the matter of power savings where the mistake has frequently been made of neglecting to consider other factors, aside from bearing friction, which are generally of equal importance. The possibility of saving power by the use of anti-friction bearings depends upon the relative efficiencies of this type and the plain bearing, as well as the percentage of the total power input which is absorbed by bearing friction.

Usually where conditions are such that high power-losses are present in the plain type of bearing, the principal advantage to be obtained from ball and roller bearings is the improved service from a maintenance point of view rather than spectacular savings in the realm of power consumption alone.



An example of heavy-duty bearing use; Tapered roller bearings in a steel rolling mill



Two types: *Left,* a super-precision ball bearing and, *right,* a double-row SKF bearing of the cylindrical roller type

There is no extremely great superiority from a standpoint of low operating friction of ball and roller bearings over the plain bearings, provided the latter are perfectly lubricated and in good shape. In fact, for the higher loads, the coefficient of friction for the roller and plain bearings is practically the same. For ball bearings the coefficient of friction is lower and remains fairly constant under different loads and speeds.

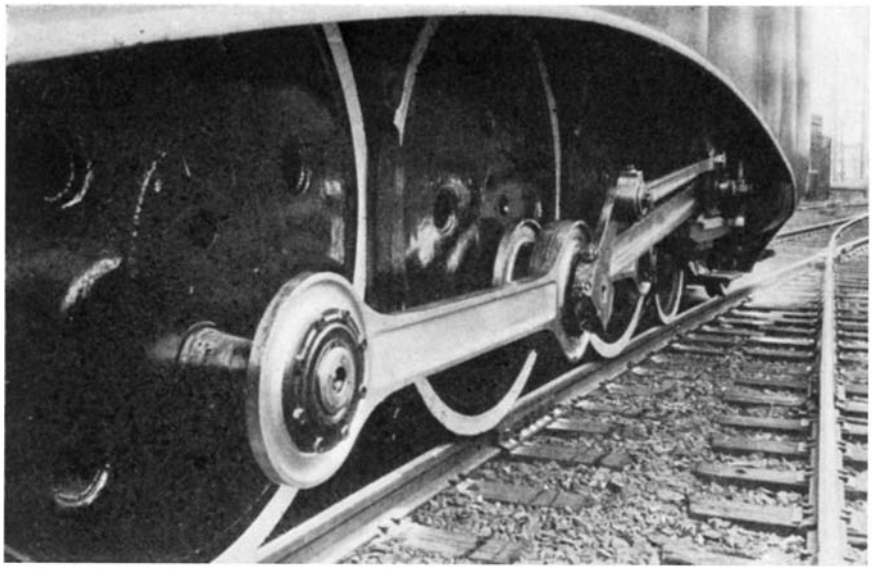
In considering starting friction, however, the plain bearing has a relatively high coefficient of friction, whereas the ball and roller bearings have practically the same friction at starting as when running. This is a valuable property where starting torque is an important consideration, as in railway service.

The possibilities of the ball or sphere as a rolling, load-carrying member were appreciated very early in the development of the anti-friction bearing. Owing to its simple shape, it was a comparatively easy matter to produce balls of high accuracy. The problem of turning out accurate rollers at competitive cost is more involved but today it is possible to make rollers which compare favorably with the best balls.

WITH roller bearings, the difficulty encountered was the tendency for the cylindrical rollers to skew or misalign. In a few revolutions of a moderate size bearing, the rollers would travel the equivalent of only a foot or so. But at several thousand r.p.m., the rollers would be required to travel approximately a fifth of a mile each minute. Any means to prevent the skewing tendency of the rollers in this distance requires a certain amount of force and means additional metal-to-metal sliding friction and wear. For this reason, roller bearings are used for high-speed work only when their design is such (cylindrical rollers, for example) as to reduce skewing to a minimum with low frictional losses.

Cylindrical roller bearings do not take thrust or angular load. Whereas this is an advantage in many applications it explains why other types of bearings must be used on a shaft to fix it axially. Pre-loaded ball bearings, however, carry combined radial and thrust loads with yields which are small enough to justify exclusive use of them where the loads are low. This applies, for instance, to internal grinder spindles. For the same reason ball bearings are good enough for many other high-speed applications with low loads such as electric or compressed-air hand tools, and so on, running at speeds up to 75,000 r.p.m.

Since the anti-friction bearings with cylindrical rolling members do not resist thrust or angular loads, many types have been produced with rollers variously tap-



Cross-head and all crank pins are equipped with Timken roller bearings

ered, thereby enabling them to resist thrust in one direction, in addition to radial loads. Upon this principle the Timken roller bearing was built. The Timken Roller Bearing Company asserts that true rolling motion is assured by making all lines coincident with the tapered surfaces of the rollers, cup and cone meeting at a common apex. This basic principle has been applied for more than 40 years by The Timken Roller Bearing Company and, judging from the number of Timken roller bearings in service, it is evidently a satisfactory principle.

Each type of bearing, roller and ball, has its limitations. The ball bearing generally carries light loads at high speeds. The roller bearing, on the other hand, accomplishes the opposite of the ball bearing. Where heavy loads, both constant and shock, are found, the roller bearing is preferred. Its higher load-carrying capacity is attributed to its greater contact surface. In a ball bearing little more than point contact is attained, whereas in the roller bearing the load is theoretically distributed along the entire length of the roller.

THE needle bearing is a type of roller bearing which has compactness as its main advantage. This feature has been made use of in late automotive design of steering gear, kingpins, transmissions, universal joints, and in magnetos. In many applications, needle bearings are replacing the common brass bushing.

The SKF Industries have designed a bearing which is a compromise between the ball and roller bearing. They call it the spherical roller bearing. This bearing has the inherent ability of self-alignment, thus permitting the utilization of its full capacity under high radial and also high thrust loads or extreme conditions of shock load. The barrel-shaped rollers are so designed that they will remain in permanent contact with the center flange, thus assuring positive roller guidance. This bearing is particularly suited for heavy duty applications.

The first spherical roller bearings to be used for railway journal boxes in the United States were mounted on six coaches in 1921. Another "first" for these SKF products was an installation in the engine trucks of a steam locomotive in 1927, the first in this country ever to be mounted on anti-friction bearings. An outstanding example is one locomotive with spherical roller bearings in the driver boxes put in service in 1931. Since then the engine has run over 1,700,000 miles without bearing replacement—a fact which goes a long way in explaining why railways have found spherical roller bearings an effective aid in meeting competition.

As early as 1926, the Chicago, Milwaukee, St. Paul & Pacific Railroad came out in the market for roller bearing equipment for passenger train cars of all types. The problem confronting the Milwaukee Road was this: they were obtaining new equipment, including Pullman cars, for two luxury trains and they felt certain that it would be necessary to increase the number of cars in the trains. The existing locomotives would not have sufficient power to handle these heavier trains at higher speeds. The lack of power was particularly evident when starting. To have provided new power to handle these trains would have meant the expenditure of several million dollars, whereas the road had sufficient locomotives if some way could be found to reduce the starting and running loads.

Prior to this the Milwaukee had placed an existing car in service with tapered roller bearings and had run dynamometer car tests. The results of these tests demonstrated to their satisfaction that the roller bearing would reduce starting resistance and running resistance to the extent required for their existing engines to handle the new trains.

The first cars were placed in service during the winter of 1926-27 and in the early spring the first complete train, "The Pioneer Limited," went into regular revenue service. By early summer of 1927 all of the new cars were completed and "The Olympian" went into service. These first cars now have more than two million miles to their credit.

THE first Timken applications to steam locomotives were made to the engine truck or leading truck. However, the company was anxious to get some test installations on driving axles, but the big drawback was that it was considered at that time that the openings in the existing frames were not large enough to provide for a sufficiently large bearing, which meant that new frames would be required.

The Timken management in 1929 decided to build a new locomotive to be equipped on all axles with roller bearings and to be loaned to the railroads for trial operation with the following points in mind: It would save a lot of time that would be required in developing tests on a number of roads. It would demonstrate in a dramatic way their confidence in their product to do the job.

The Timken locomotive was loaned to 14 different railroads during the 18 months' test period, covering approximately 100,000 miles. There were a large number of other roads that wanted to try out the engine, but at the end of 18 months, it was felt that the Timken position had been proved. The locomotive was then sold to the Northern Pacific Railroad and

it still is in passenger service on this road. It now has around 1,000,000 miles of service and nearly all of the original bearings are still in use.

The advice received from the operating departments of the railroads was that the locomotive was one of the finest engines ever built. The tests indicated that roller bearings provide a means of developing a combination engine which would be capable of handling all freight service and, without making any change whatever, would handle any passenger schedule in the United States and do both jobs in an efficient manner.

From the test data obtained from the many railroads which used the Timken locomotive, the final results were as follows:

The starting friction was 5 percent of that of plain bearings. The reduction of friction in starting the locomotive weighing 711,000 pounds adds an equivalent amount of weight that can be started without jerking. This equivalent is five Pullman cars.

Free coasting was achieved; that is, closing the throttle did not result in the bunching of the train on the locomotive and consequent taking up of slack when the throttle was opened.

Notable reductions were observed in maintenance and consumption of lubricants, fuel, and water. The conservative figures for increased development of power and of locomotive availability were set at 10 percent and 50 percent respectively.

Furthermore, the use of this locomotive would permit increased speeds, a reduction in road maintenance, and the elimination of hot boxes. With roller bearings, the temperature rise was only 15 to 30 degrees, Fahrenheit. Trainmen have commented that it was on the Timken locomotive that they saw frost on the driver bearing housings for the first time.

Such conclusive evidence could no longer be overlooked by the railroads. Since 1930 the majority of the locomotives built have been equipped with anti-friction bearings.

The successful use of anti-friction bearings by the railroads is typical of their use in all industries. The wheels of industry roll faster on anti-friction bearings.

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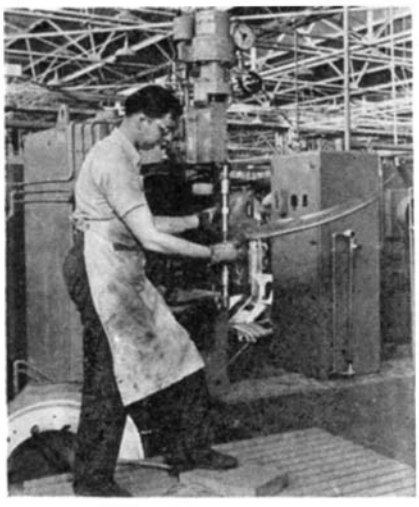
Stored Energy for Welding

High Current Flow for Short Time Period Particularly Adapted to Difficult Jobs

C. E. SMITH
Control Engineer, Westinghouse Electric and Manufacturing Co.

WITH the immediate emphasis on the production of airplanes and other defense implements, a new method of resistance welding assumes special significance. A recent development in resistance welding consists of first storing energy, either electro-statically or electro-magnetically, and then discharging it through the two metal parts to be joined. Thus it differs from conventional resistance-welding methods in which alternating-current energy is taken directly from the supply line while the weld is being made. It is particularly suited to welding metals of high thermal conductivity such as aluminum, because extremely high currents are required for very short periods of time if the weld is to be completely formed before the heat can be conducted away from the joint.



Welding with stored energy

One form of electro-magnetic stored-energy method of welding is shown schematically in Figure 1. It consists of a three-phase power supply, an ignitron welding

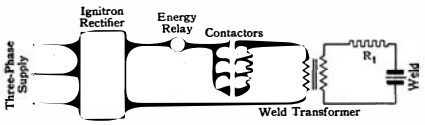


Figure 1

rectifier, a welding transformer, the welding machine, the main direct-current contactor, and suitable control relays. When the welding operator places the metals between the electrodes and pushes the foot switch, the electrodes are brought into contact with the work and the circuit through the welding transformer is automatically closed. The ignitron rectifier impresses a direct-current voltage across the transformer primary and the current rises exponentially at a rate determined by resistance and inductance of the transformer, which is the equivalent of an inductance with resistance in series. In this manner a charge of energy is stored in the iron core of the transformer for later release as welding energy.

Since any change of current in the primary of a transformer induces a current in the secondary, a current flows through the work even during charging and serves to preheat the work. At a preset primary current a current relay causes the contactor to start opening. As the contacts open, one after the other in sequence, more resistance is inserted until finally the last contact opens and ruptures the remaining primary current. The

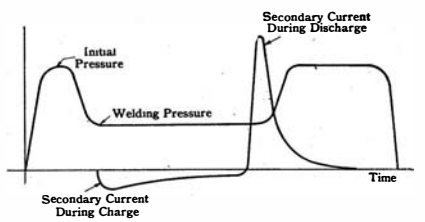


Figure 2

opening of the contactor causes a rapid reduction of primary current. The rapid change of flux in the iron caused by quick interruption of primary current generates a heavy surge of welding current in the secondary winding and the weld is made. This welding current then decays exponentially to zero as the energy is used up in the weld and in resistance.

The weld is made in a manner that differs from the usual resistance-welding technique in which the work is simply held under pressure between the electrodes during the current flow. With the stored-energy method, pressure on the joined parts is varied during welding operation. As shown in Figure 2, when the material to be welded is placed between the electrodes

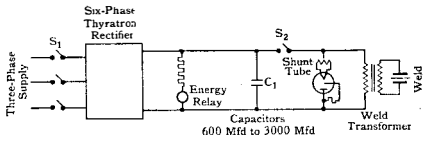


Figure 3

the welding machine applies to them a full pressure provided by an air-operated piston behind the upper or moving electrode. This action forces the two metal parts into intimate contact. After this application of initial contact pressure, the electrode pressure is decreased slightly. At the start of this period of pressure retraction the ignitron begins to charge the transformer. During this charging period the small preheating current flows in the secondary. When the maximum-current relay de-energizes the main contactor, the secondary current flows. During the fall or decay of secondary current, electrode pressure is suddenly increased. The final compression takes place as the heating period is near completion and after the material has fused. This action causes a mechanical working of the metal, which compensates changes in grain structure of the fused material caused by the heat during fusion. This application of pressure and its variation during welding is controlled by two separate magnetic valves through the action of electro-static time-delay relays.

THE electro-magnetic stored-energy system of welding, like conventional spot-welding schemes, makes use of ignitron tubes, although in a different way. Ordinarily ignitrons are used not as rectifiers but as power switches for a timer, advantage being taken of their timing ability to measure out the required number of cycles of alternating current allowed to flow into the "spot." On the new system, the ignitron is used as a rectifier, but there is no essential difference between the two ignitrons; the only difference is in their control. The rectifier is three-phase half-wave, using three single-anode ignitron tubes and three firing tubes for control of the ignitrons.

Inasmuch as the maximum charging time is approximately one second and since the bulk of a welder operator's time is taken with handling the work, it is economical to operate two welding machines from one rectifier. By electrical interlocking, only one welding machine can be loaded on the rectifier at a given instant.

The electro-static stored-energy system is shown in Figure 3. Here the power supply consists of a high-voltage multi-phase rectifier of 50 or 60 kva. With the closing of S_1, the capacitor bank, C_1, is charged to a high preset voltage. Then by means of an electronic energy relay the capacitor energy is discharged into the welding transformer. Adequate energy must be supplied in short time to make a good weld and the welding current must decay rapidly to prevent arcing as the electrodes separate. For these reasons an aperiodic secondary current has been found best.

AN advantage of either the electro-magnetic or electro-static stored-energy principle of welding is that energy is drawn from the supply lines slowly and discharged quickly. The instantaneous demand is reduced to approximately one-tenth that required by an equivalent alternating-current spot welder and the power-factor is increased almost to unity. Also, the load is balanced on the three-phase system, instead of being a peak single-phase load. As a comparison, the instantaneous power demand of an alternating-current spot-welding machine while welding two pieces of 0.080 aluminum is approximately 200 kva at 30 percent power-factor, single phase. The stored-energy method requires from 40 to 50 kva, on a three-phase balanced line at 100 to 90 percent power-factor.

A further advantage of the stored-energy system is that normal line-voltage variations do not alter the welding energy because the current relay does not release energy into the weld until the energy storage level established by the preset control has been reached.

Unlike mild steel, aluminum and many other metals and alloys have a sharp fusion points; hence a narrow range of current, pressure, and time within which quality welds can be made. The stored-energy system thus broadens the field of resistance-welding controls by providing a new method of welding non-ferrous metals and alloys that are normally considered difficult to weld.

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BACK TO BESSEMER

Increased Versatility Paints A New Picture

THE invention of the Bessemer process in 1856 provided the cheap steel needed for rails and machinery in the great expansion after the American Civil War. Later it was largely superseded by the open-hearth process; but, today, steel men again are taking increased advantage of the speed and low equipment requirements of the Bessemer process.

The distinctive feature of the Bessemer process is a blast of cold air blown through the bottom of a pear-shaped vessel holding a molten pig-iron charge of as much as 35 tons. The air removes by oxidation the carbon, manganese, silicon, and other elements present as pig-iron impurities. The open-hearth charge contains some 150 tons of metal as scrap, pig iron, and iron ore. These, together with fluxing materials, are melted in a long, shallow hearth and the impurities oxidized by oxygen from the ore and from the furnace gases playing over the charge. In both Bessemer and open-hearth processes the oxidized impurities (except carbon dioxide, a gas) are removed in the slag.

Compared with the open-hearth process, the Bessemer has been a speedy but self-willed prima donna. The Bessemer air blast accomplishes in minutes the pig-iron purification which takes hours by simple reactions of the constituents of the open-hearth charge. However, the Bessemer process requires a liquid charge, with attendant supply difficulties; can use little scrap (not over 15 percent at the most); and has in the past been unable to remove phosphorus and sulfur from the pig iron. As commonly practiced in the United States, the Bessemer converter's refractory lining is acid in character and the slag must therefore also be acid and cannot absorb phosphorus present in the pig iron.

Since the phosphorus must be excluded from the finished steel, only low-phosphorus, "Bessemer" ores can be used. While the United States has a fair supply of such ores, the non-Bessemer grade predominates.

The basic open-hearth process can operate with liquid or solid charges, and generally uses large amounts of scrap, the percentage depending on the relative price of scrap and pig iron and usually averaging about 60 percent of the charge. It removes practically all the phosphorus from the charge into the slag, which is basic in character, and retains it, so that pig iron from high-phosphorus ore can be worked. Also it is possible to make a far greater range of steels than by the Bessemer process, including all of the ordinary alloy steels. However, the Bessemer plant and equipment are less expensive to erect and maintain and the process is simple in principle and in execution. With the Bessemer converter, the average time per heat is about 18 minutes for a charge of 25 tons, compared with 10 to 11 hours for a 150-ton open-hearth charge. The steel usually made is of the low-carbon grade and quite suitable for ordinary grades of wire and wire products such as fencing and nails, for some sheet products, for welded pipe, and excellent for screw machine products where free machining is essential.

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COMMUNICATION: The American railroads use 1,285,898 miles of telephone and telegraph wires in their operations. This would be sufficient to reach more than 51 times around the globe at the equator.

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A method has been worked out recently for observing the spectacular flame characteristic of the Bessemer process and thus regulating temperature and determining the exact time to turn down the vessel and end the operation. The end of the blow is the critical period; a few seconds' under- or over-blowing may cause non-uniform quality and actually harm the steel. By means of photo-electric cells, proper filters and amplification, more accurate control is possible, thus facilitating correlation of results with operating conditions and permitting later improvement in operating details.

If the sulfur in the orginal pig iron is too high for Bessemer use, the charge can be pre-treated in a ladle and much of the sulfur removed. This procedure was developed recently in iron foundries where the iron is treated with soda ash and sulfur removed in the basic slag produced. One plant using a two-ton converter to make steel for castings so treats its pig iron and produces finished steel castings comparable in sulfur content with many open-hearth products, and with consequently improved physical properties.

A STRIKING new method produces low-phosphorus Bessemer steel by after-treatment of the blown Bessemer metal in the ladle before pouring into ingots. A mixture of carefully burned lime, roll scale or iron ore, and fluorspar is added to the stream of liquid metal entering the ladle from the converter or vessel. A slag is produced which removes and retains much of the phosphorus. The acid Bessemer slag must be held back in the vessel or converter and must not enter the ladle, which requires careful attention to the analysis of the pig iron and to the method of blowing so as to produce a lumpy, viscous vessel slag that can be easily held back. With existing Bessemer equipment one steel company has thus made over 400,000 tons. This steel is of the usual low-carbon grades, but changes in equipment should make possible other grades, comparable with many that are now made in the open-hearth process.

In line with the increased versatility of the process, attention is being paid to converter size and design. Capacity per heat could apparently be increased at least to 50 tons and perhaps more. Improvements in blowing equipment and vessel-handling machinery are also being considered.

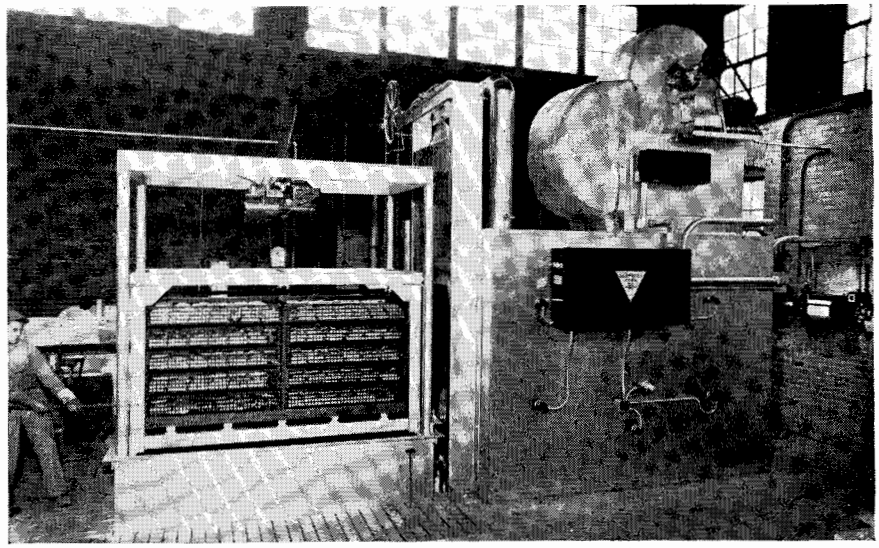
In 1939 about 3.5 million tons of Bessemer steel were made out of a total of about 53 million tons. This year 15 million out of a total of about 80 to 85 millions seems probable and another 10 million tons, compared with 2.25 million in 1939, will be blown in Bessemer converters for the tonnage possibilities and then transferred to open-hearth furnaces for finishing. Altogether a new picture is apparent in this revival of a spectacular old process.—*Industrial Bulletin* of Arthur D. Little, Inc.

FURNACES

Fans Give Uniform Operating Temperatures

FURNACE parts of stainless steel are helping many foundry-men to beat contract schedules for heat-treating jobs — particularly those that require close temperature control on a 24-hour-a-day operating basis. These stainless-steel parts generally include the convection fans, the interior linings, and the racks used in holding the loads. Examples of such furnaces are those made by the Despatch Oven Company, in a range of types that can be heated by gas, oil, or electricity.

One of our illustrations shows a Despatch furnace designed for handling aluminum castings, in which the interior temperature uniformity is held to within five



Withdrawing load from an aluminum heat-treating furnace

degrees, Fahrenheit, plus or minus, over an operating range which has 1000 degrees, Fahrenheit, as a maximum. This uniformity of temperature is accomplished by the use of oversized fan equipment which is mounted on the top of the furnace and circulates the air at a rate exceeding 20 miles per hour.

PLASTICS APPLICATIONS

A British Writer

Offers Suggestions

IT IS no exaggeration to say that engineers are now becoming favorably impressed with the claims of plastics for applications where formerly metal was used exclusively. It is realized that for highly specialized purposes where metals suffer from certain inherent defects, plastics can often be relied upon to give a better performance. The classic and most impressive example is the use of laminated bearings for steel rolling mills instead of those formerly made of phosphor bronze. Experience over several years has now convinced many mill managements that the plastic bearing, although initially more expensive, is, in the long run, more economical. Not only is the plastic material able in many cases to insure a superior mechanical performance, but the actual time and labor saved in the fabrication of plastic parts can be considerable. An instance of this is the use of cams shaped of laminated board instead of steel for automatic screw machines. These new-type cams are now being made in less than one-sixth the time taken for steel. A set of three cams from laminated sheet blanks can be produced by means of a bandsaw and sander or file in 30 minutes, whereas three to four hours are necessary if steel is used. Moreover, these plastic cams are good for runs of 100,000 pieces or more, depending on the type of piece and the pressure.

In a time of national emergency, such as the present, the time and skill saved in machining by the use of plastic material can be quite appreciable, and the economy thus practiced may be reflected in an increased production of vital metal goods. The fact cannot be too widely known that plastics do offer solutions to several problems, and their extended use for applications which have so far been ignored would undoubtedly release labor and material.

The greatest need at the moment is for machine tools. A consideration of some of these should, therefore, prove of interest. Take, for instance, a modern engine lathe. At first sight this solidly built piece of high-precision engineering may not appear to offer very much opportunity for plastics, and yet there are several small ways in which these new raw materials could be incorporated in the design without interfering in any way with its efficiency. The actual casing of the lathe is normally made up of metal castings, which, in the main, must be very sturdy, strong, and rigid. The author stresses the qualifying remark "in the main," because certain parts of the casing are not normally subject to strain, and could be usefully made of formed laminated sheet or molded from high shock-resistant plastics. The end door for feed gear train, for instance, might be made of this laminated material, and its use for this purpose would not only save metal, but also reduce the total weight of the machine. Another part of the lathe which is not under strain is the oil sump, which is also made of cast metal. A good shock-resisting phenolic resin, preferably one reinforced with flock, would serve the purpose admirably and be well able to stand up to vibration and service wear and tear. Yet another application is the casing for the push-button station for the electric motor. Plastics are really ideal for this purpose as, quite apart from their avowed purpose of protecting the electrical parts, they are able to afford a high degree of insulation and thus help to prevent earthing. Various levers and wheels could also be molded of high-impact plastics without any reduction in efficiency.

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WEIGHT SAVING—In the manufacture of 10,490-pound freight car underframes, welded construction saves 1020 pounds of steel over riveted construction.

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Another type of machine tool now in great demand is the milling machine. This also offers opportunities for plastics. Casings for the starting boxes for drive and feed motors would be better molded of phenol-formaldehyde resin than made of metal stampings or pressings. The plastic casing would afford maximum protection to the switch-gear and also insure full protection from shock for the operator. Many other parts could be molded of suitable plastic material; for instance, the tool shelf, hand wheels, levels, speed plates, and so on. Another possible application for plastics in machine-tool construction is for extruded tubing of synthetic resins and rubbers for the cutting oil discharge and return lines now made of heavily armored rubber. Vinyl resins, neoprene, Thiokol, and so on, are virtually unaffected by oil, alkali, and water, and the extruded tubing can, therefore, be relied upon to stand up to service conditions.

Acrylic resin, such as Perspex, also offers some promise for oil gages normally made of glass. The former would be more robust than glass and be even more transparent. A suggestion was made some time ago by an American lighting engineer that special methyl methacrylate lighting devices might be constructed for use on machine tools, which would possess the major advantages of even, non-glare, and shadowless light and cold lighting, as distinct from the usual heat-producing methods of illumination. This is an advantage, as the normal system of lighting can cause considerable discomfort to operators during summer weather or in badly ventilated workshops, especially during a black-out.

The above suggestions, although apparently only referring to two types of machine, can be applied generally to many other types such as bandsaws, pantographs, cup grinders, and so on. The point the author would like to stress is that plastics are available possessing good mechanical properties, which, although not as good as steel, are sufficient for non-stressed or only moderately stressed parts. Undoubtedly, for at least half a dozen minor applications a plastic material is available which is well qualified to give satisfaction. The question might well be asked: what advantages can be gained by this policy of substitution? These can, perhaps, be best summarized as follows: Saving in metal, which may be quite appreciable; saving in time and labor; lower shipping weight; self-insulation of electrical parts.—*Haydn K. Wood, in* Plastics *(London).*

INDUSTRIAL TRENDS

AIRCRAFT PRODUCTION TOMORROW

ANY attempt to trace industrial trends today must always be tempered by one unpredictable factor: the outcome of World War II. Also, every industry in the United States has felt the effect of national defense and of all-out aid to Britain and her allies. In some cases this effect has been relatively minor; in others it has changed the whole course of large industries and hence will have a definite bearing on future operations. In no case has the change been more spectacular than in the aircraft industry.

In any event, assuming always that the result of the war is such that free enterprise in one form or another still exists in at least a few countries of this troubled planet, aircraft manufacturers who are now rapidly expanding their production facilities can look forward to three general post-war markets for their products. First, in point of plant equipment and possibly even in dollar volume, will be military requirements for replacement in a continuance of adequate national defense. Second will be the demands of commercial transportation units for the expansion of passenger, express, and freight traffic that is bound to come. Third will be the private plane market, an outlet for planes that, slow as it has been in developing, is now showing signs of some day reaching proportions, for business and pleasure, somewhat comparable with that of the automobile market.

Just how large will be the demands for military planes after the war will depend mainly upon the unpredictable factor mentioned before. It is relatively safe to assume, however, that the lessons of the past will be applied to the future and that the United States will continue to pursue a policy of national defense as the best assurance of keeping out of trouble. In this event, basing a forecast on the assumption that our defenses will have been built to par before that so-far mythical period of "after the war," one of the jobs of the aircraft industry will be to keep our air forces supplied with replacements and with new types as they are developed and required. In this connection it is interesting to note that one naval authority has stated that, under routine peacetime maneuvers and operations, about 5 percent of all planes are put out of service annually through retirement and crackups. An Army Air Corps official estimates that the life of a pursuit plane is approximately two years and not over four. From these statements can be drawn a fairly adequate idea of military requirements of the future, using as a basis the highly publicized 50,000 planes that have been placed as our national defense goal.

The same factor of replacements that operates in the military aviation field also applies to commercial air transportation; because of the limitations that have been recently placed on the airlines, transport plane replacements immediately after the present emergency will undoubtedly put heavy, if temporary, demands on production facilities. Add to this the fact that air transportation for passengers and many express and freight items is rapidly gaining in popularity and the picture does not look too bad for the plane manufacturers. Although the Civil Aeronautics Board, at the moment, does not appear to favor the establishment of new airlines, it is probable that there will be considerable expansion of routes, although this expansion may be slow in coming; there is ample room for increased service.

On this page in our June, 1941, number, was discussed the matter of private planes, of which 6000 were produced during 1940. Today, according to the Civil Aeronautics Administration, there are about 100,000 private pilots in the United States, most of them the result of the government's pilot training program. The Army and Navy together expect to turn out some 20,000 to 40,000 pilots annually for the next few years. A large percentage of these fliers will undoubtedly be in the market for small, safe planes to be used for business and pleasure. If the development progresses as it should, and landing facilities in keeping with requirements are provided, the private-plane field should go a long way toward making aircraft manufacturers happy in the future.

So far nothing has been said about foreign markets, and purposely so. Whichever way the cat of war jumps, there will be keen competition between manufacturers in the United States and in Europe. What kind of economic warfare will result will depend on who wins the war, and this page is no place for unfounded guesses. While foreign markets will be an integral part of the post-war airplane manufacturing situation, it appears to be best for the moment to confine a consideration of trends to possibilities and probabilities within our own nation.

Come what may, the picture of aircraft production after the present emergency has passed seems to work out something like this: Highly expanded facilities will have to be curtailed somewhat to meet the requirements of the moment, yet it does not appear that the curtailment will by any means spell disaster. Markets there will be aplenty, although there will be ample and spirited competition in them all. The net result should be a healthy industry in which consolidations and combines, such as have characterized the coming-of-age of automobile manufacturing, will be in a position to take advantage of the experience gained under emergency production conditions to face any necessary readjustment with a minimum of difficulty and a maximum of continued operation.

GLASS TAKES ITS PART

THE fact that the glass industry requires no raw materials that are essential to national defense—as the phrase is applied to aluminum, steel, tin, chlorine, explosives, and so on—is enabling it to carry on an expansion program such as has never been seen before in its history. As a result of this lack of restraint on development work, research is being carried on apace in an effort to provide replacement items for those which have been curtailed in the name of Mars. Thus there is being produced a wide variety of glass containers for materials which heretofore were packaged in tin cans, and large quantities of metals are being released for military purposes. It can be depended upon that the industry will exert every effort to continue this trend toward increasing uses of glass.

—The Editors

Cataract

In Recent Research Medical Science is Hot on the Trail of the Causes of this Ill

BARCLAY MOON NEWMAN

CATARACT is loss of transparency of the crystalline lens of the eye brought about when almost insignificant pinpoints of milky white appear here and there in it. If the tiny areas of opacity spread, varying degrees of cataract result. Sometimes complete blindness is the final stage.

The precise nature of the change in the living tissue of the eye lens is unknown. Most ophthalmologists believe that the proteins are coagulated—with a loss of transparency similar to the phenomenon taking place when egg white is heated. Glass blowers are continually exposed to the infra-red, or heat, waves from their flames, and they develop one type of cataract, presumably caused by the coagulating effect of infra-red rays on the albumin and other proteins of the lens.

Interest in cataract has increased greatly, not alone because of the increasing proportion today of the elderly in our population, among whom there is always a certain incidence of so-called senile cataract (the most common form of cataract), but also because of new and important discoveries on experimental cataract — that is, cataract deliberately produced in laboratory animals by a diversity of methods, chiefly chemical, in the hope of solving the mystery of cataract in human beings. This rising interest has led to more careful examination and study of the lens of the eye in persons past 50 years of age, and ophthalmologists now tell us that they are surprised to note how many "opacities"—pinpoints and small spots of opaqueness—are to be found in our eyes. Most of these almost insignificant opacities appear not to spread, or to spread very slowly. Yet, in an important percentage of cases, the development of the mysterious chemical change goes on apace so that sometimes vision is seriously impaired after a very few years.

The new discoveries are noteworthy and inspiring; since, where knowledge of cataracts in general is being gained, important facts about the special types that occur in human beings must follow, and where underlying causes are discovered, treatments and cures usually can be devised.

Some practical applications of the findings already have been made. A chemical, dinitrophenol, once unwisely promoted for weight

A normal rat fed galactose . . . .

reducing, has been shown to cause cataracts in animals—and this experiment clearly explains the strange development of cataracts in some persons after taking that chemical. Of course, you now cannot buy this chemical—even hidden, as formerly, in a "reducing medicine"—though as recently as a year or so ago you could.

Dr. Paul L. Day has reported the development of cataract in mice, rats, chicks, and monkeys whose diet does not have enough riboflavin, one of the vitamins (previously known as B_2 as well as G). Recent confirmation of this investigation has taught that, in all probability, human lens tissue is healthy only if a certain minimum of riboflavin is eaten. You get riboflavin in any balanced diet—milk, eggs, liver, contain more than enough. The medical application here is now limited—and merely extends to making sure that the undernourished patient eats enough protective food factors. It is not known whether or not certain cases of *senile* cataract could be prevented from developing further by supplying riboflavin in quantity; *senile* cataract is definitely not the outcome of vitamin deficiency, though the eye, as we are all aware, suffers directly or indirectly whenever any portion of the human chemical mechanism is deranged, as by faulty diet. Nevertheless, with regard to another vitamin, ascorbic acid (vitamin C), it has repeatedly been reported by investigators that in dinitrophenol cataract, and even in senile cataract, a quick and favorable response follows large doses of this vitamin. Satisfactory confirmation, however, for these encouraging reports has as yet not been forthcoming.

RABBITS and rats given naphthalene develop cataract with startling rapidity — within a few days. This information is of value to industrial medicine which has the duty of protecting workers who annually handle 100,000,000 pounds of naphthalene and who under certain circumstances may be exposed to unusual concentrations of vapor from this raw material derived from the coal tar industry. (Here, however, it must be emphasized that mothballs, though they are made of naphthalene, are in no way dangerous in the home —that is, unless we should settle down to a steady diet of them!)

Cataract can also be produced experimentally by removal of the parathyroids, the tiny glands in intimate contact with the thyroid at the base of the neck. The parathyroids are vital regulators of the use of calcium. Calcium deposits in the lens of the eye are characteristic of senile cataract, and abnormally increased concentration of calcium there is generally found in any type of cataract. Hence, one theory is that in cases of cataract the parathyroids have long been acting abnormally. Evidence in support of this theory is turned up in cases of under-activity of the parathyroids, of over-activity, and of surgical removal (as for tumor) of these glands—in human beings.

Still, there is nothing definite along this line except a new lead and new inspiration for additional research.

Removal of the pancreas, which produces insulin as well as digestive juices, renders the animal used in experimental research diabetic. Diabetics often suffer cataract. Because insulin is an indispensable agent in holding sugar to normal concentrations in the blood, one theory is that diabetics develop cataract because of long-continued high concentrations of blood sugar. Another theory is that the bodily use of fatty substances is primarily disturbed—fat use being connected with sugar use. Further, in diabetic and senile cataract, fatty deposits are found. But some authorities think that the fatty deposits in the lens can occur only after injury to the eye tissues caused by exposure to high blood sugar concentrations.

Along this avenue there appears to have been definite advance, brought about largely through the work of Dr. Helen Swift Mitchell, research professor in nutrition at the Massachusetts State College.

Dr. Mitchell has discovered the strange phenomenon of "carbohydrate cataract." By simple feeding methods she has been able to bring sugars to a high concentration in the blood of rats, and when this very high level of sugar is maintained through several weeks, within this brief time all stages of senile cataract of the human type, as well as human diabetic cataract, seem to run a hasty course. Here is a neat and conveniently swift reproduction of cataractous changes, many, if not all, of which are to be found in degenerating human eyes —though, of course, the *start* of human cataract must, as we have seen, in different instances have different causes than mere high concentration of blood sugar and sugar in the lens tissue.

ONCE the start has been made, cataractous changes of different types apparently follow much the same course. To think of senile cataract as the result of high blood sugar is to confuse the first or basic cause with the way in which a lens can degenerate. For illustration, there may be many causes of falls from a dangerous cliff, yet the course and the end result do not differ in different cases. Detailed knowledge of the probable phases of development of human cataract is being accumulated.

Unlike human beings, rats are not adapted by evolution to the assimilation of large quantities of the simple sugar known as galactose, a close relative of dextrose, which can be derived from milk sugar. Hence rats, as Dr. Mitchell was the first to discover, when fed diets containing a large proportion of galactose run a very high blood sugar content, and cataracts are the most striking outcome of the experiment. It was at first thought that the particular sugar, galactose, was the specific cause of the cataract, and some persons, knowing that human milk contains, in terms

. . . . **soon develops cataracts**

of dry weight, 50 to 55 percent of milk sugar, began in alarm to speculate: "Is it safe for babies to have mother's milk?" But cooler heads pointed out that babies are not rats, and are by natural evolution adapted to and require large quantities of milk sugar, more than any other species; that diabetics develop dextrose cataract through upset of carbohydrate metabolism; that rats can be given dextrose cataract by removal of the insulin-manufacturing pancreas, and that probably any sugar appropriately administered (as by repeated hypodermic injection) can be used to induce cataractous changes.

Sure enough, Drs. William J. Darby and Paul L. Day, of the University of Arkansas School of Medicine, have been able to use another simple sugar, xylose or "wood sugar," in causing high blood sugar concentrations and, afterward, cataract in rats. Now it is universally recognized that milk sugar and galactose have nothing to do with human cataracts, whereas disturbance of dextrose use in the diabetic has direct bearing on changes in the eye. Since it is impossible to devise a life-giving diet without the use of dextrose and galactose (or a dextrose-and-galactose-producing carbohydrate, such as starch or milk sugar), the excitement about the danger of feeding mother's milk to babies has subsided; milk sugar produces, during digestion, both glucose (dextrose) and galactose. Further, baby needs galactose for the development of major components of brain and nerve tissue, as well as for the production of vital molecules in every part of the body.

Research on the changes taking place in carbohydrate cataract in rats continues. One important finding is that in this type of cataract, too, there is a greatly increased quantity of calcium in the eye lens, and efforts are being made to determine the way in which this mineral element becomes thus concentrated in eye tissue though not in the blood of the same animal. Hence, studies on the permeability of the membranes of the lens to calcium passage in and out are under way. If means of preventing or even of reversing the migration of calcium can be devised, a major step in the treatment of senile cataract will be at hand.

Meanwhile, we already have an inspiring conclusion derived by a distinguished ophthalmologist, Dr. Arthur Yudkin, of New Haven, from his recent experience in applying the newer knowledge of nutrition to the treatment of many patients suffering eye degenerations through deficiency of vitamins A, C, and B complex: "There is little doubt that many elderly patients could be restored to an active, healthy, happy existence by giving attention to their diet." Eye changes, but not cataract, result from deficiencies of these vitamins; yet, where so much gain has been made in a few years, far more important advances, extending even to cataract, are to be logically expected. And as Dr. Yudkin reminds us, the eye is the most sensitive register of bodily health. Cataract can be but a symptom of deeper ill. When cataract is treated successfully, we can be sure that more serious disorders are being alleviated. Thus experimental cataracts have great import.

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PROSTATE

Treatment Gives Hope For Sufferers From Cancer of Prostate

LIVES of thousands of men suffering from cancer may be saved by a new sex hormone treatment announced by Dr. Charles Huggins,

Dr. George Gomori, Dr. C. V. Hodges and Dr. W. W. Scott, of the University of Chicago.

The treatment brought spectacular benefit in 80 percent of cases of cancer of the prostate gland, which is one of the commonest and most hopeless types. The treatment is not a "cure," Dr. Huggins said, because it does not kill the cancer cells, but it stops the malignant activity of the cancer cells in the prostate gland and of those that have spread from there into the bones, and shrinks the size of the cancers. The 21 patients reported on were beyond hope of benefit from operation to remove the cancer when the new treatment was started two years ago, as are most patients with this type of cancer when first seen by physicians. Today, 17 of the 21 are alive, although they would ordinarily have been expected to live only half this long even with the aid of radium or X-ray treatments. Of the four who died, only one died of cancer, the others dying of apoplexy or heart disease.

The successfully treated patients have gained from 40 to 80 pounds each, their red blood cells have increased from an anemic 2,000,000 to a healthy 5,000,000, they are free of the pain which was so severe as to require constant morphine, they have hearty appetites, demanding "seconds" at every meal, instead of the cancer patient's typically poor appetite, and they have been able to get out of bed and go back to work.—*Science Service.*

RIDICULOUS?

Grandma Was Partly Right— She Didn't Know Why

SOME of the old therapeutic customs that seemed ridiculous in the dawn of this scientific age have since been found to have basis in sound fact, *The Industrial Bulletin* of Arthur D. Little, Inc., states. The feeding of ashes of burned sponges to persons suffering from goiter is now recognized as effective, if a bit crude, because of the high content of iodine in the ash. The Chinese use of the skin of the head of a toad for staunching wounds seemed most revolting until a considerable content of adrenalin was demonstrated therein. Another old custom, the taking of sulfur and molasses as a spring tonic, now appears to have similar scientific justification. While the usefulness of the sulfur part of the combination remains to be proved, the molasses part has been found to provide dietary supplements needed particularly after the depletions of the winter.

Molasses has been found to be a rich source of iron and calcium, the minerals most commonly lacking in the American diet, and also of several vitamins of the B complex, which are associated in nature with plant carbohydrates. Unlike a number of other foods having a relatively high iron content, molasses has its iron mostly in a form readily assimilable by the human body.

Refined white sugar is a pure carbohydrate, more devoid of minerals and vitamins than any other food we eat, even more than white flour, which is currently attracting so much attention directed to enrichment with food factors lost in processing. Sugar forms more than two-thirds as large a part of the American diet as does flour. Since molasses is essentially a concentrate of the portions of the sugar cane juice lost in refining, its dietary value in foods and feed can be readily understood.

SWIMMERS

Anatomical Trick Useful in Protecting Sinuses

THE TRICK of closing one's nostrils when diving into the water is not a completely lost human accomplishment, despite medical opinion, reports *Science Service.*

One of the leading physicists of the National Bureau of Standards, Dr. L. B. Tuckerman, has made known that in childhood he had recaptured this ability supposedly lost in the evolutionary process.

"Some of the boys who went swimming together when I was young heard about how hard it is to wiggle one's ears and make the muscle, *compressor narium,* close the nostrils," Dr. Tuckerman expained. "So we practiced faithfully until several of us could do both.

"I can still do both. When I dive today I always close my nostrils."

Doctors advise that water be kept out of the nose, ears, and sinuses, particularly if the swimmer has had sinus or ear trouble. Diving or underwater swimming forces water into these parts of the human anatomy, unless they are protected. Infections may thus be spread. Use of a nose clip is recommended for those who cannot close their nostrils naturally.

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ACCIDENTS: More persons between the ages of three and twenty-four years die as a result of accidents than as the result of any disease.

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SUPERSONICS

Antigens Extracted from Germs With Ultrasonic Waves

SQUEEZING and shaking substances valuable in medicine out of cultures of disease germs by means of intense sound waves is the biological feat that has been accomplished by two University of Pennsylvania scientists, Dr. Leslie A. Chambers and Dr. Earl W. Flosdorf, reports *Science Service.*

The substances they obtain belong to the class of antigens — poisons secreted within the germs' bodies. Injected into the human body in suitably small quantities, they may be used in provoking the formation, by our own tissues, of opposing antibodies, which defeat the germs, if they attack later on. Or the antigens may be injected into the bodies of animals, from which blood is later withdrawn for making serums.

Present methods of obtaining antigens involve heating, addition of chemicals, or other treatments that injure or destroy certain of the more sensitively composed antigens. This is what the new method of Drs. Chambers and Flosdorf is designed to avoid. Its treatment of the germs is strictly physical or mechanical, and it can be conducted at a low temperature.

The foundation of their apparatus is a magnetized metal tube, usually made of nickel, which is caused to vibrate extremely rapidly by an alternating electrical current flowing through coils surrounding it. The sound waves thus set up may be exceedingly shrill, or even in the ultrasonic range.

Over the upper end of the metal tube a glass tube is fitted, with a leak-tight rubber joint. Into the chamber thus formed is poured a culture fluid containing billions of germs. Then the current is turned on and the vibrations started.

Whence Came Oil?

Most Geologists Now Hold that Petroleum Was Derived from Plants and Animals

RANDALL WRIGHT
Petroleum Geologist

THE problem of the origin of oil is one of the most intriguing mysteries of science. Theories which have been offered to solve this question are as varied as they are curious and interesting.

Gasoline that drives your car as well as bomb-dropping airplanes is obtained from crude oil that comes up from the Earth's subsurface, through wells drilled to subterranean reservoirs. The working oil geologist is, of course, concerned mainly with the purely practical problem of finding where these reservoirs are now. Naturally, however, he also wonders how the oil was originally formed. If you ask him he usually will say, "We do not know," chiefly because as a scientist he is conservative and prefers to play safe. But he has some pretty good ideas about the various theories of the origin of petroleum, which he may discuss with you if you catch him at the right moment.

There is, for example, a theory that might, if you will permit the word, be called "atavistic" — the theory that petroleum was made at the time the Earth itself was formed. If the Earth was born out of the Sun, then it should be elementally similar to its parent—which it is. The chemical elements contained in oil exist in the Sun; the spectroscope has shown us that carbon and hydrogen are there. Also, a spectroscope at The Mount Wilson Observatory recently revealed that "heavenly hydrocarbons" — substances which are either oil or closely akin to it—do exist in the Sun's atmosphere. Then, too, we know that some of the meteorites which fall to earth contain asphalt, as though they had been in contact with oil some time in their past. If the Earth were formed of fragments which came out of the Sun, as most geologists agree actually happened, why is it not logical to suppose that oil might have arrived on earth ready-made?

This idea is intriguing, but it does not fit the facts that geologists have uncovered. For, if this scheme were true, oil could be found almost anywhere on Earth; whereas it is found in large quantities only in certain kind of rocks in certain special areas. These are the stratified rocks, and rocks of this type were formed, not mere periods but long eras after the Earth was born. The primordial earth-stuff was disintegrated by frost action and kindred processes into sand grains and mud particles, which then were carried by ancient rivers to the seas, there to be deposited and in time to become consolidated to make the sedimentary strata. In many of these sedimentary rocks there is no oil whatsoever, and thus it appears that we must abandon this imaginative theory as inapplicable to the conditions imposed by observation.

Courtesy Wallace E. Pratt, The Humble Oil and Refining Co.

Foraminifera, microscopic shells of marine growth, are frequently associated with petroleum deposits

At least as picturesque as the preceding hypothesis is the idea that oil was born in volcanoes. There is some striking evidence to support such a postulation. The lavas of Etna and Vesuvius contain oily substances. Further, the quicksilver ores of California, which are volcanic, contain a wax, Napalite, which might have been derived from petroleum. Also, oil in valuable amounts actually comes out of wells drilled in igneous, formerly molten, rocks in Mexico, Texas, California, and some other places.

THIS theory has had some ardent and capable supporters. For example, Mendeleëf, Russian chemist and author of the classification of chemical elements, was among the first to suggest that oil was formed in the processes of vulcanism.

Now these processes that occur deep within the Earth are complicated and manifold. Chiefly they involve tremendous heat and pressure, and it is true that under these conditions new substances form. Among these substances very probably are combinations of carbon with metals, such, for example, as the compound, calcium carbide, that, when touched by water, evolves acetylene gas for bicycle lamps or the primitive headlights of the horseless carriage days. Similarly, as the hot magma of a volcano works its way from the depths toward the surface of the Earth, carrying carbides, water may come in contact with it, evolving a hydrocarbon gas. In the laboratory such a gas has been synthesized into oil. Almost identical conditions arise in the volcanic environment. And, indeed, the petroleum-like substances found in the lavas and in the quicksilver ores very possibly were formed in this way.

So plausible is this theory that it carried much weight with the geologists of a couple of generations ago. They, however, lacked much of the information now available. As we now know, oil is found almost exclusively in sedimentary rocks. Those exceptions where oil in quantity is found in igneous

Courtesy Dr. Austin H. Clark, Smithsonian Institution

Conodonts, usually considered as the teeth of minute fossil fish; from black, oil-bearing shales of Carboniferous Period

rocks serve to prove the rule, since the oil in them has migrated from adjoining rocks which are sedimentary and contain oil. Further, the important oil fields are mostly distant from volcanoes. Conversely, in areas where there are only igneous rocks, no oil is found. Volcanoes may have made some oil, perhaps enough to form asphalt specimens as shown in the museums, but not much more.

The theory which is today believed to come close to the truth is that oil probably was formed in the strata deposited on the ancient sea bottoms. This idea is not so meteoric or so fiery as either of those sketched above, yet it contains more interest since it appears to involve life itself. This life is of the sort described in Beebe's "The Arcturus Adventure." Trawls were dropped from the ship to various depths and, when these nets were pulled back up to the ship, they were filled almost to bursting with living matter—microscopic plants and animals.

This same profusion of life existed in geologic eras gone by. For example, the tiny silica skeletons of the diatoms made deposits hundreds of feet thick, over thousands of square miles, in areas that now have been uplifted from the sea in Washington, California, Virginia, and some other places. If we can visualize such an enormous deposit of organic matter on the ancient sea bottom, we may be coming to understand the source of petroleum. In many places these layers of organic matter were covered with thousands of feet of sand and mud before the processes of decay could begin.

Some practical considerations strongly suggest that this idea is correct. For example, in areas from California to Russia these ancient events can be deciphered in the rocks. Moreover, the lack of oil in certain European countries has led to the mining of these organic rocks, or "oil shales," as in Scotland. These shales are slightly heated and compressed and the oil extracted.

This artificial extraction of petroleum from oil shale suggests that man is simulating Nature's laboratory. When the mountain-making movements of the Earth occur, the rocks are squeezed and probably gently heated. Then, or thereafter, it seems probable that some of the organic matter of the shale, for convenience called "carbo-gen," turns into oil and flows or migrates into the nearest porous formation, usually a sandstone. And, indeed, it is in sandstones situated close to oil shales that petroleum is most often found by drilling.

The immense quantity of tiny living matter known to exist today in the ocean is in line with the immense volume of petroleum already found. Moreover, this theory puts the milieu of formation of the oil close to that where it is now found by the drill. Also, these processes of pressing and gently heating the rocks were consistent through long stretches of geologic time, rather than evanescent like volcanoes, or primordial and cataclysmic like the birth of the Earth. Likewise, the nature of this theory suggests that much oil remains to be found.

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PETROSNOOPING

Vegetable Ashes May Help To Locate New Oil Fields

BURNING vegetables to find oil is the newest exploration wrinkle advanced by petroleum scientists. The hypothesis, yet to be adequately proved, is based on the fact that certain plants tend to concentrate particular basic chemical elements in their tissues, when traces of these elements exist in the soil. If certain elements can be proved present in a specific underground geologic formation at one oil field, and if analysis of plant ashes in another location shows the same elements, chances are that the same geologic formation is buried under the spot where the plants grow.

Oil men for some years have been following particular geologic formations, that proved productive in one part of the country, for hundreds of miles in the hope that the formation that hid an oil sand in Texas, for example, will also have oil sands in Mississippi. Core drilling and micro-paleontology, relatively expensive, have been used in this type of oil exploration. Now plant-ash analysis may be a useful new tool for the same quest.

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BECOMING COMMONPLACE: There are now in operation throughout the world some 35 cyclotrons of varying sizes.

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GOLD

Its Recovery from Sea Water Advances

COMMERCIAL recovery of gold from seawater by electro-deposition has been brought one step nearer with the announcement by Prof. Colin G. Fink, of Columbia University, of a discovery which promises to make the electrochemical process more efficient. The discovery, which clarifies a hitherto baffling aspect of electrolysis, also provides a key to the electroplating of metals such as titanium and vanadium and should have far reaching commercial significance.

The ocean's gold content has been estimated at $25,000,000 per cubic mile, although gold is present in but a few parts per billion. While the metal has been extracted from seawater experimentally by an electrochemical method, the cost at best is five times the value of the gold recovered.

Usually in trying to electrodeposit gold from seawater, the metal precipitated out rapidly and failed to collect in crystalline form at the cathode—negative—electric terminal. This difficulty was overcome by substituting a high-speed rotating cathode for the stationary cathode. Then a distinctly visible deposit of gold was recovered on the cathode. But the cost of providing high-speed rotating cathodes makes the method commercially unfeasible.

Dr. Fink sought the reason for the disappearance of the gold when a stationary cathode was employed, and discovered for the first time that when gold passes out of or into solution two distinct steps are involved. Invisible gold in solution first goes into myriads

of infinitely small particles of colloidal gold, and only later into crystalline gold. The stationary cathode method failed to extract gold from seawater because the metal precipitated out in colloidal form and dropped away before becoming crystallized.

With the process understood, the remaining problem is to develop an inexpensive means of transforming the colloidal gold to crystalline form.

MUTATIONS

Atomic Particles Produce Hereditary Changes

STREAMS of neutrons, uncharged fragments of atoms smashed in the University of California cyclotron, have produced hereditary changes in living organisms, in experiments performed by Dr. Everett Ross Dempster.

As experimental material, Dr. Dempster used the familiar fruit fly, classic "guinea pig" of genetic research. He exposed male insects to the neutron stream, then mated them with untreated females and watched their offspring for mutations, or abrupt evolutionary changes. He found that neutrons are more effective than X-rays in producing certain types of mutations, less effective in producing others. —*Science Service.*

OUTDOORS INDOORS

Simulated Showers and Controlled Lightning Bolts

A LABORATORY that will bring the stormy outdoors indoors for study of the effects of rain and lightning on electrical equipment will be installed in Northwestern University's new $5,000,000 Technological Institute on the shore of Lake Michigan, it was recently announced.

Amid simulated showers, machine-made lighting will lash out in controlled bolts in the waterproofed laboratory to test the strength and lightning defenses of transformers and other apparatus that provide today's industry and homes with electric power.

The lightning-making equipment—a 1,500,000-volt surge generator and a 500,000 volt-ampere, 60-cycle, high voltage test set—will be built and installed by the Westinghouse Electric & Manufacturing Company. Westinghouse engineers collaborated with the Northwestern Technological Institute, headed by Dean O. W. Eshbach, in planning the laboratory. These high voltage installations will help make the engineering school at the Evanston, Illinois, university one of the best equipped in the United States.

The lightning laboratory will be used in the instruction of Northwestern students, for insulation research and commercial testing. It will be equipped to test insulation strength, transformers, insulators, circuit breakers, and other electrical apparatus. Only the section especially designed for the synthetic rain tests will be waterproofed.

Doors that will act as safety switches are among the elaborate protective devices to be installed in the laboratory for the safety of students or others who might enter the high voltage room. The doors will be so interlocked with the equipment that, should a person accidentally open one and wander into the room, the high voltage circuits would be immediately opened and rendered harmless.

Northwestern later will install a "power follow" transformer for testing lightning arresters under service conditions, and the university plans eventually to add a high-current surge generator to reproduce "hot" lightning — artificially made thunderbolts that have the burning current of natural lightning. Some artifically created thunderbolts lack this firing force, which causes natural lightning to ignite barns and other unprotected wooden structures.

VIABLE

Some Seeds Germinate After Sixty Years

SIXTY years is the survival time for seeds of curly dock, evening primrose, smooth mullein, and night-flowering catchfly in one of botany's classic experiments, reported by Prof. H. T. Darlington of Michigan State College, in the *American Journal of Botany.*

Sixty years ago a former professor of botany at the college, Dr. J. W. Beal, buried 20 pint bottles, each containing 1000 assorted weed seeds mixed in sand. The idea was to dig up one bottle every five years and find out how many seeds were still viable, and what species they represented.

This five-year schedule was kept up until 20 years ago, when it was decided to make the experiment last longer by digging up the bottles at ten-year intervals. Prof. Darlington has been carrying on the project since 1915.

Of the 20 species originally put away, only four germinated in this latest test. Even these four do not represent a perfectly smooth score, for it was thought that the mullein seeds originally put into the bottles were all of the ordinary woolly species. But the smooth mullein is what came up this time, and also ten years ago, though it had not appeared in any of the earlier plantings.

Two species that survived up to the fiftieth year, black mustard and water smartweed, failed to germinate this time. Species that lasted 40 years but were missing at the half-century mark included pigweed, ragweed, peppercress, plantain, and purslane.

There are still 11 bottles buried in the soil of the State College campus.—*Science Service.*

GAS POISONING

Unexplained Effect of X-rays on Carbon Monoxide

X-RAYS saved the lives of animals nearly dead from carbon monoxide poisoning, in experiments reported by Dr. John A. Cameron, of the University of Missouri.

Rats and monkeys were used in pairs. Each pair was exposed to carbon monoxide until near the death point. Then one of the animals was given a heavy dose of X rays on the underside of its body; the other was left untreated, as a control.

"In about half the cases the X-rayed animal was active and alert after about five minutes; the control dead," Dr. Cameron stated. "In the remaining trials the recovery time of the X-rayed animal was reduced to two thirds that of the control; often to one half or less."

Spectrographs of the blood of the animals showed that the carbon monoxide content was actually reduced after X ray treatment. How this was brought about, Dr. Cameron is not yet prepared to state.—*Science Service.*

Star Stuff

Finding Out With the Spectroscope What the Sun and the Other Stars are Made of

HENRY NORRIS RUSSELL, Ph.D.

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

THERE was a time when it was supposed to be beyond human power to find out what the Sun and stars were made of. We all know how the "hopeless" problem was suddenly solved by the discovery that each element present in the Sun's atmosphere absorbs its own characteristic spectral lines, which can be matched in the laboratory. The qualitative analysis of the Sun—or at least of its atmosphere—then became simple; quantitative analysis, as in the laboratory, is more difficult.

There are three steps in the process—to measure the strength of each line; to find out how many atoms are at work producing it; and to find the whole number of atoms of each element.

The first step—the measurement of the amount of light cut out of the spectrum by a line—has been made for hundreds of lines by several observers, while Minnaert's Atlas contains easily available material for thousands. If we could perform the second, and find how many atoms were at work in producing a line of given light-loss or "equivalent width," we might get around the third—provided that we could observe the whole spectrum from the extreme infra-red to the remote ultra-violet, by simply adding the numbers of atoms producing each line of a given element. Only a rather small part of this spectral range is available; and allowance for the unobservable lines is a problem.

Coming back to the second step, we may note that no answer would be possible if the atoms at work on a given line played exactly the same note—in other words absorbed and gave out light of *exactly* the same frequency. If they did, any number of them would produce a spectral line, perfectly black, but infinitesimally narrow, which even the most powerful spectroscopes could not reveal. It is because the atoms are more or less out of tune, so to speak, that some of them absorb in different places in the spectrum from others, and give rise to a line of finite and observable width.

There are two things that put them out of tune. First, the atoms in the heated gas are in motion, and the lines of those which are approaching us are shifted toward the violet, and vice versa, by the Doppler effect. Second, no atom can keep an absolutely exact pitch. Even isolated atoms, undisturbed by others, will run a little off—some one way, some the other—and if other atoms collide with them while they are performing, they get more out of tune.

When the laborious calculations are made, it is found that when few atoms are present in the absorbing layer, the first (Doppler) process predominates, and the equivalent width is proportional to the number of atoms at work. This is represented by the steeply inclined dashed line in the illustration. If this effect alone was at work, the width would soon increase more slowly, and this curve become almost flat, as illustrated by the dashed line at the right.

THE natural imperfection of tuning gets its work in later, and causes the curve to rise again, but more slowly (the width now being proportional to the square root of the number of active atoms). When the atoms are uninfluenced by collisions, we get a curve like *A* or *B* (depending on the temperature and so on). With increasing numbers of collisions, this process becomes more important, and curves like *C* or *D* result.

We do not know in advance how much the atoms in the Sun's atmosphere are disturbed by collisions, and so cannot calculate in advance the shape of the curve of growth for solar lines. But if we can find in any way the relative numbers of atoms which are at work on different lines (whose widths we can measure), we can plot the curve from observation.

In complicated spectra, such as that of iron, there are numbers of lines which are known to be absorbed by atoms in the same state (or in closely related states). The relative numbers of the atoms in such a state that are at work on one or another of its lines can be calculated by theory, or be observed by laboratory measures of the brightness of emission lines. Such measures demand great care to escape a number of instrumental difficulties. A good start has already been made for iron and titanium, but years of work remain before we know what we would like to know, and, with sufficient pains, can find out. The present theory is satisfactory for simple spectra indicating, for example, that just twice as many calcium atoms are at work on the K line as on its companion H, or on one of the two sodium lines compared with the other. But, for intricate spectra, an accurate theory would have to take account of many complications, and is not yet fully worked out. Average results for a large number of lines should give fairly trustworthy values.

AN INTERESTING determination of this curve, based on certain groups (multiplets) of iron lines, and made by ten Bruggencate and Houtgast, at Potsdam, is reported in a German astronomical journal, a few copies of which have reached this country. Observations at the Sun's center, and close to the limb, agree in showing that the curves run steeply, a little above *D* in the drawing. For iron atoms at the Sun's temperature, and undisturbed by collisions, the curve would run about midway between *B* and *C*. It follows that the atoms in the Sun's atmosphere must be very considerably disturbed by collisions with others. We shall return to this; but let us first follow out the main problem of our quantitative analysis.

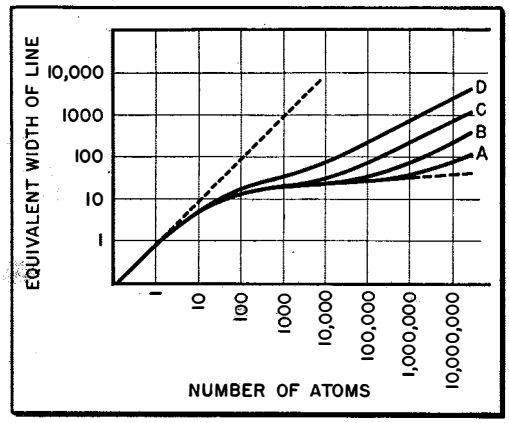
When a good curve of growth has been found, we can use it to determine how many atoms of a given element are at work in forming a particular line. The Doppler effect depends on the weight of the atoms and the temperature of the gas; but this can be allowed for. Collision,

in equal numbers, may have more influence on some atoms than on others, but this is a problem for the future. We can in any case get good values except for the strongest lines.

Problem number two is thus well advanced toward a solution. Suppose that it was fully cleared up, and that we could turn our lists of equivalent widths of lines into tables of numbers of atoms at work on each. We must now define more closely what we mean by "atoms at work." As we pointed out last month, the light which we receive from any given part of the Sun's disk is an average of contributions from different depths. Just as for the color or intensity of the light, there will be a certain average depth such that the number of atoms above it will account for the observed widths of the spectral lines. This depth may not be exactly the same for lines of different elements, and might be quite different for different regions of the spectrum, such as the red and ultra-violet. However, the observed change in color of the Sun's disk toward the edge shows that this effective depth does not change greatly, and so we need not worry much about this at present. More trouble arises from the fact that, in the ultra-violet, where the lines are strongest, they overlap one another so badly that it is difficult to interpret the complex mess.

PASSING over this also, let us take our list of "active atoms" and proceed to add up all those of each element. For some, such as sodium and calcium, all the strongest lines are in the observable region, and our census of atoms should be nearly complete and give a good estimate of the actual population. We will get, of course, only the neutral atoms; the ionized atoms have entirely different spectra, which must be handled separately. For ionized sodium, all the lines are out of reach in the ultra-violet; but for calcium and for several other metals, we can get a good census for the ionized atoms, too. This enables us to calculate the degree to which other elements, also, must be ionized, and so allow for the ionized sodium atoms (which are more than a thousand times more numerous than the neutral atoms). Thus we extend our census, till we get pretty reliable counts for all the elements which have their strongest lines where we can get at them.

But some of the most interesting elements—carbon, nitrogen, and oxygen, for example—have only weak lines in the observable regions; that is, lines absorbed only by excited atoms which have been loaded up with a large amount of energy. We can find the numbers of these excited atoms pretty well. But the fraction of all the atoms in the excited state depends on the temperature of the gas, and the influence of the radiation which passes through it. These influences may be determined by comparing the number of atoms of iron, for example, in excited and unexcited states, which have already been found; but the extension of the calculation to the very highly excited states causes some uncertainty.



The curve of growth (see text)

The hardest thing of all to measure is the amount of hydrogen. The hydrogen lines are exceedingly strong, though they are absorbed by very highly excited atoms; and there can be no doubt that hydrogen is very abundant. But the hydrogen lines are peculiarly sensitive to all sorts of broadening influences—for example, to the electric fields of neighboring charged particles in the gas—and the amount of these influences cannot yet be accurately calculated.

The presence of large amounts of hydrogen has, however, various effects upon other features of the spectrum, from which its abundance can be estimated. For example, the hydrogen atoms in the Sun are practically all neutral and contribute none of the electrons which are responsible for the general opacity of the atmosphere. At higher temperatures, as the hydrogen atoms lose electrons, the atmosphere becomes very much more hazy. The depth in it from which the light gets out to us is greatly decreased, and the enhanced lines of the metals—which would otherwise be little affected by the rise in temperature—are greatly weakened. To produce so great an effect, the number of hydrogen atoms must be something like 1000 times that for all the metals together. In the cooler stars, compounds of hydrogen with metals, though rather easy to dissociate, show strongly in the spectra—another proof of the great abundance of hydrogen.

A THIRD independent proof has just been provided. If the collisions which put the metallic atoms "out of tune" were with other similar atoms, there would be enough metal atoms to produce lines very much stronger than are observed.

Calculations by ten Bruggencate and Houtgast show that collisions with hydrogen atoms would produce just the observed effects, both at the Sun's center, where we see deep, and at the edge, where we observe only the outer layers, provided that the number of hydrogen atoms was 6000 times that of all the metals together. The older estimates were inevitably of no great numerical accuracy, and the later value is to be preferred.

Oxygen, nitrogen, and carbon would, in this calculation, be lumped with the hydrogen; but their lines are so much fainter that there can be no doubt that the Sun's outer layers are composed almost entirely of hydrogen, with what the chemist would call "traces" of other substances. There may be quite a bit of helium, but we have no way of estimating its amount in the Sun, for it produces no absorption lines, and the brightness of its emission lines (in the chromosphere) depends upon processes not yet amenable to numerical calculation.

For the hot star, Tau Scorpii, Unsöld has recently, by somewhat similar methods, found the composition (by numbers of atoms) hydrogen 10,000, helium 2000, carbon 1, nitrogen 3, oxygen 8, neon 3, while all the metals together add up about 1.

The relative abundance of the various metals appears to be decidedly similar in different stars, and much the same as on the Earth. but this story should wait until the results of new calculations—recently reported orally at Harvard—have been published.—*Jamestown, R. I., July 26, 1941.*

Curbing the Connecticut

Control Measures Linked with Power Development, Water Conservation, and Recreation

FLOOD-CONTROL work now in progress on the Connecticut River is typical in most respects of similar work now in progress at many points throughout this country. For that reason the Connecticut River system has been chosen as illustrative of the manner in which the flood-control programs for our major river systems are being carried out.

Construction of ten reservoirs to reduce flood damage in the Connecticut River Valley was authorized in the Flood Control Act of 1936. No actual construction was begun in 1936 because Congress, after having authorized expenditure of $10,028,900 on the ten reservoirs, did not appropriate money for that purpose. Studies, however, were continued actively by the Army Engineers, so that by the time Congress came to draft the Flood Control Act of 1938 it had before it a tentative plan for comprehensive flood control on the Connecticut River. The plan called for the construction of 20 reservoirs and seven levee and flood wall projects.

The comprehensive flood-control plan is now being reviewed by the District Engineer, U. S. Engineer Department, at Providence, in the light of the flood of September, 1938. An interim report on the review was submitted to Congress last year, incorporating certain minor extensions to the levee program and a revised list of 20 reservoirs having a total capacity of 939,950 acre-feet and controlling 26 percent of the drainage area at Hartford. The total capacity of this new group of 20 reservoirs is 46 percent greater than the original plan. More recently the studies were completed and now are being examined by the Board of Engineers for Rivers and Harbors.

The Connecticut River has its source in northern New Hampshire, flows south forming the boundary between New Hampshire and Vermont, crosses the states of Massachusetts and Connecticut to discharge into Long Island Sound. It is 392 miles long and drains 11,260 square miles. The upper and western sections of the watershed are mountainous, the ruggedness decreasing as the coast is approached.

Knightville Dam, Westfield River

Floods have been frequent in the Connecticut River Valley and have produced a serious problem in the highly developed sections of the lower river and in the industrial towns that center around available power sites on the tributaries. The greatest flood of which there is record on the middle and lower river occurred in March, 1936, and caused direct damages estimated at $34,500,000. The flood of November, 1927, which, prior to the flood of September, 1938, was next in magnitude in recent years, was most destructive in the upper basin, notably in the White River watershed in Vermont. The direct damage amounted to $15,526,000. As a result of a heavy rain that preceded the hurricane of September, 1938, floods on the lower tributaries of the Connecticut exceeded all previous records, although the main river at Hartford was 2.2 feet below the 1936 record. The direct damage caused by the flood of 1938 amounted to $25,596,000. As a result of the 1938 flood, further changes in the flood control plan that had been submitted to Congress are now being studied.

Early in the studies of means for protecting communities in the Connecticut Valley from floods it was found that while complete protection to some of the communities in the lower valley could be provided by means of levees and flood walls, the main reliance in any scheme of protection would have to be placed on a combination of reservoirs and flood walls or levees. Further, it was found that complete protection could not be provided by means of reservoirs, because of the high cost of reservoirs of adequate capacity low enough on the tributaries to keep the flood flows on the tributaries and in the main river within safe limits. Main dependence had to be placed on comparatively small reservoirs located far enough up the tributaries to be above the settled regions of high land values.

FOR the design of levees and walls, a design flood was established by assuming an intense rainfall over the watershed and then translating this into run-off by the use of established methods. The discharge from each tributary was computed from the rainfall and the unit hydrograph of that particular stream, and the discharges from these several contributing areas were routed down the main river to produce the hydrograph at critical points in the lower basin. The rainfall assumed was about the same as for the storm of September, 1938, although differently distributed.

For the purpose of determining the economic justification for the projects under study, benefits were classified as those resulting from the elimination of recurring losses either directly or indirectly due to

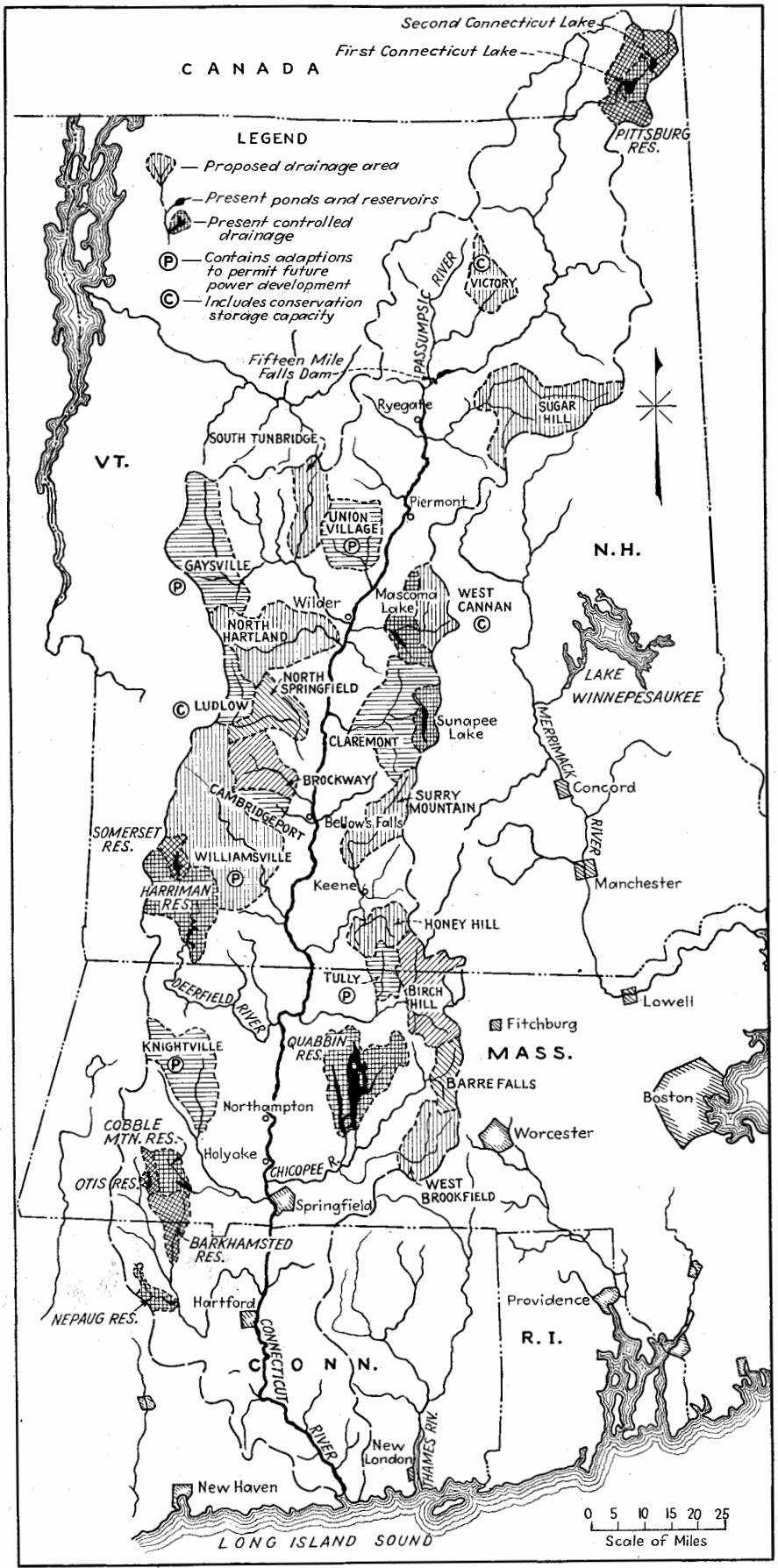
Text and illustrations courtesy *Engineering News-Record.*

flooding, and those resulting from the restoration of property values. Flood losses were appraised under three corresponding classifications. A careful determination of the direct and indirect losses resulting from the March, 1936, flood was made as soon as possible after the flood, for use in fixing preventable direct and indirect losses, which form the basis for direct and indirect benefits. Similarly, the actual or probable damage resulting from floods of lesser magnitude was determined, making it possible to place a value on the savings or benefits which result from each foot of reduction of the flood crest. Setting these figures over against flood-frequency curves, it was possible to put the probable direct and indirect benefits on an annual basis, thus giving a figure that could be compared with the annual cost for any reservoir or group of reservoirs.

THE DISTRICT engineer credited to the reservoir system all of the benefits which would accrue to it from reduction of direct and indirect damages, assuming that no levees would be constructed. He also credited to the reservoir system the benefits developed by the restoration of property values outside the area proposed for levee protection. To the levee system was given credit for the additional direct and indirect damages which it prevented, plus all benefits from the restoration of property values within the leveed area.

The reservoirs proposed in the interim report control 26 percent of the drainage area at Hartford. Existing water supply and power projects increase this control to about 32 percent. The system of 20 reservoirs will reduce flood heights at Springfield and Hartford by about five and six feet, respectively, in a flood of the magnitude of that of 1936.

The size of the individual reservoirs was selected to give the optimum ratio of flood protection benefits to annual charges. The locations of the reservoirs were selected to provide the most effective flood protection practical for the basin as a whole, due consideration being given to the sites available and the economics of the situation. Consideration was given to the relative economic values of the individual reservoirs; to the control of the amount of watershed area desired; and to the geographical distribution of reservoirs to ob-



Flood control reservoirs as now proposed for the Connecticut River Valley will control 26 percent of the area above Hartford. This map shows the drainage areas controlled by existing dams and dams under construction or proposed in an interim report submitted to Congress

tain dependable reduction of flood stages in the middle and lower reaches of the main river during storms of all probable types and magnitudes.

Spillways were designed for the worst possible conditions, it being assumed that each reservoir would be full to the spillway crest at the time its design flood occurred, even though the reservoirs are normally kept empty.

The costs of the comprehensive plan and the benefits to be derived from it were compared on an annual basis. Reservoir costs were computed at 3½ percent of the capital cost, plus a proper allowance for maintenance, operation, and amortization. The total benefits of the reservoir system proposed in the interim report exceed the total costs of the reservoirs. Similarly, the total benefits of the proposed levee protection exceed the total costs thereof. Extensive reservoir control is highly desirable, since it provides general benefits to the valley as a whole and will tend to increase in value with the normal development and expansion of communities in the valley. A reservoir system must be well distributed over the watershed in order to insure the realization of the benefits credited to the system as a whole, even in the event of a storm such as that of November, 1927, which centered over a limited portion of the watershed. This intangible "location" value may render an otherwise uneconomic reservoir desirable as one element of the total plan, in case of a storm centering above the reservoir. Levee protection is essential for low-lying congested communities along the main river in order to insure the complete protection which these highly developed communities require. Thus the combined system of reservoirs and levees will provide general protection for the valley as a whole and especial protection for those centers where damages have been concentrated as a result of past floods.

The most economical and easily improved sites for water-power development in the Connecticut basin have already been developed. The New England Power Association has had under consideration for some years the construction of a large hydro-electric plant at Upper Fifteen Mile Falls, a few miles above the existing plant located at Lower Fifteen Mile Falls.

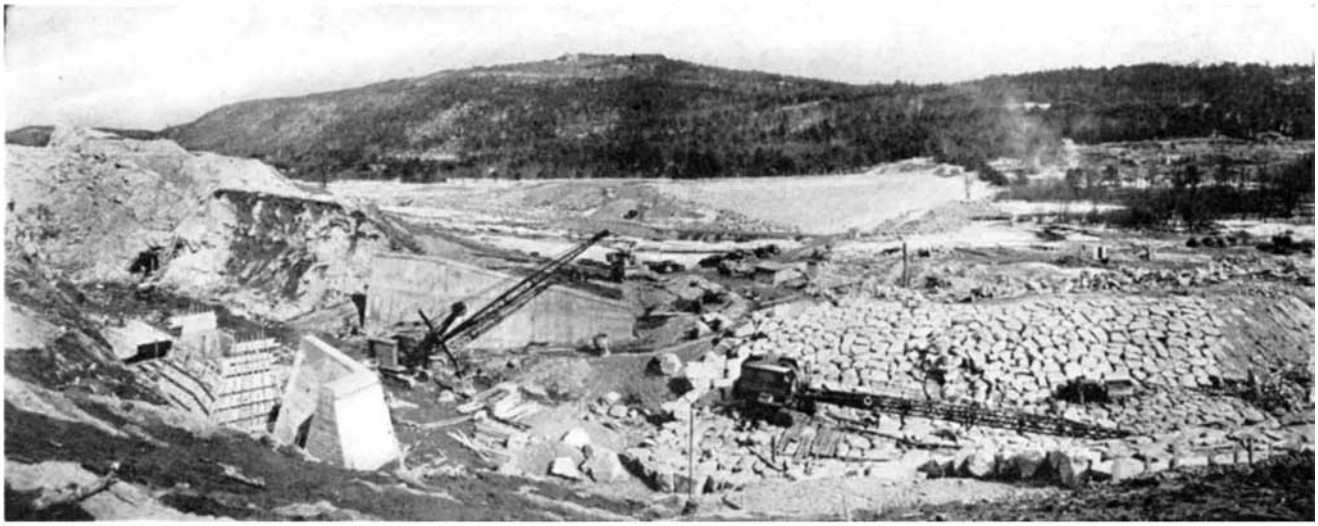
THE ONLY possible water-power sites on the main river below the mouth of the Passumpsic River that have not been developed are at Piermont and Hart Island. Existing plants at Ryegate, Wilder, and Enfield do not have equipment of sufficient capacity to utilize additional flows, and until these plants are re-developed no appreciable benefits to them can be realized from future storage reservoirs. On some of the tributaries there are attractive natural sites for the development of new power stations, but on account of their comparatively small drainage areas and the wide variation in natural flows, these probably never will be developed unless conservation storage reservoirs are constructed above them.

The possibility of increasing the size of flood control dams in order to develop conservation storage or power in conjunction with flood control has been studied. It appears feasible at a few sites, either under present conditions or under assumed future conditions of more extensive power development of the basin as a whole. It is contemplated that, when flood control reservoirs are constructed at sites where power might be developed, provisions will be made so that the dams may be raised in the future to provide the necessary head and storage for power. Likewise, where it is contemplated that additional storage will be provided for streamflow regulation, provision will be made either for raising the dam in the future or, where the regulation is now justified, for providing the additional storage initially.

The possible benefits deriving from small increments of permanent storage to be used for recreation were evaluated, and found, in a few cases, to equal or exceed the costs of providing the additional storage. Such additional storage provides benefits of a local character, and may be provided at almost any of the sites if local interests bear the increment of cost. Recreation benefits are always realized wherever conservation storage is provided.

Construction is now under way on the Surry Mountain, Knightville, and Birch Hill reservoirs. Levees and flood walls at Northampton, Springfield, Chicopee, and Holyoke, Massachusetts, are completed or well along toward completion, and those at Hartford and East Hartford, Connecticut, are under active construction.

Flood control in the Connecticut River Valley is under the general direction of the Chief of Engineers, U. S. Army.



Construction work on Surry Mountain Dam on the Ashuelot River above Keene, New Hampshire

Rough Riders of '41

YOU'VE got to be tough to take the rough-and-tumble jolting of a modern tank or scout car. Tanks no longer waddle slowly over obstructions, but leap and bounce over rough terrain at speeds up to twenty-five and thirty miles an hour. Scout cars, like the one in the picture, can leave the highway and roll right across country. Their crews—the "rough riders of '41"—must take the bumps. So must the machines themselves and the powerful engines that drive them.

American engineers not only produce the best automobiles, but today they are turning their skill and ingenuity to the problems of gasoline-powered defense equipment—tanks, armored cars, trucks, airplanes and motor torpedo boats. They are giving America the best equipment, the best engines and the best fuels in the world.

We of Ethyl are privileged to help this vital work through both product and service. Ethyl's product, anti-knock fluid containing tetraethyl lead, is used by petroleum refiners to improve gasoline. Without high anti-knock fuels we might not have had many of today's most efficient types of engines—the compact gasoline power-plants that save weight and space where every pound and every inch count.

Because Ethyl's anti-knock fluids are an important factor in the development of both fuels and engines, our research laboratories in Detroit and San Bernardino cooperate with both automotive and petroleum technologists. We function as a "clearing house" for technical information, help to coordinate many individual research efforts and contribute the results of many of our own tests and experiments with fuels and engines.

Thus, by supplying an essential product and by offering the services of our research laboratories to technical men and executives in every phase of automotive development, we are, we believe, serving the nation.

ETHYL
ETHYL GASOLINE CORPORATION
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Insulate to Aid Defense

Home Insulation, for New or Old Houses, Will Save Fuel, Keep Uniform Temperature

HARLAND MANCHESTER

IF THE walls of your house were full of holes, and 30 cents out of every dollar you paid for heat went to warm the great outdoors, you could see right away that it would save money to plug the holes.

Well, your walls *are* full of holes, in effect. Every time you stoke the furnace you are straining your back to melt the snow on your roof.

This is the simple lesson that a dozen public and private agencies have been dinning into the ears of the nation's householders ever since it became obvious that freight car and tanker shortages might jeopardize the supply of home fuel this winter.

There are 37,000,000 dwelling units in the United States, and most of their walls and roofs leak heat badly. The Bureau of Mines estimates that our domestic heat bill thus is $1,000,000,000 a year larger than it needs to be.

The experts will give you the remedy in one word—insulate. If you are building a new house, insulation has become a "must." Your architect or contractor will help you select from a wide variety of insulating materials the one best fitted for your needs. Insulation may add from 2 to 3 percent to the cost of the house; if so, you will get the money back many-fold. Sometimes it actually costs nothing because you need not install so large a furnace. And perhaps, with a smaller furnace, you can do with a smaller cellar—or none at all, and save still more money.

If you are living in an uninsulated house, fill the empty spaces in your walls and ceilings with insulation, put on storm windows, and tack weather-stripping around your windows and doors. You will save money to pay your income tax, and release fuel and rolling stock to keep the defense plants going. If you haven't the ready cash, a loan for the improvement is easy to obtain (the FHA will insure loans for insulating houses, old or new) or the firms which insulate houses have instalment terms so moderate that the saving in fuel will take care of the payments. It is not a gamble—nearly a million homes have already been insulated in this manner.

The investment in home insulation should pay for itself in five years on an average. Then you begin to pocket the fuel dividend; meanwhile, you will have fewer drafts, a quicker warm-up on cold mornings, a cooler house in summer, and additional fire protection.

THE principle is simple. Heat always travels from a warmer to a cooler surface. In winter, the walls and roof of a house conduct heat outward just as heat is conducted toward the handle of a spoon when you stir hot coffee with it. Summer heat travels inward the same way. Porous insulating materials contain vast numbers of minute trapped air cells which retard the flow of heat.

The history of mineral wool, now widely used in home insulating, goes back a full century to a town in Wales, where it was made in small quantities for use in a factory. A house in Salem, Virginia, was treated with it nearly 50 years ago.

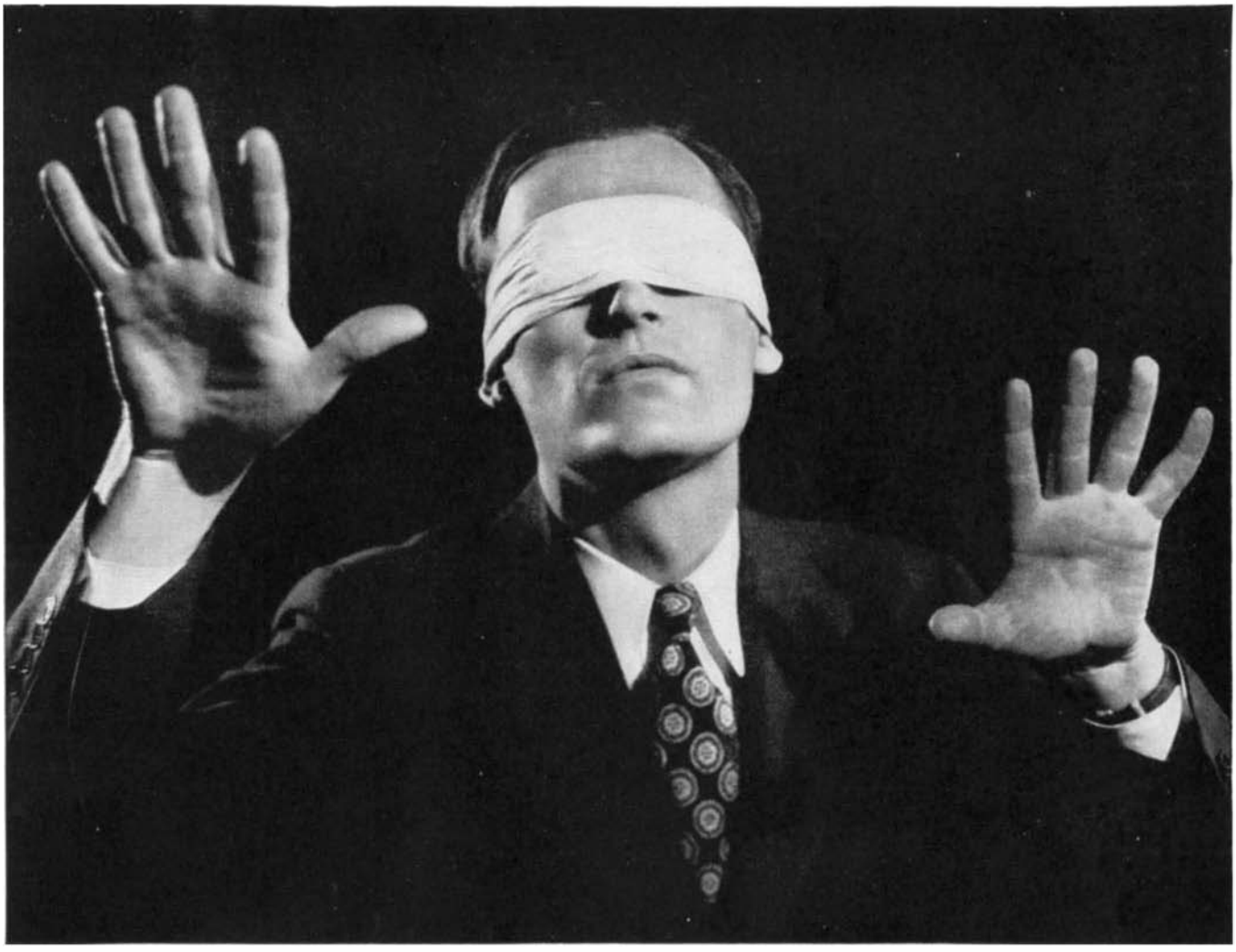
But until comparatively recently, it was difficult and expensive to insulate a house once it was built. In 1928, however, a cheap method was devised for doing this work. Holes were cut in the sides of a house near the eaves and compressed air was used to blow the loose wool through a hose into the wall spaces. This system is now widely used. Mineral wool comes in shreds which you can buy by the bagful; it is sold in "bats"— rectangular, paper-wrapped sections just wide enough to fit between the studs of a wall; and it is available in "blankets" of the same width, which any householder can unroll and tack between rafters or studs. There is a form for every use, and sometimes two or more forms are used in the same house.

Mineral wool is made from rocks and smelter slag. Nature has been producing it in volcanoes for countless centuries. Sometimes when a stiff gale whistles over the crater of Mount Pele in Hawaii, molten lava is blown into fine silky threads which the winds carry for miles. The natives used to say the goddess Pele was tearing her hair in rage.

Today, man-made volcanoes in 18 states, their red-hot craters roaring like the crack of doom, are turning out mineral wool. Piles of slag, which looks like field stone, are hoisted to the tops of steel towers three stories high and some ten feet in diameter. These "volcanoes" are upside-down. Slag, coke, and limestone slide into the lofty maw of the furnace, which no one dares to look at without a mask. Far below, the "eruption" takes place. A stream of molten slag no larger than your thumb pours forth from the base of the cupola. A horizontal jet of steam hits this stream and shatters the molten rock into thousands of small comets which fly hissing and spitting through an aperture into a barn-like chamber, lined with steel. The shot-like heads of the comets face the steam and their tails of fire stream before them. The little comets fall on a conveyor and cool to form a grayish, fleecy substance which, when the shot is combed out, is strikingly similar in appearance to wool from the sheep's back.

Seventy-five firms all the way from New Jersey to California are making mineral wool, and prices have gone down 40 percent in the last five years.

To conserve fuel in this time of national emergency, it has been suggested that all householders be asked to keep their homes five degrees cooler than customary during the coming Winter. Much greater fuel economies can be made by insulating, with no sacrifice of comfort. Thousands of home-owners have discovered this fact, and savings have been figured out to the last cent in a number of controlled tests. Two winters ago Mrs. Harriet Wilson and her son lived in twin houses at New Hyde Park, Long Island, identical in every respect save that the son's



WHITE COLLAR MEN ARE STILL A DIME A DOZEN!

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

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

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

HOW IT'S DONE! The difference between success and merely "getting along" lies in executive training. In the old days, successful executives had to gain their ability through long years of experience. But as business became more complicated, educators became business-minded. Many big universities added schools of business; the Alexander Hamilton Institute was founded—and since then has pointed the way to success to more than 400,000 men!

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

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

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Business Address.....
Position.....

house was insulated and the other was not. They used the same type of oil-burners and the same grade of fuel oil and regulated the temperature by thermostat. Mrs. Wilson, who kept the figures, found at the end of the winter that her fuel bill was $191.52, while fuel for her son's insulated house cost only $155.68—a saving of about 19 percent.

Although both houses were kept at the same temperature, a test extending over a period of five days proved that because of fewer drafts and more even distribution of heat in the insulated house, it was comfortable when the thermostat was set five degrees cooler than in the other house.

How much coal or oil you can save obviously depends on the climate, the type of construction, and the kind of heater and fuel you are using. Tests conducted in low-cost houses in North Carolina by the TVA revealed that complete wall, floor, and roof insulation cut the fuel bill as much as 44.75 percent. And John B. Rodee, of the Pierce Laboratory of Hygiene, in New Haven, states that the heat bill of a small house in Milwaukee can be cut from $75 to $42 annually by insulating completely with mineral wool.

EVEN if you do not do the whole job at once, partial insulation pays dividends. One of the simplest approaches is to begin with the attic. The day after a snowstorm it is easy to see which attics are without insulation; the snow is melting much faster on those roofs. Wasted furnace heat is melting it.

Any home owner can prevent this particular leakage of heat with a small expenditure of money and work. If the attic has no floor, or if the boards can be easily removed, he can buy loose mineral wool or some other "fill" type of insulation and spread it between the ceiling joists to a thickness of three or four inches. Or he can tack prefabricated blankets between the rafters, covering the whole with insulating board. This often produces extra living space in addition to saving fuel. In a small house, the cost of the material might run between $20 and $35. Engineers of the U. S. Housing Authority recently estimated that, in one project, every square foot of roof insulation would save three and a half pounds of coal a year.

Many insulating materials have given good service in various localities. Eel grass quilted between paper has been used for more than 50 years; redwood bark is popular on the West Coast; corn stalks, flax stalks, palmetto roots, and other vegetable products are used. Wood particles, processed to open up the fiber and make a kind of wool, provide effective insulation. There are a number of insulating wall boards which also add structural strength; one of the most widely used is made of bagasse, which is sugar cane after the juice has been extracted. There are metal-coated papers which keep the heat in by reflection; aluminum foil, now difficult to obtain, is an example. And there is vermiculite, a mica-like material mined in Montana, which is processed to form feather-light pellets used as loose fill. In deciding which material is best for his house and his locality, the home-builder should profit by the experience of his neighbors and consult local construction experts.

If insulation did no more than cut the heating bill, that would be enough to justify its wide use, but it throws in several bonuses for good measure. Attic insulation keeps out the heat of the sun in summer time. Dark roofs absorb the sun's heat readily, and often on warm, sunny days, shingles or slate are as hot as 140 degrees. The heat penetrates the roof rapidly, but if there is insulation beneath your roof or attic floor and ventilators in the gables, little of it gets through to your living quarters. Wall insulation also plays an important part in keeping the house cool. In air-conditioned houses, complete insulation is an economic necessity.

Wall-paper keeps its appearance longer on an insulated wall. It has been found that without insulation, there is greater variation in the temperature of different parts of the wall, and that this causes uneven condensation of vapor. Dust settles on the more humid areas, making alternate light and dark stripes along lath and beam locations. Uniformity of room temperature and lack of drafts likewise make for warmer air near the floors, so the children can play more safely.

And as a final, extra dividend, mineral wool cannot possibly be ignited. It is, after all, rock. Tests show that a wall filled with mineral wool retards fire by about an hour, thereby vastly increasing the chances of the department getting to the scene on time.

It is no wonder that mortgage lenders encourage the insulation of houses. "If a man likes the house he lives in, he'll keep up the payments," they say. And more than any other housing development, insulation has stimulated a new approach to home-building, familiar to anyone who drives a car, but often overlooked in the past by the family buying a house —the idea that the upkeep is fully as important as the original cost. Insulation cuts down the upkeep, and makes it easier for a man to keep his home, come depression, war, or inflation.

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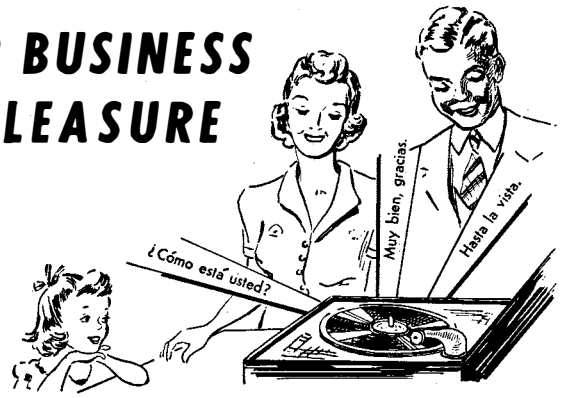

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It is claimed that Dupli-Color dries in 20 minutes and can be polished four hours after application.

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PENALTY: In Jugoslavia, and some other European countries, when policemen capture a speeder, there are no accusing words or bickering over a ticket. Officers simply let the air out of all tires, tip their hats, and go on their way. The driver's session with a tire pump which follows is a lesson that he doesn't forget in a hurry.

• • •

GAS MILEAGE

450 Miles Per Gallon — If . . .

GASOLINE is sufficiently powerful to propel a car 450 miles to the gallon, petroleum technologists say, if means could be devised to obtain complete efficiency of consumption.

With 14 gallons of gasoline a new model of any popular make could do 6300 miles at 20 miles per hour on a perfectly level road, provided there were no power losses through friction, heat radiation, wind resistance, and a few other factors.

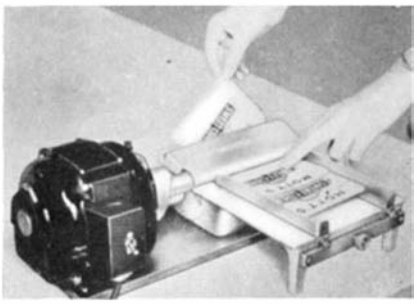
The trouble, it is explained, is not in the gasoline, one gallon of which contains 99,000,000 foot-pounds of potential power, but in the difficulty of building vehicles and highways which will permit complete advantage to be taken of this dynamic fuel.

Scientific progress will do much to improve operating efficiency of the motor vehicle, and also will improve the highway, it is believed, but the complete elimination of power losses cannot even be imagined at the present time—and probably not in the future.

GLUE SPREADER

Speeds Up Hand-Labeling Jobs

LABELS from the very smallest up to those eight inches wide can be fed through the glue spreading machine illustrated in these columns without danger of curling or of being coated with too much or too little adhesive. Thus there is assured at all times ample glue to do the job, but with no wastage.



The adhesive is regulated

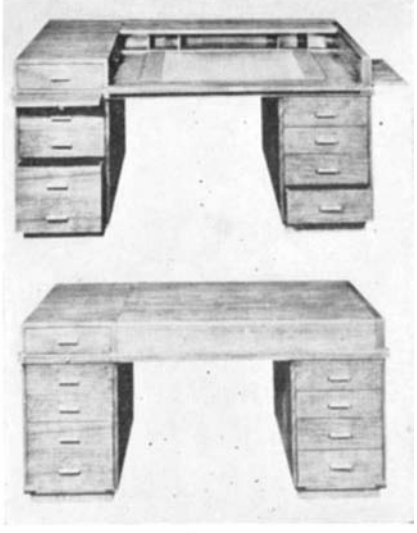
In operating the device, the labels are located between adjustable guides and are brought into contact with the glue-spreading roller one at a time. Small fingers on the delivery side of the device lift the label so that the operator can pick it off by the corner. Known as the Labelit, manufactured by the Alsop Engineering Corporation, the device will apply all types of adhesives to plain, lacquered, or varnished paper labels and to cellophane and cloth labels.

DESK

Two Tops in One Unit

EXECUTIVES in many branches of business and industry will be interested in the new Duplex "Two-Top" Desk recently developed by the Duplex Desk Company. As one of our illustration shows, this desk may be considered as a modernized form of the old roll-top desk, but with added advantages.

When the top of this new desk, composed of closely matched and fitted ribs, is pushed back, a working space is disclosed, complete with pigeon holes. When the movable top is pulled forward, any papers and documents on the working surface are covered with the movable top which becomes a second working surface, clear of all impediments. The movable top can be locked securely in the closed position.



Streamlined roll-top

PSYCHIC RESEARCH

• 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. Further reports of The Scientific American Committee for the Investigation of Psychic Phenomena will be published in forthcoming issues. •

NYLON THREAD

Synthetic Material Available for Home Use

TESTS have shown that Nylon thread, manufactured by Belding-Heminway - Corticelli Company, and now available at leading department and chain stores throughout the country, has great strength and elasticity. Thus it can be used for both hand sewing and machine stitching, producing garment seams which will stretch under unusual strain without danger of breaking the stitches. Bias seams, too, stand the strain of longitudinal stretching. Nylon thread is also resistant to rot from perspiration, does not shrink when a garment is dry-cleaned or washed, is not adversely affected by normal ironing conditions, but, as with all fine fabrics, use of a very hot iron should be avoided.

SEARCHLIGHT

High Intensity, for Emergency Use

ANNOUNCED in these columns a year or so ago was a high-intensity, battery-operated, portable searchlight designed for emergency use. By combining excessive battery drain with a bulb operating on an "over-load," a tremendously high light out-put was achieved. Because of the method of operation, however, this searchlight had an operating life of only six minutes.

Now the Burgess portable searchlight has been redesigned and a

180,000 beam candle-power

case provided which holds two 45-volt B batteries provided with simple plug-in connections. With this new arrangement this searchlight will supply 180,000 beam candle-power for approximately 35 minutes. The two batteries are wired in parallel and supply current to a 22-volt spotlight bulb.

• • •

TRAVEL: It is estimated by the Automobile Manufacturers Association that 2100 American towns and cities ranging from 2500 up to 50,000 population have grown up without interurban mass transportation systems of their own. The combined population of nearly 12,000,000 depends for routine movements upon private cars.

• • •

PHONOGRAPH

Tandem Tone Arm Plays Both Sides of Disk

WITH one of the new RCA victrolas recently placed on the market, it is possible to stack 15 records on the automatic mechanism and then be entertained with two hours of uninterrupted music at the touch of a button. All this is accomplished by the use of a new type automatic record changer which plays both sides of phonograph records without turning them over. Heart of the system is a tandem tone arm, shown in one of our illustrations, which consists of two arms and two pickups, one for playing the top side of the record and the other for reproducing the lower side.

When the starting button of this new phonograph is pressed, the

BOTH must breathe!

AT 30,000 feet—above all animal life, 10,000 feet above the extreme limit of Alpine mountain vegetation, higher than Everest, higher even than the South American condor soaring over Chimborazo—MAN FLIES!

Another medium has been added to the land and the sea, almost another dimension has been added to the air itself—the stratosphere. Here, planes can travel phenomenally fast, amazingly far; here are the high roads for today's bombers and tomorrow's transports; here are the new high battlefields where a superplane may rise to dominate the skies—and all the earth below.

But at 30,000 feet in the stratosphere the air is so thin that no human lungs and no airplane engines can breathe deep enough to sustain life.

Yet with the aid of oxygen masks man breathes and survives; and, with the aid of turbosuperchargers, American-built engines can breathe and fly nearly seven miles up—"on top" of the best combat planes of any other nation.

More than 20 years ago a General Electric engineer, Dr. Sanford A. Moss, equipped a Liberty airplane engine with a turbosupercharger that he had designed. And for more than 20 years, while America's aeronautical engineers designed ships to fly farther and faster, General Electric engineers worked to perfect the machine that would enable them to fly higher and higher.

Today, no bombers can fly farther than our American bombers, no combat planes can fly faster than our American interceptors and fighters. And, thanks to the turbosupercharger, no enemy planes can rise above them. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

952-228N1-211

Continuous music for two hours

tandem tone arm automatically swings over and plays the top side of the bottom record of the stack, which has been dropped to the turntable. After reaching the end of the record, the tandem arm swings clear while the direction of the turntable is reversed. The tone arm then rises far enough to make contact with the bottom side of the record. After the first record has been played on both sides, it is deposited gently in a felt-lined compartment, whereupon another record from the bottom of the stack drops into place and the cycle is repeated until all the records have been played.

Reproduction of the records is accomplished through the use of a carefully ground sapphire point which replaces the needle. This tracks in the record groove with a minimum of pressure, assuring almost indefinite life for both the sapphire point and the records.

GRASS STUDY

Made-to-Order Weather

Aids Work

SCIENTISTS of the U. S. Regional Pasture Laboratory, State College, Pennsylvania, have just set up a new "climate maker" to test pasture plants in controlled environments. Made-to-order weather will aid U. S. Department of Agriculture research in breeding improved grasses and legumes and in improving pasture management practices.

The "climate maker" is a heavily insulated cabinet with four large chambers where sample plants can be grown under controlled light, temperature, and moisture. The chambers have outer doors of refrigerator type, and inner doors fitted with observation windows. Above each chamber a bank of fluorescent lamps, insulated by plate glass, provides maximum light with minimum heat.

Air conditions and other environmental factors can be made to vary as they do on ordinary days during a growing season. Special apparatus controls the temperature, humidity, and flow of air in each chamber. Soil temperature, moisture content, and nutritional value are under control. Varying lengths of day and different light intensities simulating cloudy or clear weather can be provided. Recording devices trace an accurate, continuous account of the manufactured weather and soil conditions inside the chambers.

INK

Water Set, for

Letter-Press Printing

VIRTUALLY without odor, a new printing ink sets by application of water spray or vapor. Known as Vaposet ink, it dries almost instantaneously, the water vapor rapidly diluting the ink solvent in the printed impression.

IT REFLECTS

Many Uses for Adhesive

Glass-Sphere Surface

TURNING night into day and making dark ways safe ways is the figurative function of Scotchlite, a reflecting medium recently placed on the market by Minnesota Mining & Manufacturing Company. Comprised of tiny glass spheres which reflect light back to the source of light, Scotchlite is finding many new uses. Latest of these uses is on the Mississippi River where the United States Coast Guard has been making tests over a six-mile stretch below St. Paul. While the test results are still under consideration, photographs taken on the test trips indicate that the buoys and shore markers coated with the material could be seen plainly and that the light reflected by these markers was visible for distances of upwards of half a mile.

These tests gave rise to consideration of the material for other uses on water; boating enthusiasts are experimenting with it for use on docks and on the sterns of the pleasure craft themselves. Heretofore, the reflecting medium has been used as a safety measure in marking bridge abutments, guard rails, and railroad cross bucks, as well as for commercial advertising purposes and for outlining rear ends of night-riding trucks.

Small glass spheres, some 5000 of them per square inch, are coated on a treated fiber backing and bonded to the backing by means of a pigmented binder which has been found capable of resisting outdoor weather conditions for a period of upwards of two years.

On the reverse side from the sphere-coated surface, there is a coat of cement which adheres to the sign or marker it is desired to illuminate at night. During the day, the sign or marker will have its customary appearance; at night, when light shines on the coated surface, a glare-less reflection gives the coated object its daytime appearance.

BATTERY

A NEW storage battery for use in portable radio sets has been developed by the Willard Storage Battery Company and is being featured in the recently introduced General Electric self-charging portable receiver.

Development of the new battery makes possible the construction of a portable radio set which can be depended upon to give consistent service with a minimum of attention from its owner. In its application in portable receivers, the battery is used to supply both "A" and "B" power — the former direct, and the latter by means of vibrator conversion.

Supplies "A" and "B" power

A safe, clean, silent charger, built into the receiver itself, permits recharging the battery by simply plugging into an A.C. electric light socket. Recharging may be accomplished while the set is being operated on alternating current, or while idle. In any case, use of the set needn't be foregone when recharging becomes necessary for, even if A.C. is unavailable, provision is made for recharging the battery from the storage battery in one's car.

This new battery measures 4

inches long by 3 inches wide, and is 5½ inches high. Its case is formed of a strong, acid-proof, transparent plastic. This transparency makes it easy to see the quantity of electrolyte in the battery, as well as the built-in charge indicator. The green ball sinks when the battery is 10 percent discharged; white ball when 50 percent discharged; the red ball when completely discharged. The balls float again as the battery takes charge.

A spill-proof cover is provided to prevent loss of the electrolyte. This makes it possible to operate the receiver in a tilted position, on its side, or, for that matter, upside down. A new type of electrolyte-retaining insulation soaks up the electrolyte like a sponge, keeps the solution in contact with the plates and greatly reduces the quantity of free solution required.

BOMB TAXI

Transports Suspicious Packages to Safety

THE Bridgeport, Connecticut, Police Department has constructed a unique "bomb taxi" consisting of a large tank of ⅜-inch boiler iron mounted on a sheet iron platform. The tank and platform are mounted on a heavy two-wheeled chassis with heavy-duty springs acting as cushions. No bolts were used in the construction of the tank. One-inch cable is wound around the tank and welded every few inches. A heavy iron mesh net covers the tank to prevent particles from flying out of the tank when the bomb explodes.

When a bomb or suspicious package is discovered, the bomb taxi is towed to the spot. The bomb is placed in the tank which is parked in the center of the street. If the bomb does not explode, the taxi is then hauled to an open lot where trained technicians use a half-stick of dynamite to destroy the package.—*Fire Engineering.*

MONEY'S WORTH

Weather Services Cost Each Citizen Five Cents A Year

SERVICES of the United States Weather Bureau cost each citizen an average of only five cents a year, Merrill Bernard, supervising hydrologist of the Bureau recently stated. Among the agencies this five cents keeps at work throughout the year, Mr. Bernard listed the following:

About 40 radio-sonde stations, sending up balloons carrying automatic instrument kits, that automatically report by radio what the weather is like "up there."

Wind-study stations — 144 of them—that send up small balloons, and by means of instrumental "tracking" obtain data on height, direction, and velocity of air currents high aloft.

About 300 first-order stations in principal cities and at airports. These are the places you think of when you say "Weather Bureau." Meteorologists stationed there not only forecast tomorrow's weather; they collect data on rainfall, temperature, atmospheric pressure, wind, cloudiness, river stages, and a lot of other things needed by aviators, farmers, shippers, and other persons whose lives are in constant critical contact with the weather.

Automatic rainfall stations, now numbering about 2000, where precipitation is automatically measured and recorded, with only occasional human attendance.

More than 5000 co-operative stations, managed by volunteer observers, usually working without

Sand—Symbol of Optical Independence

BY itself, only a handful of sand—fine, pure, white crystals of quartz from a Pennsylvania hillside. But, blended, with boron, sodium, barium, lead, phosphorus and other elements—fused and fined at white heat—cooled, sorted, annealed and selected—it becomes optical glass, one of the basic indispensable materials of national defense—and of modern civilization.

Thirty years ago America was wholly dependent on Europe for a supply of glass for optical instruments. But before the first World War had cut off that source, Bausch & Lomb scientists, at Rochester, N. Y., were at work on the development of a glass-making technique. By 1918, glass to fill the vital needs of optical manufacturing in the United States was pouring from the B&L glass plant.

Today, for binoculars and fire control equipment that are the eyes of the Army and Navy—for metallographic and spectrographic equipment that are the eyes of industrial research—for microscopes that are the eyes of all science—for spectacle lenses that are the eyes of the nation's citizens — America is completely independent of foreign supply.

BAUSCH & LOMB
OPTICAL CO. • ROCHESTER, NEW YORK
ESTABLISHED 1853

AN AMERICAN SCIENTIFIC INSTITUTION PRODUCING OPTICAL GLASS AND INSTRUMENTS FOR NATIONAL DEFENSE, EDUCATION, RESEARCH, INDUSTRY AND EYESIGHT CORRECTION

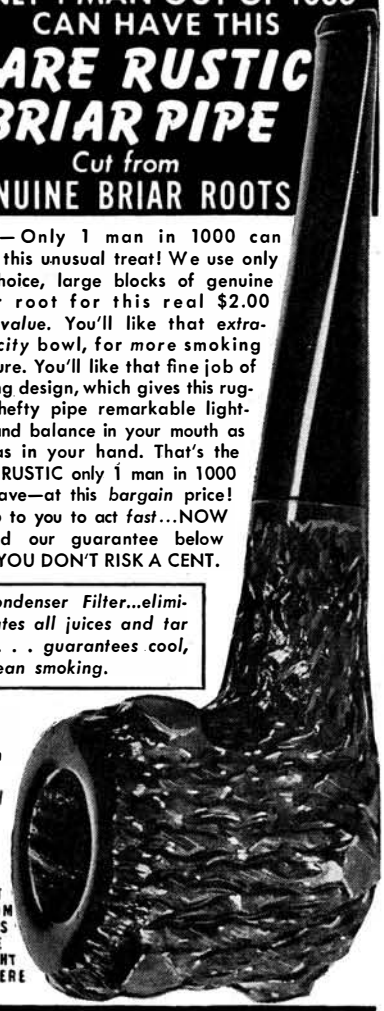
ONLY 1 MAN OUT OF 1000 CAN HAVE THIS
RARE RUSTIC BRIAR PIPE
Cut from
GENUINE BRIAR ROOTS

YES! — Only 1 man in 1000 can enjoy this unusual treat! We use only the choice, large blocks of genuine Briar root for this real $2.00 pipe *value*. You'll like that *extra-capacity* bowl, for *more* smoking pleasure. You'll like that fine job of carving design, which gives this rugged, hefty pipe remarkable lightness and balance in your mouth as well as in your hand. That's the RARE RUSTIC only 1 man in 1000 can have—at this *bargain* price! It's up to you to act *fast*...NOW ... and our guarantee below says: YOU DON'T RISK A CENT.

Condenser Filter...eliminates all juices and tar .... guarantees cool, clean smoking.

Pipe shown 7/8 actual size

FLAT BOTTOM KEEPS PIPE UPRIGHT ANYWHERE



RARE RUSTIC BRIAR reg. value. $2.00
1 POUCH *Original* RUM and MAPLE PIPE MIXTURE, Blend 53 .15
1 FOIL PACK THREE SQUIRES TOBACCO .15
Total Value $2.30

ALL FOR $1.00 POST PAID

Original Rum & Maple—America's No. 1 Fine Tobacco. The Pouch Pack sells for 15c. Available at stores everywhere.

FREE with EACH PIPE

Three Squires Tobacco is mild, friendly, mellow. A great value at 15c. These tobaccos can be smoked individually or blended together. Sold in stores from coast-to-coast.

MONEY BACK GUARANTEE

Here's our pledge. You examine the pipe, smoke it with the tobaccos, enjoy it. If you decide our claims don't measure up 100%, keep pipe and tobaccos ... and we return your money in full. Speed your order on the way today to get in on this. Dollar bill, check, money-order or stamps will do ... and you'll get entire combination without further cost. Or, if you prefer, send penny post card and pay postman $1.00 plus 18c C.O.D. fee. Illustrated catalog included FREE.

JAMES B. HALL, Inc.
Pipe Purveyors & Tobacconists
34-F UNION SQUARE (Cor.16th St.) N. Y. C.
(If Convenient, Visit Our Retail Shop)

salary. Their records fill in the gaps between the less numerous first-order stations with government-paid staffs.—*Science Service.*

DRAWING BOARD

Illuminated for Working on Stencils

DESIGNED for holding duplicator stencils in position so that hand work may be done on them, a new illuminated drawing board called Dupliscope has been placed on the market by Remington Rand, Inc.

The board itself, faced with a sheet of flashed opal glass, is supported by a hinged assembly that permits adjustment to a number of positions. On the face of the board are scales to assist in the drawing work and a T-square with a locking clamp. The T-square may be used either vertically or horizontally.

Throws light on the job

Built into the back of the board is a light source which is connected through a toggle switch to an extension cord.

FRESH FRUIT

Inexpensive Treatment Solves Salad Preparation

EVERY housewife and chef knows that such sliced fruits as apples, bananas, nectarines, peaches, and pears quickly discolor and become unappetizing in appearance on exposure to air. In terms of pantry labor this has meant that all sliced fresh fruits must be prepared at the last minute—practically while the other food is being served—and this has eliminated quantity serving at banquets.

Scientists at the Boyce Thompson Institute for Plant Research, Inc., at Yonkers, New York, worked on the problem and discovered a non-toxic chemical, thiocarbamide, which would effectively prevent browning of cut plant tissue. It has been made available, under the name Frulite, in tablet form.

A tablet of thiocarbamide dissolved in a quart of cold water is adequate to treat a quantity of sliced fruit and if any of the solution is left, it may be held for subsequent use. The fruit, cut to the desired shapes and placed in a sieve, is immersed in the solution for not more than 30 seconds, drained, and put into the refrigerator.

Sliced fresh fruit so treated will retain its normal color at room temperature for one day; in frozen condition, it will not discolor even after many months, and sliced apples, treated previous to drying, will retain their full color two to three months at room temperature or for a year in cold storage.

PLASTER PAINT

Can be Applied to Day-Old Surfaces

WHERE it has formerly been necessary to wait several weeks for plaster or masonry to dry before an oil paint would adhere satisfactorily to the surface, it is now possible to apply a newly developed oil paint when the plaster or masonry is only a day old.

This new paint, called "Bondlite" by the manufacturer, The Wilbur & Williams Company, is so compounded that it is not affected by lime or alkali. At the same time it is a "breathing" paint which does not seal moisture into the surface to which it is applied, but allows the moisture to dry out naturally as it should.

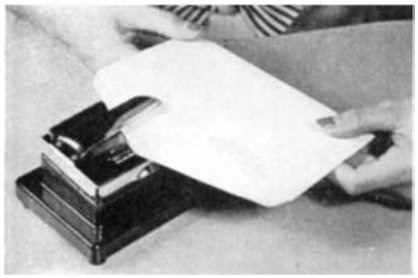
It is claimed that "Bondlite" has all the qualities of a high-grade paint and is durable. It can be obtained in both an interior and exterior mixture, dries in about an hour, and is as washable as other good-grade oil paints.

MOISTENER

For Labels, Stamps, Envelopes

A THREE-INCH wide adjustable brush, the base of which rests in a water reservoir, does a versatile job of moistening in a device placed on the market by E. W.

Pike and Company. The unit, weighted so that it hugs the desk or other surface on which it is placed, is provided with a curved metal guide so that all surfaces to be moistened, from postage stamps to large envelopes or labels, can be quickly and easily passed over the end of the brush where just sufficient moisture is supplied to do the job. Multiple moistening of



It licks one or a dozen

envelope flaps may be accomplished by "fanning" the envelopes and passing the flaps through the device as shown above.

In addition, the brush of the device serves as a ready means of moistening the finger-tips preparatory to counting money, sorting papers, and so on.

INKLESS RECORDER

Has Chart Speed of Only One Inch per Day

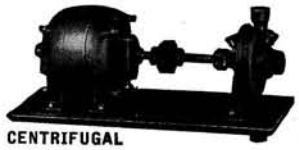
FOR use in many central-station and industrial applications, a newly designed low-speed chart record can supplement high-speed recorders and telescope a record of 30 days of electrical operation into a chart only 30 inches long.

This new instrument, announced by the Meter Division of the General Electric Company, has a chart speed of only one inch per day. Thus the operating record for an entire month can be checked at a glance; unusual conditions indicated on the 30-inch chart can then be located quickly and studied more closely on the regular high-speed recorder.

The one-inch-per-day speed of the new recorder is made possible by the inkless recording mechanism which makes an impression by pressing the chart against a typewriter ribbon. The inkless feature obviates the freezing and evaporating difficulties in extreme temperatures inherent with pen-and-ink mechanisms; the recorder will function accurately in temperatures ranging from —10 to 120 degrees, Fahrenheit.

LATEST TYPE INDUSTRIAL & LABORATORY EQUIPMENT FOR IMMEDIATE DELIVERY AT UNUSUAL PRICES

BRONZE GEAR AND CENTRIFUGAL PUMPS



CENTRIFUGAL

		Inlet	Outlet	Price	With A. C. motor
No. 1	Centrifugal	1/4"	1/8"	$ 6.50	$22.00
No. 4	"	3/4"	1/2"	13.50	28.00
No. 9	"	1 1/4"	1 "	16.50	31.00

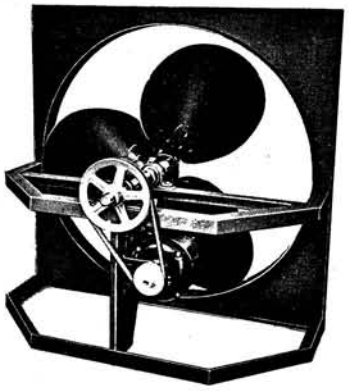
No. 1½	Gear	1/8"	Price $ 9.00	With A.C. motor	$22.00
No. 2	"	1/4"	" 10.00	" " "	23.50
No. 3	"	3/8"	" 11.50	" " "	25.00
No. 4	"	1/2"	" 12.50	" " "	28.00
No. 7	"	3/4"	" 15.00	" " "	32.50
No. 9	"	1 "	" 16.50	" " "	45.00
No. 11	"	1 1/4"	" 48.50	" " "	on request

FORCED DRAFT BLOWERS COMPLETE WITH MOTOR

TYPE	H.P.	R.P.M.	CU. FT. MIN.	INLET	OUTLET	PRICE
0	1/20	1750	160	4 1/2"	3 3/4"	$18.00
0½	1/8	1750	350	6 1/2"	3 3/4"	20.00
1	1/8	1750	535	6 "	4 1/2"	25.00
1¼	1/4	1750	950	7 1/2"	6 "	30.00
1½	1/2	1750	1900	9 1/2"	7 "	65.00

PRICES QUOTED ARE FOR A.C. 110 V. 60 CYCLES ONLY. OTHER VOLTAGES ON REQUEST.

ATTIC AND INDUSTRIAL FANS



Belt driven, slow speed, exceptionally quiet in operation, highly efficient. G. E. Motors.

SIZE	H.P.	R.P.M.	C.F.M.	PRICE
24"	1/6	660	4200	$43.00
30"	1/6	540	5800	48.50
36"	1/4	415	8000	54.50
42"	1/3	390	11500	67.50
48"	1/2	360	16500	90.00

General Electric Immersion Heaters

Suitable for heating liquids, tanks, kettles, etc. (1 KW raises temperature 100°F 3 gallons per hour.) Fitted for 1½" iron pipe thread. Can be used as 110, 220 volt or 3 heat 110 volt.
600 Watt .....$6.00 1200 Watt .....$ 8.75
750 " ..... 6.30 2000 " 10.25
3000 Watt $12.00

We have on hand a large variety strip (space) heaters. Quotations on request.

Exhaust Fans, Bucket Blade, G. E. A.C. 110 volt motors.

	RPM.	cu. ft. per min.	Price
9"	1550	550	$10.50
10"	1550	550	11.50
12"	1750	800	16.50
16"	1750	1800	17.50
16"	1140	1650	25.00
18"	1750	2500	19.50
18"	1140	2100	28.50
20"	1140	2800	30.00
24"	1140	4000	35.50
24"	850	3800	38.50

Other voltages & frequencies available at slightly higher prices.

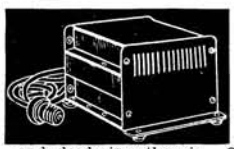
ROTARY PUMPS FOR VACUUM AND AIR

Especially designed for laboratories, jewelers, dentists, doctors, hospitals, etc. Also for small gas furnaces.
No. 1, max. pressure 5 lb. $8.90
Complete with AC., 110 volt motor $25.00
No. 2 max. pressure 10 lb. $13.25
Complete with AC., 110 volt motor $30.00

DURAKOOL MERCURY SWITCHES

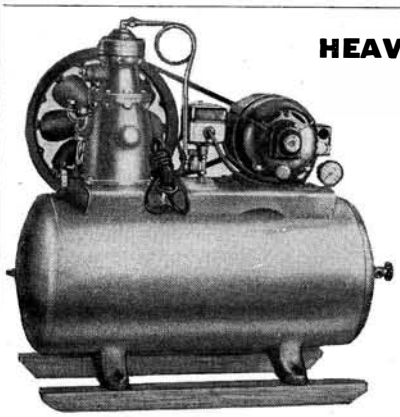
This metal mercury switch overcomes faults of usual mercury switches. May be turned a full 360°. Has thousands of known applications from tiny lab instruments to gigantic power controls.

1 Amp.	.....$1.10	20 Amp.	.....$3.15
3 Amp.	..... 1.65	35 Amp.	..... 5.50
5 Amp.	..... 1.65	65 Amp.	.....11.00
10 Amp.	..... 2.00	200 Amp.	.....50.00



COROZONE OZONATOR

An electrical device that converts ordinary oxygen into ozone. Revitalizes and deodorizes the air. Suitable for laboratory, factory, office or home. 110 volt AC Only 10 watts. $7.50



HEAVY DUTY TWIN COMPRESSOR

Complete automatic twin cylinder outfit fully equipped with a heavy duty ¼ H.P. motor, air tank (300 lbs. test—150 lbs. A.W.P.), automatic adjustable pressure switch, gauge, check valve, safety valve and drainer, etc. Delivers 150 lbs. pressure. Displacement 1.7 cu. ft. per min.

Model S H T ¼
12" x 24" tank A.C. 110 or 220 v. 60 cycle **$52.50**
16" x 30" tank A.C. 110 or 220 v. 60 cycle **$62.50**

Large stock of air compressors, ¼ H.P. to 20 H.P. A.C. and D.C., all voltages, 1 to 120 C.F.M. displacement, built for all requirements. Additional data on request.

PIONEER AIR COMPRESSOR CO., Inc.
120-s CHAMBERS ST. NEW YORK CITY, N. Y.

LONGINES
the most honored watch in Aviation

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THE WORLD'S MOST HONORED WATCH

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Montreal, Canada

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75th Anniversary Watches
PAR AVION SERIES, EACH WATCH $47.50

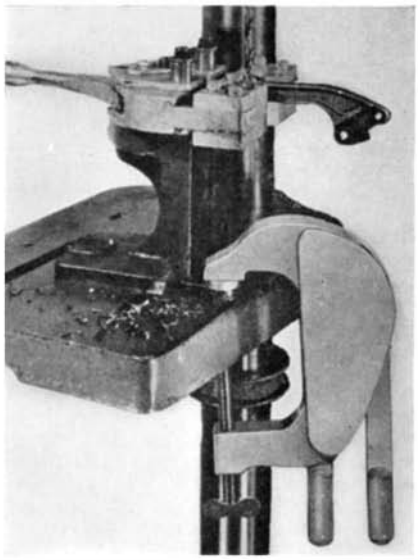
Industrial Growth

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

CLAMP

Holds Work With One-Ton Grip

FOR holding work in position on any routine jobs in the shop, a new model, deep throat, toggle-action clamp has been announced by Knu-Vise, Inc. The lower jaw of the "Klampacto," as the new clamp is called, swings clear of the work



Grips securely

when released. Two handles are provided so that it is unnecessary to hold both the clamp and the work when fixing it in position. A squeeze of the hand applies 2000 pounds of pressure to the jaws. This clamp is available in three models with five-inch, six-inch, and ten-inch jaws.

PAINT

Substitute for Aluminum Paint Has New Features

COATING qualities formerly found only in aluminum paints are provided by a new type of paint which uses a penetrating oil vehicle. It is reported that this new surface coat, known as Totrust, produced by The Wilbur and Williams Company, will serve many purposes just as well as does aluminum paint, yet is much less expensive and is not affected by priority rulings.

This new coating material can be applied over moist surfaces, directly on galvanized metals, or to surfaces that have rusted to any degree. The penetrating quality of the vehicle enables the paint to penetrate pin holes and rusted pits in the metal, expelling any moisture and surrounding and effectively isolating any particles of rust. The resulting film is said to be hard and durable, yet flexible. It is available in a light gray shade that is claimed to have approximately the same light reflection as aluminum paint.

BRAZER

Compact Portable Unit for Silver Soldering

WHEREVER soldered joints are required in the construction of motors, transformers, various types of fittings, carbide tool tips, and the hundred and one other applications in various industries, use will be found for a new electrical brazer designed for the application of silver solder. This portable device, known as the Ideal Brazer, consists of a power unit or transformer and

Brazing pliers in use

a pair of electrical heating pliers. When the part to be soldered is held in the pliers and the secondary circuit is closed, the part is quickly heated to brazing temperature. Heat is accurately controlled by a foot switch and the jaw ends of the heating pliers are removable so that different shaped jaws can be used, depending on the work to be held.

The brazer operates on 230-volt or 440-volt power supply, the secondary voltage being reduced to only ten volts.

HEATERS

Immersion Type Booster

For Industrial Use

IN MANY coating and saturating processes involving the use of heated asphalts, oils, paraffins, waxes, resins, creosote, varnishes, insulating varnishes, and so on, it is necessary to increase or maintain temperature of the material by applying heat in the line between storage tank and the container where processing occurs. For use in such cases there has recently been designed an immersion type booster heater available in capacities ranging from 10 to 100 kilowatts. These heaters, known as Falcon and manufactured by H. O. Swoboda, Inc., consist of spirally coiled heater strips arranged to form a compact unit. The heater is installed in a sealed tank built in the pipe line between storage vessel and coating or saturating tank. Temperature is maintained uniformly by means of automatic controls. Only two simple connections are necessary for connecting the heater to the electric circuit.

For booster service

The Falcon booster heater is applicable for use with any materials having electrical insulation properties (non-conductors). In operation, the "bare" electric coils are immersed in the material to be heated. In this manner a direct thermal contact is established, in-

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Pocket type. 360° Limited Quantity..... **$10.50**

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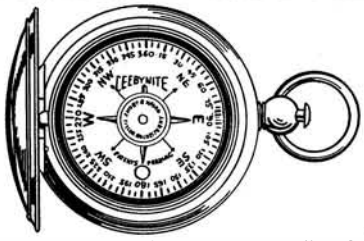
2-inch Liquid, compensated. For taking bearings in horizontal plane. Measuring angles, distances, triangulation. topographical drawings. Needle attached to jeweled dial azimuth circle in 64 divisions revolves on fixed center point. Case has glass sight etched hairline, underneath is a horizontal level, in line with center of needle is a hinged slit-sight. Also magnifier for reading compass bearings when object is sighted. Leather case.. **$3.50**



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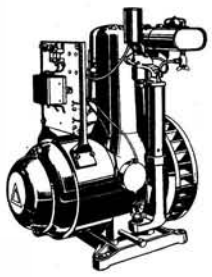
Engineers U. S. Army Precision Type Tripods
Keuffel & Esser, precision type hardwood, 42" long, 3" diameter bronze platform with 5/16" #18 threaded stud ¾" long. Has brass tension adjusting screws. Legs reinforced with cast bronze and steel tips. Weight 5 lb.
Price **$4.95**

U. S. Army Generating Plants, New

Gasoline Driven. "Delco" 1000 watts, 120 volt direct current generator. Single cylinder, 4 cycle air cooled 2½ inch bore, 5 inch stroke, 1400 RPM, battery ignition. Hand crank. Weight 340 lbs. Price **$200.00**



Additional data on request.

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A-12	" "	450.	"	12.50
B-4	" "	75.	"	4.00
B-2(J-3)	" "	37.	"	3.50
M-8	" "	11.	"	1.50
L-20	" "	13.	"	2.00
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All cells 1.2 volts each.

Above prices are per unit cell. For 6 volt system use 5 cells. 12 vt.—10 cells, 110 vt.—88 cells. Note: On all cells 75 amps. or less an additional charge of 10% is to be added for trays.

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Keuffel & Esser Alidade, Brass, black finish, beveled edge, 10½ in., graduated to 5000 meters. Folding Sights, with hair line, 40 divs., (Div. equals 10 miles), with spirit level.
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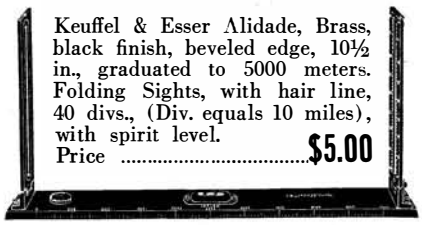

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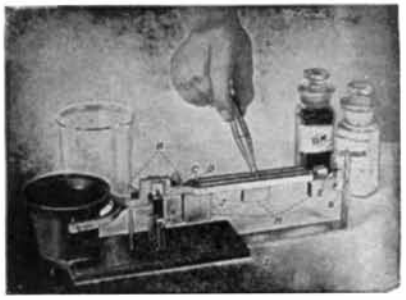

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suring that practically all the heat generated is transferred to the material, and providing an improvement over the ordinary radiant and strip heaters normally used on the exterior of tanks. Due to the large surface area of the heating elements, and the fact that the heater is designed for operation at an extremely low watt density per unit of heat transfer surface, no temperature gradient is set up between heater and material. This prevents disintegration accompanying other methods which operate at a higher surface temperature than that of the charge.

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OCCUPATIONAL skin diseases of various types are to be found among workmen whose hands are constantly exposed to various types of oils and solvents. For men working under these conditions a new type of glove made of a material called Resistoflex PVA has been developed which provides complete protection yet is not bulky enough to hinder ordinary manual operations.

Since the material from which these gloves are made contains no sulfur, they can be used when handling finely polished metal surfaces without danger of tarnishing.

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ADEQUATE protection for welder's eyes is provided by a new shield-equipped goggle known as Arc Ban, placed on the market by

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—SCIENCE IN INDUSTRY—

Bausch and Lomb Optical Company. Not only do the lenses provide protection, but louvres in the side shields, which are made of a composition material, keep out all light while admitting sufficient air for ventilation.

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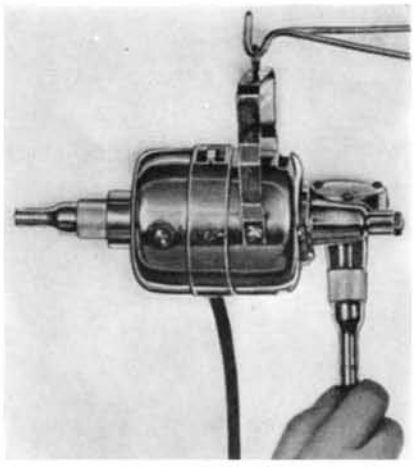
TOOLS

Flexible Shafts, Wide Speed Range

A NEW line of hand tools specifically designed for shop requirements where a wide range of speeds is called for have been made



Attaching flexible shaft to the worm-gear, low-speed shaft end

available by the Foredom Electric Company. A simple and quick method of changeover from direct to worm-gear reduction is provided by a double-end shaft on the motor. For direct drive, the flexible shaft assembly is screwed into one end of the motor; for worm-gear drive, the flexible shaft assembly is attached to opposite end of the motor.

Speeds available with this tool are stated to be from 2000 to 14,000 revolutions per minute with direct drive and from 500 to 5000 at the geared end. Motors supplied are universal, air cooled.

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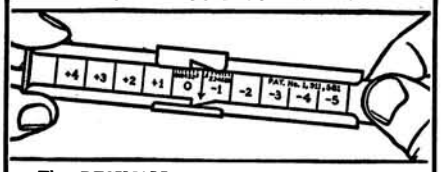
The Morse Decimalizer



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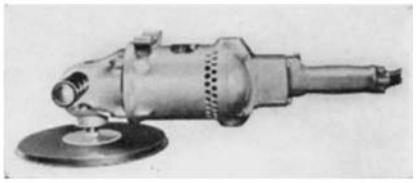
self-emulsifying degreasing solvent, Gunk, recently described in these columns, by the simple addition of light lubricating oil and a low-cost petroleum distillate. Water-soluble cutting and grinding lubricants may be prepared in exactly the proper grade to fit each particular job at hand. Variation of the quantity and type of materials used will vary the resulting compound to suit any given specifications. Such composition may then be diluted with water to form the final cutting and grinding emulsion.

The concentrated Gunk is said to impart to the emulsion, by virtue of its alkyl phenol content, a quality that leaves ferrous metal surfaces resistant to the formation of rust.

SANDER

Heavy-Duty Unit for Fast Work

DESIGNED for constant production-line use with nine-inch disks, a new Black and Decker sanding



Fast and tough

machine has been produced to meet demands for faster schedules. The sander incorporates a universal motor and a new spindle-lock for quick disk changing.

PRIMARY BATTERY

High Capacity, Indefinite Life When Idle

RAILROAD signaling systems and protective devices, as well as other applications where primary batteries have been used previously, can now be provided with a new power source which has over 70 percent more current output than any of its predecessors. Recently announced by Thomas A. Edison, Inc., this new primary battery is believed to be the most powerful of its kind ever made as a standardized product. It belongs to that group of power sources generally referred to as "copper-oxide caustic soda batteries." The electrical output is generated entirely by the chemical action of a sodium hydroxide solution on electrodes of zinc and copper oxide.

This new battery has a capacity rating of 1000 ampere-hours. When discharging, it will deliver that amount of power at any rate of current up to 22 amperes. Operating voltage is approximately .65 volts, with higher voltages obtained by connecting batteries in series. The high current output makes it possible to supply many current requirements with a single series-connected group where it was formerly necessary to use multiple-series groups.

MAGNIFIER

Compact Design For Small Parts Inspection

FOR inspecting the finish and other details on small machine parts and similar work, a practical device in-

Well lighted

corporates a large diameter lens and an incandescent lamp. This unit, known as the Spectifier, is so designed that the parts to be inspected can be passed rapidly under the lens by hand. The inspector uses both eyes; critical inspection can be made from all angles and at any reasonable distance from the lens. The device uses no focusing system and needs no holders for materials being inspected. The uniform lighting provided by this device is an important factor in standardizing on a method of inspection, eliminating objectional variations that are found when inspection is carried on under non-uniform lighting.

Ocean Air Transport

Painstaking Planning is Behind Our Transatlantic Service; A Glimpse of the Future

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

THE twenty-ninth Wilbur Wright Memorial Lecture, before the Royal Aeronautical Society in London, was delivered by J. T. Trippe, President of Pan American Airways. Mr. Trippe, with an unrivaled international reputation as an organizer of ocean air transport, gave our English friends a history of development, a masterly exposition of the scientific manner in which flights are planned and conducted, and a glimpse of the future, of which only a brief summary can be presented here.

The Boeing B-314 Clippers have rendered splendid service during the war. Individual mail loads of 13,000 pounds, in addition to 33 passengers eastbound and 35 westbound, were being transported over the Atlantic at the time when Mr. Trippe delivered his paper. The flights have been made under very difficult weather conditions at times. Yet the hint was given by the lecturer that the 84,000 pound Boeing Clippers may, in 1942, be superseded by landplanes. Why landplanes for over water service? Because emergency landings in rough water are not much safer with flying boats than with landplanes properly equipped. Boats, rafts, and the vicinity of ocean lanes are the real safeguards; even a sturdy flying-boat hull will soon yield to the pounding of the North Atlantic. Because landplanes will have cruising speeds of some 75 miles an hour faster, and faster cruising speeds are indispensable in view of high velocity westerly winds in winter. Because there is always danger of ice at North Atlantic coast points. Because heavy swells at Horta in the Azores delay passage. Because the real advance in North Atlantic flying is to be by means of non-stop operation from New York to London, and only landplanes are capable of giving this service.

Thanks to Conrad, McFee, and Forrester, almost every landlubber knows something of life at sea, of standing watch, of eight bells. But the public may not yet have learned that the Clippers are developing a routine and a life in the air, and a tradition which is very like that of a sea-going vessel. The Boeing Clippers have a crew of eleven: Captain; First Officer; Second, Third, and Fourth Officers; two engineers; two radio men; two stewards.

There are four engines on the Clippers and, with their accessibility and high endurance, it is unlikely that more than one engine will fail on a trip. There must, however, be a margin of safety in the fuel carried. The operations men calculate an actual fuel load which is computed after thorough analysis of all forecastable conditions which the plane must encounter on its planned crossing. Over and above this calculated fuel load there is placed aboard the boat 4½ hours of reserve flying fuel.

Then there is a Scientific Control of Flight. Briefly, this is a process by which the most efficient performance of the aircraft is charted through the most favorable conditions available to the flight. Before the beginning of each crossing, the crew assigned for that particular transatlantic flight, accompanied by maintenance and service engineers, inspectors, and so on, puts the ship through a test flight on which air speed and all fuel-flow indicators are calibrated and all compasses are carefully compensated.

Then the Meteorologists get to work and prepare a three-dimensional chart, prepared on the latest air-mass analysis. This third-dimensional or vertical weather chart is drawn to provide the pilot with an illustration of what conditions he is to expect and to illustrate the clouds, rain, fog, and icing areas forecast on the route. From these charts, the meteorologist divides the projected flight line into various zones. Each zone represents an area of more or less consistent winds and the lengths of each are dependent upon the location of the various pressure areas and weather fronts along the route. From

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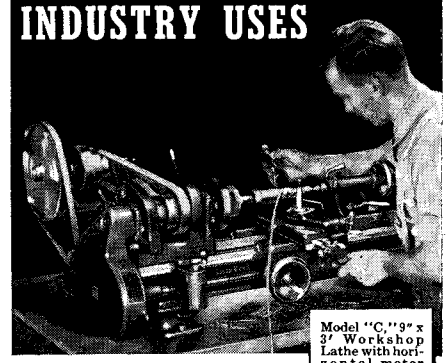

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weather maps and the third-dimensional chart a Flight Forecast is prepared. This reports the state of the weather, the amount, type, and height of clouds, the estimated level at which freezing temperatures might be encountered, and wind direction and velocity at 1000, 4000, 8000, and 12,000 feet, as well as much other useful information.

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Finally, there is the "Howgozit Curve" which was developed by Captain Harold Gray, Chief Pilot of the Atlantic Division. To describe the "Howgozit Curve" we can do no better than to quote Mr. Trippe's own words: "Its purpose is to present to the crew aloft and to the flight watch ashore, a continuous flow of information as to the fuel reserve remaining aboard the aircraft and the fuel required for completion of the flight . . . Using the path selected in the Flight Forecast and performance charts for the plane and its engines, a curve of miles *vs* gallons is plotted. The second curve shows gallons *vs* hours of flying. The third curve is of hours *vs* miles." Similar curves are drawn for three-engined operation out of the four. All these curves are drawn solidly. As the flight proceeds, a constant record of the plane's actual fuel consumption and mileage is maintained. Along the solid curves, the First Officer draws dotted curves showing how everything is going. Hence the title, "Howgozit Curve."

Our readers will agree that the Captain of the ocean airliner is no longer merely a brave and skilful flier. He is now as skilled a planner, navigator, leader, and administrator as the captain of a crack ocean liner.

SOARING

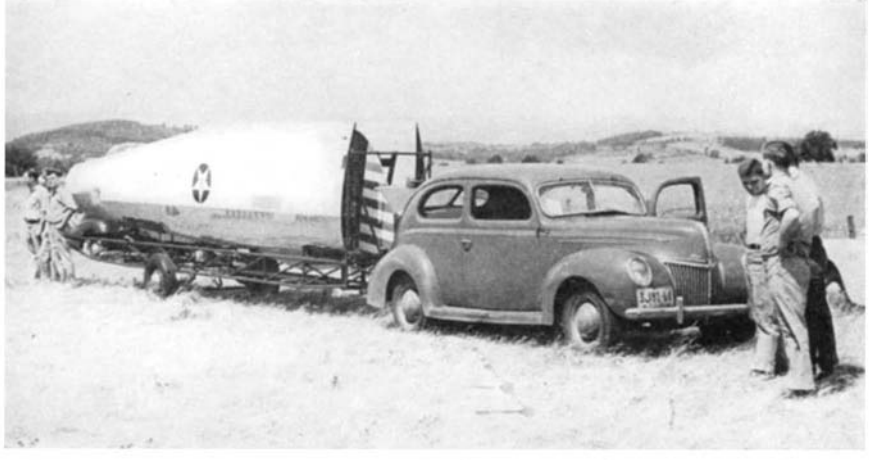
Interest Stimulated by Military Uses

THE Twelfth Annual National Soaring Contest held at Elmira was as successful as usual, with fine performances turned in by the winners, and a larger gathering of enthusiasts than ever. Gliding is probably coming into its own at last in the United States.

General Henry H. Arnold, Deputy Chief of Staff, has stated: "We have been studying gliders and their possibilities for usefulness in connection with national defense and are preparing a glider program including training of glider pilots and procurement of several types of gliders. We consider gliders essential to possible operations of all modern air forces." General Arnold also mentioned the fact that 12 Army Air Corps officers recently completed glider training.

Major Lester D. Gardner, Executive Vice-president of the Institute of Aeronautical Sciences, predicted Federal stimulation of glider training and thought that an inexpensive and excellent way of selecting power-plane pilots was to glean them from the ranks of thousands of youths training with gliders.

In general, there is a feeling that gliders may serve to bridge the



A sailplane for the Army

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Of promising military value

gap between model building and power flying; that gliding should create a reservoir of skilled fliers; and that the military uses of the glider in transporting men to hostile territory are most promising. —*A. K.*

TRAINER

Learning Flight Fundamentals on the Ground

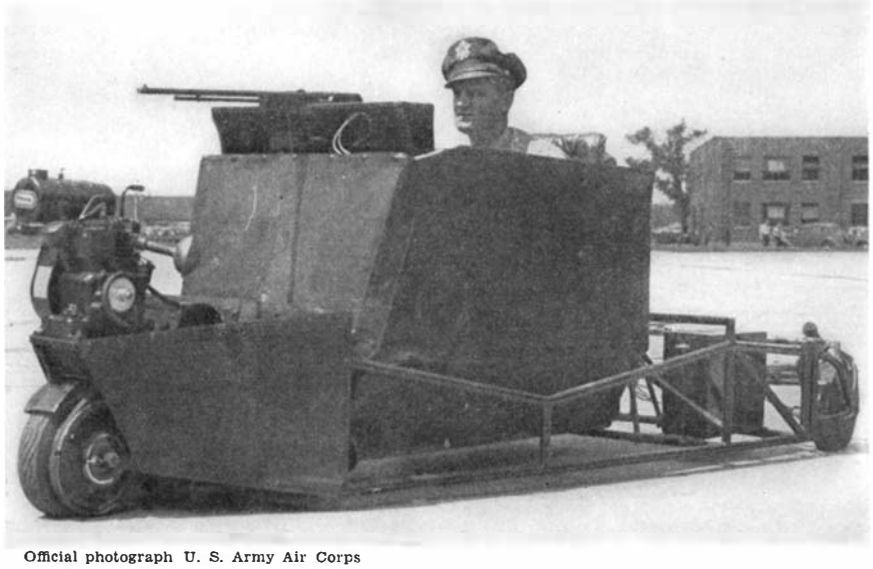
A CURIOUS device, known as the "Preflight Reflex Trainer," and designed to teach a student how to coördinate stick and rudder controls before actual flight training, has been built at Wright Field by Major G. V. Holloman of the Army Air Corps. Equipped with a standard airplane seat and regular service controls—that is, rudder, stick, throttle, brake, and gun trigger—the preflight trainer can be operated on any large pavement. It is powered by a small gasoline engine. The cockpit, suspended in a triangular frame mounted on three wheels, banks in response to the controls. Control and operation of a machine gun can be practiced in conjunction with operation of the usual flight controls. A warning horn informs the student when he over-banks or makes any other mistake in coödinating the controls. The apparatus was conceived jointly by Colonel William C. Ocher and Major Carl J. Crane.

In these days when so many thousands of pilots have to be trained in short order, the preflight training may prove of real value.—*A. K.*

PRIVATE FLYING

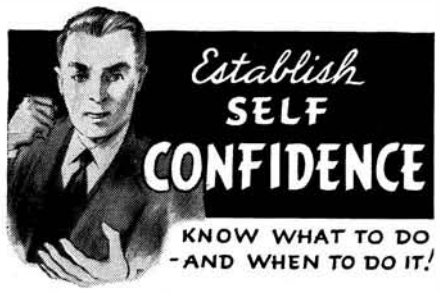
Research Institute to Be Established

PRESIDENT of Aeronautical Corporation of America, Carl Friedlander tells us that he will establish the Aeronca Research Institute solely for the investigation of private flying problems—new designs, new materials, new conceptions. This is an excellent idea. Private flying is constantly extending, and after the "emergency," it should grow on an immense scale, particularly if research helps to solve its problems. In all probability this will be the first research institute of its kind ever established by the American aviation industry.—*A. K.*



Official photograph U. S. Army Air Corps

It has everything but wings



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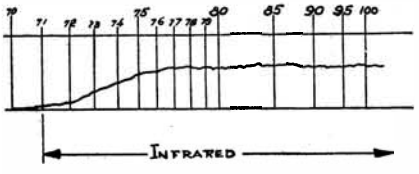
Introducing Blackout Flash

"BLACKOUT" (infra-red) flash photography, already a practical tool abroad, where it is being used by newspaper cameramen in routine press photography during blackouts, has become available in this country through the introduction, by the Wabash Photolamp Corporation, of the Blackout Superflash Bulb. Specially treated with a "black" infra-red filter jacket designed to absorb practically all the "visible" light produced inside the hydronalium wire-filled bulb, transmitting predominantly the infra-red rays invisible to the eye but having an instant effect on infra-red film in a camera, the lamp is the flash version of the black filter used with infra-red film outdoors or of similar filters used over light sources in indoor infra-red photography. Its size is the same as the Superflash bulb No. 2, but the new lamps are dipped in a special dye-lacquer solution which, when dry, provides a hard "skin-tight" filter over the entire bulb.

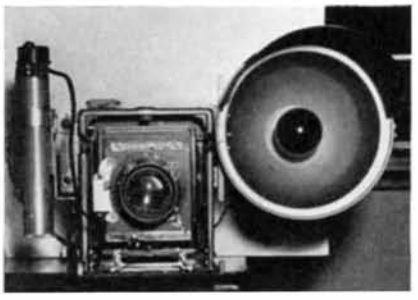
The spectrum which, revealed by a prism, shows the color composition of white light as ranging from violet and blue at one end to orange and red at the other, is generally familiar. This is known as the "visible" spectrum because these colors produce a definite sensation upon the human vision. However, the complete spectrum does not stop there; it also embraces "colors" we do not see. At the one end is the invisible ultra-violet and at the other end is the invisible infra-red.



Infra-red range, Blackout bulbs

The various sections of the spectrum are frequently identified in terms of wavelength, this being progressively shorter as one approaches the ultra-violet end of the spectrum and progressively longer as one goes towards the infra-red. Specifically, the visible spectrum is confined approximately within the limits of 4000 to 7000 Angstrom units. Infra-red photography, however, is concerned solely with the region beyond 7000 A.

The infra-red transmission of the Blackout Superflash is shown in the spectrogram reproduced here. The Wabash company, who supplied the chart, describe the light transmission of the filter as follows: About 9 percent is in the ultra-violet area. Light transmission in the red starts at 6900 A (that is, in the still visible red), gradually rising to 7500 A.



Infra-red reflector at right

The blackout bulb is used with infra-red film, available from several manufacturers. Eastman and Agfa produce it in roll film, and DuPont in 35mm rolls; Eastman also supplies the film in sheet form. The film is sensitive to ultra-violet, violet, and blue at the short end of the spectrum as well as to the infra-red at the longer end. However, being more sensitive to the shorter than to the longer wavelengths, a special filter is required that will effectively absorb or "hold back" the shorter wavelengths but freely transmit the longer. Without the selectivity thus provided by the filter, the characteristics of an infra-red photograph would be lost and the result hardly differ from normal photography. The black bulb is introduced to do this job for flash.

No special synchronizing adjustments are necessary when using black bulbs and the reflector normally employed for flash work is completely suitable for the purpose. Slightly greater efficiency, however, may be had by using a gold-plated reflecting surface, according to Wabash. A special reflector, designed by Sun Ray on recommendation of Army officials, is shown in one of the illustrations. The reflector has an adjustable hood or visor for use in blackouts as a precaution against detection by enemy aircraft flying above the photographer, since the flash is clearly visible in darkness. In the illustration, this special reflector is shown mounted on the left side of the

In a black dark-room

camera, with the synchronizer in its normal position on the right-hand side. This is to facilitate a quick change from black bulbs during a blackout or other situation, to ordinary flash bulbs afterward, the regular reflector being mounted over the battery case, as usual. The black bulbs may, of course, also be used in ordinary "open-and-shut" fashion.

On the basis of test exposures,

From a panchromatic negative . . .

using Eastman Infra-red cut film, the following table provides an accurate guide to exposure with the blackout bulb. The table presupposes, however, that pictures will be taken in a room with light-toned walls or outdoors where a similar condition can be arranged. In rooms with dark walls or outdoors, where one cannot count on the added reflection from light surfaces, one stop larger should be used. The distances refer, of course, to the number of feet separating the lamp and the subject, irrespective of the camera distance.

Distance	*f/ Stop*	*Shutter*
6 feet	*f*/8	1/50
10 "	*f*/5.6	1/50
12 "	*f*/5	1/25
14 "	*f*/4.5	1/25

The light to which the infra-red film is sensitive does not come to sharp focus on the same plane as does visible light. It is sometimes necessary, therefore, to make manual compensation for this discrepancy by racking the lens forward slightly. In practice, however, this is not always required. In the case of miniature lenses, for example, because of their short focus and consequent depth of field, compensation may be ignored, particularly if medium small stops are used. As a matter of fact, the correction required varies widely with different lenses, this variation ranging from ¼ to 3 percent of the focal length of the lens used. Dr. Walter Clark, authority on infra-red, states that "anastigmatic lenses used on hand cameras are usually satisfactory, especially if they are stopped

. . . and by infra-red

down to *f*/8 or less." He further declares that "in actual practice, most anastigmats working at *f*/4.5 and of focal length of 7 inches or less give fairly good definition at full aperture."

Wabash recommends that infra-red film exposed by flash be developed 50 percent longer than indicated time in order to hold shadow detail; to avoid burning up the highlights, they suggest soft development in some such developer as ABC Pyro or Agfa 47. We used D-76 in accordance with manufacturer's instructions—about 10 minutes in a tank at 65 degrees, Fahrenheit—with satisfactory results. Development is in total darkness or by the light of a Wratten Series 7 (Infra-red) Safelight using a 10-watt bulb and at a distance of three feet from the developing tray.

In handling infra-red film, the following precautions should be observed: use the cut-film holders having the five little knobs on the grip edge of the slide; do not use those having only three knobs as they may cause fogging of the film due to the material having a tendency to transmit heat. Infra-red rays being heat rays, any condition that may permit unusual heat to reach the films will cause fog. Therefore, do not carry the holder against the body; no camera loaded with infra-red should be kept exposed to the sun for any length of time; when loading film, do not place fingers on the material, as heat from the fingers will fog the film.

In flashing a number of bulbs, it is recommended that the photographer make some immediate disposition of the used bulbs to avoid confusion with unused bulbs. Marking with a piece of white chalk is suggested. This department found, however, that in actual practice the bulb provides its own check by a telltale corrugation on one side of the bulb, where the intense heat causes the coating to swell and then cool in irregular ridges.

The effect of infra-red light is pe-

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AMATEUR PHOTOGRAPHY CONTEST

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

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

Divisions In Which Prints May Be Entered

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

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

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

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Address all Entries to

Photograph Contest Editor, Scientific American
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Rules of the Contest

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

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

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

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

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

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

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

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

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

10. No entries will be considered from professional photographers.

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

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

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

THE JUDGES:

McClelland Barclay
Artist

Ivan Dmitri
Artist and photographer

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

Robert Yarnall Richie
Photographer

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UNIVERSAL PHOTO ALMANAC AND MARKET GUIDE. *How, when and what to photograph in order to make money with your camera; where to sell different types of prints. $1.00.*

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culiar, as may be seen from the photographs of the young lady and of the two darkroom workers. Lipstick is recorded as white, veins lying under the skin show up like black lines sketched on the arms, facial tones are distorted, and red stripes on a yellow dress are practically merged into a single white tone. Comparison with the photograph taken on panchromatic film in normal photography will show the startling differences. The men in the darkroom, though clean shaven, look as though they needed another one. Old stains in clothing, though dry-cleaned, often show up clearly.

Besides blackout work, the bulb is intended for use in darkened theaters and night clubs, courtrooms, public lectures, symphony concerts, candid photography, as well as scientific research.

We have found, however, that the light produced by the flash is definitely visible, particularly so when intensified by surrounding darkness. In flashing the portrait of the young lady, we could clearly see the face of the subject bathed in a red glow during the brief flash interval. We cannot, therefore, agree that the light is "invisible" to the extent that the flash would go undetected in a darkened room. Because of the undoubted value of such a bulb, we do hope the manufacturers will experiment further with the dyes involved in order to bring about the desired improvement. Perhaps by the time this is published, the improvement will be a fact.

Fall Colorings

NATURE'S annual Fall show is here again, and a grand show it is, as usual. Unquestionably, it is a job for color, whether you shoot still or movies, or both. It is particularly attractive as a movie subject. The movement of the branches, the falling of leaves, the slow procession of clouds in a blue sky, all combine to make a perfect "set" for the movie-maker. Get a boy and a dog into the picture, walking along a winding road in the country, and you have something that looks as real as life. Don't always work with the sun behind the camera; try some shots with the sun to the side or back-lighting the leaves. Use a polarizing screen to give extra "umph" to the blue sky; you will like the dramatic effect of white clouds against the deep blue. Include a lot of close-ups and glean a lot of "oh's" and "ah's" when you show the results on the screen.

Low Viewpoint

IN OUR August, 1941, issue, we published a picture of a boat at low tide, which we described as having been photographed with the camera about six inches from the ground. One of our readers took issue with us because, he wrote, "the height of

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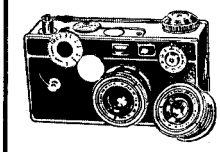
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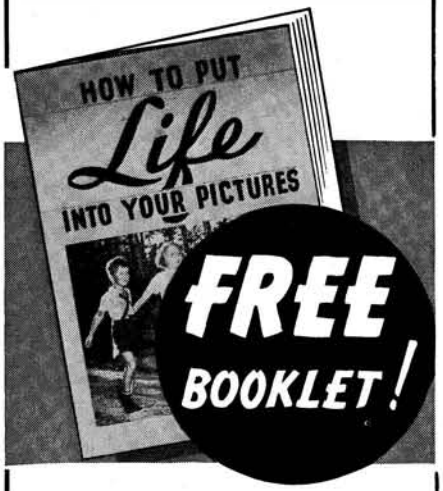

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the sea horizon is the measure of the height of the camera," and went on to say that "this indicates that the camera was considerably higher than 6 inches above the beach shown; I would estimate that the camera was about 4 feet higher than the beach on which the boat rests."

First, it is necessary to point out that the view of the boat as shown in the picture could not have been photographed except from a low angle. Secondly, it must be realized that the height of the horizon in a print is not a measure of the height of the camera. The position of the camera in the case in point was, we repeat, six inches from the ground; in making the print, the foreground was favored and part of the sky was eliminated in the interest of good composition.

Emergency Weights

WHEN in need of extra weighing units or when these have been temporarily misplaced, darkroom workers have used American coins as substitutes to give approximate equivalents, as follows:

Silver dollar	400 grains	26 grams
Half-dollar ..	200 "	13 "
Quarter-dollar ..	100 "	6½ "
Dime	40 "	2½ "
Nickel	80 "	5 "
Cent	50 "	3¼ "

When the Wind Blows

WHEN in need of extra weighing units or when these have been even a painter goes to in order to steady his easel (notice the yards of linked chain suspended in the center of the tripod easel?) when the painter himself assumed a pose that had pictorial possibilities. Such as they are, judge for yourself in the accompanying reproduction. To us, there seemed to be such movement in the shot that we have seldom seen its equal in a still picture. The pose of the painter (not posed for the shot, as he was totally oblivious to our presence), the position of the right leg, the sweep of the grass as it was blown by the wind, the formation of the clouds at the click of the shutter, all added their bit to the total impression. The exposure was on Plus X film, red filter, 1/50 of a second at *f*/16.

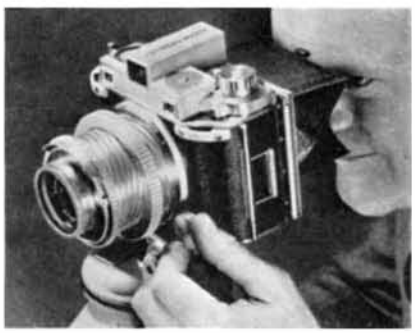
"On the Dunes"

• • •

WHAT'S NEW

In Photographic Equipment

KODAK MEDALIST ($165): 2¼ by 3¼ camera using roll film; adaptable to cut film, film-packs, and plates. All-American-built, uses 620 roll film; with accessory back, 520 film-packs and 6.5 by 9cm films and plates. Equipped with Kodak Ektar lens *f*/3.5, 100mm focal length, comprising five elements. Interior glass-air surfaces treated, reducing inter-surface reflections to minimum. Angle



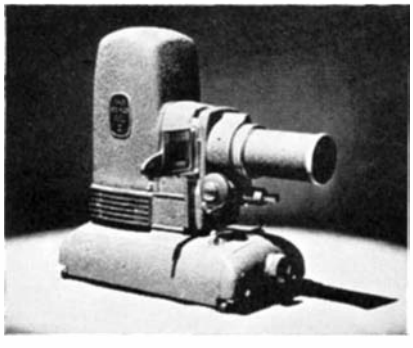
of coverage 54 degrees, flat field. Shutter special model of Kodak Supermatic No. 2, gear-train retard, presetting type, with low-inertia blades of thin spring steel; has eight apertures *f*/32 to *f*/3.5; nine speeds from 1 second to 1/400 second, plus bulb. Has built-in, delayed-exposure mechanism; cable release socket for remote control; Photoflash synchronization. Lens support consists of two helically inter-threaded tubular members; lens extended and retracted by focusing ring or micro-focusing knob. Depth of field scale, built into top of camera, coupled to operate with focusing tube after extension to picture-taking position. Range finder split-field, military type coupled to operate automatically with lens. Range finder located small fraction of an inch below eyepiece of view finder. View finder gives parallax correction automatically while range finder eyepiece shows central portion of subject field covered by view finder. Red marking for infra-red. Film transport and shutter work together, preventing double exposure.

ABBEY AMPLANE REFLECTOR ($4.75): Designed for use with midget lamps. Choice of wide or narrow beam offered. Reflector constructed with removable disk. With latter in place, flat, spot-free illumination from side to side up to 20 feet indoors

obtainable with normal diaphragm openings. Disk used for concentrated light, which leaves highly polished center exposed, allowing shots at 50 feet. With disk removed light useful for spot-lighting and special effects. Amplane surfaces silver-plated, protected by special heat-resisting and extra tough lacquer, yielding high reflection.

3A KODAK, SERIES III: Postcard size pictures, 3¼ by 5½ inches. Equipped with Kodak Anastigmat *f*/6.3, 170mm focal length, mounted in Kodamatic shutter with speed range 1/10 to 1/200 of a second, plus time and bulb; also delayed action. Equipped with rising front, brilliant waist-level finder adjustable for vertical or horizontal pictures; folding, metal-frame eye-level finder on side panel. Uses six-exposure No. 122 Kodak roll film.

FILMO SLIDE MASTER: For projecting two by two-inch transparencies. Features "base-up" lamp (operates with base upward); blackening deposit formed during operation of lamp not deposited on sides of lamp but is carried elsewhere in lamp, out of beam. Top of lamphouse hinged snap-cover, which automatically breaks electrical circuit as it is opened. Designed to take 500-, 750- or 1000-watt base-up lamps. No



light spill. Motor-driven fan circulates forced draft of cool air throughout projector, including area around slide. Offered with choice of 3½-, 5- or 7½-inch *f*/4.5 anastigmatic lens. Condenser includes two heat absorbing glass filters. Slide carrier of die-cast metal, with special air passages for circulation of air around slide. Operates on 100- to 125-volt AC or DC.

CROWN CABLE FLASH SYNCHRONIZER ($3.95): Basic unit consists of standard metal cable release with synchronizing mechanism built into portion normally held in hand. May be used either as simple cable release or converted to synchronize when connected by means of electrical cord to a battery case and reflector. Features: will operate any camera using cable release; operation combination of manual and mechanical, therefore self-cocking and easy on shutter; special action, sealed in light aluminum shell, levels off differences in individual operation of cable release; stroke control element adjusts synchronizer to individual shutter; timing element fixed—preset to accommodate present-day flash bulbs; differences of adjustment in plunger length only. Device weighs slightly more than the conventional cable release.

BOLEX IRIS VIGNETTER ($10, $11.50): Closes down completely. After iris closes, special arm drops into place over last point of light, completely blacking out circle. Specially made for Leitz Hektor Rapid 27mm *f*/1.4 lens; may be adapted to all other 1 inch lenses for use on all cameras. Cameras having back-winding mechanism provide means for making satisfactory lap-dissolves with this device.

NEW KALART LENS-COUPLED RANGE FINDER ($24): Model "E" supplants present Model "F." Fits all Speed Graphic cameras, Watson Press cameras, and most film-pack cameras. Streamlined in appearance, has bigger and brighter image permitting focusing even under unfavorable light conditions. Superimposed image type. Close working distance increased to 2½ feet on new shorter focal length lenses. All adjustments internal. Range finder adjustable for all lenses from 10.5 to 16.5 cm.

WABASH BLACKOUT SUPERFLASH (60 cents each): Specially treated flash bulb for use with infra-red film when photographing in total darkness. (See lead article, Camera Angles.)

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KOTAVACHROME PROFESSIONAL PRINTS: Reproduced by Eastman Kodak Company, Rochester, New York, from Kodachrome professional film transparencies. Prints range up to 30 by 40 inches from all sizes Kodachrome professional film except 11 by 14 inches and stereo sizes. Maximum print from any transparency limited to six diameters. Prices range from $12 for an 8 by 10 inch print to $90 for a 30 by 40 inch print; for additional prints from same transparency ordered at same time prices range from $6 for an 8 by 10 to $60 for a 30 by 40.

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"Skeeter Trap" in Defense

SEVERAL months ago (May 1941) we talked about the "Skeeter Trap," extolled its virtues for wing-shooting practice with shotguns. Now we find this excellent little piece of mechanism, designed primarily for the scatter-gunner's recreation, assigned to a niche in the vast picture of national defense.

Residents of Pleasantville, New York, like citizens of innumerable other villages and cities throughout the nation, have formed a civilian defense unit, known as the Pleasant-

Trains emergency police

ville Emergency Police. Some 40 or 50 men above draft age—many of them veterans of World War I—are taking a course in rudimentary police work under the guidance of Lieutenant Kenneth Romaine, of the regular Pleasantville police, and a graduate of the National Police Academy, Washington, D. C., a training institution conducted by the Federal Bureau of Investigation.

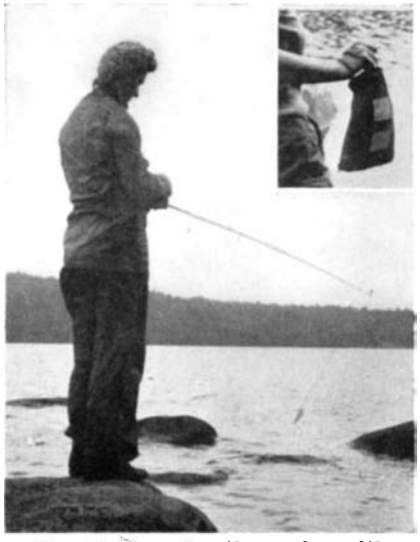
Naturally, this work involves an operating knowledge of firearms, including shotguns. To this end the "Skeeter Trap" has been put to work tossing out the little 2⅝-inch clay targets a distance of 70 to 80 feet so the embryo officers may obtain practice in shooting at moving targets. The "Skeeter Trap" was given this assignment in Pleasantville's defense preparations because it is ideally suited to the use of miniature clay targets, which cost considerably less than the regulation size used in skeet or trap shooting. As shotgun shells and flying clay targets for a body of 50 men regularly engaged in shooting practice can run to heavy expense, the combination of "Skeeter Trap" and .410 bore shotgun proved one way of keeping costs down and still providing splendid gunnery work for Pleasantville's Emergency Policemen.

On Keeping Dry

RAIN in its place is fittin' and proper; a four-day session of squally, driving showers in the course of a camping-fishing trip — when your home is your tent—can be very uncomfortable if you're not properly prepared. It used to be that a fellow lugged along a pair of rubber boots and either a poncho—which, it's true, served many purposes—or a suit of oilskins, and each item was bulky and weighed plenty. Now, however, you take a "Rain-Set," manufactured by Ironall Factories Company, the newest thing in rainwear, and adaptable to most outdoor avocations.

Made of rayon cordura fabric, a Du Pont product, the trousers and jacket that comprise a "Rain-Set" are treated with Goodyear Tire and Rubber Company's synthetic Pliosheen to provide the waterproofing. On a recent camping and angling trip we took along a "Rain-Set" for the lady-who-catches-more-fish-than-we-do, and in view of the extensive amount of moisture encountered in that four-day rainy spell, the suit was put to a thorough test.

The report of the wearer was most enthusiastic. Around camp, climbing in and out of the canoe, the two-piece



For fishing in the rain with comfort. ***Inset:*** **Carrying bag**

arrangement was found to be a distinct advantage over the conventional raincoat or poncho from the dual standpoint of keeping dry and offering far greater freedom of action. Best of all, the packed "Rain-Set" weighs but four ounces and in its Pliosheen-treated carrying bag it measures about five by eight inches, can be stored in pocket or tackle box, and will not mildew, shrink, or stretch, nor will the material become sticky or stiff. The suit is quickly slipped on over regular clothing and, in addition to keeping the entire body dry, it serves as an excellent windbreaker. With its several advantages, the "Rain Set" will be equally welcome on the golf course, in the sail boat, and outdoors in general.

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THE NEW ENGLAND COUNCIL offers a free 48-page "Fisherman's Guide to New England," compiled and published by the editors of *National Sportsman & Hunting & Fishing Magazines*. For those who would angle this autumn in the fresh or salt waters of any of the six New England states, the Guide offers timely and complete information on good sections for inland fly and bait fishing, surf casting, deep sea game fishing, recommended lures and tackle, seasons, licenses, and other helpful data.

"PISTOL HIGHLIGHTS OF 1940" is Colt's Patent Firearms Manufacturing Company's answer to popular demand for a sequel to their last year's publication, "Spotting the 1939 Pistol Scores." In compiling this latest 40-page booklet, 65 of last year's most important pistol matches held in the United States and Hawaii were analyzed and have been indexed according to location. Replete with pictures of ranges and competitors—both winners and high tyros—it's a splendidly written resumé of 1940 handgun activities and will be royally welcomed by all pistoleers. Although the Colt people have been on an all-out defense program for months, they still find time to maintain their wide interest in civilian target work, as the new book indicates. Name and address, "pliz," and we'll send you one, free.

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Use of a 16-mm. movie camera, geared up to operate at 128 frames per second, enables Richard E. Bishop, noted etcher of American game birds, to observe true details of ducks in flight, as in above etching

BOOK OF THE MOMENT is a 36-page publication, "Wild Ducks," by Col. H. P. Sheldon and Frederick C. Lincoln. Former is Chief of Division of Public Relations, United States Fish and Wildlife Service, and is nationally known for his knowledge of and articles on firearms and game conservation. Latter is one of our foremost authorities and writers on wildfowl and wild-bird migrations. Together, these men have now contributed a notable piece of work, delineating the history of wild ducks, their depletion and methods adopted to prevent it, and the results obtained. Publication contains 16 superlative pictures of as many species of wild ducks, reproduced in full, true-life colors from paintings by Fred Everett, noted illustrator, whose work has been described as "portraits rather than just pictures of birds and animals." Accompanying each of the five by six inch color plates is a concise, yet complete description of that species, together with outline map of North American continent on which, by means of shadings, are shown both breeding and winter ranges. All-in-all, a constructive contribution to our game program and an excellent reference book. Sells for 25 cents and in our opinion is the biggest quarter's worth we've seen in years. Copies may be obtained from the publisher, The American Wildlife Institute, 822 Investment Building, Washington, D. C.

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TELESCOPTICS

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SELDOM does the pupil stop to think that there must have been a time, long, long ago, when his teacher was himself only a lowly pupil, making the same timid beginnings and experiencing the same troubles that now perplex him. In case you have ever wondered how the preceptor and patron saint of the amateur telescope building hobby, Russell W. Porter, first took up telescope making, Figure 1 will place you at the exact original locus. It is true, this photograph was not taken at the original time—no such photograph now exists—but the surroundings are the exact ones in which Porter worked at Port Clyde, Maine, about the year 1909 when he was himself a rank beginner. The site is the cellar of his former home at the center of a 50-acre peninsula jutting into the Atlantic, about one third of the distance down—that, is, up—the Maine coast. The jug was surreptitiously slipped into the setting by the irrepressible Graves, of Los Angeles, who was present when the reminiscent photograph was taken, not long since.

How, in the first place, did Porter happen to become an amateur telescope maker? To understand this we must jump back 15 years farther, to 1894, when we discover him working his way through the Massachusetts Institute of Technology and studying architecture. One evening he heard Commander Peary lecture on the Arctic, and from that moment he was down with a bad attack of "arctic fever." He laid plans to get himself included in one of Peary's polar parties but was defeated through an unsuspected influence, though Peary had intended to include him: his mother secretly begged Peary to turn him down. Just then, along came a

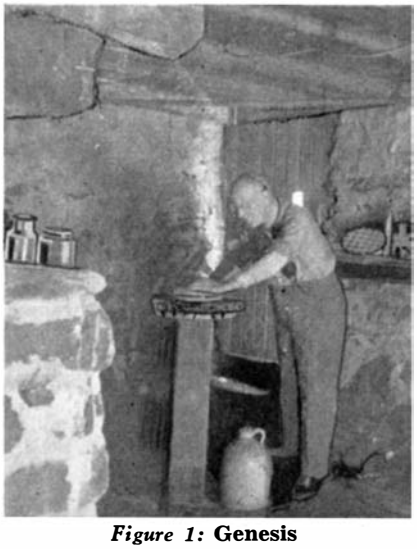

Figure 1: **Genesis**

Figure 2: **House at "Land's End"**

certain Doctor Cook, unknown but affable and entirely plausible. Yes, indeed, he was willing to accept the youthful Porter to go on an expedition to Greenland. Porter went, and the ship was wrecked and sunk (See Cook, "The Cruise of the Miranda.") In 1896, however, he went with Peary as far as Greenland. In '97 he led his own party to Baffinland. In '98 he started overland to the Klondike, reached the headwaters of the Peace River far up in British Columbia, but could get no farther by that difficult route. In 1900 he took a party to Greenland on Peary's ship. In 1901 he went to Franz Josef Land with the first Ziegler Expedition, and in 1903-4-5 he was with Fiala on the second, in the same high latitude. In 1906 he went to Alaska with Doctor Cook. The doctor had not yet been "shown

Figure 3: **Porter's Folly**

up" but, as almost any arctic explorer will tell you today, he was a personally lovable man despite his weaknesses. Cook announced a plan to ascent Mt. McKinley, highest on the continent, but also cooked up a plausible excuse to send Porter in another direction while he was ostensibly climbing the great mountain.

On all these expeditions Porter was not only the official artist and surveyor but the expedition astronomer. He picked up astronomy as he went along — the brilliant arctic skies aroused his interest.

By 1907, Porter's "arctic fever" had finally burned out and he married and settled down at Port Clyde, Maine. An old friend, Governor James Hartness, head of the Jones and Lamson Machine Company of Springfield, Vermont, Porter's real home town, sent him several copies of *Popular Astronomy*. In one of those he found an article by a man named Holcomb, of Decatur, Illinois, who described making a reflector. Through correspondence with Holcomb, Porter learned of the book, "Glass Working by Heat and Abrasion," by Paul Hasluck, now out of print. He set up the pedestal shown in Figure 1, made of wood sunk in the soil of the gloomy old cellar, and started work on a 10″ disk. "I shudder even today," he recently commented, "when I recall its horrible figure." Encouragement for the tyro! Porter afterward made approximately 100 mirrors.

At the left, in Figure 1, is a stone pier having a ledge. Originally this

Figure 4: **Stained glass ship**

pier supported four fireplaces in the rooms above, but it proved to be squarely in Porter's way when, some time after his beginning, he wished to test a 16″ mirror whose radius of curvature was 36′. The ledge represents the cut he therefore made in the pier, to enable him to make the test diagonally across the cellar. At another time, during Mrs. Porter's absence, when he wanted to try out a polar type refractor, he slashed a hole straight through the dining room wall of the house. She's still talking about it. Well, can you blame her?

Your scribe has visited this house and seen the cellar, in which various mirror-making accessories — glass tools, laps, and so on—remain, neatly arranged just as they were left about 25 years previous. They still remain. Figure 2 shows the house, built in 1819, and on it may be seen the small wing which Porter added as a study. Above this wing an unpainted vertical strip may be seen. Here the Porter polar telescope, shown in "A.T.M.," page 51, at V in Figure 42, once was attached.

Near the old house stands the fieldstone castle shown in Figure 3, built about 1910 by stonemason Porter, who wielded his own trowel.

Figure 4 is an interior view in this castle, showing Porter drawing heavily on a pet pipe. What looks like a picture of a ship is really a stained glass window showing the expedition ship *America* held fast in the ice near

Franz Josef Land in 1903, just before she was crushed and sunk there, leaving the explorers on half rations for two years. (See Fiala, "Fighting the Polar Ice," which contains a section by Porter). This window was made by Porter, of pieces of stained glass and lead "came."

Near the stone castle are the only remains of Porter's first observatory —a low circular stone wall on which, before it rotted down, stood a wooden fixed wall surmounted by a canvas dome.

If Porter hadn't heard Peary Lecture one night in 1894, he probably would have escaped his ten years of arctic fever, and thus his interest in astronomy. He therefore would not have wanted a telescope on his final return from the Arctic. The telescope making hobby would not have been expanded when it was; and so you, instead of making telescopes, might have been building bird houses for a hobby, or helping the ladies grow roses.

As Everest says, in "A.T.M.A.," a long stroke is scarcely sufficient for parabolizing a very short focus mirror, because after it reaches a certain depth it refuses to dig farther. Cyril G. Wates, Edmonton, Alberta, states that he therefore tried a star lap, as Everest recommends. "I cut a star in the middle of a disk of heavy cartridge paper, boiled this paper in paraffine wax, warmed up the lap and cold-pressed the paper disk into the lap, thus obtaining a star in relief. The result was good. This is essentially similar to Everest's method of pressing down facets with thin paper, but is more drastic.

WHEN a mirror has a very short focal ratio, say from $f/2$ toward $f/0$ (properly described as a "greater" focal ratio, though the number used is smaller), it is doubtful whether much or any gain in time will be made in attempting to parabolize from the usual sphere. Recently we told here how Buchele, of Toledo, worked 14 hours to excavate a paraboloid from a 12" sphere of $f/2.4$. More recently, Ferson, of Biloxi, Miss., started out to parabolize a 12½" $f/1.4$ sphere by the ordinary method. Here r^2/R was more than one full inch. After 20 hours of perspiring he found he had gained only a quarter of this and leaned back to puff; and while puffing he suddenly decided to charge off the time thus far expended to experience and do the rest with Carbo.

He therefore gave it about three hours of No. 600 and then a little 303½ emery, and when the curve was approximately down to the desired point (as determined by giving it a brief polish, good enough to afford a rough knife-edge test), he did the regular full polishing and figured with pitch laps of 3", 6", and 12" diameter. In this latter sub-diameter tool technique there is a good deal in

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common with working the correcting plate for a Schmidt.

STUNT for controlling fineness of rouge was described several years ago in a letter from C. A. Spickler, Yardley, Pa. He siphoned the rouge water from a bowl into a tea cup placed at a lower level, using a strip of woolen cloth. The fineness of the rouge deposited in the cup is regulated, he states, by the quality of the cloth. This may be the answer to some workers' trials with scratchy rouge.

CONSERVATIONIST James G. Hayden, New Lexington, Ohio, urges others who are hard up to follow his example. With a "biscuit cutter," or rotating metal ring armed with abrasive, driven by a motor, he cut up two old glass tools of 6" and 10" diameter into two 4¾" and two 3¾" mirror disks and now has four extra mirrors where none grew before. Of course, if you count your time—but don't count your time.

FOR the benefit of non-mathematical readers, Ellison, in his treatise on the objective lens, according to Royal W. Woodring, of Woodring and Mattie, masons, 202 Highland St., Roxbury, Mass., "explains the meaning of the term reciprocal, goes into his 'rule of three,' and, in general, does a lot of hopping and skipping around to confuse the reader. I have reduced his equations to order."

We can't admit that Ellison's equations are confusing, though the Ellison presentation probably would strike some who do not need such help as containing much that is superfluous. Anyway, for those who have already mastered Ellison and Haviland on the objective lens, the compact framework offered by Woodring undoubtedly will be a big help. It is as follows:

First Curve

Crown lens: Radii of surfaces as 2: 3.

Flint lens: One surface fits one surface of crown. The other is plane (or very nearly so).

(Decide on the focal length you want for completed objective and call it F).

$$r_1 = \frac{5\ F\ (cr\ u - 1)\ (cr\ V - fl\ V)}{3\ (cr\ V)}$$

= number corresponding

to [0.22185 + log F + log (cr u − 1) + log (cr V − fl V) − log (cr V)]

$$r_2 = \frac{3}{2} r_1$$

$$r_3 = r_2$$

$$r_4 = \frac{5\ F\ (cr\ u - 1)\ (fl\ u - 1)}{5\ (fl\ V)\ (cr\ u - 1)} \frac{(cr\ V - fl\ V)}{-\ 2\ (cr\ V)\ (fl\ u - 1)}$$

= number corresponding

to [0.69897 + log F + log (cr u − 1) + log (fl u − 1) + log (cr V − fl V) − log $\overline{5\ (fl\ V)\ (cr\ u - 1)}$ $\overline{-\ 2\ (cr\ V)\ (fl\ u - 1)}$]

[Formula for r_4, above, being too long for the column, its numerator and denominator are each broken in two pieces. Similarly with single term under vinculum, above.]

Second Curve

Crown lens: Radii of surfaces as 3: 2.

Flint lens: One surface fits one surface of crown. The other is plane (or very nearly so)

$$r_1 = \frac{5\ F\ (cr\ u - 1)\ (cr\ V - fl\ V)}{2\ (cr\ V)}$$

= number corresponding

to [0.39794 + log F + log (cr u − 1) + log (cr V − fl V) − log (cr V)]

$$r_2 = \frac{2}{3} r_1$$

$$r_3 = r_2$$

$$r_4 = \frac{5\ F\ (cr\ u - 1)\ (fl\ u - 1)}{5\ (fl\ V)\ (cr\ u - 1)} \frac{(cr\ V - fl\ V)}{-\ 3\ (cr\ V)\ (fl\ u - 1)}$$

= number corresponding

to [0.69897 + log F + log (cr u − 1) + log (fl u − 1) + log (cr V − fl V) − log $\overline{5\ (fl\ V)\ (cr\ u - 1) - 3}$ $\overline{(cr\ V)\ (fl\ u - 1)}$]

Third Curve

Crown lens an equi-convex.

Flint lens plano-concave. Its concave surface has the same radius as either surface of the crown.

$$r_1 = \frac{2\ F\ (cr\ u - 1)\ (cr\ V - fl\ V)}{cr\ V}$$

= number corresponding

to [0.30103 + log F + log (cr u − 1) + log (cr V − fl V) − log (cr V)]

$$r_2 = r_1$$

$$r_3 = r_2$$

$$r_4 = \frac{2\ F\ (cr\ u - 1)\ (fl\ u - 1)}{2\ (fl\ V)\ (cr\ u - 1)} \frac{(cr\ V - fl\ V)}{-\ (cr\ V)\ (fl\ u - 1)}$$

= number corresponding

to [0.30103 + log F + log (cr u − 1) + log (fl u − 1) + log (cr V − fl V) − log $\overline{2\ (fl\ V)\ (cr\ u - 1)}$ $\overline{-\ (cr\ V)\ (fl\ u - 1)}$]

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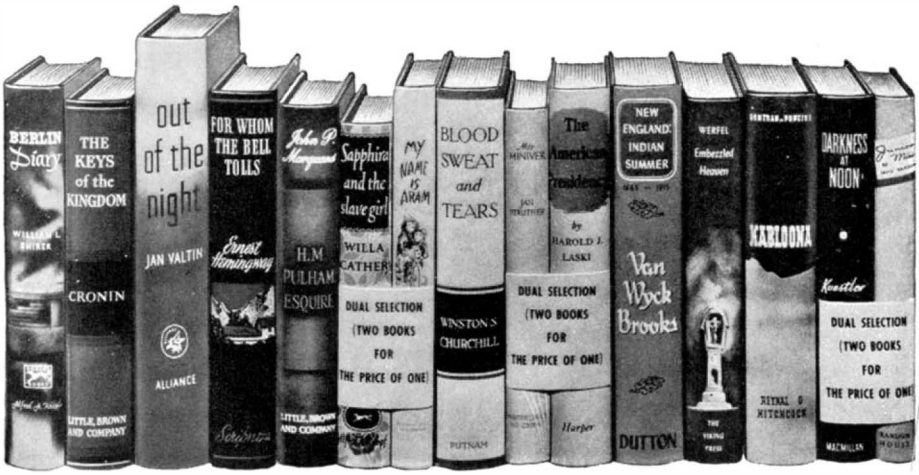

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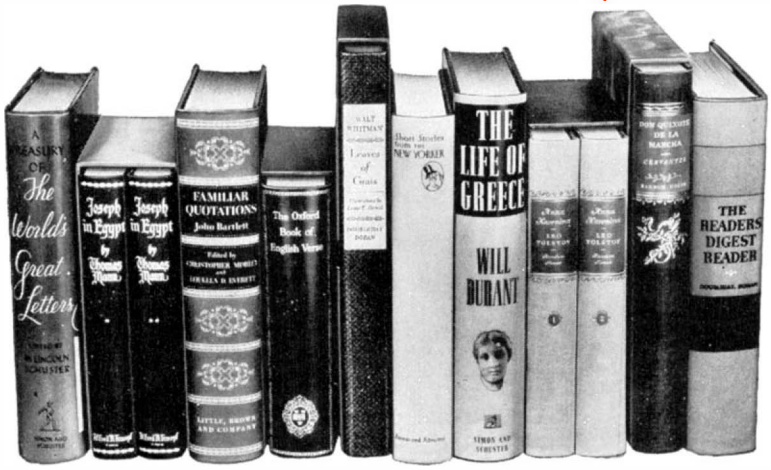

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