TIME STUDY GOES HUMAN . . . Page 55

SCIENTIFIC AMERICAN

AUGUST • 1942

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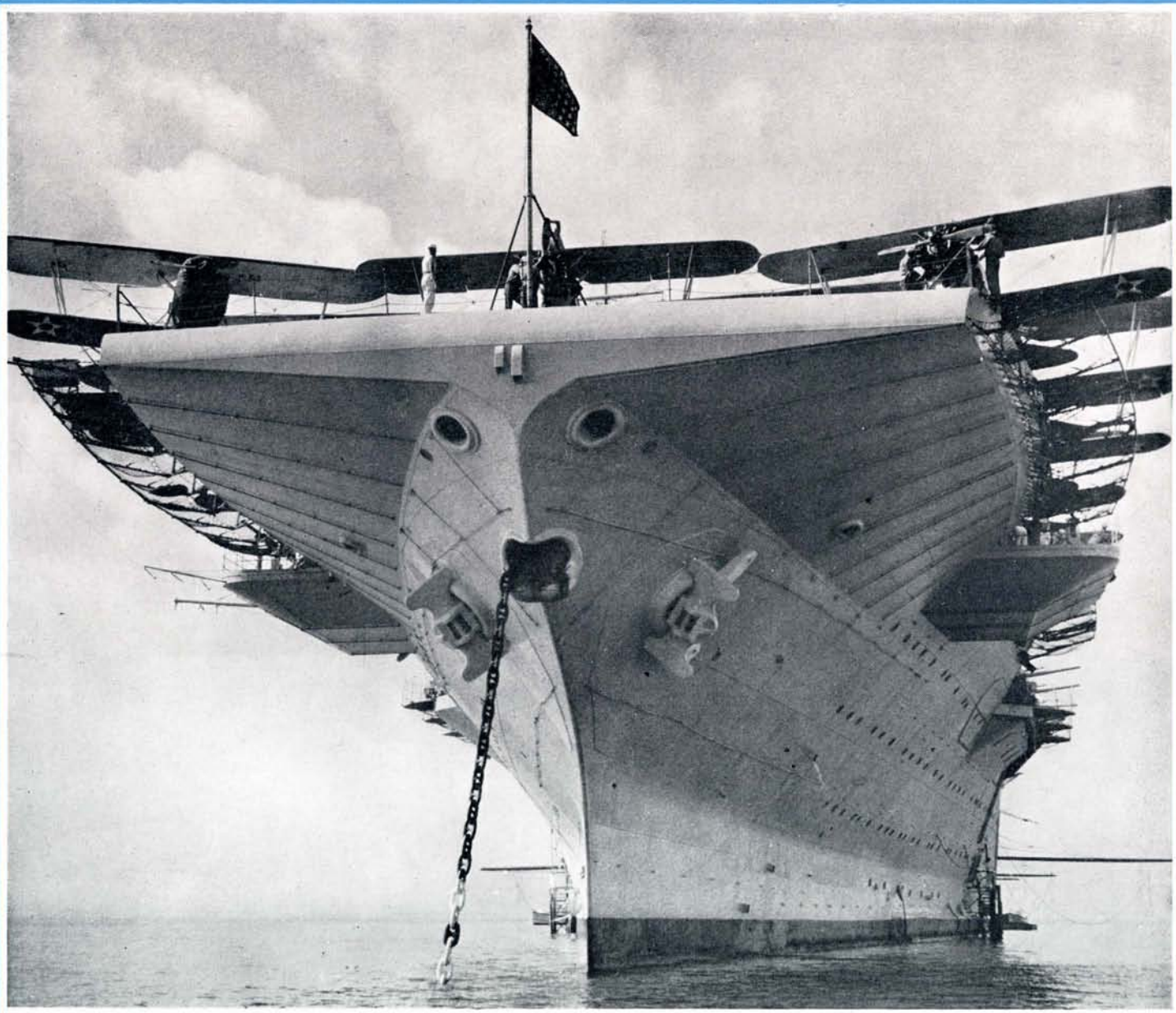


U. S. Navy Official Photo

"Valiant" is the Word for U.S.S. "Lexington" and Her Crew

America's Secret Weapon

You won't find it on the production lines at Rock Island or Willow Run.

It isn't guarded at the Brooklyn Navy Yard, or tested at Aberdeen.

But it's the toughest weapon these men you are looking at will ever take into battle. It's the stuff with which all our wars are won.

The boy in the uniform doesn't call it *morale*. That's a cold potatoes word for something John American feels deep and warm inside.

Perhaps he can't give it a name. But he can tell you what it's made of.

It's made of the thrill he gets when his troop train stops at a junction point and fifty good-looking girls are at the station with cigarettes.

It's made of the appreciation he feels for a bright new USO clubhouse where he and his friends can go for a few hours' rest and relaxation.

It's made of laughter and music—when Bob Hope or Lana Turner visits his camp with a USO show.

It's even made of a cup of coffee and a Yankee smile—at some lone outpost in Alaska or the Caribbean

Maybe it's just a feeling of kinship with this land of a hundred million generous people. Maybe it's just the understanding that this whole country cares; that the soldier is bone of our bone; that he and we are one.

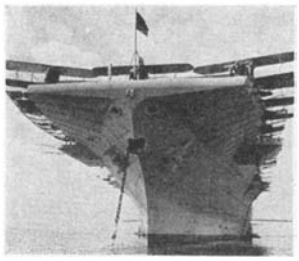
Name it if you can. But it's the secret weapon of a democratic army.

What can you do to sharpen this weapon? Give to the USO. This great national service organization has been entrusted by your government with responsibility for the service man's leisure needs.

The requirements of the USO have grown as enormously as our armed forces themselves.

Give all you can—whether it's a lot or a little. Send your contribution to your local chairman or to USO, Empire State Building, New York City.

★ USO ★



THE PLANE carrier, *U. S. S. Lexington,* damaged in the Battle of the Coral Sea, later sunk by American torpedoes to prevent possible usage by Japs, was a gallant ship, manned by a gallant, hard-fighting crew. The story of the *Lexington* and her sister plane carriers and the role they must play in this war begins on page 52 of this issue.

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SCIENTIFIC AMERICAN

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

AUGUST • 1942

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed From Issues of August, 1892)

INVENTION—"Invention being practically synonymous with new thoughts, and thoughts being the outgrowth of knowledge, the value of knowledge to the inventor is apparent, even though it may be in the nature of obscure impressions of the memory, vague suggestions from men and things, or broad yet accurate and practical information on any subject. . . . There is certainly no limit to the amount of material available. It is only necessary for the inventor to place himself in the proper relation to existing materials to enable him to reach out and take the reward."

FALLING BODIES—"An exceedingly interesting series of experiments is now being carried on in Paris, by MM. Cailletet and Colardeau, in which they are seeking to verify the law of falling bodies and at the same time those of the resistance of the air to the passage of bodies. . . The investigators have installed their laboratory on the second landing of the Eiffel tower, which gives them a free fall of about 370 feet. . . MM. Cailletet and Colardeau have employed a very ingenious

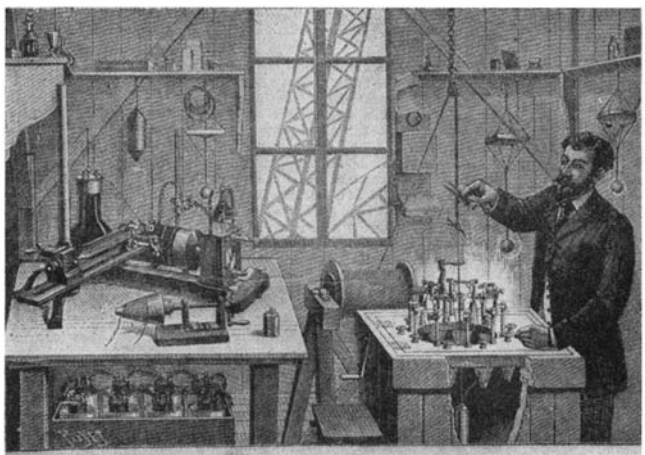


Fig. 1.—LABORATORY IN THE EIFFEL TOWER, PARIS.

electrical method of timing the fall of the variously shaped objects experimented with. . . The falling body is attached to a very fine light thread, which is divided into sections of 20 meters each. Each one of these sections is wound on a wooden cone. . . When each of the sections of 20 meters is unrolled, an electric contact actuates a registering pen upon which an electric tuning fork chronograph indicates the instant with a precision of 1-100 of a second. Thus at the end of every 20, 40, and 60 meters, etc., a time record is automatically made."

TRANSPORTATION—"The removal of horses from the street cars and the propulsion of the latter by means of electricity already has been accomplished in many of our towns and cities. The day seems to be near at hand when this marvelous agent will be still more extensively employed in connection with pleasure carriages and vehicles of all kinds. In fact, the electrical omnibus now exists in London."

TIES—"A summary of five years' experience with metallic ties on the Belgian State railroads is given by Mr. Janssen. . . . Up to the time of making the report the track with metallic ties has cost for maintenance about nineteen times as much as the track with creosoted oak ties. Beyond this, many of the metallic ties are damaged to such an extent that they must soon be removed."

BEER—"The total production of beer during the past year upon which revenue was collected amounted to 31,475,519 barrels —a net increase of 1,453,519 barrels over the production of the previous year. The average annual consumption is a little less than one half barrel for every man, woman and child in the United States."

BIRTH AND DEATH—"French science has to deal with a peculiar problem, how to prevent the depopulation of the country, which is now going on so rapidly that the deaths exceed the births by nearly 40,000 in a single year. Increasing the birth rate having proved impracticable, the present hope is to diminish the death rate. . . . It is now illegal for any person to give children under one year of age any solid food except on medical advice, and nurses are forbidden to use nursing bottles having rubber tubes. Efforts are being made also to induce Parisian mothers to nurse their own infants."

TELEPHONE—"The original patent for the electrical telephone was granted to Alexander Graham Bell, of Salem, Mass., on March 7, 1876, for the term of seventeen years. The patent expires March 7, 1893. . . . The expiration of the telephone patent throws open to the public a new invention of incalculable value to the country. Its future development and expansion must necessarily give rise to many collateral new industries, furnishing wealth and employment for thousands of busy workers."

WATER-WEIGHTED—"A novel form of inclined railway has been built at Bridgenorth, England. . . . There are two cars, on separate lines of rail, and they are connected by a steel cable passing round a wheel at the top. They are thus balanced, and a preponderating weight is given whichever one is at the top, by pumping a supply of water into a tank placed in the frame of the car."

IRONCLAD—"The French ironclad Le Hoche has just given the world an object lesson in the use of the ram. On July 7, the French squadron at Marseilles was exercising, and the ironclad was crossing the roadstead at full speed, when it struck the mail steamer Marechal Canrobert (1,200 tons), then coming in from Italy, hitting her fair and full. The shock was tremendous, and the captain of the ironclad, foreseeing the consequences, ordered the steamer to be secured to his own vessel, and the passengers transferred. The fastening hawsers were then cut, twelve minutes after the collision, and the steamer instantly sank, the blow having cut her nearly in two. The ironclad remained uninjured."

POWDER—"On July 2, on the invitation of the directors of the Smokeless Powder Company, a number of gentlemen interested in military matters witnessed an exhaustive trial of the qualities of the explosives manufactured by the company. . . Five men, having the spectators at the 400 yards firing point, fired rifle volleys at 300 yards and at 200 yards, the result being that no substantial wreaths of smoke were visible. Finally, 500 shots were fired with the powder from the Maxim gun, with the result that there was very little smoke to be seen, although ten shots with black powder made an opaque cloud."

98TH YEAR SCIENTIFIC AMERICAN AUGUST 1942

SEA NESTS FOR WAR BIRDS

Modern Warfare is Proving the Value of Aircraft Carriers

WALTON L. ROBINSON

● Second of a series of analytical articles on the United States Navy, the first of which, dealing with battleships, appeared in our issue of May, 1942. Other articles will be published when and as released for publication by the Navy Department. — The Editor. ●

NEXT to battleships, aircraft carriers are the largest and most costly type of naval vessel. Despite their huge size they are not, however, combatant ships in the strict sense of the term. Although several have rather heavy armaments and fairly good protection against medium-caliber shells, they are not intended to engage enemy ships in battle. Their guns are purely for defensive purposes: to beat off hostile aircraft or warships which penetrate their protective screen of fighter planes and destroyers. Their offensive strength is entirely concentrated in the squadrons of bombers and torpedo planes which they accommodate in their enormous hangars and which can quickly be put into the air from their broad flight decks.

Relatively new and untried on the outbreak of the present war, aircraft carriers have since demonstrated their great value and are now indispensable adjuncts of every large and well-balanced navy except the Italian. When operating directly with the fleet they are generally stationed about 100 miles to the rear of the battleship line. In this position they are reasonably safe from the enemy's cruisers and destroyers, although still offering an inviting and highly vulnerable target to his aircraft. A few bombs landed on the flight deck would render that particular carrier useless for the remainder of the action.

Carrier-based aircraft have won four major successes: Taranto, Cape Matapan, destruction of the *Bismarck,* and Pearl Harbor. In this last operation three or four Japanese carriers brought about 150 bombing and torpedo planes to within at least 500 miles of our great Pacific base. In successive attacks lasting all day these aircraft sank the battleship *Arizona,* destroyers *Cassin* and *Downes,* minelayer *Oglala,* and target ship *Utah;* gravely damaged several other heavy and light warships, including the battleship *Oklahoma,* which capsized; and destroyed a large number of Army planes, most of them on the ground. Defending forces shot down about 40 of the attacking planes.

The United States Navy is fairly well provided with aircraft carriers. Last December we had seven regular carriers in service and eleven others under construction or on order. Several large merchant ships, taken over by the Navy, had been or were being converted into auxiliary carriers. Two of these ships were the U.S.S. *Long Island* and U.S.S. *Kitty Hawk.* Our seven regular carriers displaced around 155,000 tons and normally operated about 575 fighting, bombing, scouting, and torpedo planes. Japan's carrier force, exclusive of a number of converted merchant ships, consisted of at least 11 units. They were, however, much smaller and slower than their American counterparts. They displaced about 173,000 tons and accommodated only about 500 planes. But that the Japanese know how to employ their carriers was amply shown at Pearl Harbor and in more recent operations in the Southwestern Pacific.

America's aircraft carriers range in size from the 14,500-ton *Ranger* to the 33,000-ton *Saratoga* and *Lexington,* largest ships of their kind in the world. The eleven under construction or on order will be ships of about 25,000 tons. Three of them are scheduled for completion next year, three the following year, four in 1945, and one in 1946. Planes and carriers to match Japan's present overwhelming air superiority in the Far East are our Navy's greatest needs today.

Our oldest carriers are the giant *Saratoga* and *Lexington,* launched in 1925 and completed in 1927 at a cost of about $45,000,000 each. They were originally authorized in 1916 as units of a class of 35,300-ton battle cruisers armed with eight 16-inch guns. After the war, but before construction had begun, their design was altered and displacement increased to 43,500 tons. The *Saratoga* (Battle Cruiser No. 3) was laid down September 25, 1920, by the New York Shipbuilding Company and the *Lexington* (Battle Cruiser No. 1) January 8, 1921, by the Fore River Shipbuilding Company (now the Bethlehem Steel Company). Work on them and their sister-ships *Constellation, Ranger, Constitution,* and *United States* had not progressed very far, however, when early in 1922 the Washington Naval Treaty put a stop to further competitive building of capital ships by the world's five principal sea powers. In accordance with the terms of this treaty Congress on July 1, 1922, authorized the conversion of the *Saratoga* and *Lexington* into aircraft carriers. Their four sister-ships were broken up on the building ways in compliance with the same treaty. The scrapping of these fine ships and of seven powerful dreadnoughts, not to mention that of 20 older battleships in service, was America's magnificent but futile contribution to the ideal of disarmament and world peace.

THE *Saratoga* and *Lexington* have a standard displacement of 33,000 tons; fully loaded they displace over 40,000 tons. Their length on the waterline is 830 feet and their over-all

U. S. Navy Official Photo

Navy planes warming up on the deck of a carrier, preparatory to the take-off

length, which includes the overhang at bow and stern, 888 feet, making them the longest warships ever built. An extreme beam of 105½ feet barely enables them to squeeze through the Panama Canal locks. At full load they draw 32 feet of water.

These two carriers mount what in reality is the most formidable armament ever provided in ships of their class. They carry eight 8-inch guns, twelve 5-inch anti-aircraft guns, and numerous smaller weapons. Their 8-inch guns are 55 calibers in length (that is, 36 feet, 8 inches), elevate to 30 degrees, and hurl a 250-pound shell at a maximum range of some 28,000 yards or about 16 miles. They are mounted in pairs in four armored gunhouses along the starboard side of the flight deck, where they enjoy an exceptionally wide arc of fire. It is this excellent distribution of their 8-inch guns which makes the *Saratoga* and *Lexington* actually the most heavily armed carriers in existence. Two Japanese ships, the 26,900-ton *Kaga* and *Akagi,* mount ten 8-inch guns, but these are mounted singly along the ships' sides and well below the flight deck with the result that only five of them can bear on either beam. Consequently, these Jap carriers have a broadside fire of only five 8-inch guns.

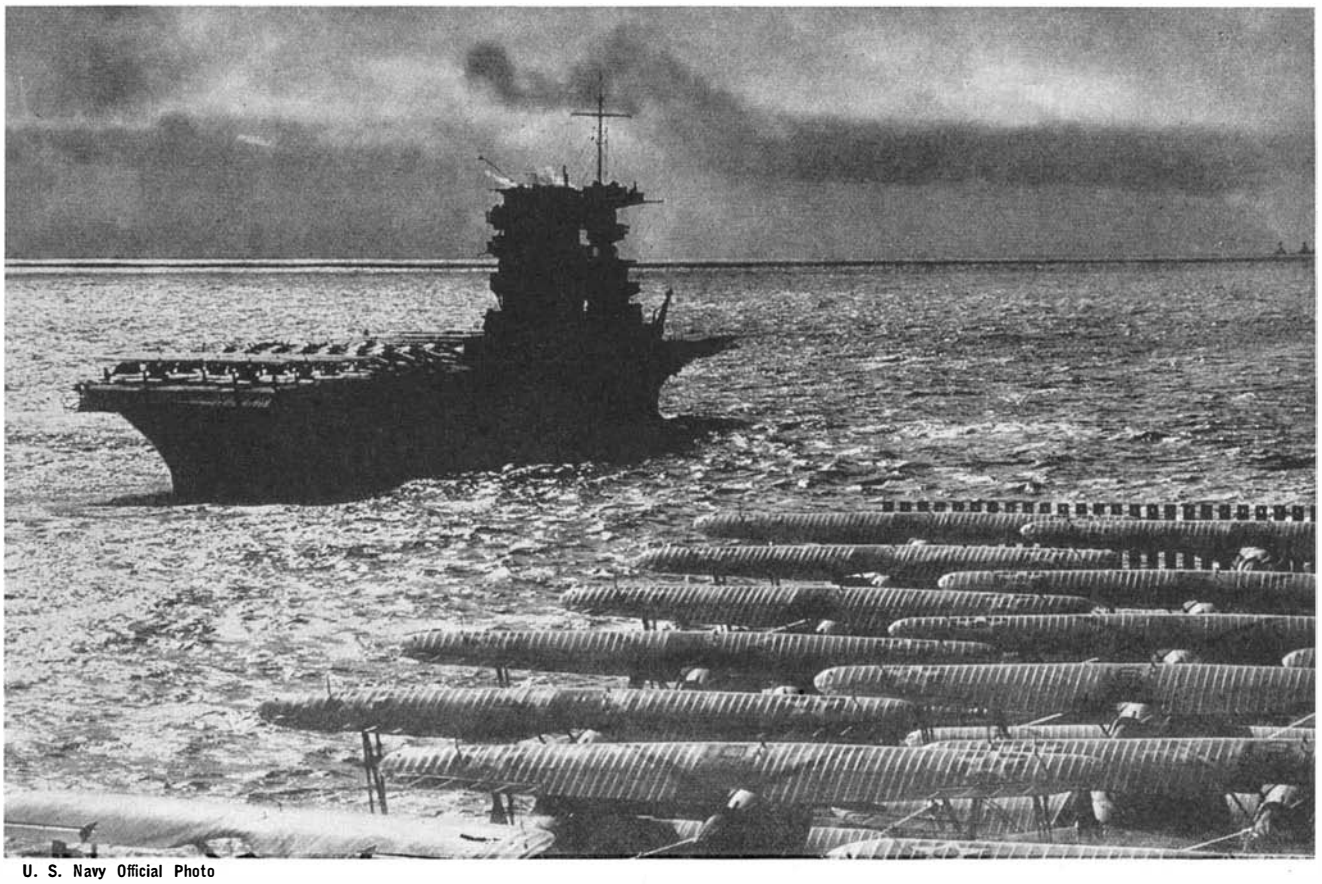
The twelve 5-inch, 25-caliber anti-aircraft guns, firing shells weighing about 50 pounds, are mounted singly along the ships' sides. They are grouped in four positions just below the flight deck, which is somewhat recessed to give them as wide an arc of fire as possible.

The *Saratoga* and *Lexington* each has a maximum capacity of about 106 aircraft; under normal conditions, however, only some 80 are carried. Normal complement consists of a complete Air Group of four 18-plane squadrons plus a number of reserve and utility planes. The *Saratoga,* as flagship of Carrier Division One, Battle Force, Pacific Fleet, has, in addition, a two-plane flag unit. One of her squadrons consists of scouting planes, another of bombers, a third of fighters, and the fourth of torpedo planes.

These aircraft are housed in the spacious hangar located just below the flight deck. Here also the planes can be fueled, repaired, and loaded with bombs or torpedoes. Two large elevators convey them from the hangar to the flight deck. This latter, 880 feet long and 85 to 90 feet wide, is 60 feet above the water-line. At the bow, a catapult, 155 feet long, launches the heaviest planes into the air at a flying speed of better than 60 miles an hour. On the starboard side are two powerful derricks for lifting seaplanes and flying boats out of the water.

The defensive characteristics of these great ships have never been officially disclosed, but they are believed to include a wide 6-inch armor belt running some 600 feet along the water-line, a 3-inch deck over such vital spaces as the magazines and engine- and boiler-rooms, triple hull construction, and anti-torpedo blisters or bulges. This protection, particularly the deck armor, may recently have been improved.

THE *Saratoga* and *Lexington* were designed for a speed of 33.25 knots, which they both have exceeded in actual service. Their machinery—General Electric turbines with electric drive—is the most powerful ever installed in a warship. Sixteen boilers with a pressure of 295 pounds per square inch provide steam for the turbo-generators which supply current for the eight 22,500 horsepower electric motors. Two of these motors are connected to each of the four propeller shafts. On one occasion the *Lexington* made the 2228-mile voyage from San Diego to Honolulu at an average speed of 30.7 knots and on another maintained a speed of 34.5 knots for one hour. Fuel oil capacity is 7000 tons, an enormous amount, but not



U. S. Navy Official Photo

Eleven more of these important naval vessels are under construction or on order for the United States Navy, as of June 1, 1942

excessive in view of the daily consumption of some 2000 tons when the ships steam at full speed.

Although sister-ships, the *Saratoga* and *Lexington* are not identical in appearance. They can most readily be differentiated by the platform around the top of the latter's funnel. This platform is lacking in the *Saratoga*. Both ships can easily be distinguished from any of our other carriers by their huge flat-sided funnel. This funnel, which is really a single casing enclosing a number of boiler uptakes, rises 79 feet above the flight deck. Whatever its merits, it certainly offers an excellent target to the enemy.

Our first carrier originally designed as such is the 14,500-ton *Ranger,* authorized in 1929 and laid down two years later by the Newport News Shipbuilding Company. She was launched February 2, 1933, and commissioned for service 16 months later at a cost of about $19,000,000. Her water-line length is 728 feet, her beam just over 80 feet, and her mean draft 19 2/3 feet. Her complement, including flying personnel, amounts to some 160 commissioned officers and 1650 enlisted men.

The *Ranger* mounts eight 5-inch, 25-caliber anti-aircraft guns, sixteen 1.1-inch machine guns, and 24 smaller ones. Her armor protection is very scanty, comprising only a one-inch deck and a thin patch of side plating over the engine- and boiler-room spaces. For defense against torpedos, mines, and near bomb misses, she relies on her double hull and internal sub-division below the water-line.

Recently the *Ranger* has been carrying 84 aircraft, which is just about her maximum capacity. Two of her four squadrons are composed of scouting planes and the others of fighters. A dozen reserve and utility planes complete her brood.

Aside from being our smallest and most lightly protected carrier, the *Ranger* is also the slowest. Her 53,500 horsepower geared turbine engines, driving two propellers, give her a designed speed of 29.25 knots. On trials she just exceeded 30 knots with 58,700 horsepower.

The *Ranger* differs radically in appearance from our other carriers. On the starboard side on her flight deck she has a small island superstructure and a short tripod mast, but her funnels or smoke ducts, of which there are no fewer than six, are located near the stern, three on each side of the flight deck. They are very thin and short and can be lowered outboard in a horizontal position while aircraft landing-on operations are in progress. For the past several years she has been assigned to Carrier Division Three, Atlantic Fleet.

The 19,900-ton *Yorktown* and *Enterprise,* authorized in June 1933, were laid down in May and July of the following year at Newport News. The contract price for their hulls and machinery amounted to $38,000,000, but the actual cost worked out at a considerably higher figure. Including armament and aircraft, these ships cost around $25,000,000 each. They were launched in 1936 and commissioned for service two years later. Their completion and final acceptance by the Navy was delayed by serious mechanical defects which developed in their engines and boilers. In the *Yorktown* this trouble necessitated the replacement of the reduction gearing and of more than 1200 boiler tubes.

The *Yorktown* and *Enterprise* are 761 feet long on the water-line, 809 1/2 feet over-all, and have a beam of 83 1/4 feet and a mean draft of 21 2/3 feet. Their flight deck, which commences some 15 feet short of the bow and extends about the same distance beyond the stern, is approximately 800 feet in length.

These ships carry eight 5-inch, 38-caliber "dual purpose" guns, sixteen 1.1-inch anti-aircraft machine guns, and numerous smaller weapons. The

(Please turn to page 82)

Motion Study Goes Human

Workers Co-Operate in Achieving Increased Production Efficiency Through Time and Motion Research

ALBERT RAMOND
President, The Bedaux Co., Inc.

At a table in a factory office a lone watcher sits behind a portable movie projector, facing a portable screen. As he watches the screened action, he writes occasionally on a sheet of paper—writes a kind of engineering shorthand. And this watcher differs further from the ordinary movie fan in that never does he say, "Well, this is where I came in," and get up and walk out. Rather, he sits through the same sequence over and over; and as his film, in the form of a loop that does not require rethreading, spins through his projector again and again, he goes on writing.

Now he snaps off the projector motor switch and, operating the machine by hand, examines his picture frame by frame. And still he writes. . . . Thus, with the aid of motion photography, which suffers no slips of memory, overlooks no details, and measures time in thousandths of a minute, modern-day scientific management goes about the task of streamlining production methods in many of America's war industries, conferring benefits alike on worker, employer, and on the all-out war effort. By means of movies, filmed in electrically-driven cameras whose speed is synchronized precisely with the speed of the projectors, production engineers are enabled to study workers' motions in order to improve and simplify methods of work.

Motion study is but one of the tools in the modern production engineer's kit. Scientific management, an extension of a field first explored by the late Frederick W. Taylor, concerns itself also with such matters as time study and establishment of production quotas, plant layout, planning, scheduling and routing of the production flow, training of workers and supervisors, and incentive plans to reward workers equitably for extra effort.

And in every step of the procedure of improving production and management methods, modern-day scientific management enlists the workers' interested co-operation, thus insuring between management and labor the wholehearted kind of teamwork that America's wartime production job demands. The techniques employed produce substantial results.

To cite a recent instance, production engineers, in a plant that produces gun mounts and earth-moving equipment, helped increase output in a bottleneck department by 102 percent. Meanwhile, thanks to the workers' increased productivity, wages went up while costs declined.

In this instance, it was the engineers' findings, derived from study of the movie records of workers' motions, that led directly to the department's improved achievements. Here, as in many other instances, motion study disclosed a need for jigs and fixtures for holding and rotating heavy work; and here, as has often been found in other cases, the installation of jigs and fixtures not only stepped up production but also reduced the workers' fatigue and contributed to their safety.

Let's look as this last-mentioned phase of the matter more closely. As the engineer - turned - photographer watches his movie film unroll, he keeps vigilant watch for signs of wasted energy—signs that experience in similar studies in many other plants has taught him to expect.

Let's assume that, in the course of his step-by-step survey of the operations in a plant department, he has set up his camera and photographed a worker's cycle of operations at a punch press. Now, as he sits behind his projector to run off and to study the photographed record in detail, the engineer watches for the answers to such questions as these:

Are the worker's motions symmetrical—that is, do the right and left hands reach, grasp, carry, hold simultaneously; or does one hand frequently wait for the other? Is the work so arranged that motions are short and smooth; or are they long and jerky? Can the working surfaces be so arranged that work need not be picked up, but may be slid into place? Can the weight of the work be reduced? Are there periods during which a hand or an arm must assume a cramped position—perhaps to hold work in place—and will a jig or fixture reduce fatigue and enhance accuracy?

Thus, step by step, the engineer diagnoses. Next he prescribes. Motions, work arrangement, jigs and fixtures—all details are noted that need correcting. On paper he creates an improved work-cycle. Then, back at the punch press, the new routine is explained to the pressman.

"Looks better," the pressman concedes.

"Try it," the foreman suggests.

The pressman tries it and says, "It *is* better."

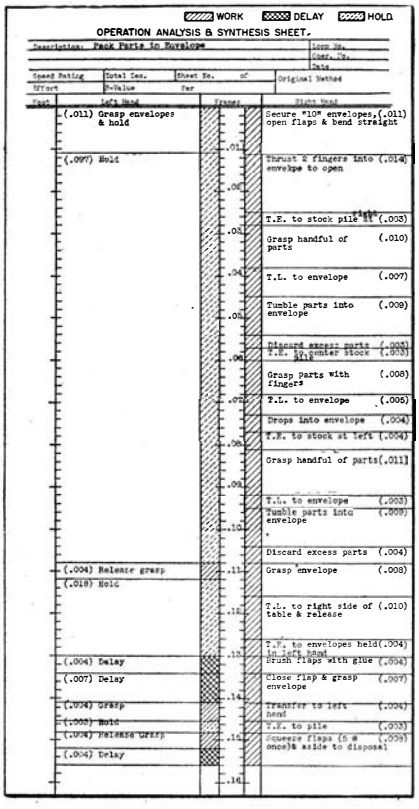
"In a few days, after you've got the hang of it," the foreman tells him, "We'll bring the camera back and shoot another picture. I think we'll be surprised at the difference."

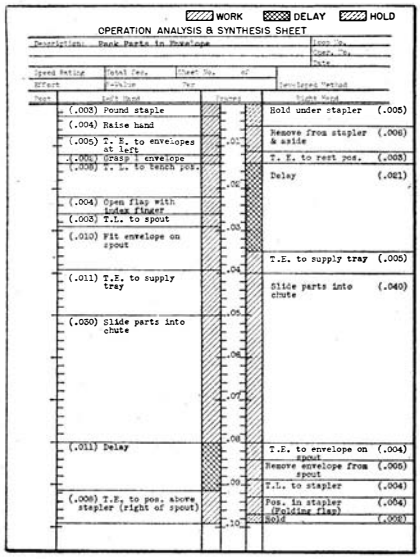
Seldom, however, is the engineer greatly surprised; experience has taught him that when the second loop of film comes back from the developers it will run but half or at most two thirds the length of the first. That much motion and time will have been saved. And the engineer, having run the second version through his projector for checking, may recommend still further changes in method, or he may file it away for future reference—and for use, perhaps, in training other workers.

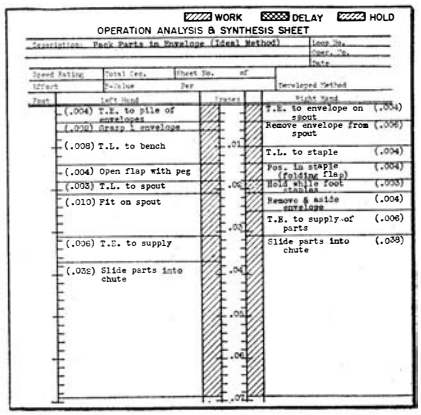
Thus, step by step through a department or through a factory, motion study discloses the little energy losses—losses that, added together, a few seconds here and a few seconds there, have been found to add up to hours and hours of time.

Time study was mentioned a few paragraphs back. The primary object of time study is to measure work accurately and, by scientifically determining normal rates of production, to obtain a yardstick for comparing what is being accomplished with what could be accomplished under reasonably efficient conditions. Such a study, often coördinated with motion study—in fact, the two are frequently carried on simultaneously—makes possible setting of equitable rates of pay, with extra reward provided for extra effort.

Here must enter the workers' enlightened understanding. In one large plant the time-study man is the president of the employes' union. Collaborating thus, guided by accurate time studies, and allowing liberally for fatigue and other factors that influence production, both management and labor may feel sure that the wage rates that result will be fair.







Results of a camera analysis of a simple bench operation consisting of placing a number of small spare parts in a paper envelope. The operation as originally observed took up the time of 156 frames of motion-picture film, in which one frame is one exposure corresponding to 1/1000 of a minute. The operation cycle was, therefore, .156 of a minute. The most noticeable thing disclosed by this study is that the right hand (chart at extreme left) is working for the entire cycle, while the left hand is working for only .012 of a minute and is used for holding for .129 of a minute or about 83 percent of the cycle. By re-locating parts on the bench and re-allocating the work on both right and left hands, the total cycle was brought down to .099 of a minute (chart in center), a reduction of 36½ percent. Then the stapler used to close the envelope was modified to be foot-operated. This permitted a further reduction of the cycle to .069 of a minute, or 30 percent more, giving a total reduction in time, over the original of nearly 56 percent (chart at right). With the foot-operated stapler, both hands are used in a productive manner all of the time except that the right hand holds the parts under the stapler for a period of .003 of a minute

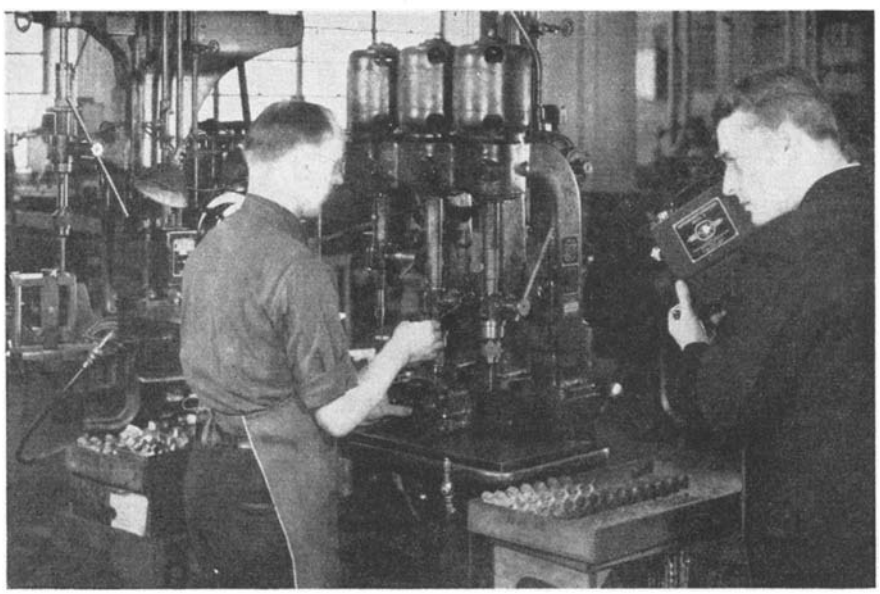
Time study does even more than this. Because it records elapsed time in terms of productive and non-productive effort, it highlights time-losses and the reasons for them. These reasons may include defects in plant layout, or slips in planning and scheduling the production flow from machine to machine, or from department to department. Or the losses may be due to delays in receiving materials, tools, or instructions.

IN an ordnance foundry, better planning and a complete overhauling of the method of compensation—permitting workers to earn more when producing more—resulted in increasing output by 110 percent. In this plant the erstwhile slowest worker now is the fastest. Methods had been improved. Potentialities for earnings—his own and his colleagues'—had been increased. Should he, who used to be the laggard, now become a one-man bottleneck and slow down a whole department? Not he! Promptly, he stepped out in front; and, as a producer, at this writing he still leads.

In a steel-casting plant that, among other things, makes anchors for warships, production engineers found that nearly everyone, at one time or another, stood around, waiting. The engineers found moulders waiting for sand and for patterns. They found pattern makers waiting for orders. They found truckers, trundling their trucks through the aisles between the moulders, waiting for the moulders to get out of their way.

Again the engineers prescribed rearranging, rerouting, and rescheduling. Orders, it was provided, would go to the pattern shop fore-handedly enough so that patterns would reach the mouders on time. Sand would go to the moulders, not through the aisles—which were the moulders' working space—but along the rear, and thus clear the working space for work. At one spot, a stoppage-point in plant traffic, a flight of stairs was replaced by a ramp to make easier the trip from one level to another. Rearranged, this plant stepped up its production 96 percent—and workers' earnings went up substantially.

To be sure, not always are production delays so obvious; but, in times such as these, when production, because of pressure of the war demand, often must be gotten out by main



Taking a movie from which time and motion studies will be made

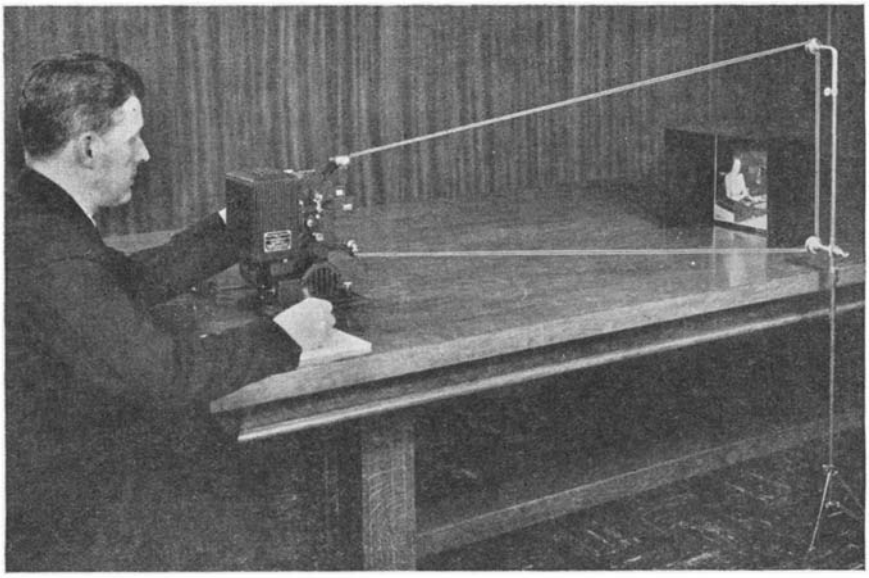
strength, even glaring delays are frequently tolerated because they seem to be necessary evils. But trained observation just as frequently shows that these evils are not necessary at all.

Detailed study of operations almost invariably reveals certain bottlenecks —sometimes divisions or whole departments—the true effects of which have not even been suspected. Thus, in a plant that makes seamless tubing for aircraft, job studies disclosed that stoppages in the annealing department could be eliminated by assigning certain technical tasks to the personnel of the plant laboratory instead of to production men as had been former practice. When the stoppages had been cleared, the plant's over-all production went up 42 percent.

Not only in enterprises where operations are repetitive and more or less standardized, but also in maintenance and repair work and in those fields of industry where each successive operation may differ from those that have gone before, modern methods of production control have stepped up output. For example, a warehousing operation that handles steel sheets, bars, angles, and other steel shapes—all essential materials in our industrial war program—ran far behind its service potential, until production engineering technique rearranged such warehousing functions as classifying, segregating, stacking, inventorying, and even cataloging. These improvements, together with a replanning of the crane service, enabled the warehouse to improve its over-all performance by 44 percent.

SIMILARLY, it was an overhauling of layout and a rerouting of the flow of work that enabled production engineers to bring about a seeming miracle in the maintenance department of a great steel mill. In this mill, rearrangement of planning methods brought about production increases in four major repair shops, ranging from 72 to 128 percent. Incidentally, with equipment scarce and with machinists becoming still scarcer, proper control of maintenance work in almost any kind of factory becomes increasingly vital.

Fortunately, both labor and management well realize today that in winning the war each side has a stake. On an ever-broadening front, labor has accepted as socially and economically sound the principles of scientific management and has participated in their application. In part this attitude is the result, of course, of the war program. In part, and even more important in the long run, it is the result of the adoption by management of a broader, enlightened labor policy.



A motion-study engineer views a loop of film over and over again

Through the years, one of labor's major objectives has been greater security. And because, through these same years, *efficiency* came to be linked in the workers' minds with loss of jobs, the word became unpopular. Meanwhile management, having come to realize that in its employe relations a good deal was lacking, had begun to overhaul its personnel policies and its methods of production control. It is to further this overhauling—this humanizing—of policy that present-day production engineering, far from laying aside the techniques of scientific management, now applies those techniques with labor's co-operation.

ARE the methods of a factory to be examined and improved? Openly, frankly, and fully, supervisors and the production engineer talk the matter over with the men. Are operations to be studied in detail? The workers help. They know what is afoot and —more importantly—they know why. Are wage rates to be established? The workers are taken into the procedure. The workers do more. In instance after instance, having watched production engineering step up output, they have gone on the alert for opportunities for still further improvement; they have come to management and said:

"Look here! Everything's fine as far as we've gone; but we haven't gone far enough. At least, *you* haven't. Here is something you have overlooked."

That something usually turns out to be a managerial blind spot—a lapse in planning or supervision. The bottleneck eliminated, the workers say:

"O.K.! Now we can go places with this plant!"

Time after time, experience has proved that a proper approach to a solution of the problems involved in increasing production brings a favorable reaction from everyone concerned. A broader application of these principles—a development for which management must assume the primary responsibility—would provide a vital stimulus for our war effort.

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IRON-GLASS SEAL

Made Possible by New Invention

TIGHT seals between iron and glass, eliminating the need for nickel and cobalt, critical war metals, for wires leading into certain types of vacuum tubes, are now being made with a new development of Dr. Albert W. Hull and Dr. Louis Navias, General Electric scientists.

From early days of the electric lamp, a problem of construction has been to make a tight seal between metal and glass. It is also involved in making radio tubes. Even with tubes in which the glass shell is replaced by one of metal, the lead-in wires pass through glass insulating bushings.

The difficulty is that most kinds of glass expand with heat at a different rate from that of the metal. Glass and metal may be tight at one temperature, but when they are heated, the glass will either crack or pull away from the metal, because the change in their dimensions is not the same.

Platinum was used in the first electric lamps, since it has nearly the same rate of expansion as the glass then employed. Various substitutes for platinum were devised which

were satisfactory for lamp seals, though they were not adapted to the large seals used for powerful vacuum tubes, for example. However, Dr. Hull and others developed special nickel-iron-cobalt alloys for this last application.

Since nickel and cobalt are used in many ways for war equipment, and their supply is extremely limited, the new invention of Dr. Hull and Dr. Navias is an important one since, for certain applications, it permits tight seals to glass without their use. They have devised a series of glass compositions which can be used with iron and certain iron alloys. One consists of 45 percent silicon dioxide, 14 percent potassium oxide, 6 percent sodium oxide, 30 percent lead oxide, and 5 percent calcium fluoride. The rate of expansion of these glasses is very close to that of iron.

• • •

FORGERY—Many forged checks can now be detected instantly at a bank teller's window by means of an ultra-violet ray lamp developed in Westinghouse laboratories. All checks are coated with fluorescent chemicals which glow brightly in the dark when irradiated with invisible ultra-violet. Any erasure or change on the checks removes part of the chemical coating even though the alteration cannot be seen in ordinary light. Under ultra-violet the tampered part of the check shows as a dark blotch.

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STANDARD STEELS

Can Speed-Up Production For War Needs

PRODUCTION of steel for war equipment is being facilitated as steel producers and consumers concentrate more and more on making and using a relatively small group of standard steels rather than literally thousands of special-order steels.

The standard steels on which emphasis is being laid consist of a group of 87 alloy steels and 77 carbon steels selected after a two-year period of study and research by top-ranking steel plant operating executives and outstanding metallurgists working through the American Iron and Steel Institute. Hitherto, carbon and alloy steels had been made in more than 4000 different combinations of chemical elements.

Last year the groups of standard steels represented approximately 90 percent of the total output of carbon steel, 70 percent of the alloy steels made in open hearth furnaces, 85 percent of the electric furnace alloy steels, and 100 percent of the stainless steels.

In 1942, it is expected that standard steels will constitute an even greater proportion of the total steel output.

Steel plant efficiency has materially improved along with the greater production of standard steels, and both producers and consumers are sharing the advantages of large-scale production.

Efficiency has been improved in many ways. By enabling steel plant operators to assign a furnace to the more or less continuous production of one class of alloy steel, such as chrome-molybdenum, the crews which work on the furnace on the present round-the-clock schedule have a chance to improve their performance by specializing in producing that one class of steel. When a great variety of specifications had to be met, it was more difficult for the crews to develop a routine of high efficiency.

Standardization also has resulted in fewer "off-heats" which must be discarded or diverted because they do not comply with consumer specifications.—*Steel Facts.*

PLANE CONTROL

Made Smoother by New Rubber Bushings

THE development of a new material to be used for bushings and guides of the primary controls of an airplane has just been announced by the research department of The Firestone Tire & Rubber Company. This new material is a composite construction of a special rubber compound, a special cotton fabric, and a new method of impregnating the assembly after vulcanization.

Because of its elastic properties, bushings and guides of this new material provide, without restriction of action, a tighter fit than has previously been possible with conventional type guides and bushings. Combining shock absorption qualities and the ability to minimize lost motion, it contributes to smooth operation of the plane.

The new material is being used mainly in bushings and guides for the rudders, elevators, and ailerons of planes.

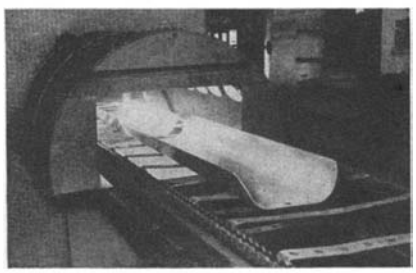
REFLECTOR

For Fluorescents Releases Steel for Other Uses

DEVELOPMENT by the fluorescent lighting fixture industry of a new-type reflector, constructed of materials not vital to war production, was announced recently by the Lighting Division of Hygrade Sylvania Corporation. An industry-wide change-over to this type of reflector would release, for more critical war production, important quantities of steel currently used in reflector manufacture.

Because fluorescent lighting makes more efficient use of electrical power and provides more light of better quality, it is considered an extremely important factor in 24-hour-a-day war production. It is being used in a great majority of war production plants, and thousands of fixtures are being manufactured for this purpose daily. The fixtures utilizing the new composition reflector will employ only about 1/3 as much steel as present fixtures, and thus the amount of steel made available for other war production will be considerable.

Made of a specially treated composition, the reflector is considerably



Out come new reflectors

lighter in weight than present reflectors. General appearance, however, remains the same. The reflecting surface is the same high-temperature synthetic enamel used on many present Hygrade fixtures, and has equally high light reflectivity.

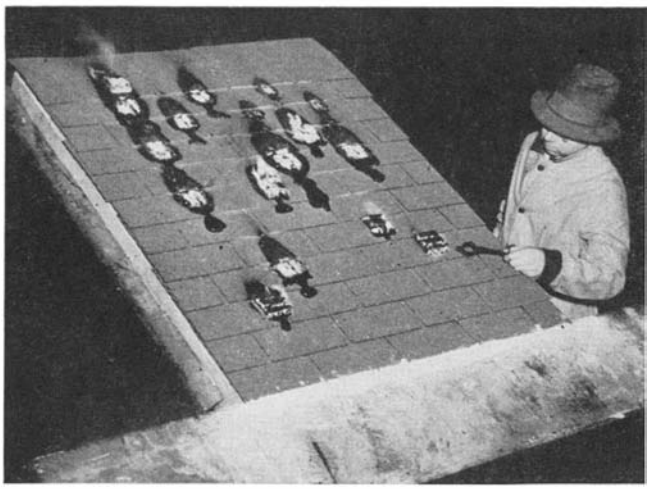
FIRE RESISTANT

Roofing Proved in Grueling Tests

FEW home owners think of the roof as one of the most fire-vulnerable parts of a building, yet sparks landing on combustible roofs have been responsible for 55 of every 100 conflagrations in this country since 1900, according to figures compiled by the National Fire Protection Association.

On the other hand, there are instances where fire, sweeping across a section of a city, has stopped when it reached a community in which fire-resistant roofs were in the majority.

The choice of roofing, therefore, is not one for the individual alone, but for the community as a whole, to influence. More than 600 cities and towns in the United States permit only fire-resistant roofing within their fire limits, and this number is growing



Left: Wind-blown flames melt asphalt, do not set roof deck aflame. *Right:* Firebrand test

almost daily. Either in peace or in war, such protection is a first line of home defense.

Much of the credit for the present high standards of fire-resistant roofing belongs to the Fire Underwriters' Laboratories in Chicago, which, as one of its many fire-protective functions, tests and classifies roofing according to the fire protection it will provide under actual fire conditions.

Testing and classifying of fire-resistant roofing is done by duplicating roof construction and fire conditions at the laboratories. A section of roof, built of wood like that of an average house, and covered, for example, with asphalt shingles, is placed on an inclined framework before a wind tunnel. In the mouth of the wind tunnel there is a three foot wide gas flame. This flame, with the gas pressure carefully regulated, is then blown against the surface of the roofing by a 12-mile-an-hour wind from the tunnel. The flame is applied intermittently, two minutes on and two minutes off. To pass this test successfully, there must be no flaming on the underside of the roof deck at the end of the test period.

To determine the protection which asphalt roofing—the most widely used fire-resistant roofing—will provide against the danger of flaming brands being blown on to it, further tests are made with actual burning brands of various sizes. These are placed on a new test sample and allowed to burn themselves out. Here, again, the period should end with no flaming of the underside of the deck.

A third test measures the ability of the roofing to prevent the spread of flames. In this case, a 1400 degree, Fahrenheit, flame is blown continuously against the surface of the roofing; the distance which it progresses is noted. This indicates whether the roofing adds any fuel to feed the fire

These tests, combined with several others, determine whether or not the roofing is readily flammable, and whether or not it carries or communicates fire. They also show the degree of heat insulation the roofing provides for the combustible structure underneath and whether—in a fire—the roofing will slip from place and create a flying brand hazard.

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WIRE—A strand of wire reaching from New York to Montreal, a distance of 469 miles, can be produced from a rod of tungsten 5½ feet long having a diameter slightly larger than a lead pencil.

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TEST SAVING

By Generating Electricity With Airplane Engines

NEW airplane engines which once consumed great quantities of aviation gasoline but did no useful work during break-in runs now have been harnessed to produce enough electric power to supply all machines and lights in the factories where the engines are built, according to R. H. Wright, an engineer at the Westinghouse Electric & Manufacturing Company.

"In this way, one new airplane engine on test actually drives machine tools producing parts for other engines and at the same time saves electricity needed for other war factories," said Mr. Wright.

The new power-producing method has been achieved by harnessing the airplane engines to ordinary electric generators of the type long used in small Diesel-electric power plants. Westinghouse already has supplied one large airplane engine manufacturer with 16 of the generators. Mr. Wright continued:

"Every airplane engine runs about half a day in a specially constructed test cell before it is built into one of our fighting skycraft. It is first given what aeronautical engineers call a 'green' run to unlimber it. Then the engine is taken apart, inspected, and reassembled for a final break-in run.

"In some engine factories, 40 or more of these cells are in use continuously. As a result, engine manufacturers are among the largest users of aviation gasoline. For example, in one plant, engines on test have burned more than 1,500,000 gallons of this fuel in one month."

By installing generators in test cells, each aircraft engine can produce about 2000 kilowatt-hours of electrical energy during its test runs. Mr. Wright explained. Generators now in use in one factory will produce each month more than 4,000,000 kilowatt-hours, worth about $24,000. That much electricity is enough to supply the entire factory — driving lathes, drills, grinders, boring machines and other machinery used to manufacture airplane engines—including lights. In less than two and one-half years, it is estimated the generators will pay for the additional cost of installation.

The generators can also operate as motors to crank the stiff, new engines for their first trial run. Then, after the engines gain speed under their own power, the electrical machines automatically become generators, producing power instead of using it. By measuring the amount of electricity generated, engineers can tell whether the engine is running properly. Such accurate checks are not possible when the engines drive propellers in test cells not equipped with generators.

Test cells that use generators can be built smaller and less expensively. Propellers make so much noise that their cells must be built larger and with sound baffles to keep them from being a civic noise nuisance.

INDUSTRIAL TRENDS

RUBBER COMPANIES, AS CONVERTED

THE fact that rubber is vital to the conduct of a modern war has been hammered home so thoroughly that it hardly seems necessary to give it even one more tap. We can, therefore, in this column dismiss for the moment this well-understood fact, and also disregard the subject of natural-*versus*-synthetic elastomers, to pass along to certain data of interest regarding the rubber companies themselves. From such data can be obtained a clear picture of the entire rubber industry as it stands today; from this picture can be deduced with some degree of certainty the general trend.

When the average person thinks of the products of a large rubber company, the first thought is, quite naturally, of vehicle tires. Yet, in peace-time, over 30,000 different products make use of rubber in one form or another and it is this versatility that makes rubber of such tremendous value in times of war. The manufacture of such a wide range of products calls for the application of research and engineering knowledge of no small moment, and for a diversification of such knowledge in many fields that, ordinarily, would not be considered in any way related to the rubber industry. This knowledge—the fashionable word of the moment is "know-how"—is essential for progress in the commercial world of peace; in war-time it becomes invaluable to the country holding it. Up to the start of the war it led the rubber companies into many new fields, and in some measure prepared them for what was to come.

As a result, a general survey of the five largest rubber companies shows that all of them are managing arsenals. Individual tire-makers are producing in large quantities such war material as airplane sub-assemblies and anti-aircraft gun carriages. One company is turning out machine tools, while the industry as a whole is in production on barrage balloons for protection against enemy aircraft. Such, briefly, is the over-all view. Let's look closer at the five largest rubber companies.

Goodyear: Normally the world's largest tire producer, this company is now rated as one of the largest suppliers of airplane sub-assemblies, supplying specified units to at least five aircraft plants. Also manufactured are airplane wheels and brakes, bullet-sealing fuel tanks for planes, rubber life-rafts, gas-masks, barrage balloons, semi-rigid airships for coast patrols, and so on.

Operating factories in seven foreign countries, and owning rubber plantations in the Netherland Indies, Philippine Islands, Panama, and Costa Rica, Goodyear has the heaviest foreign investment of any rubber company.

Firestone: Now reported to be the largest producer in the United States of metallic clips for machine-gun cartridges, this company is also manufacturing such non-rubber items as oxygen tanks, airplane wheels and brakes, and Bofors anti-aircraft gun mounts and carriages. Among rubber items being made are gas masks, life rafts, and tank track blocks. Tires, which ordinarily constitute 70 percent of Firestone's output, continue as one of its most important products.

Although Firestone operates factories in seven foreign countries, its most substantial investment outside the United States is in rubber plantations in Liberia, on the west coast of Africa. These areas have not yet felt the hand of war, and are considered to be highly valuable.

United States Rubber: Manufacturing nearly every product made of rubber and being the country's largest producer of non-tire rubber products, U. S. derives only slightly more than one half of its total sales in normal times from tires and tubes. Thus the non-tire rubber requirements occasioned by war are of material benefit to this company. Barrage balloons, bullet-sealing fuel tanks, and rubber life-rafts are some of the military products which U. S. is making.

Goodrich: Here is the one company of the five under discussion which has gone in heavily for development of the synthetic rubber field. At the same time, it has also broadened its operations in natural rubber. Credit is given to Goodrich for the endless rubber tread now being used on high-speed military scout cars, and for the de-icer for airplanes which operates by inflation and deflation of a rubber section on the leading edge of the wing. Also being made are balloon and airship cloth, bullet-sealing tanks, and military tires.

In the field of synthetic rubber, Goodrich is found to be part-owner, with Phillips Petroleum Company, of Hycar Chemical Corporation, the nation's largest producer of the petroleum-based synthetic, butadiene. Goodyear also makes the rubber-like synthetic known as Koroseal and, in 1940, put into commercial production automobile tires using the synthetic rubber called Ameripol.

General Tire and Rubber: Mainstay of this company's business always has been vehicular tires. But, some five years or so ago, there was opened a General plant for the manufacture of non-tire items. As a result, this mechanical goods division was ready to do its part in the war effort when required. Thus, the output of all types of tires is being supplemented by General's manufacture of barrage balloons, wind socks, gas masks, and molded airplane parts.

That's the way the rubber industry shapes up in the present war effort. Add to the above the fact that each and every one of these companies is managing one or more government-owned arsenals for the production of TNT, small arms ammunition, powder-bag loading, and so on, and it is evident that the rubber industry is doing at least its share in the present war. It is also obvious that it will come out of the war effort with a vastly increased amount of "know-how" that the rubber companies will be able to apply to their operations in the field of peace-time production.

STEEL IS PERFORMING

BEHIND the iron and steel that are playing such an important part in our war effort is an industry that has alternately been cursed and blessed throughout its existence, an industry that despite its size is sufficiently diversified and flexible as to have survived world-wide criticism and to have been ready for emergencies when they arose.

Critics would have us believe that the bigness of the steel industry, its financial strength and integrated management, its ability to control valuable processes, are all undesirable features that should be overcome. But let those same critics see how the steel industry is meeting the present requirements of economical operation, is making extensive savings in the use of precious alloying metals, is operating at virtually 100 percent capacity and, if they correctly interpret the trends, they will realize that the very features which they criticised most loudly are those features which are making it possible for the steel industry to contribute largely toward winning the war.

—*The Editors*

OUR *Point* OF VIEW

"GET TOUGH"

"IN WAR you cannot afford the luxury of squeamishness. Either you kill or capture, or you will be captured or killed." Not pretty but, unfortunately, factual to a ghastly degree for both armed forces and civilians in today's world. The quotation is from Captain W. E. Fairbairn, formerly of the Shanghai Military Police, lately instructor of the British Commandos, and now on loan to our own armed forces. The Captain's new book, "Get Tough," embodies his years of experience in the art of rough and ready self defense and offense with the hands as one's only weapons. It is not nice reading. It tells casually and coolly how to gouge, break an opponent's arm, leg, or neck—but, unpleasant as the subject matter may prove to many readers, its underlying philosophy is the only acceptable one for Americans who desire to continue "our way of life."

It's about time we did get tough. In six months of war we have lost thousands of men, hundreds of ships, untold tonnages of food and war munitions—which, nevertheless, our taxes must pay for—to say nothing of the Philippines, Wake and Guam Islands, and portions of the Aleutians. We lost face with other nations, both friend and foe, and, worst of all, we lost some of our own self respect. What did we win? We won the battles of the Coral Sea and Midway Island and many smaller engagements, tactically important, but hardly compensatory with our losses.

These comments have nothing to do with our armed forces. At Pearl Harbor, Wake, Bataan, Corregidor, on the seas, and in the air our fighting men have indelibly recorded *their* toughness in their own blood on the pages of history's newest tome. But what of the rest of us?

We were a tough people during the dark days of '76 and the long years that followed. We were tough in 1823, when a man in the White House spoke important words to all the world, words later called the Monroe Doctrine. We got "that way" after the Alamo; when the battleship *Maine* was sunk; when a Kaiser and his henchmen torpedoed shiploads of our women and children—but are we that way now?

That fellow, Schickelgruber, and his pesky little yellow cousins in crime think we aren't. For their own sound reasons they do not question the hardihood of the boys in blue and khaki—but what of the rest of us? Are we tough enough? Do we realize that this Thing that is loose on our gory globe is so big, so strong, so ruthless that unless we in the United States all get tough—and soon—we may suffer the loss of many idealistic and realistic things, things that will make the present commodity shortages seem extremely picayune?—*A.D.R., IV.*

WHAT'S AN AMATEUR?

THE amateur works because he cannot help it, impelled by a love of the work he does.

Today the amateur home mechanic is helping to win the war in at least three specific ways: as a "bits and pieces" machinist bending over a cellar lathe at home after regular working hours while the owls hoot outside; as a repairman reconditioning firearms for home-guard uses; and as a precision optician making parts of the optics of armament to fight Hitler.

All three of these amateur movements have been organized and are now in actual production. The results they have given are changing the meaning of the word amateur. What is an amateur?

The trouble with this two-headed word is that it means two different things that sometimes actually march in diametrically opposite directions. It means, first, a dilettante who makes a superficial pretense. But it also means a man who practices an art for the love of it. Now, when it turns out, as it is turning out more and more often, that the man who practices an art for the love of it equals, or even excels, the professional who works mainly to earn a livelihood and sees little romance in what he does, the word amateur comes to connote something not derogatory but entirely good.

The program for home machinists has been described in other publications. Hundreds of lathes and other machine tools in cellar and attic shops have been put to work on bits and pieces of armament, their owners becoming sub-contractors.

The National Rifle Association has organized those of its members who are gunsmiths in a program for reconditioning old rifles of standard caliber. It also is endeavoring to round up for similar uses as many as possible of the old Springfield rifles which had been sold to private individuals and to put them to better uses than lying in attics.

Scientific American, since last autumn, has quietly organized in a program some of its thousands of amateur telescope makers. A limited number of these advanced workers have already demonstrated that the amateur who works mainly for the love of the work, or for the hate of Hitler's regime, can successfully do precision optical work of a grade of difficulty that is looked upon even by most professionals as ultra, and which some of them find it prudent not to tackle. Several of these amateurs now hold primary contracts, and some of them, if they continue to make good on the promise contained in their preliminary successes, will no doubt be able to expand their home shops into much larger plants.

There is today far less tendency to look down the nose at the amateur than there was a generation ago, for the amateur has proved up in too many ways. The classic example of this proof was the help given in World War I by the American Radio Relay League, about which everyone has often heard. The War Department discovered that it had among those amateur "hams" a huge reservoir of virtual virtuosi in radio engineering. Since then it has been far easier for amateurs of any kind to get a straight-faced hearing, and today the professional who low-rates the amateur is likely to be warned by some other professional that he had "better look out, or that fellow you scorn will soon be catching up and blowing on the back of your neck."

There is no longer even any need for the amateur to over-compensate by being cocky and assertive. In most places he meets with an honestly co-operative reception and an intrigued interest in what he is trying to do. Sometimes the professional envies him, for the amateur hasn't had his fun spoiled by having to make a living from it.—*A.G.I.*

Housing on the Double Quick

Factory Production-Line Methods Applied to Speed Construction and to Conserve Building Materials

GEORGE MICHELSON
Vice President, J. Slotnik Company, Boston, Mass.

On a 600-unit housing development to accommodate personnel at a Navy Yard, practically the only tool the carpenters used in the field was a hammer. The explanation of this unusual operation was complete pre-cutting of all lumber, each piece being plainly marked when cut and stacked near the fabrication yard. When the foundations were ready, the lumber for the floor of one building was hauled to point of use, followed, as required, by all the framing lumber and then by plumbing, roofing, and electrical materials. Trim and interior finish came to the work cut to size and was completely assembled in a job fabricating shop. Erection utilized production-line methods, a crew doing only one operation on a house, then passing on to the next building.

Pre-cutting and assembly-line techniques were adopted by the contractors to conserve material and to meet an expected shortage of skilled help in an area where little construction had been done in the last ten years. This solution of the labor problem was based on the expectation that an unskilled man would become efficient quickly by working at the same job day after day.

Before ground was broken the contractor analyzed carefully the operations necessary for construction, and agreed on 22 essential operations for the construction of the one-family units with only one more operation necessary for the double units. The next step was to estimate the number of man-hours required to perform each operation and select proper size crews to keep each portion of the work "in step." Sufficient crews were then organized to insure the desired overall progress on the project.

Field supervisory forces consisted of a general superintendent to whom an assistant general superintendent, the expediter, and the office manager reported. The assistant general superintendent held direct supervision over field engineers, inventory control of warehouse and mill, assistant superintendents in charge of subcontract work, and operation superintendents directly responsible for several team captains in charge of small groups on the various essentials of construction.

The 600 dwelling units of the development are made up of 150 single units, 24 feet, 4 inches, by 28 feet, and 225 two-family units, 24 feet, 4 inches, by 55 feet, 8 inches. Each family section has a living room, kitchen, two bedrooms, and bath. No basement is provided but full outside walls are carried below the frost line. A storage space 10 by 10 feet is floored in the attic with access through a 30 by 30 inch scuttle. Heat is oil-fired hot air, the heating unit (located in a kitchen alcove) supplying year-'round hot water. Electricity is used for cooking and refrigeration.

Exterior walls are two- by four-inch studs at 16 inch centers with one inch wood sheathing, building paper, and creosoted wood shingles. Roofs follow the same pattern as the walls but use composition shingles.

Interior walls are 3/8-inch thick fiber board nailed to the studs, no other wall insulation being used; the ceiling is the same material but has insulating batts laid between the ceiling joists; walls and ceilings are painted. Double houses have special soundproofing in the party wall, the insulating strips being zigzagged between studs facing each way to entirely break the connection between the units.

The supervisory men responsible to the assistant general superintendent were in charge of certain operations only, rather than over a particular area or group of blocks in which houses were being built. The contractor's plan of operations was to follow as nearly as possible the straight-line factory production methods except that the workmen move past the product in lieu of the product moving past the workmen. By organizing the work in this way, a minimum of non-working foremen were required. Within each group of men working on a particular operation was a team captain with two-fold duties. First, he was responsible for maintaining the rate of progress established for his "team"; secondly, it was his responsibility to his team to make certain that their materials were at hand. The exercise of these duties kept the teams alert and active. Each man, after an operation was started, quickly realized his importance to his team; a "ringer" posing as a carpenter was quickly routed out by his teammates to better their production rate.

A system of inventory control was set up to conserve material and prevent waste. The inventory control served not only this function but also alleviated the unskilled labor situation by supplying all possible parts ready to use, thus substituting routine operation for general craft skill. In order to carry this out successfully, it was

Rough framing of single and double units, and rough boarding of a single unit. In foreground are pre-assembled window frames and studs cut to length

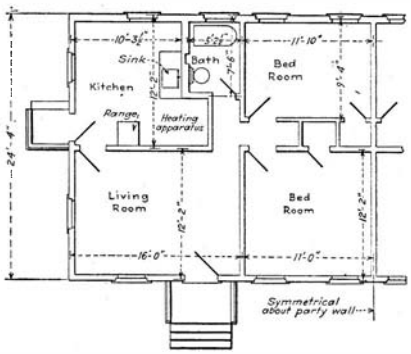
Courtesy "Engineering News-Record."

necessary that the proper amount of the materials required for each operation be made continuously available to the craftsmen. If workmen were obliged to look for a piece of lumber or were allowed to exercise choice in the use of lumber, this method of operation would have failed.

A carpenter shop 150 feet by 80 feet was set up for the purpose of milling the framing lumber and building up such sections of each house as it appeared could be economically prefabricated. The mill was made of adequate size so that when the milling operations were nearly completed, the mill could be transformed into a suitable shop for pre-cutting the wallboard and also for setting up door frames and hanging doors and installing hardware.

At the time that the engineering staff divided the job into the various operations, full-size details of every piece of lumber going into the house were prepared. This was carried out even to the preparation of blocking for plumbing fixtures. The next step was to determine which members could be economically built up and delivered to the house location ready for installation.

All the lumber was cut in advance



Floor plan of half of a two-unit house. Single-unit plan is similar, but with a bedroom window in what here is a party wall dividing the two dwellings

and, where possible, partially assembled in the shop. Sills were cut for positions above and below windows and the short studs nailed to them in the proper length to fit in their marked position.

Incoming materials were received by a stock control supervisor who assigned them either to the warehouse or to the mill. Lumber assigned to the mill was placed upon gravity conveyors which fed two lines of radial-mounted circular saws. Each saw was set to make one cut, after which the piece passed on to the next saw. For a hip rafter the first cut was a double mitre on the front end of the piece, after which it was measured to a

Trees were carefully protected during house construction, and every care was exercised in locating the homes to take advantage of the contours of the site

templet and marked for two straight bevel cuts on the opposite end and then passed to the next saws until all cuts were made. Each piece was marked to show its exact location in the finished work.

Excavation for water and sewer lines and for the outside walls of each house was carried to a depth of four feet. Truck-mixed concrete was used for an 18-inch wide, 12-inch deep footing under the exterior wall with 18-inch square footings for the interior columns. Bricklayers then placed concrete block walls and columns to the height required to accommodate the building to the existing ground.

The material for a complete floor system was collected on a truck at the storage yard and hauled to the building site and piled—not dumped—as close to the work as possible. (Skids and tractors were used during the spring thaw.) The exact number of pieces of lumber required were taken to the work and if one was broken it was returned to the yard for replacement or, if taken for other purposes, a special explanatory requisition was issued. Unsatisfactory lumber was culled during the operations carried out in the carpenter shop. Savings in waste, in rehandling of material, and in reduced confusion are believed to have compensated for the few trips necessary to the storage yard for replacement material.

Floor framing was started by laying stringers over the center piers, followed by floor joists set in place at 16-inch centers and lapped over the center stringer. Bridging, already cut for quick handling, was nailed in place, followed by the sub-flooring, not precut, which was placed over the entire area; the edges were trimmed with a portable electric saw. Necessary openings through the floor were cut later by a special crew.

As soon as the floor was laid the framing for the rest of the structure was brought to the site and piled so that material required first for construction was on top. The walls were assembled on the completed floor, the previously sawed-to-length studs, and sills with short studs, expediting the operation.

FOLLOWING the same procedure there was delivered to each house the exact quantity of side wall and roof paper, asphalt roof shingles, creosoted wood shingles for side walls, including pre-cut wood shingles for gable rake, window frames, sash, and wallboard. Doors were fitted, hung, and hardware installed at the mill so that they were delivered as a complete package to each house and the field work involved merely the erection of the unit in the rough opening left in the framing. Some of these details are shown in the illustration on the opposite page.

Shipments of material from the warehouse or the lumber yard were made in accordance with definite schedules. Variations from the scheduled quantities were reported immediately, investigated, and rectified. Use of this method of controlling materials proved that building mechanics can be trained to follow schedules; that waste can be eliminated; that the cost of maintaining the inventory control system is much less expensive than the cost of waste; and that, at no extra expense, rubbish can be greatly reduced.

Star of 1054

Our Crab Nebula Proves to be a Guest-Star Strikingly Observed in China 900 Years Ago

HENRY NORRIS RUSSELL, Ph.D.

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

In the western part of Taurus, due north of Orion, a fairly bright nebula was observed and catalogued by Messier. Later, some imaginative observer called it the "Crab Nebula." Its sponsor must have had as lively a capacity for seeing figures in the sky as blessed the ancients who named the constellations, for it is a somewhat irregular oval mass, which looks more like a potato than a crab—but the name has stuck to it, and is now generally used, at least in English.

By whatever name it is called, it is one of the most remarkable objects in the sky. It is of moderate size, about 6′ by 4′ in extent, and shows the familiar nebular bright lines—forbidden lines of oxygen and neon and ordinary lines of hydrogen and helium—all superposed on a faint continuous background. So far, there is nothing unusual, but Lampland, at the Lowell Observatory in 1921, comparing photographs taken at an interval of eight years, found that the nebula was in motion, and measures by Duncan at Mt. Wilson confirmed this.

Later photographs by Duncan extend the interval of observation to nearly 30 years, and reveal the character of the motion clearly. It is illustrated in our illustration (from Duncan's paper of 1939). The arrows show the observed displacements of each of the measured points, multiplied by 17, so as to get the motion in 500 years.

It is evident that the nebula is expanding in all directions, and at a very rapid rate, astronomically speaking. Carrying the observed lines of motion back, they all pass close to the point indicated by the white dot which has been inserted in the figure. (There is no such thing in the nebula.) The small discrepancies in direction probably arise mainly from uncertainties of measurement of the nebulous condensations, which are not very sharply defined. Carrying the motion back in time as well as in space, it appears that all parts of the nebula started from this central point at nearly the same time, about 800 years ago—the discordances being again attributable to uncertainty in the measures.

This suggests almost irresistibly that the nebula owes its origin to some great outburst, about eight centuries ago, near the marked point, which ejected masses of gas in all directions, and with somewhat different velocities, whose persistent outward motion has resulted in the observed picture.

If some of these gas-masses were thrown out almost directly toward the Earth, or away from it, they would appear to move slowly, even if they were really moving as fast as the rest. This explains why the central part of the nebula is also bright.

A conclusive test of this interpretation may be made spectroscopically. If the light of the central region really comes partly from gas on the front side of the expanding mass, moving toward us, and the rest from gas at the rear, moving away, the lines in the spectrum of the first should be shifted toward the violet, and those of the second toward the red, giving double lines—somewhat like those in the spectrum of RW Tauri, described last month, but arising this time from motions straight out from the center, and not in a circle around it.

Double lines were observed in the spectrum of this nebula by Slipher at Flagstaff in 1913. Spectra adapted to accurate measurement, taken by Mayall at the Lick Observatory in 1936, showed that the velocity of the outward motion for points apparently near the center of the nebula was 1300 kilometers per second in each direction—falling off toward the edge of the nebula—as we might expect, since the motion of points in this region should be nearly crosswise to our line of sight. This makes it certain that the nebula is really expanding. Assuming that the rate of motion is the same in all directions, its distance may be calculated. Duncan finds 1250 parsecs, or 4100 light-years. The greatest diameter of the nebula, as we now see it, comes out about six light-years.

This is not the first known case of an expanding nebula. The gaseous envelope surrounding Nova Aquilae of 1918 (which is still faintly visible, and still expanding, at a uniform rate) was undoubtedly formed by ejection of matter from the star, literally under our eyes. Hence, as soon as the expansion of the Crab Nebula was discovered, the suggestion was obvious that it owed its existence to some similar outburst eight centuries or so ago. Since the Crab Nebula is still fairly bright, the catastrophe which produced it was probably of extraordinary magnitude and visible as a very bright Nova.

Lundmark, in 1921, pointed out that certain Chinese records described the appearance of a "guest-star" in the right part of Taurus, and in the year 1054 A.D.—translating the Chinese constellation and year into our familiar system. This is almost 900 years ago, instead of 800, but it would hardly strain the observations of the fuzzy moving nebular condensations to fit them to this slower rate of motion, and the hypothesis that the Crab Nebula was produced by the outburst of a new star seen in China in 1054 has ever since been regarded as probable. New evidence, just published, appears to settle the question in the affirmative.

Professor Duyvendak of the University of Leiden—a distinguished authority on matters Chinese—has discovered, in other ancient chronicles, several additional references to the "guest-star" which appeared in this year. For example, "In the first year of the period *Chih-ho*, the 5th moon, the day *chi-ch' ou* (July 4, 1054) a guest-star appeared several inches south-east of *T'ien-kuan* (ξ Tauri). After more than a year it gradually became invisible," and from another chronicle: "It was visible by day, like Venus; pointed rays shot out from it on all sides; the color was reddish-white. Altogether it was visible for 23 days." References to this object are also found in chronicles written in Peking, and in Japan. These detailed records were evidently due to the belief that the appearance of this strange star was a portent of things to come; but they preserve information of much scientific importance which has been discussed by Professor Oort, of Leiden,

and Dr. Mayall, of Lick Observatory.

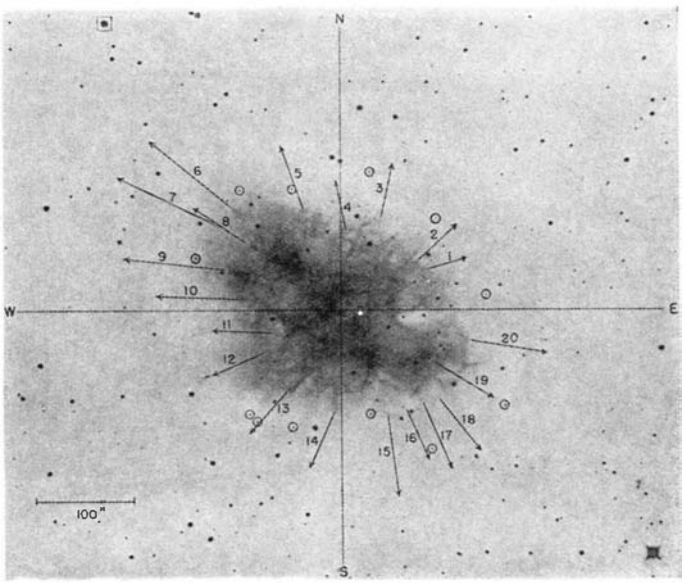
The great brightness at maximum, combined with the known distance of the Crab Nebula, show that the "guest-star" of 1054 was a supernova of unusual brilliancy.

To be visible by day, like Venus, it must have had an apparent visual magnitude of about −4; but this is rough, for the Chinese had no way of estimating how much brighter than Venus it was. Even at this long interval, we may improve this rough value. The 23 days mentioned in the ancient chronicle evidently refer to the interval during which the star remained visible in the daytime. Now, three super-novae in distant extra-galactic nebulae have been well observed in recent years. Their light-curves were remarkably similar—the decline in brightness in 23 days after maximum being 1.3, 1.5, and 1.6 magnitudes. Hence it is reasonable to assume that at maximum the star of 1054 was 1.5 magnitudes brighter than when it was last seen in the morning after sunrise, by observers who had followed it through the dawn. The limit of visibility under these conditions is about −3.5 magnitude, so that the supernova at maximum must have been near −5.

The region of the Crab Nebula is affected by the absorption of light by the thin dust-haze which is widely present in the Galaxy, and causes distant stars to appear fainter and redder than they would otherwise look. From measures by Stebbins and his colleagues, of stars in the same region and at about the same distance, it appears that this absorption amounts to about one magnitude.

HAD it not been present, the star of 1054 would have been at maximum of visual magnitude −6, and brighter than any other celestial object on record except a few comets. With the distance of 1250 parsecs, this corresponds to an absolute magnitude of −16½, or to nearly 300,000,000 times the light of the Sun. This might put a strain on our belief, were it not that the brightest recently observed super-nova, which appeared in 1937 in the nebula I.C. 4182, had the well-determined absolute magnitude −16.6 —just a shade brighter.

Further evidence of the great brightness of the "guest-star" is found in the fact that, according to the Chinese records, it remained visible to the naked eye for some 650 days after its appearance. The super-nova in I.C. 4182 declined in brightness by 11½ magnitudes photographically in this interval. The visual change was somewhat less. Assuming the same for the earlier one, and that it was of the 6th magnitude when lost to sight, its maximum comes out at −5. This, by itself, is a rough value; but it shows that all the data are consistent with the belief that the ancient and modern super-novae were extremely similar. It is very remarkable that so much information is still available about an astronomical event which was visible nearly 900 years ago.



Courtesy "The Astrophysical Journal"

Arrows show the expansion of the Crab Nebula

No direct evidence is available about the later history of either super-nova, for that of 1054 sank beyond the reach of the naked eye and that of 1937 beyond that of the 100-inch telescope, when the real brightness was, in each case, about 10,000 times that of the Sun. We can be sure, however, that the star which produced the Crab Nebula has not gone out. The emission spectra of gaseous nebulae can be accounted for only on the assumption that some very hot star, within or close to the nebula, floods the gas with ultra-violet light of very short wavelength, which, in rather complicated but well-understood ways, sets the atoms of gas to shining.

Almost at the center of the Crab Nebula is a very faint double star, with components of the 16th magnitude. One of these appears to be a normal star; the other is very probably the surviving remnant of the super-nova. In visual light, it is now about half as bright as the Sun. Its ultra-violet radiation must be enough to maintain the visible light of the nebula, and probably much other radiation invisible to us. It may then be concluded that it is still exceedingly hot—probably more than 100,000° even at its surface. Without "telling tales out of school" the writer may reveal that an interesting discussion of this subject is soon to be published by a Western astronomer.

Meanwhile, we may note that this nebula presents a very striking instance of the complications which arise in trying to apply our ordinary time-conceptions to objects at vast distances.

The "guest-star" appeared—to observers on earth—early in July, A.D. 1054; but the stupendous explosion which gave it birth actually happened about 3000 B.C. We see it now as it was in 2100 B.C. with an uncertainty of a few centuries affecting both figures in the same direction and to the same extent. It appears to us now as a gaseous cloud of six light-years in extreme diameter; but that was its size in 2100 B.C. At present it must be almost 5½ times as big—if, indeed it is shining any longer.

WE cannot yet say whether the initial star can keep up its extraordinary ultra-violet radiation indefinitely or whether it is still drawing on and slowly exhausting a store provided by the great cataclysm. Even if it has remained without change for the 4000 years and more that separate the star as we see it from the star as it is, the nebula must be much farther from the star, much more feebly illuminated and much fainter. If the star has cooled to an ordinary stellar temperature, the light which the nebula reflects must be much too faint to be observable.

What it is like now—or, more precisely, what it will look like to the observers of A.D. 6000—is for the present a secret, perhaps to be revealed soon by theory, but otherwise in the very safe keeping of light-waves which at the moment are neither here nor there, but are buried inaccessibly in that vast portion of space-time which Eddington, in one of his moments of inspiration, has called the Absolute Elsewhere.—*Princeton University Observatory, June 3, 1942.*

Our Search for the Supernatural

Dunninger Explains How Table-Turning, Once Explored by Faraday, May be Accomplished

"TABLE-TURNING. *Spiritualism.* Movements of tables, et cetera, attributed to the agency of spirits."—Webster's International Dictionary, Unabridged.

More comprehensively, and according to Lewis Spence, author of "An Encyclopedia of Occultism," table turning is a form of psychic phenomena in which a table is made to rotate, tilt, or raise completely off the ground by the mere contact of the operator's finger-tips, and without the conscious exercise of muscular force. The modus operandi is exceedingly simple. The sitters take their places around a table, on which they lightly rest their finger-tips, thereby forming a "chain," as it is known in psychic circles. In a few moments the table begins to rotate, and may even move about the room, seemingly carrying the experimenters with it.

This apparent phenomenon has been for years, and still is, in high favor among spiritistic mediums as an alleged means of communicating with the spiritual world. The alphabet is slowly repeated, or a pencil is run down the printed alphabet, and when the letter the spirits desire to indicate is reached, the table tilts. Thus have been "dictated" sermons, poems, "information" regarding the spirit world, answers to sitters' questions, and, who knows—perhaps at Berchtesgaden, even the Nazi war strategy.

Table turning originated in America, spread to Europe, reached England early in 1853, where it became immensely popular.

So prevalent did table turning become that men of science were urged to turn the light of scientific knowledge on the "phenomenon" and to endeavor to explain it on rational grounds. Foremost among distinguished investigators was the English scientist, Michael Faraday. By means of a simple apparatus of his own devising Faraday showed that the movements of the table were due to unconscious muscular action on the part of the sitters, who were thus, themselves, the automatic authors of the messages purporting to come from the spirit world. The conclusion drawn from Faraday's experiments was that when the sitters believed themselves to be either pressing downwards, or not pressing at all, they were actually pressing obliquely in the direction they expected the table to rotate—an expectation generated, possibly, by an advance statement, frequently on the part of the medium or leader, that the table would first move in such-and-such a direction.

Then, as now, not all agreed with the conclusions pointed to by scientific experiments. Two of the earliest investigators became satisfied the table was motivated by a force radiating from the operators, a force they termed "extenic force." Others were less rational in their explanatory attempts and the public, on the whole, was disinclined to accept Faraday's scientifically reached conclusion. People seemed to prefer the spiritistic explanations, or the pseudo-scientific theories which asserted that the "chain" of operators formed a sort of electric battery which supplied the table with vital energy, or, as it was then called, "electro-odyllic" force. Other explanations offered were odic force, galvanism, animal magnetism, and—strangest notion of all—the rotation of the earth.

Raduano tilts 10-ounce table

The apparent phenomenon of moving, tilting, or levitating a table remains as much as ever an argumentative question between those who subscribe to the tenets of spiritistic control and those who do not. On July 21, 1941, Signor Raduano appeared before the Scientific American Committee for the Investigation of Psychic Phenomena, and tilted—not levitated—a small table of his own, as well as one belonging to the Commodore Hotel.

The signor was given complete freedom to utilize powers which he prefers to term "psychic" rather than "supernatural" to tilt his tables, but his failure thus far to re-appear for simple tests before our Committee—in accordance with his own agreement—left no choice but to refer the matter to Chairman Dunninger for an explanation.

In presenting our Chairman's views, it must be remembered that neither Dunninger nor the Committee maintains the following method was employed by Signor Raduano but until and unless the signor keeps his agreement to carry on his demonstrations under simple test conditions before the Committee, it will be accepted that this or some other mechanical device or means was utilized in Signor Raduano's table-turning exploit of July 21, 1941.

The three-legged table used by the signor was his own property. This was in accordance with our policy that "demonstrators of psychic phenomena will be permitted to name and to work under their own conditions during the first seance or demonstration." The signor's table was constructed of papier mache, or some other extremely light-weight substance, it weighed only 10 ounces, and was covered with a material resembling billiard-table-cloth in texture. Thus, the slightest friction between hands and table-top would tend to tilt the table. Whether or not the motion was accentuated by use of the right knee or the right foot cannot be factually stated, but one of the photographs taken at the time indicates that both these portions of the signor's body were in close proximity—if not in actual contact—with parts of the table. The hotel table, at the right in our photograph, weighed little more than the signor's special affair, and could likewise have been motivated by friction between its top and the palms of the hands. When a newspaper man was asked to place his hands on the outer, forward corners of the signor's table, and when the signor had succeeded in raising one table leg from the floor, the demonstrator removed his own hands, leaving the table poised on two legs, supported, apparently, by the palms of the newsman's hands. The slightest pressure, even unconsciously applied by the reporter, would serve to maintain the poised position of the 10-ounce table.

This report, supplementing the one in our March 1942 issue, closes the Raduano case, unless the signor desires to re-appear before our Committee.

Ships Off the Line

Science and Ingenuity Help Produce Cargo Vessels for the Emergency—and for our Future Merchant Marine

A. D. RATHBONE, IV

● THIS IS A WAR OF SHIPS . . . . Rear Admiral Emory S. Land, Chairman, United States Maritime Commission, stated in the April issue of "Marine Engineering and Shipping News" that: "This is a war of ships! American shipbuilders and shipworkers hold the destiny and freedom of the nation in their hands.

"Every hour lost in building a ship—no matter how it is lost—every work stoppage or slowdown—no matter why—is repudiation of that responsibility. . . .

"Ships built in time are truly Liberty ships.

"Too late, they will be slave galleys for Americans.

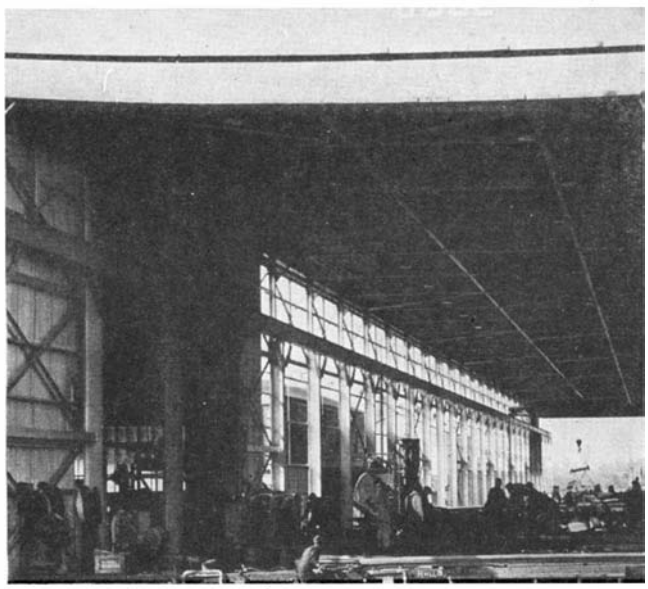
"The men who build ships and the men who command them cannot fail America. Knowing them as I do, I am confident they will not fail." ●

It's a long, thin room. It's filled—even in the daytime—with light-perforated dimness, the unending, clattering roar of giant rollers squeezing huge steel plates, the machine-gun staccato of riveters, and the hissing overtone of acetylene cutting and welding apparatus. This is an "assembly line" for production of Liberty ships, those 441-foot emergency cargo vessels that are now sliding off American shipways at the unprecedented rate of two a day—soon to become a near-miracle of three a day.

This third-of-a-mile-long room, 300 feet wide, is the fabrication plant at one of Bethlehem Steel Company's several shipbuilding yards; it's never quiet; and into the great maw, which is the receiving end of the building, are fed daily, from stock piles, enough steel plates to enable workers to cut, shape, and weld the 400 hull-plates necessary in the construction of one Liberty ship. There are 16 ways in this yard. Throughout the United States there are now 60 great shipyards aggregating more than 300 ways. Together they will produce and put into service 2300 ocean-going merchant ships by the end of 1943. Approximately 1500 will be the 7200 gross-ton Liberty vessels; slightly more than 300 will be tankers; most of the rest of the ships will be the modern C-types, destined to form the nucleus of America's great post-war merchant marine. Some idea of our present merchant shipbuilding program may be had by comparison with similar efforts in World War I. The present plan is nearly twice as big in its five-year scope from 1939 to 1943 as was that of the other war in a seven-year period—2486 ships aggregating more than 25 million deadweight tons, against 1911 ships during the last war totaling over 13 million deadweight tons.

Why is it necessary for us to set up such a stupendous plan—a plan that will demand every ounce of energy for its accomplishment? There are several very sound answers.

The battle fronts of today are in every far-flung corner of the world, and requirements of our war-production and delivery set-up must, therefore, depend on maritime commerce on a much vaster scale than ever before. Secondly, last time we had the use of cargo carriers from France, Italy, Japan, and other nations. It's different this time. Add to these the deplorable condition of the shipbuilding industry and our merchant marine before hostilities broke out. Shipbuilding had fallen to its lowest level of production when the United States Maritime Commission was brought into existence by the Merchant Marine Act of 1936. Then we had but 10 shipyards, with only 46 ways capable of producing 400-foot ocean-going vessels—and half of those were occupied with naval construction. Significant, too, is the fact that between 1922 and 1937 American shipyards produced but two ocean-going cargo vessels, other than tankers and liners.



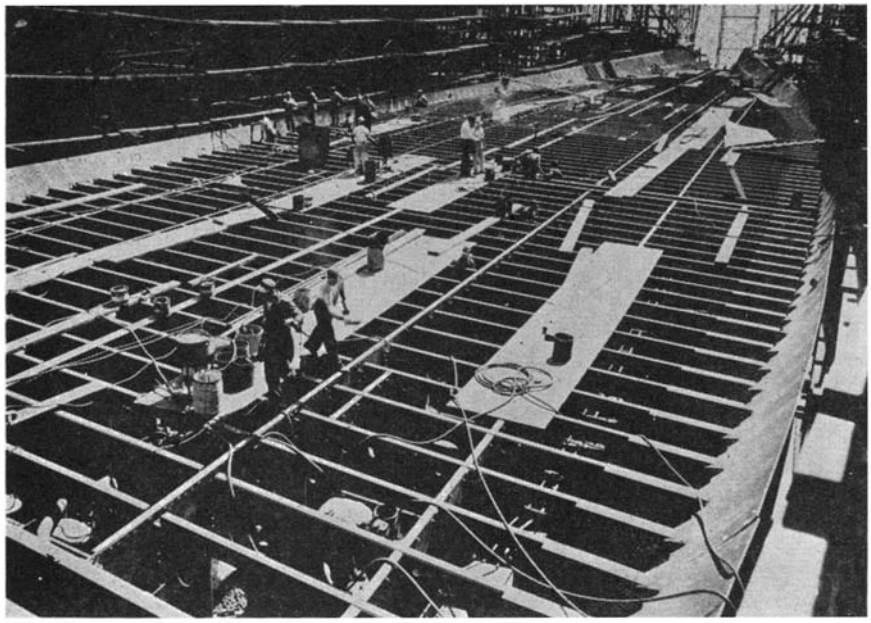
Courtesy "Marine Engineering and Shipping News"

"It's a long, thin room, dimly lit . . ."

A primary purpose for the establishment of the Maritime Commission in 1937 was to devise plans for construction of new merchant ships to replace worn, obsolete, American merchant marine ships, virtually all of which had been constructed prior to 1922. Late in 1937 the Maritime Commission proposed to construct 50 ships a year over a 10-year period. From that modest beginning there has been a constant mushrooming of the program to the point where American shipbuilders now *must* produce an average of a little more than three ocean-going ships a day to meet the war needs.

The original annual quota of 50 ships was doubled when Hitler set fire to the world; it was doubled again in 1940, and, in January, 1941, the yearly goal was set at 400. However, not only were the existing shipyards—then 18, with 70 ways—incapable of producing more ships than already were scheduled, but the limited capacity for production of turbines and gears, the most modern propulsion machinery for the C-types of vessels originally developed by the Maritime Commission, had been fully absorbed by the then-existing program. That condition brought the Liberty ship—Emergency Cargo Vessel—into existence. The maritime Commission was forced to adopt specifications for a ship propelled by reciprocating steam engines, a vessel not comparable to the already-approved Maritime Commission designs which called for the finest, most efficient, and swiftest merchant ships ever built—but, Liberties could be built faster, ever faster!

Never before had the shipbuilding industry of any nation been called up-



"Build more ships faster to win the war," says Rear Admiral Emory S. Land

on to utilize the ingenuity and efficiency necessary to produce 10,000-ton cargo ships in so short a time. Handicapped by lack of ways and yards, lack of steel, and a serious shortage of skilled workers and experienced supervisory ability, America's Maritime Commission and cargo vessel makers literally and figuratively rolled up their sleeves and went to work. They took a most important leaf from the automobile manufacturers' book—assembly-line and mass-production methods—and altered it to fit their needs. "Standardization" was the watchword. The Maritime Commission became the purchasing agent for everything that goes into the Liberty ships—from steel plates and engines to galley equipment and table linen, from windlasses and fuel-oil heaters to radios and gate valves. This ever-growing stream of thousands of items is retained in the Commission's central pool and consigned to the 60 yards as required.

A spread-the-work program has placed orders for ships' parts with 500 large and small plants in 32 states. Everything is uniform, so that no matter who makes it, it will fit in any Liberty ship. Worker training schools, under Maritime Commission authorization, are bringing out thousands of new skilled workers each month. Today, more than a million are employed in our American shipyards. Pre-fabrication of many parts, as well as pre-assembly of units, was successfully accomplished. Specifications were simplified to save time and essential materials. Welding took the place of riveting—Liberties are 85-percent welded. More ways and more yards were built, almost overnight, and all were laid out, so far as possible, to permit straight-line production. Schedules were expedited from the originally contemplated six months for one ship to 105 days, with greater speed-ups still to come. All this took place during a feverish 1941.

Then came Pearl Harbor.

One month later President Roosevelt called for an expansion of this already huge program by another 50 percent, and a later directive brought the goal to 2300 ocean-going merchant ships by the end of 1943.

LET'S go back to that long, thin, dimly-lit room and see what manner of miracle is making this biggest shipbuilding program of all time click so well.

The first step is to unload the steel at the railroad siding. The storage yard beside this Bethlehem plant—only one of many, remember—receives 6000 tons a week, and on one day recently 127 cars of steel arrived. Enormous steel plates are carried by crane and flat-car into the pre-fabricating plant, where they are cut and formed. Much of the cutting is done by an instrument called a Travograph, in which four oxyacetylene cutting tips simultaneously slice four identical shapes from 5/16-inch steel plates with extreme and continuous accuracy. In this shop two of these multiple cutters, working full time, cut enough storage tank pieces—and they are legion—to supply all ships produced by this yard. In Travograph cutting, as in all such steel cutting, or "burning," for ships' parts, templates or molds, previously constructed in the mold-loft to full size of the ships' sections, are used to insure accuracy. Measuring lines, identification marks, rivet holes, welding spots are copied from template to each plate or piece so that later workers will know what they have and where it goes.

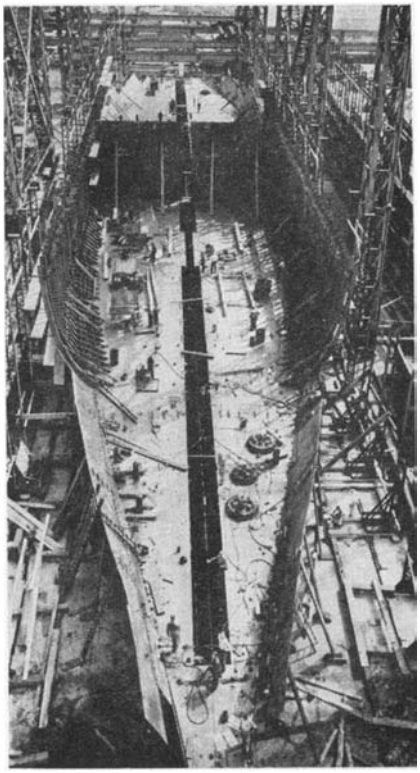
Farther along this 1380-foot assembly line the welders get in their work. As an indication of the extent to which arc-welding is used as the method of fabricating steel work one of the nations' larger shipyards has installed enough welding equipment in an open-air assembly line to keep over 3000 men busy operating more than 1000 welding arcs 24 hours a day—and that's only one shipyard! Frames, deck sections, bulkheads, bow assemblies, and other parts are formed and fabricated. Someone estimated that approximately 35 miles of arc-welded joints are made by manual operation and more than 7½ miles by automatic operation in each Liberty ship. On railroad flat-cars these sections are delivered to the ways, where keels have been laid and hulls are beginning to take shape.

With a precision that amazes the layman, the myriad parts unerringly find their way to their pre-destined locations. This is the job of the erectors and shipfitters, who can read and understand the weird hieroglyphics painted on the parts and assemblies. A small army of reamers, drillers, riveters, chippers, "burners," and welders swarm over the hull in what may seem the height of confusion, but in reality the co-ordination of plans, material, and labor in American shipyards is maintained on an exacting scale, as proved by the reduction in construction time from the prescribed 105 days to three months in many instances, and recently a Liberty ship came off its ways 46 days after

The welder is vastly important in the construction of our Liberty ship fleet

the keel of the ship had been laid.

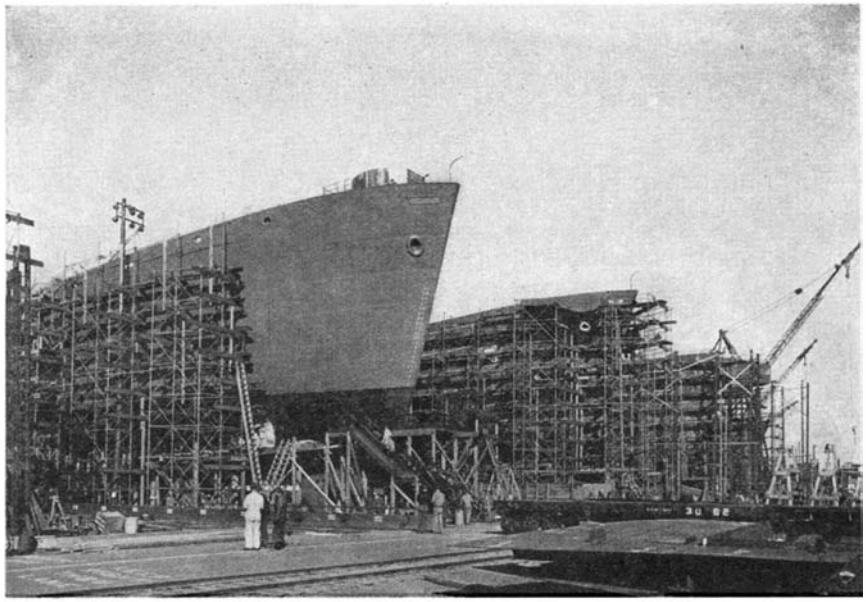
When decks and hatchways have been installed, the ship is launched—still an imposing spectacle, even though more commonplace these days. The ship moored to outfitting piers, welders, electricians, steam-fitters, and other artisans complete their particular installations. Altogether, some 500,000 man-hours are needed to produce one Liberty ship, and with increasing rapidity they are leaving their outfitting piers for their rigid



From high above on the scaffolding, a Liberty ship has skeletonized form

test runs; but this speed-up of building in no sense implies sacrifice of ability or sea-worthiness. Rather, it is another reflection of Yankee ingenuity and abilities. While Diesels are not available at present to power these Liberty ships, it will be possible to replace present propulsion machinery after the emergency is over with Diesels, or with turbines and gears, thus making them into faster and even more efficient carriers.

All along the line the Maritime Commission's central pool of supplies has functioned in providing material and parts with which to build a ship, get it into the water, get it completely outfitted, get it ready for occupancy and for cargo service. Now, with test run over, the ship okayed for immediate use, the Commission makes its last move before actual service. Every single item is checked into its place. The larder is stocked, the pots and pans are in the galley, fuel tanks



Courtesy "Marine Engineering and Shipping News"

A keel is laid, the hull begins to form, and pre-fabricated sections are placed

are full of oil, the furniture in officers' and crews' quarters is in place and in perfect order, water tanks are filled—nothing is lacking now but a crew, a cargo, and a destination.

Across the bay from the shipyards are great wharves and warehouses, filled to capacity with the manifold munitions of war. There, too, await the highly trained and doughty seamen of the American Merchant Marine. After the Maritime Commission's final inspection and acceptance of the ship at the fitting-out pier, the newest Liberty steams across the bay to those docks, in charge of a temporary crew. Her captain and his men take her over, her holds are packed with every ton of war freight they can stand, and she is off to brave the Axis-born dangers of war-time shipping. Through cargo transportation she will do her share to make the Seven Seas once again the safe world highways of commerce they must be for a new and greater American Merchant Marine.

It is significant that even during the stress of war, American ship operators are retained to a great degree in their normal industrial function. Although the War Shipping Administration has taken control of merchant ships, the title to most of them remains with the owners, who continue to supervise their operation as direct agents of the Government. This policy of the Maritime Commission and the War Shipping Administration is indicative of the fact that war has not caused the abandonment of the primary objective of the Maritime Commission. If our merchant vessels survive the ravages of enemy action, war will have served as a medium for expediting our original Merchant Marine restoration program. And, with ship operators retaining identities in the present maritime structure, they may, without serious dislocation, resume their previous status when peace comes.

It seems clearly apparent that this nation will be called upon for years to come to provide the bulk of the ships and the sailors which will be necessary

Courtesy "Marine Engineering and Shipping News"

Larders are stocked—"soup to nuts"

to restore economic balance and stability to this war-shattered world. Never again should we allow our shipyards to be disassembled. Never again should we permit our merchant fleet to reach the low level of efficiency and competitive ability which it attained in the post-war years following 1918. With present capacity at our command, we *can* maintain the 1943 rate of production of 15 million deadweight tons—and even increase it—if future developments show needs for additional tonnage.

East-Coast Cattle Ranching

A Vital Industry Gains New Life Through Scientific Development of Pasturage and of High-Quality Stock

HAMILTON M. WRIGHT

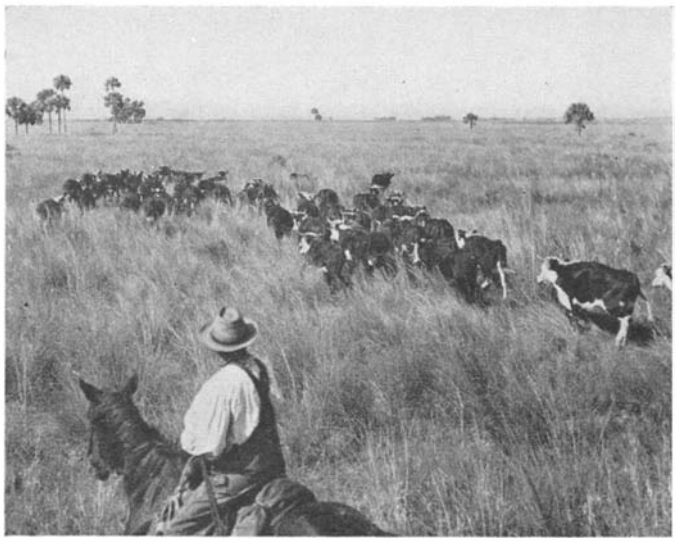
WITH wartime needs putting the demand for beef at an all-time high, the 1942 slaughter of livestock in the United States is expected to include 28,000,000 head of cattle and calves, according to Secretary of Agriculture Claude S. Wickard. Thus, the progress of the beef-cattle industry in Florida and the neighboring tidewater states of Georgia, the Carolinas, and Virginia, creating a new cattle country in the South Atlantic Seaboard, is beginning to assume an important place in the nation's economy. Florida's 1942 cattle population is already estimated at 1,500,000 head by Florida state authorities, but they say that Florida alone, with an estimated 25,000,000 acres of range land available for pasture improvement with newly introduced grasses, will eventually support a tremendous increase in this number.

This prediction is understandable in view of a statement by an experienced cattleman, who has raised beef cattle upon a large scale both in Wyoming and Florida, that he can raise a steer at an over-all cost of three dollars a year on the Florida range, as compared with 15 dollars a year in Wyoming where cold weather makes prolonged winter feeding necessary.

However, as recently as 1923 the most chronic optimist would not have dared to predict prosperity for Florida cattle. From a low ebb at that period, brought about by the ravages of the fever tick, beef cattle in Florida have undergone a phenomenal change. With the practical eradication of this dangerous pest since then, thousands of pure-bred beef bulls, including Herefords, Black Angus, the huge Guzerat Brahma, and other superior beef types have been crossed and recrossed on the native scrub cows, descendants of Spanish stock first brought to Florida in the 16th Century, to produce a preponderance of first-rate beef cattle.

In Georgia and North and South Carolina, where ten years ago a prime beef steer was the exception, thousands of acres of land withdrawn from the cultivation of cotton and tobacco by Government order are rapidly being converted to improved pastures or to winter cover crops, including small grains and legumes, to provide feed for large numbers of sleek cattle.

Centered in Florida, the industry has swept swiftly up the Atlantic coast. Moss-hung plantations between Savannah, Georgia, and Charleston, South Carolina, where rice, indigo, and cotton once supported lordly establishments, have been transformed into cattle ranches. Visitors last fall to the famous old Combahee Plantation at Whitehall, South Carolina, about 60 miles below Charleston, witnessed the auction of 500 baby beef steers, the largest sale of its kind in that part of the country to date. Almost two score of fat stock shows, where prime beef animals are exhibited for prizes and sold to highest bidders, have been held in Georgia and the Carolinas this past Spring. Many of these animals are used to breed improved stock and some have supplied beef to army camps.



Herefords at home on a Florida range

What has caused the tremendous development of the cattle industry in the Southeast? The answer is, necessarily, not brief. The relatively mild climate for all, or a larger part, of the year, the availability of land for pasturage, good transportation, proximity of markets, all have contributed to make beef cattle a profitable venture in the Southeast. Yet one must look beyond these propitious factors, important though they are. Cattlemen from Arcadia, Florida, to Rocky Mount, North Carolina, will tell you that without the collaboration of science the cattle industry in the Southeast could never have advanced.

Truly, scientific achievement has effectively shown the way to conquer at least three outstanding obstacles which, beyond the memory of the oldest stockmen in the Southeast, had barred progress in cattle raising. These are, first, the cattle fever tick; second, lack of quality cattle; third, lack of improved pasturage and forage.

In the short space of two decades, men of science have contributed enormously to the solution of these problems. The scope of their cumulative effort can well be imagined, when it is considered that not only animal husbandry experts, including nutritionists, but plant pathologists, agronomists, mycologists, bio-chemists, bacteriologists, and, not the least, far-sighted cattlemen, often volunteers for co-operative research, have led the frontal attack. Contributing, also, is the enterprise of the County Agricultural Agents and other representatives of the United States Department of Agriculture, the extension services and experimental stations of the state agricultural colleges, and the livestock and agricultural experts of the railroads. These agencies have been and still are a potent force in educating the rank and file of stock-raisers as to how they can best benefit from the constantly expanding work of the scientists.

All-out efforts to eliminate the fever tick had begun in the Carolinas in 1917-1918 and in Florida several years later. The native cattle of Florida had developed some resistance to the ravages of the tick through constant infection, though it was not unusual for a cattleman to lose from 10 to 15 percent of his herd in late winter and early spring in areas where natural

All photographs courtesy Atlantic Coast Line Railroad

Powerful tractors drawing heavy water-weighted cylinders armed with eight-inch knives are used to knock down palmetto growth and to reduce it to matchwood. Ground so cleared is planted with grass that has proved its all-around value as cattle feed

pasture was at its worst at that time of year. Moreover, they were tough, stringy animals, of slight commercial value. Good beef animals, when imported, promptly died of fever. One of the biggest cattle ranches, containing 99,000 acres, near Arcadia, lost an entire herd of imported Hereford bulls, worth $7500, in a single summer from fever tick infection. Leading cattlemen, with the assistance of Government and state officials, organized a concentrated drive to eliminate this destructive cattle pest. Corrals, chutes, and "dips" were created throughout the cattle regions, and the stock was dipped in tick-destroying solutions.

Tick eradication also started fencing, which made the animals easier to get at and prevented infected animals from mixing with those that were tick-free. At the present time no less than 12,500,000 acres of range land in Florida are under fence.

With the practical elimination of the fever tick from the Florida ranges, pure-bred beef bulls began to pour into the state. They were crossed with the already acclimatized native cows and the progeny again and again mated to imported stock. The imported blood most widespread now in Florida livestock is that of the Brahma, sacred cow of India, which can stand heat because it sweats like a horse, and which can go far for water and feed. But the white-faced Hereford is also seen everywhere, and the state is now firmly established as a producer of fine beef cattle.

The third step in the creation of Florida as a scientifically operated cow country is the sowing or sodding of nutritious, introduced grasses in place of native grasses. Native grasses provide satisfactory seasonal grazing only; the native wire grass, for example, is liked by cattle only for two and a half to three months, after which it becomes tough, unpalatable. Improved grasses afford exceptional pasturage for eight or nine months or more of the year. Some of these improved pastures, in fact, will feed a steer all the year 'round. One of the biggest ranchers in south Florida winter-fattens his stock on para grass pastures. Cattle like the introduced grasses better than the native. They fatten on them quicker and do not wander so much.

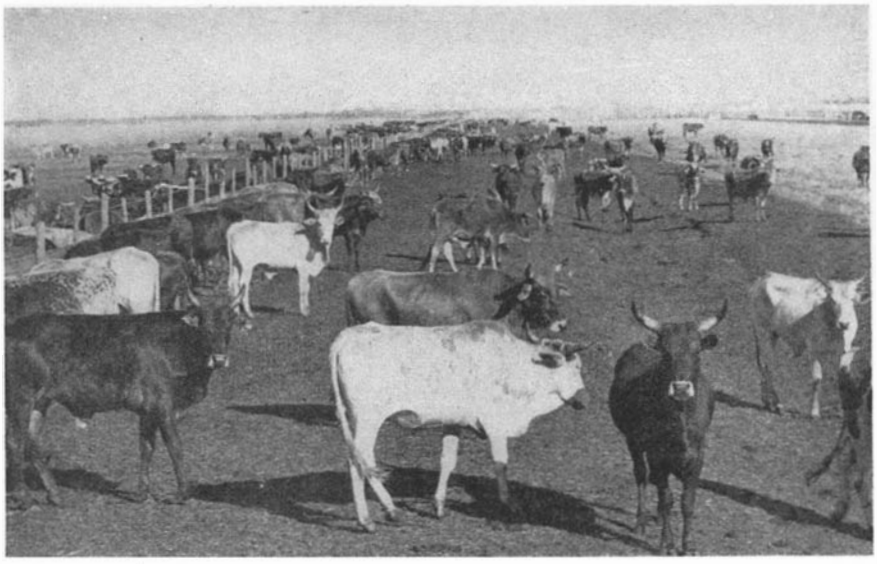
Of Florida's 25,000,000 acres of cattle range, 3,000,000 acres so far have already been partially improved as pasture. This land requires only continued work upon it to be rated as fully improved, capable of supporting several times the number of cattle that now graze upon it. In addition, there is much land to which carpet grass *(Axonopus compressus)*, which is now almost a native of our southern states, has spread.

A dynamic change in Florida's progress as a cattle state came in 1936. At that time Florida cattlemen began large-scale planting of improved pasture with the financial aid of the Agricultural Adjustment Administration. Between the close of 1936 and January 1, 1942, 360,000 acres of improved pasture were put in with the aid of the AAA. Florida is now proceeding at an even faster pace; last year, cattlemen in that state put in 156,000 acres in improved pasture, with government aid.

An historic firm of Florida cattlemen, packers, and ship-owners are now operating two huge palmetto choppers on a day and night basis, clearing the ground of heavy palmetto growths for the sowing of pasture grass in the flatlands northwest of Lake Okeechobee in southern Florida. These machines comprise rotating steel drums, each weighted with 500 gallons of water and armed with eight-inch steel knives that reduce entire palmetto trees and the heaviest kind of shoulder-high palmetto brush to an appearance of chopped matchwood. They are drawn by Diesel Caterpillar tractors, each making a speed of four miles an hour. Each machine clears an acre an hour. The combined clearance of the two machines is, therefore, almost 50 acres a day. When the land has been cleared of palmettos, carpet grass is disked-in to start the pasture. The entire destruction of the palmettoes requires two additional applications of cutters, one year apart.

This sort of land clearance is going on all over the palmetto regions in the Florida cattle ranges. Within three months of disking-in the carpet grass, cattle are grazing on the new pasture. However, carpet grass requires three years to become firmly established, and it is helped by close cropping.

Far to the North, yet within the Coastal cattle belt, which extends more than one thousand miles North and South, near Wilmington, North Carolina, a famous agriculturist and stockman has developed a continuous grazing program for his dairy herd, by a scientific rotation of small grains, feed crops, legumes, and grasses. Eleven different crops are involved. This permits his cows to graze the year 'round in the open on rich, succulent green feed, and must be regarded as an im-



Above: The imported blood of the famous Brahma cattle strain is evident in this herd of Florida cattle. Brahmas (a pure-bred bull is shown below) are notable for their ability to withstand great heat

portant contribution to the livestock industry in the South. This plan, like others, which makes the animals do the work of harvesting in winter, is one of the factors that makes cattle raising in the Southeast so profitable. In this connection it should be pointed out, however, that the program represents a highly perfected grazing plan and that the majority of beef and dairy stockmen in the Southeast limit themselves to five or even as few as two crops on the list, although some cattlemen, farther South, carry their cattle successfully on improved pasture through the year.

A favorite grass in south Florida is the para grass *(Panicum purpurascens* or *Panicum barbinode),* well known in south Florida and originally introduced from Brazil, used both as pasturage and also in silage in the winter feeding of cattle. This grass, a very fast grower, has been known to yield 30 tons to the acre under favorable conditions. The density of this crop can be inferred when it is considered that there are 43,560 square feet in an acre, and that to attain this result each square foot must average a production of more than one and one-third pounds of the grass. This grass has creeping stems sometimes as long as 30 feet and as large as a lead pencil. It takes roots at the joints and makes an upright growth of three to five feet. It has a tendency to choke itself by its thick root growth and must be disked before it is killed out by its own excessive vigor.

Among other grasses, especially developed for beef cattle in Florida, are Napier or elephant grass, which attains a height of six feet, and a new cold- and wilt-resistant selection of Bahia grass. The selection of Napier grass, evolved by the agronomy department of the University of Florida

College of Agriculture, represents but one of more than 4000 specimens of this variety of grass studied that would best meet cattle forage requirements in Florida. A new type of Bahia grass that is more cold-resistant and a better seeder than common Bahia, a native of Paraguay, has been developed by the United States Everglades Experiment Station. The painstaking selection process, often requiring at least five years of experimentation before the grass is released to stockmen, is just one of the methods employed in evolving improved grasses for the Southeastern cattle industry.

At Moore Haven, west of Lake Okeechobee in southern Florida, one cattle buyer during the past winter secured fine results with winter feeding of cattle for the market by using in silage 15 tons of black strap molasses to each 320 tons of para grass cut green. But now that molasses is getting scarce, it is proposed to use the residue from the citrus canning plants in a similar manner. Already, some 35,000 tons of dried citrus-pulp are being used as cattle feed per annum.

Florida and its sister tidewater states have undeniable natural advantages for cattle raising. Mild climate and plenty of rainfall permit continuous grazing for nine months in the year in certain parts of this territory and already for a full 12 months in other sections. Excluding transportation facilities and proximity to markets, in both of which the Tidewater States occupy an enviable advantage, the low cost of feeding cattle is the Circean lure that is proving irresistible to experienced cattle investors from other parts of the country.

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LAWNS

Grow Best When Planted in the Fall

There has been considerable controversy in the past as to the best seeding time for lawns, but it is now generally conceded that Fall is by far the best, according to a statement made by J. W. Lentz, Director, Scott's Advisory Lawn Service. In spite of this, Mr. Lentz estimates that about 70 percent of home lawn growers still defer seeding until spring; he stressed, in a recent interview, that spring grass seedlings are apt to perish with the advent of hot, dry summer weather.

Early September seeding is ideal, since the grass then has a good start before freezing weather. Even seeding done in winter months results in better lawns than when sowing is deferred until spring, for the seed will germinate during the early days of spring when the soil would usually be too soggy to work.

FINGERPRINT

Classifiers Wanted In War Jobs

Fingerprint classifiers will be appointed in Government service through an examination announced recently by the United States Civil Service Commission. The Bureau of Navigation in the Navy Department, the War Department, and other Federal agencies in Washington may make appointments. The salary is $1620 a year. There are no age limits. Since the last announcement for classifiers made by the Commission, the experience requirements have been reduced, and the field has been broadened to include

members of fingerprint clubs or other organizations who have had training in the Henry system of fingerprint classification.

Instruction in the Henry system, and, in addition, three months of appropriate experience in that system, may qualify applicants. Their experience may have been in Federal, State, or municipal bureaus, in the employ of private corporations or individuals, or in fingerprint clubs under professional supervision. Proof of experience must be submitted. Perfect vision is necessary. The written test will be a practical one on the identification of basic fingerprint patterns and classification under the Henry system.

Applications must be sent to the Civil Service Commission, Washington, D. C., and will be accepted until the needs of the service have been met. The forms for applying may be obtained at first- and second-class post offices throughout the country, or direct from the Commission.

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PAPER—Wood pulp (wholly or in part) is the source of nine-tenths of American paper.

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ASBESTOS SUIT

Designed for Rapid Use, Complete Protection

A NEW one-piece asbestos protective suit, which provides instant and complete personal protection against flame hazards in emergencies, consists of an upper-and-lower durable asbestos garment securely sewed together, with helmet, gloves, and boots attached to completely enclose and protect the wearer. The unit prevents the entry of flame, insulates against heat, guards the head from injury by falling or flying material, and enables speedy and effective work at the scene of emergency.

Flames can't enter

The helmet of the suit is made of laminated Bakelite, asbestos covered, and with front and rear aprons to protect the head and neck. A large window of heat-resistant glass in the hood permits unobstructed vision.

Quick access to the suit, made by the Mine Safety Appliances Company, is provided by a zipper opening extending down the front from neck to waistline. When closed, the zipper is protected by a flap held in place by two arctic buckles. Zipper fasteners at the wrist and lower sections of outside leg seams facilitate rapid donning of the suit. Wrists, ankles, gloves, and neck portion are flannel-lined for comfort. Sole and heel of boots are reinforced with asbestos brake lining material, riveted in place for durability, long wear, and protection.

The suit is made in a universal size only, with tabs at each side and back to adjust length.

PHOSPHORESCENT

Material In Sheet Form For Blackouts

A FABRIC sheet with a phosphorescent coating on one side is now available in rolls under the name Conti-Glo P-10. The material can be cut from its sheet form into strips and used to outline objects and obstructions so that they can be seen in the dark. For example, long strips may be applied to the side of a stairway or along the wall of a room. Shorter strips may be used on the stair risers.

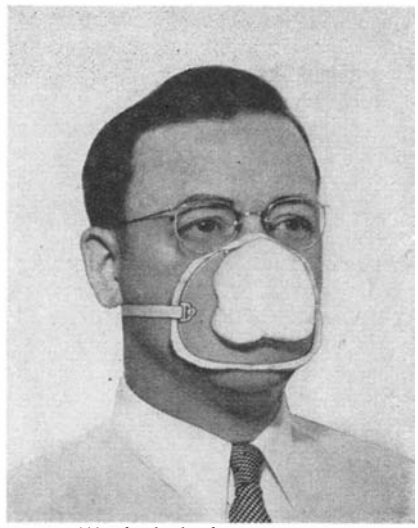
The material resembles oilcloth in appearance and can be secured to any surface by tacking, by the use of adhesive tape, or by cementing in place.

RESPIRATOR

Keeps Out Dust, Can be Used with Inhalant

WEIGHING only half an ounce with its filter pad in place, a new respirator is useful in industry as well as in the treatment of certain respiratory ailments.

This respirator, announced by Allergy and Medical Products, Inc., and shown in one of our illustrations, is reported to be very comfortable to wear. This is due to its light weight,



Weighs little, has many uses

plus the fact that the frame of the mask is composed of a thin sheet of metal which can be molded to the contour of the face and which is held in place by an adjustable head band.

A wire frame, attached to the bottom of the mask, holds the replaceable filter pads away from the nose and mouth, thus giving a large breathing area.

For ordinary use where it is desired to keep dust from the respiratory tract, plain untreated filter pads are employed.

For treating colds and other respiratory infections, a few drops of an effective inhalant are dropped on the filter pad, enabling the patient to bathe his membranes continuously with the soothing vapors.

STORED CARS

Need Complete Protection Against Deterioration

"UNLESS you are prepared to take the necessary precautions, it may be thriftier to drive your car sparingly than to put it in storage for the duration," says T. H. Stambaugh, director of national service operations for the Hudson Motor Car Company, and continues:

"If a car is stored for a year or two without precautions, it is doubtful if it can be put back in operation without a major repair job. In addition, the owner is likely to find that his tires have deteriorated, the battery is ruined, and the car's finish is damaged.

"I have no quarrel with—in fact, I commend—those individuals who want to store their cars for patriotic reasons. Nor will I argue about possible savings in gasoline and oil if cars are taken off the road. However, preservation is one thing and waste is

another. To preserve, we will have to go the full way through preparation to make preservation a practical thing and not just a theory.

"Persons who are considering storing their cars for the duration to save tires should consider the fact that tires deteriorate when not in use. This is because normal operation of a car flexes the rubber and keeps it alive. Light—even artificial light—damages stored tires. All windows in the storage place should be blacked out and the car should be blocked up to remove the weight from the tires. Even then, there should be a certain amount of inflation during the storage period, calling for periodic checking.

"When a car is placed in storage, all gasoline must be drained and then a half pint of mineral spirits, naphtha, or benzine must be run through the pump, carburetor, and engine to remove every last vestige of gasoline. If this is not done, gum accumulates, and the valves may stick so tightly that they may have to be literally 'hammered loose' from the guides.

"Before this is done, the oil in the engine should be changed to a very high grade product and the engine run for 5 minutes. Then 2 ounces of a high grade No. 10 motor oil should be injected in each spark plug hole and the engine turned over several times with the starter, so that rings and cylinder walls will be thoroughly covered with a protective coating. Failure to take this precaution may mean that when the engine is started after a long period of storage the rings may be 'frozen' in the cylinders, and great damage could be done the engine when attempts were made to start it after the storage period is over.

"The radiator should not be drained, because moisture remaining in the cooling system could start rust formations. The cooling system should be kept up to full level at all times. A rust inhibitor should be added to the coolant and if there is danger of freezing temperatures, anti-freeze should be added.

"To prevent rusting, springs, frame parts, clevises, and other chassis parts should be sprayed with motor oil. All bright finished parts must be treated with paraffin wax after rust spots, if any, have been removed.

"To prevent deterioration of the lacquer, the car finish should be thoroughly washed, cleaned, and waxed.

"Upholstery should be thoroughly protected from moths with a minimum of four one-half pound cakes of naphthalene when placed in storage, and every 60 days thereafter with one half-pound cake. Openings around foot pedals should be protected with screening or metal to keep out rats and mice. The body should be air-tight through closing all doors, windows, and ventilators, so that the naphthalene can do its work.

"Batteries deteriorate and should be stored where they can be charged regularly and the solution kept at the proper level."

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TRAIN—The hobby of playing with toy trains now has more than 100,000 American men enthusiasts, who have invested at least $10,000,000 in their equipment and support three hundred local clubs, three magazines, and a national association which holds annual conventions. One millionaire even has one of these miniature railroads installed in a Wall Street building, where it occupies two entire floors.

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FOREST RADIO

Antenna Needs No Insulation

ONE of the new devices for use in emergency radio communication, now aiding the United States Department of Agriculture's Forest Service in the current and continuing fight against fires, is a simplified radio antenna perfected recently at the Forest Service's Radio Laboratory.

The new forest radio antenna has no insulators, requires no elaborate installation, and can be pre-tuned before installation. Costing but a small fraction of what the usual commercial antenna costs, it is called the PD ("plumber's delight") antenna by forest rangers because it can easily be made from simple materials like pipe and fish poles and installed with the aid of a few plumbers' tools. The fact that no insulation is necessary prevents power losses and reduced efficiency due to insulator leakage. Resistant to snow and ice, the antenna is especially suitable for lookout stations at high elevations.

It is equally effective on wood and metal buildings. Another asset is that instead of representing a lightning hazard, it acts as a lightning rod, adding to the safety of the structure to which it is attached and of the occupants. Reduced to barest essentials, the PD antenna consists of a vertical radiator, working against a ground established by four horizontal quarter-wave radials. For Forest Service radio frequencies, the antenna is only six to seven and one-half feet long.

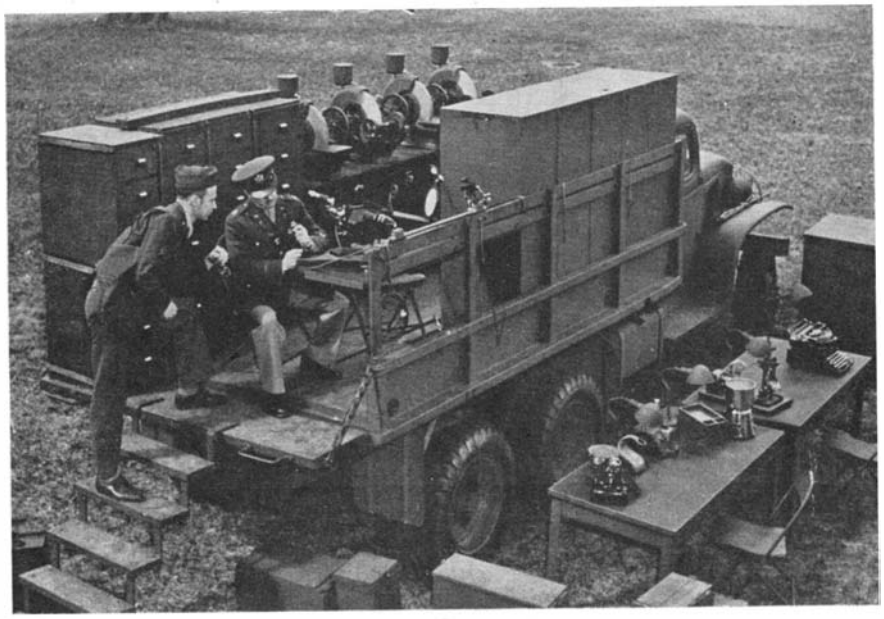
MOBILOPSHOP

Army Spectacle Wearers Have Fewer Worries

OVERSEAS soldiers who break or lose their spectacles in camp or on the battlefield will have them repaired or replaced in the field by mobile optical shops, first of their kind to be attached to United States field armies.

The first of these units, built by the American Optical Company, and commanded by Captain J. R. Harrison, was designed at the request of the Surgeon General's office. It contains optical machinery, 36,000 lenses, 8400 frames, 600 pairs of extra temples, and 1200 spectacle cases. A total of 120 single lenses can be edged and mounted daily, which is estimated to be sufficient for the average requirements of a field army of 300,000 men.

Approximately 15 percent of the men in the armed forces wear glasses. In World War I an optical shop was set up for the A.E.F. in a suburb of Paris. As it was stationary, speedy



Mobile Army eyeglass shop satisfies requirements of a field army of 300,000 men

Men in the Armed Forces

—Soldiers, Sailors, Marines—

Would Appreciate a Gift Subscription to Scientific American

AS a gesture to those hundreds of thousands of American men who have severed their home and business ties to do their part in building up the Army, Navy and Marine Corps of the United States, Scientific American is making a special offer of half-rate subscriptions when mailed to members of our armed forces.

Keep the boys informed of the happenings in Science and Industry which are so important to our present-day economy, and which will be doubly important to them when they return to civilian life. Send us the names and addresses of those members of the services to which you want the magazine sent, enclosing only $2 for each one (regular subscription price is $4 a year) and we will mail Scientific American regularly to each one of them for a period of 12 months.

There is a constant call for reading matter from all branches of the service. Here is your chance to make life a little happier, a little fuller, for the boys by sending them the one magazine that gives them accurate and authentic information on progress in a wide range of fields. Just fill in the coupon below (use a separate sheet if you need more room) and send it to us with the correct remittance. We will do the rest.

REMEMBER: This special half-price offer is good only for subscriptions to be entered in the name of service men. when sent direct to us.

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I am enclosing $..... Please enter subscriptions for the service men listed below at your special price of $2 per year for members of the armed forces of the United States.

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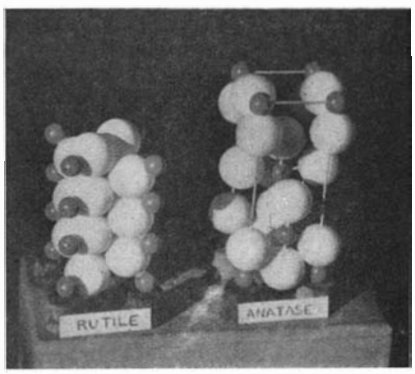
spectacle service to the soldiers in the field was impossible. A member of the present editorial staff of this magazine, whose glasses were broken in line of duty, was forced to journey to a distant city, find a French optician's shop, and pay for the replacement from his own pocket.

In the present war each soldier who wears glasses will have a copy of his prescription attached to his service record at the headquarters of his respective organization. When he needs glasses, he applies to headquarters for the necessary authorization, after which the optical unit swings into action. Thus, today, they are doing things better.

IT'S IN THE CRYSTAL

New Form of Paint Pigment Covers Better

THE patterns of the crystals composing titanium dioxide—the whitest white substance man has yet found for making and keeping white paints white—are physically at considerable variance. One of the three known



Pigments that go farther

types of titanium dioxide crystals is as compact as a clenched fist; the titanium and oxygen atoms in one of the other crystals are arranged in an open, loose fashion. Herein lies a minute difference of mighty significance.

This pair of titanium dioxide crystals—left to right, in the picture—are known as rutile and anatase. Rutile, the chunky fellow, is a newcomer. After ten years of research, the Krebs Pigment & Color Corporation, E. I. du Pont de Nemours & Company, Inc., is now able to make its whiter-than-white titanium dioxide pigment in the form of rutile crystals.

Previously the pigment that revolutionized the formulation of white paints came in the form of anatase titanium dioxide—which had more than double the hiding power of any previously available white pigment. Now, with white pigment available in rutile form, hiding power is increased another 25 to 33 percent. To put it in another way, a rutile enamel can be used to cover one third greater area than an anatase enamel without any increase in the "show-through" of the background. The manufacturer can make four gallons of paint with "Ti-Pure" R—the official name for the new rutile form titanium—where he could only make three with the anatase grade. And this is all due to the fact that the compactness of the new rutile crystal affords a higher index of refraction—or hiding power—than any other titanium pigment available today. Rutile titanium, in the language of the paint-maker, means more "covering power"—greater mileage for enamels and lacquers as well as white paints.

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POWER—Start of long-distance transmission of electric power was recently recalled when the world's first alternating current waterwheel generators at Niagara Falls were returned to service for the duration of the war. Built in 1896, these 10 machines had been retired for 17 years as stand-by equipment. They were installed in the Edward Dean Adams Station at Niagara Falls, by Westinghouse, 45 years ago to produce the power which was sent over wires to Buffalo, New York, 20 miles away.

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ROAD CORRUGATIONS

Caused by Air, According to New Theory

IN a paper reported in *The Journal of the Institution of Engineers*, Australia, Alan Price recently discussed the cause of road corrugation on certain types of paved and unpaved surfaces. He states that it is a mistaken idea that corrugation results from the frictional action of motor car wheels. He points out that, if this were so, the corrugations would occur only adjacent to the wheel tracks, whereas actually they are found to extend right across the road width, and he postulates the theory that they are the direct result of air currents produced by the motion of the car.

Observations and experiments are quoted by Mr. Price to show that wind, or air currents, have wavelengths which eventually bring about "heaps" or corrugations at right angles to the directions of flow; in the case of a road, however, these corrugations do not occur exactly normal to the center line, but lie slightly forward from left to right. The reason for this latter phenomenon is that the air stream is not running parallel to the center line, because the camber of the road induces the current to follow the line of least resistance and to swerve somewhat to the left; this results in two sets of corrugations—one on either side of the pavement—parallel to each other, but frequently breaking step at the center, making this generally the most uncomfortable portion of the road on which to travel.

BLAST CUSHIONING

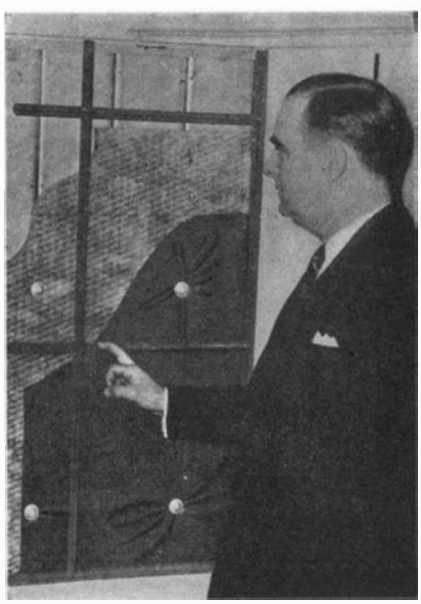
Glass-Fiber Panel For Factory Blackouts

A NEW blast-cushioning, incombustible glass-fiber material for blacking out war-production plants is designed to reduce damage from concussion and to provide protection against the spread of fire caused by incendiary bombs or explosives.

Known as Fiberglas OC-9 Board, the new material is composed of fine, resilient glass fibers compressed and treated with a binder which gives it sufficient rigidity to serve as a self-supporting, fire-resistant material. The material can be faced with glass-fiber cloth, plywood, or other surfacing materials.

Experience in England has shown that even fairly distant bombing may prove highly destructive to industrial operations by shattering windows, scattering death-dealing glass fragments, and disrupting delicate instruments. Although the concussion-absorbing qualities of the compressed glass fibers cannot provide complete protection against nearby blasts, the resilient, light-obscuring and protective materials may prove of definite value by absorbing part of the concussion caused by explosions.

A recent demonstration of this panelling was the first showing of the



Reduces damage from bomb concussions

use of glass-fiber materials for blacking out existing industrial plants. Large quantities of glass fiber products were, however, used for heat insulation and sound absorption in the fire and shatter-resistant walls, and the fire-resistant roofs, of two huge blackout bomber assembly plants already built.

RISKY

Black Widow Spider Menace is No Joke

IN the "Annals of Surgery," Dr. H. T. Kirby-Smith cites evidence that privies are a major menace because they so often harbor the highly venemous *Latrodectus mactans.* As abstracted in *The Journal of the American Medical Association,* his findings show that bites by the black widow spider occur more frequently than is generally supposed. He has collected 15 cases from the records of the Vanderbilt Hospital and has encountered nine cases during five years of private practice. Fourteen of the 24 patients actually saw the spider, and the history and subsequent course of symptoms of the other 10 leave no doubt that they were bitten by the black widow.

Eleven of the bites were on the penis, four on the buttocks, one on the scrotum, one on the thigh, four on the arms and hands, one on the chest, one on the knee, and the site of one was not mentioned.

Sixteen of the victims were bitten while in a privy. Twenty-two of the patients were male. Symptoms ensued from 5 minutes to two and a half hours after the bite. The bites were inflicted from April through October. There was 1 death. Death following a bite by a black widow spider is uncommon.

SPRAY CHECK

Makes Possible Rapid Study of Insecticides

A PRECISION sprayer and duster devised by scientists at the New York State Experiment Station, which make it possible to deposit fungicides on one half of an apple leaf, leaving the other half as a check, are aiding in more rapid evaluation of the effectiveness of new spray materials for the control of orchard diseases.

"In the orchard," say the Station specialists, "the environment must be accepted as it is without control and the complexity of factors that affect the results make it difficult to come to any definite conclusions. Also, years of experimentation may elapse before conditions suitable for certain phases of a study are encountered. Orchard trials will always remain the final test of effectiveness of spray materials, but laboratory and greenhouse procedures which duplicate orchard conditions most closely provide a rapid and economical method of testing new fungicides, and also open up possibilities for much fundamental research about fruit diseases and their control."

Three different types of precision sprayers have been designed. For the most rapid testing of fungicides, particularly sulfur, glass slides are sprayed with the materials under test and the spore suspensions of the desired fungus are applied to the slides to determine the comparative values of different sprays. More reliable tests on foilage grown in the greenhouse are made with a horizontal type of sprayer which makes it possible to spray one half of a leaf, leaving the other half as a check.

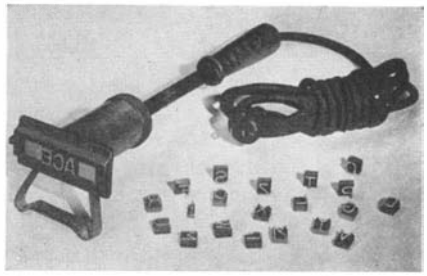
To duplicate orchard conditions, a small model orchard sprayer has been set up in the laboratory. This does not give as accurate control as the precision sprayers, but very uniform and reproducible coverage is obtained by placing the potted trees on

a turntable and passing them through the spray for a definite period of time.

BRANDING TORCH

For Tires, Protects Against Theft

FLEET owners and garage men are finding plenty of use for a tire branding outfit which has recently been made available and which can



Identifies your tires

go far toward preventing tire thefts. This branding torch, illustrated in these columns, is heated electrically, the heat being transferred to interchangeable letters which are firmly fastened in the slotted face of the tool.

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SUGAR—A single acre of sugar beets produces, according to the United States Beet Sugar Association, approximately 3100 pounds of granulated sugar, as well as enough by-products for feed to produce 253 pounds of beef or lamb.

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END BRUSH

Designed to Clean Welded Joints

A POWER-DRIVEN end brush, made by The Osborn Manufacturing Company, is designed particularly to facilitate the cleaning of slag, scale, or oxidation from welds on inside corners, as well as in other locations which are

Brushes hard-to-get-at welds

difficult of access. It is claimed that this new brush will get into any space which is accessible for welding; it takes no more room to manipulate the brush than it does to weld. The brush can be used in all standard power tools, whether air or electric.

FUMIGANT

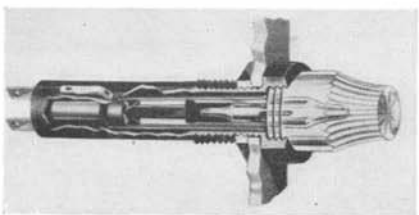
Kills Insects in Grain and Flour

A NEW fumigant for grain and flour, highly penetrating and deadly to insects but harmless to humans, is announced by the University of New Hampshire. The compound, chlorinated nitroethane, is a clear liquid with a distinct but not disagreeable odor, stated to be safe to ship in ordinary containers. It evaporates readily on exposure to the air, and the fumes penetrate quickly even into large masses of grain or flour. A simple method of fumigating grain in cars consists of putting the chemical on top of the grain and then sealing the car.

INDICATOR LIGHT

Gives Visual Indication Of Circuit Break

A SMALL panel indicator light which goes on only when an electrical current is broken is now finding use in railroad signalling equipment, in aircraft applications, and in many other circuits where a remote indication of trouble is desirable.



Operates only when circuit is broken

When this indicator light, manufactured by Littlefuse, Inc., is installed at any convenient point in connection with a remote control setup, it works instantly, giving a plainly visible signal. The lights are available either with filament bulbs or neon lamps which will glow on currents as low as 100 microamperes.

INTER-AMERICAN

Highway Now More Than Half Completed

LINK by link, the great Inter-American Highway is being built from the United States through Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama to South America. Approximately 3,500 miles of all-weather surfaced road is involved and more than half of it is already completed and open for travel, although the completed segments are not all continuous.

The longest section of the Inter-American Highway which has been opened to automobile travel to date is a stretch of over a thousand miles extending from Laredo, Texas, through the greater part of Mexico. Most of this section is surfaced with asphaltic materials. It was actually started some 15 years ago. Each of the Central American countries has constructed an extensive strip of the highway but shorter lengths remain to be finished. Guatemala was the first to improve its entire mileage (300) for all-weather travel. Impassable trails still exist at certain points along the route through Central America. However, completion is now within sight.

Effect of the new highway will be far reaching. Tourists will find within easy range the historical land of the Aztecs and the early Spaniards, the floating gardens of tropical lakes, and the snow-covered volcanos of continuous mountain ranges.

From the standpoint of business the highway will be especially important because it will open up rich producing regions of rubber, wool, hard rice, tea, cinnamon, camphor, coffee, quinine, copra, oils, varnish gums, abaca hemp, and many other commodities including rare woods.

The Inter-American Highway is being financed by the United States and by all the countries through which it passes. Its construction utilizes the latest tools of the modern world. A

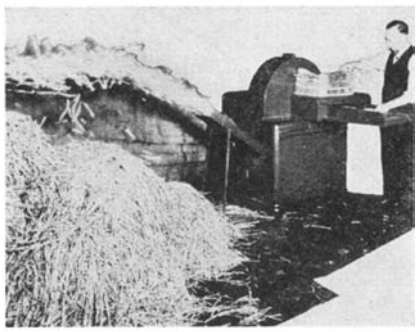
veritable swarm of trucks hasten to and fro, hauling heavy loads at a fast clip, making early completion of such a mammoth enterprise possible. When this great highway is finished, it may well be regarded as a monument to modern trucks and road-building equipment.

PAPER SHREDDER

Rapidly Produces Quantities of Packing Material

OLD newspapers, magazines, waste paper, and out-dated correspondence can be converted into paper excelsior with a shredding machine which produces this packing material at low cost.

With this machine, manufactured by Mitts and Merrill, fresh packing



Make your own paper excelsior

material is readily made from paper that otherwise might be baled and sold, thus obviating the necessity of purchasing new packing material. The shredding knives in the machine are made of hardened tool steel which, it is claimed, will cut light metal such as paper clips, staples, pins and so on, without injury to the cutting edges.

PSYCHIC VACCINATION

Rats Made Immune to Noises by Other Noises

PSYCHIC "vaccination" against the nerve-shattering effects of war noise is a future possibility, it is suggested by a report recently made to the Mid-western Psychological Association. Noise-sensitive rats that ordinarily would be thrown into fits similar to epileptic seizures by certain shrill or irritating noises have been made immune to the seizure-producing sounds, according to Dr. Norman R. F. Maier, of the University of Michigan. The immunity lasted for several days.

The protecting treatment consisted merely of preceding each seizure-producing noise with another to which the rat is not sensitive. Continuation of this procedure with daily tests for

about two weeks makes it possible to expose the rats to the seizure-producing sounds without harm. After a week without tests, the animal is again susceptible.

The noise-induced seizures in rats are due, Dr. Maier concludes, to nervous tensions, and if enough preparation is given, the organism can adjust. In states of low energy the tensions are not sufficient to break through and get control of the animal.

Just how closely the noise-induced fits of susceptible rats resemble the jumpy, jittery nerves produced in some humans by the explosive blasts, shrieking shells, and roaring dive bombers of modern war is not yet known to psychologists. But the fact that a means has been found for protecting the rats by this sort of psychological immunizing process raises hope that some similar method may be developed for helping humans to protect their nerves against war damage.—*Science Service.*

CONVEYOR

Portable Unit Has Variable Incline

A PORTABLE conveyor for use in piling boxes, bales, and other materials, illustrated in one of our photographs, is provided with rubber tired wheels which make it possible to move the machine from one site to another by simply hooking the lower end of it to a motor truck.

The belt on this new conveyor rides on rollers mounted in a structural frame that is hinged to a supporting frame so that the discharge end may

For piling, loading, and unloading

be raised and lowered from a minimum of four feet to a maximum of eight feet. Elevation of the unit is accomplished by a hand crank and geared drums.

The belt of the conveyor is driven by a motor and speed reducer with chain connection to a pulley at the lower end. Adjustment of the belt is accomplished through an idler pulley at the upper end. This unit, known as the Portable Belt Piler, is manufactured by the Standard Conveyor Company.

NATIONAL DEFENSE

SEA NESTS FOR WAR BIRDS

By Walton L. Robinson

Continued from page 54

5-inch guns are of a new model and can be used with equal effectiveness against warships or aircraft. They comprise the main armament of all our modern destroyers and of the four 6000-ton light cruisers of the speedy *Atlanta* class, which are now joining the fleet. They also constitute the secondary battery of the new battleships *North Carolina* and *Washington.*

Maximum aircraft capacity of each of these carriers is over 100 planes, but in normal service the *Enterprise* accommodates 81 aircraft—a 75-plane Air Group and 6 utility planes. Her combatant aircraft comprise one squadron of torpedo planes, one of bombers, one of fighters, and one of scouting planes. The *Yorktown,* flagship of Aircraft, Battle Force, Pacific Fleet and Carrier Division Two, has the same aircraft complement plus a four-plane Flag Unit. One of the most interesting features about these ships is their ability to catapult their aircraft from the hangar deck as well as from the flight deck. This is a great advantage, for it increases the number of planes which can be put into the air at short notice.

The *Yorktown* and *Enterprise* are much more stoutly armored than the *Ranger.* They have a heavy protective deck and a patch of side armor, unofficially reported to be four inches thick, over machinery and boiler spaces, and the usual internal sub-division. They are also very fast—the fastest carriers in our Navy and probably faster than any foreign ones. Their 120,000 horsepower geared turbines, driving four propellers, give them a designed speed of 34 knots, which they have exceeded on trials. Steam is supplied by nine Babcox and Wilcox express type boilers.

In general appearance these ships bear some resemblance to the *Saratoga* and *Lexington,* though they can easily be distinguished from them. They have a fairly large flat-sided funnel, tripod mast, and considerable island superstructure on the starboard side of the flight deck, but no gun-houses such as in the older and larger carriers. In peace time it was possible to differentiate between them by the large black "Y" painted on both sides of the *Yorktown's* funnel.

The 14,700-ton *Wasp,* laid down April 1, 1936, by the Bethlehem Steel Company and commissioned four years later at a cost of nearly $21,000,000 (exclusive of armament and aircraft), is a smaller edition of the *Yorktown*

with certain features of the *Ranger's* design. Her hull lines closely follow those of the *Ranger,* but her superstructure, save for her smaller funnel, resembles the *Yorktown's* in general arrangement. On the water-line the *Wasp* is 688 feet long and 80 3/4 feet wide and in a light condition draws 20 feet. She is, therefore, 40 feet shorter than the *Ranger,* but slightly wider and deeper in the water. Her over-all length is 739 feet. This is also the length of her flight deck, which extends beyond the over-hanging bow and stern. Her armament is the same as the *Yorktown's* and her protection generally similar to the *Ranger's.*

The *Wasp* carries two squadrons of scouting planes, two of fighters, and six utility planes—a total of 84 aircraft. Her engines, Parsons geared turbines, develop 55,000 horsepower for a designed speed of 30 knots.

America's newest regular carrier, the $32,000,000 *Hornet,* was commissioned last October—some months ahead of schedule. She was laid down September 25, 1939, and launched December 20, 1940, by the Newport News Shipbuilding Company. Details concerning her are restricted, but it is known that she is a modification of the *Yorktown* design, incorporating a number of improvements. Her water-line length has been reported at 770 feet and her displacement at over 20,000 tons. From photographs it is evident that she varies only slightly in appearance from the *Yorktown.* Most of this difference is to be found in the island superstructure.

Our eleven carriers under construction or on order are expected to be ships of around 25,000 to 26,500 tons and to cost in the neighborhood of $60,000,000 each. The *Essex, Bon Homme Richard,* and *Cabot* are scheduled for completion next year, while most of the others will follow in 1944-45. They will be welcome additions to our Navy in its life-and-death struggle in the Pacific and in its efforts to assist Britain in maintaining the vital lines of communication in the North Atlantic.

● READERS of the accompanying article on aircraft carriers, and of other articles on naval matters in monthly magazines, must always bear in mind the time-element involved in the publishing business and in the release of information by the Government to writers and editors. Thus, Mr. Robinson's article was written and set in type after the Battle of the Coral Sea, but before the details of that battle were released. Hence it will be understood why the carrier "Lexington" is written of as a ship in being, whereas she actually was destroyed as a result of that engagement.—The Editor. ●

Industrial Growth

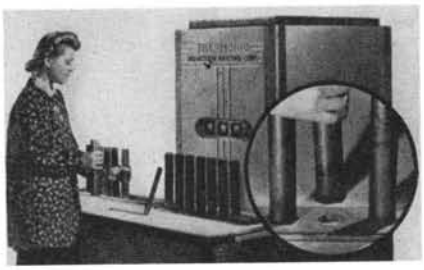
New Products and Processes That Reflect Applications of Research to Industrial Production

BRAZING

With Induction-Heating Equipment

SKILLED labor is not necessary for the operation of a new induction-heating unit for brazing assemblies of various types. The unit shown in one of our photographs was designed to braze a steel tube and a steel hexagon head, but the effectiveness of this particular job may suggest other brazing or metal-treating operations which will facilitate production and decrease labor and material costs.

The equipment used in the unit shown, manufactured by the Induction Heating Corporation, consists of



Skilled labor is unnecessary

a high-frequency generator of 20-kilowatt rating and a double seven-place heating coil. With this double unit, seven working assemblies are heating or cooling on one side while seven others are being removed or set up on the other. A silver brazing alloy is used which penetrates quickly through the joint, the resulting strength of the joint, it is claimed, being as high as or higher than the solid parts.

STICKERS

For Identification, Are Easily Removed

A NEW type of dry sticker having a special adhesive substance that makes it particularly adaptable for use in defense plants is being used for inspection, rejection, instruction, and identification purposes where speed and accuracy are important. Sold under the trade name of Kum-Kleen Stickers, it is claimed that they overcome many of the disadvantages of ordinary labels, tags, and markings. They are applied quickly, without moisture, on any smooth surface, including polished metal, glass, and plastics, simply by a slight finger pressure. Unaffected by intense heat, cold or humidity, they stick permanently, though they may be peeled off easily by hand without leaving a stain or mark.

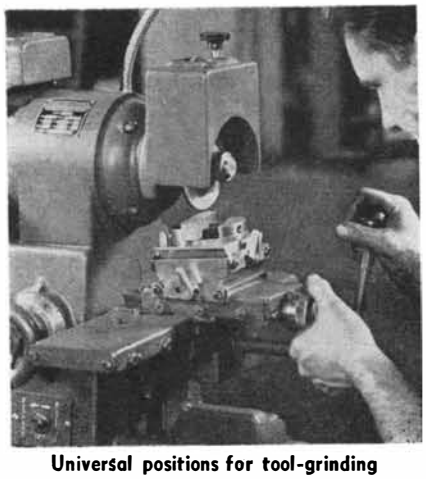
ANY ANGLE

Tool Vise Can be Firmly Locked in Position

COMPLETE in itself, a new tool vise that can be locked firmly at any angle is mounted on a lug base which is easily affixed to a machine table.

The vise, designed particularly for tool grinding, is constructed on a double-cradle principle permitting adjustment of grinding angles on three separate planes. Two closely machined steel blocks, rounded on the bottom, are cradled into each other at right angles. After adjustment, they are solidly locked together by tightening cam locks operating in machined segments at ends of the respective blocks. Mounted atop these two blocks is a flat, circular piece which swivels 90 degrees from center of any of the four sides of the block immediately below. This piece carries the vise jaws, holding tools firmly by means of Allen screws.

The principle of closely fitting steel blocks which may be tightly locked together permits of absolutely no vibration or deflection, thereby insuring maximum accuracy of the grinding



Universal positions for tool-grinding

angle selected. Readings on each block are clearly marked. Each tilts 15 degrees either way from horizontal, and this adjustment, combined with 360 degrees selectivity of the circular piece at top, provides almost any angle desired. The vise has been placed on the market by Hammond Machinery Builders, Inc.

COOLANT STRAINER

Strains Chips and Cuttings from Fluids

FOR machines which require the use of a coolant, a new strainer has been developed which removes metal chips and cuttings remaining in suspension, permitting only chip-free cooling solution to pass through the pump. This

Saves production interruptions

strainer, made by Metal Textile Corporation, is claimed to save general wear and tear on pumps, to conserve coolant, and to increase production speed. Tests of the strainer reveal that on "dirty work" machines, operations can be continued without interruption for four to six weeks before cleaning of the strainer is necessary.

BAND SAW

Cuts Steel As If It Were Cheese

METAL-CUTTING band saws that will cut 18-inch thicknesses of the toughest die steel at a rate of six and one-half linear inches per hour have recently been developed for contour sawing. The specialized equipment used for this purpose has been designed through constant research on band saws and their cutting edges. Progress in this work has extended to a point where, it is claimed, a 3/32-inch wide saw can now be produced with about the same relative cutting efficiency as a half-inch saw.

One of our illustrations shows one of these new metal-cutting band saws developed by Continental Machines, Inc., in use shaping airplane parts. The inset picture shows a saw notching a 12 inch by 3 inch machine part. The saw illustrated will cut one-inch tool steel at a rate of 140 inches per hour.

The process of contour sawing with these new and efficient band saws per-

For shaping as well as for notching

mits shaping of the most complicated outlines in almost any material used in any industry. Aside from saving a considerable amount of time over conventional or basic cutting machines, contour saws make it possible to save practically all material not actually used to produce the parts being shaped or formed.

ELBOW

For Plumbing Use

Made of Plastic

CRITICAL metals are again conserved in the plumbing trade by a new flush elbow for connecting the tank to water closets. The problem has been efficiently solved, and an advance has been made in material adapted for the purpose, in one-piece molding of the flush "L" in tough resistant plastic, by American Molded Products Company.

This "L" is an elbow connection of tank and bowl heretofore commonly made of copper or brass, and supplied by tubular metal manufacturers. With restrictions on the metals, the trade has been much concerned about the supply.

The new "L" provides strength with lightness; it does not break, crack, or dent in the usual packing and handling with tools. It is stated to be leak-proof, impervious to water or to iron, lime, sulfur, salt, or other water-carried material, and to be non-corrosive. It is made of a porcelain-like, white, odorless plastic with a smooth finish inside and out. There is no enamel, paint, or plating to chip, crack, peel off, or tarnish.

Tales Told By Ears

Oxygen Saturation of an Aviator's Blood, Which Determines His Efficiency, is Quickly Measured

ALEXANDER KLEMIN

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

A NEW device with the odd name of the "Oximeter" has greatly increased the usefulness of the altitude chamber at Wright Field, where experiments are constantly being made in regard to the effect of high altitude on the military pilot. The measure of a man's efficiency in the thin air of high altitudes is given by the oxygen saturation in his blood; if the normal reading is 95 percent at sea level, it may drop to 75 percent at 40,000 feet, even if an oxygen mask is employed, because the atmospheric pressure is so low that the subject's body cannot absorb enough oxygen to sustain life without the added protection of a pressurized suit or cabin. Exercise hastens the rate at which the oxygen content of the blood drops. At a rating of 70 percent, a man's judgement becomes unreliable, dizziness and mental confusion set in at 60 percent, and complete loss of consciousness results at 50 percent.

A soldier inside the altitude chamber with Oximeter attached to ear

Previously existing methods of determining the blood oxygen content have been slow and somewhat unreliable, but the Oximeter, designed by Dr. Glenn A. Millikan, allows rapid determinations to be made by a medical man seated comfortably outside the altitude chamber within which tests are being made. The key to an understanding of the Oximeter is a U-shaped ear-unit, with a tiny exciter lamp on one side and a light-sensitive photocell on the other. This unit clamps on the lobe of the subject's ear, so that light from the lamp shines through the lobe into the photocell. We quote Dr. Millikan: "The Oximeter capitalizes on the fact that blood changes color as its oxygen contact changes—normally saturated it is bright red, but as more and more oxygen is lost it shades off to deep purple. Purple passes less light than red, so any change in the oxygen content of the blood alters the intensity of the light which shines through the ear lobe. These changes are relayed from the photocell by wires leading through a box of resistance coils to a galvanometer. There is lag of from one to five seconds between a true reading and the actual condition of the bloodstream. This is the time required for blood to circulate from the heart to the ear. Since light obviously can penetrate a thin lobe easier than a thick one, it is necessary to determine the thickness of the subject's lobe at the outset. Lobes are classified as shell, wafer, thin, medium, or thick so that the proper scale reading on the galvanometer can be chosen."

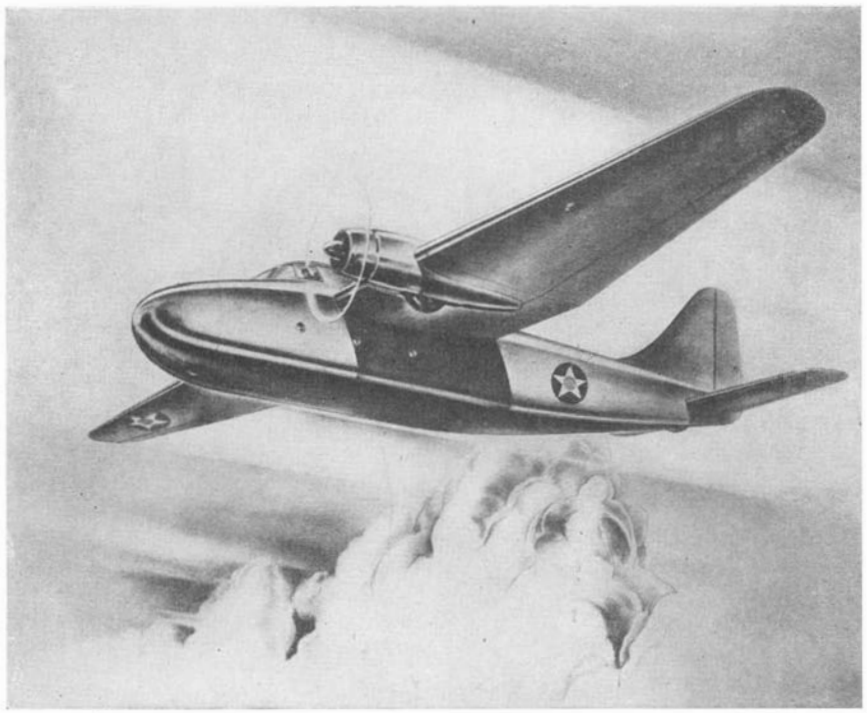
Observer records readings of Oximeter

Many successful applications of the Oximeter have been made and it has proved to be highly useful in aeromedical research.

CARGO PLANE

For the Army, Made of Plywood

IT is no secret that one of the problems of the United Nations is transportation, that transportation by surface



Artist's conception of the new cargo-carrying plane, Curtiss C-76

vessel is slow, that air transport is a tremendous help in carrying supplies and equipment and is likely to grow in importance as the war goes on. The United States Army Air Forces are fully cognizant of the situation and are ordering large numbers of cargo-carrying planes. What is more, these new cargo planes will be built of wood and other non-strategic materials not on the Government priority lists. Again, so as not to overburden the resources of the aircraft plants building combat machines, a majority of the parts of the Curtiss C-76 (as an important new military cargo ship is called) will be built in small assemblies by manufacturing organizations which are experienced in plywood construction.

The site for construction of the C-76 will be somewhere in the East, and many men with woodworking skill are being gathered for the new plant—whose exact location must, of course, remain a secret. Secrecy also must shroud the design of the plane itself, which is shown roughly in the artist's sketch. All that the sketch reveals is a clean, twin-engine plane of about the size of the twin-engine transports operating on our airlines. Whatever the design, the effort is commendable.—*A.K.*

RESEARCH

A Few of the Many Aerodynamical Problems

THE Annual Report of the National Advisory Committee for Aeronautics, which is transmitted by the President to Congress, gives, as usual, a comprehensive review of the research problems which are attracting attention of American scientists—even though the actual results of such investigations remain shrouded in secrecy.

The introduction to the report indicates in interesting fashion the desirable lines of aeronautical development. Thus, the outstanding fighters of 1940-1941—the British *Spitfire* and *Hurricane* planes, and the German Messerschmidt 109 F—had maximum speeds of the order of 360 miles per hour. The American aircraft program must provide new fighters of much higher speed; well over 400 miles an hour. To do this, it is hardly sufficient to increase the horsepower and clean up the airplane aerodynamically. It is necessary to develop entirely new wing sections of the low-drag, laminar flow type, and it is essential to re-examine the methods of cowling and cooling. Special cowlings are needed to handle the air needed to cool the engine, the oil radiator, and the intercooler which cools the air after it has left the supercharger and before it reaches the engine.

Propellers of usual design are inefficient at very high speeds, so that new propeller blade sections have to be developed. At high speeds, the airplane is subject to "compressibility" or shock wave effects, and wings, fuselage, and other parts must be designed to eliminate "compressibility" effects as much as possible.

These are but a few of the problems considered by the Committee whose laboratories must also work on the engine, aircraft structure, and innumerable other questions.—*A.K.*

CAMERA ANGLES

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

Record or Interpret

THE line distinguishing the record picture from the so-called pictorial, or interpretive shot, is sometimes so very thin that none can blame judges when they fall to squabbling among themselves as to whether a particular print should be accepted or discarded on this ground. The pictures of iris here reproduced are a case in point.

To our mind, "Record," despite some evidences of attempts to pictorialize the

"Record"

subject, is still a record. The requirements of flower photography, that the subject should be given form and texture and that proper lighting, development, and printing should bring out both highlight and shadow detail, are fairly well fulfilled. Two Photofloods in reflectors were used for illumination, one overhead, the other roughly frontal and at some distance from the subject to fill in the shadows without destroying balance and highlight detail. Development of the Eastman Super Panchro Press negative was in a much used D-76 solution.

"Pictorial"

"Pictorial," on the other hand, hits nearer the mark as an example of interpretation. Less light and a somewhat low key effect give the desired result; to balance the gracefully tapering buds with the open flower. One Photoflood, above and a little to one side, outlines the buds and the stems but illuminates the flower sufficiently to provide satisfactory over-all lighting.

The pictures were made indoors, using a small graduate as a support, with a medium gray cardboard to serve for the background.

Sunlight After Rain

THE amateur with foresight knows that there's always the chance of the silver lining after the darkness of the storm. He knows that rain does not last forever and that when the sun shines afterward, there are pictures a-plenty. Looking forward to just such an eventuality we took the camera along one rainy day and were rewarded with the chance to shoot "Sunlight After Rain." To make the most of the mud puddles, we held the camera low, taking advantage of the sunny gleam on the roof under the tree to record the cheery effect of sunlight after rain.

"Sunlight After Rain"

M-Q Versus Pyro

WHICH is better, the modern metol-hydroquinone developers or the venerable pyro formulas? The Agfa Ansco Research Laboratories recently made some tests to find out. Two M-Q developers, Agfa Ansco Nos. 17 and 47, and the three-solution pyro formula, Agfa

Ansco No. 45, were used. A straight test showed the following: pyro developed films had better tone separation in the shadows, steeper gradation of the middle tones, and less brilliant highlights, but there was some loss of speed in the threshold region despite which, however, the negative gradation was excellent for portraiture.

Another test was made with a subject having the wide brightness scale, measured from the subject, of more than 100. One set of negatives was developed in the pyro developer, with conventional proportions, another in the same developer but with the carbonate cut to 15 drops per liter of mixed developer. Equal contrast for both sets of negatives necessitated 2 3/4 hours developing time for the modified pyro bath. All negatives were printed on Convira No. O paper, those developed in the weakly alkaline solution giving better print shadow detail and more brilliant highlights, though at the cost of heavy pyro stain and a loss of film speed equivalent to between one and two lens stops.

Pictures in Shade

ONE of the most frequent complaints we hear from beginners is that the negatives they exposed in the shade or on cloudy days when the lighting lacked contrast, were woefully flat. A simple case of cause and effect: flat lighting, flat picture. But there is a remedy. Develop such negatives a bit longer than you do those exposed under normal lighting conditions. Length of development determines extent of contrast, remember.

Imagination in Portraiture

THIS is going to be an indoor summer, someone recently said, in view of the growing restrictions on outdoor photographers. That means more portraits than we ever did before. But let's use our imagination a little and get away from the beaten paths whenever we can. Not all subjects will lend themselves to such treatments as that used here; many an effective portrait has been achieved with more or less conventional poses, the subject itself frequently being striking enough without the employment of tricks and devices. But sometimes it's good to let yourself go, even though it may look a little crazy.

"The Duke di Verdura"

In the portrait of "The Duke di Verdura," by George Platt Lynes, fashion and portrait photograper of New York City, the latter wanted to get something different when he invited his friend in for a sitting. Animation in a still is difficult, but that was the photographer's objective. He achieved it by a very simple arrangement. The subject, astride a bent sheet of linoleum and with a strong light behind, raised his hands as if balancing himself. The resulting shot, informal, gay and completely natural, pleased all.

Perspective on the Beach

SOMETHING a little different in the way of beach pictures is this purely candid shot of two bathers in lively conversation.

A good story

By moving fairly close to the figure in the foreground and angling the camera to enclose the laughing face in the triangle formed by the extended arm and inclined head of the girl in front, a feeling of nice perspective is achieved. Stopping down to *f*/16 gave sharpness.

Rainbows Grounded

RAINBOWS do not all exist in the sky. Under suitable circumstances, they descend to earth as well. Once we witnessed the phenomenon when a garage employe was spraying an automobile in the course of giving it a thorough washing. Another time we saw the same thing happen in a public park when the bright sun, as in the other instance, hit the fine drops gushing forth from a revolving garden sprayer at just the right angle, from the onlooker's point of view, to exhibit a beautiful rainbow curved in a quarter circle. Thus, the humble mortal had a close-up view of what happens in the sky: the colors of the spectrum, in the shape of a bow or arc, are formed opposite the sun by refraction and reflection of the sun's rays in drops of rain. Similar phenomena occur in spray and mist, we see. As in the sky, the grounded rainbows can be recorded in color on color film in a camera. Even pictures made in black and white will give at least a rough approximation.

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By Henry Ladd Smith

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EMULSIONS AND FOAMS

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By Peter Gabriel Bergmann

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features of the theory of relativity which is not only systematic and logically complete, but also presents adequately its empirical basis. The student who makes a thorough study of this book will master the mathematical methods and physical aspects of the theory of relativity and will be in a position to interpret for himself its implications. He will also be able to understand, with no particular difficulty, the literature of the field." The author is a member of the Institute for Advanced Study, at Princeton, of which Professor Einstein also is a member. (287 pages, 6 by 9 inches, 9 illustrations.) —$4.60 postpaid.—*A. G. I.*

GETTING ACQUAINTED WITH ELECTRICITY

By Alfred Morgan

AIMED at the average man who frequently finds himself slightly bewildered by the innumerable electric gadgets in his home, in his automobile, and in his place of business, the text of this book is phrased in laymen's language that makes painless reading. Then, too, the text sticks closely to the title; there is no attempt to go beyond those fundamentals of the subject which are essential to a speaking acquaintanceship with electricity. Apparently nothing of importance has been missed. Magnetism, primary cells, electric engines, electro-magnetism, condensers, heat and light from electricity, radio communication, electro-chemistry—the whole gamut of electricity is covered. (346 pages, 6 by 9 inches, a large number of drawings.)—$3.10 postpaid.—*A.P.P.*

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By Ernest K. Gann

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By J. D. Stranathan

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CURRENT BULLETIN BRIEFS

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

COPPER & BRASS RESEARCH ASSOCIATION BULLETIN, June issue, is devoted to the part which the Maritime Commission is playing in the construction of our merchant marine and Navy and to the conversion of peace-time plants to war production. Copies of the June issue and future issues can be obtained from the *Copper and Brass Research Association, 420 Lexington Avenue, New York, New York.—Gratis.*

CHEMICALS BY GLYCO is a 112-page book giving detailed information on a wide range of commercial chemicals, including suggested formulas for the manufacture of numerous finished products. Flameproofing and waterproofing agents, synthetic resins, and waxes, emulsifying agents, and so on, are dealt with in detail.—*Glyco Products Company, Inc., 230 King St., Brooklyn, New York. — Gratis.*

HYDRAULIC JACKS is a four-page bulletin giving specifications of three types of jacks ranging in capacity up to 500 tons. —*The Watson-Stillman Company, Roselle, New Jersey.—Gratis.*

TECHNICAL BULLETIN No. 230.8 covers major applications of various colloidal graphite dispersions in water, petroleum oil, castor oil, glycerine, and in more volatile liquids such as mineral spirits. These dispersions are used for solving high temperature and other lubrication problems as well as for impregnating such materials as fabrics and so on.—*Acheson Colloids Corporation, Port Huron, Michigan.—Gratis.*

AGFA ANSCO CENTENNIAL BOOK is a profusely illustrated pamphlet which presents the story of the origin and development of America's oldest photographic manufacturer. *Service Department, Agfa Ansco, Binghamton, New York.—Gratis.*

"LONG-LIFE" LIGNUM-VITAE MARINE SUPPLIES is a folder describing various units made from this wood which has unusual characteristics of self-lubrication, acid resistance, a density almost equal to iron, and economy through long service. —*Lignum-Vitae Products Corporation, 96-100 Boyd Avenue, Jersey City, New Jersey.—Gratis.*

INDUSTRIAL TABLET COMPRESSING MACHINES is a 48-page illustrated bulletin which discusses the applications and economies and other advantages of manufacturing by tabletting or compressing. Such methods are used to reduce bulk, increase the efficiency of chemicals, and to produce parts from powdered metals and carbon mixtures. They are also applied to the fabrication of ceramic and glass parts as well as in the manufacture of pharmaceuticals, foods, confections, and so on. This bulletin illustrates and describes many tabletted parts and a variety of other industrial products. Request Catalog No. 41-T.—*F. J. Stokes Machine Company, Olney Post Office, Philadelphia, Pennsylvania.—Gratis.*

SPOT WELDING ALUMINUM ALLOYS is a 12-page circular giving spot welding characteristics of these metals and describing equipment for spot welding, design of joints, and methods of preparing for welding. *P. R. Mallory & Company, Inc., Indianapolis, Indiana.—Gratis.*

ARCHEOLOGY OF NEW JERSEY, by Dorothy Cross, is a large, thick, luxurious volume giving brief descriptions of sites located by The Indian Site Survey, a W. P. A. project. *Archeological Society of New Jersey, New Jersey State Museum, Trenton, New Jersey.—$2.50.*

TECHNI-DATA HAND BOOK, by Edward Lupton Page, B.Sc., is a spiral-bound, 64-page book which gives compact and concise essential data on mathematics, physics, chemistry, engineering, and mechanics. A number of drawings illustrate the text. *Scientific American, 24 West 40th Street, New York, New York.— $1.10 postpaid.*

MODERN PRECISION is a 16-page brochure illustrating and describing a large number of instruments, controls, and heat treating methods which are being used in industry, in research laboratories, and in teaching and testing. These range from combustion controls of various kinds through metal analysis methods and heat treating furnaces to thermocouples, filters, and electrical bridges of various types.— *Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania. —Gratis.*

METAL FINISHING is an eight-page bulletin dealing with the use of indium, its properties, and methods of plating with this increasingly important metal. *The Indium Corporation of America, 805 Watson Place, Utica, New York.—Gratis.*

ZEOLITE WATER SOFTENERS is a pamphlet describing in some detail the methods of water treatment using minerals or compounds which create reversible base-exchange reactions. Illustrations of typical installations are presented, with descriptions. *Graver Tank & Manufacturing Company, Inc., East Chicago, Indiana. —Gratis.*

SOME RECENT BOOKS FOR AVIATION MECHANICS is a bibliography prepared by the Division of Aeronautics of the Library of Congress. *Library of Congress, Washington, D. C.—Gratis.*

PROPERTIES, SELECTION, AND SUITABILITY OF WOODS FOR WOOD-WORKING, by D. G. Coleman, classifies various woods into groups according to hardness, shrinking, ease of working, nailing, stiffness, odor and taste, surface characteristics, and several other properties.—*United States Forest Products Laboratory, Madison, Wisconsin.—Gratis.*

TELESCOPTICS

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

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

LAST month in this department, R. M. Watrous, M.D., Highland Park, Ill., described a spectroscope of the concave grating, Rowland type, which he made as a follower of the amateur optical hobby, and now, in Figure 1, is a series of spectrograms which give a better idea of the refined capabilities of such an instrument than the ones he had available at that time. The spectrogram is enlarged four times from a portion of film on which are registered ultra-violet spectra extending over that part of the ultra-violet from wavelength 3100 angstroms down to 2500 angstroms. The light which made these lines is completely invisible to the eye.

The top spectrogram was made with light from an arc between ordinary cored carbons such as are used for some kinds of lantern slide projectors. Those below it were obtained by melting bits of common metals (tin can strip, tinfoil, solder, galvanized iron, brass, copper, sterling silver, silver solder, aluminum, iron) in the heat of the arc, thus causing them to vaporize and emit their characteristic wavelengths. Some of these metals did not remain in the arc long enough to record their spectra.

Since the carbons used were not of the high degree of purity required for spectrographic analysis, the lines of the elements in the core (silicon, bismuth, and magnesium) appear in all of the spectra, and are indicated at the top by their chemical symbols. The other numbers written across the top refer to the wavelengths in angstroms.

IN THE concave grating type of spectroscope mentioned above and described last month, the slit, the grating, and the spectrum, all three, lie on the circumference of a circle whose diameter is equal to the radius of curvature of the grating. How a really large—gigantic, in fact—instrument of this type shapes up is shown in Figures 2 and 3. This is the world's second largest spectrograph, 30 feet in diameter, and is at the University of Chicago. It took over a year to build, and in size it is rivaled only by a similar spectrograph at the Massachusetts Institute of Technology. The diffraction grating, in addition to focusing the light, breaks it up into its component wavelengths and fans it out over the 40′ of photographic plate.

The physics department at the University of Chicago began making diffraction gratings under the supervision of the late Dr. Albert Michelson, and after Dr. Michelson's death, in 1931, the work was continued under Dr. Henry Gordon Gale. From five to ten of these gratings have been made every year by the University and sold to scientific laboratories in all parts of the world. Only at the Johns Hopkins University are gratings made which compare, in their power to separate the spectrum lines, with those made at the University of Chicago. The grating consists of an octagonal piece of speculum metal on which vertical lines have been ruled by a ruling engine, the time required being approximately two weeks.

The giant spectrograph fills a room 40′ square. A light beam from the compound to be studied originates in apparatus outside the room, passes through a narrow slit at the point in the photograph (Figure 3) to which Professor Robert S. Mulliken is seen pointing, travels across the room, strikes the grating at which Miss Jane Hamilton, a graduate student in physics, gazes (this grating is shown in Figure 2), and then is reflected to different parts of the big circle as a large fan of light. This light impinges on the photographic plates in a strip 2″ in width and 40′ in length, arranged in a large semicircle 30′ in diameter. (The inner circle in the right half of Figure 3 is the vestige of an older and smaller spectroscope of the same type.) The photographic plate is composed of 26 sections, each 18″ in length. The sections are removed separately for developing in the neighboring darkroom. It takes from three to 40 hours to secure an adequate exposure, because the dispersion of the light greatly diminishes its intensity.

If an observer stands within the fan of light coming from the grating, and walks to different parts of the room, he can witness the differences in wavelengths of the light in various parts of the fan. At one side of the room long wavelengths will cause the grating to appear a brilliant scarlet. As the observer moves across the room the color of the grating passes from red through the

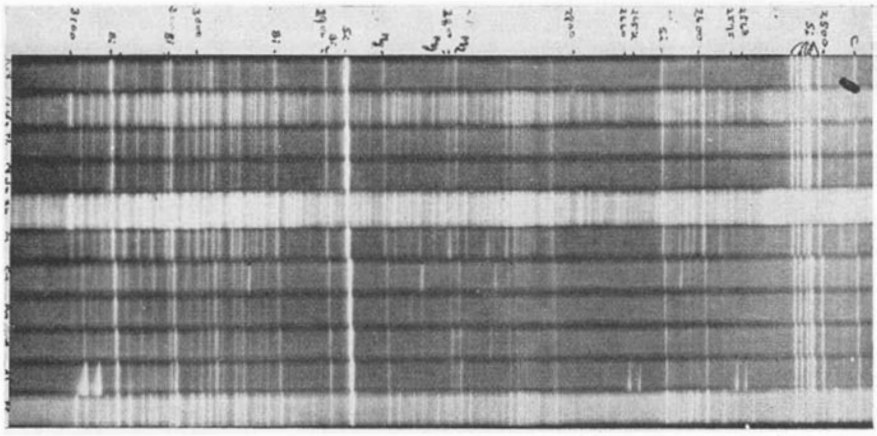


Figure 1: **Spectrograms made with an inexpensive home-made spectroscope**

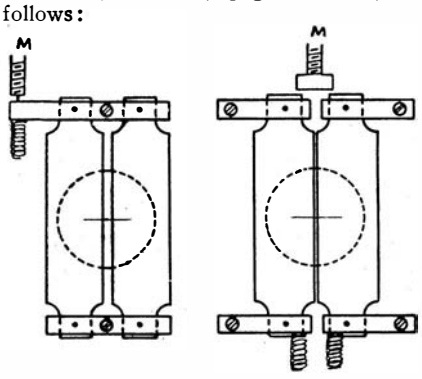
Photos Chicago Times

Figure 2: **Grating part of the big spectroscope**

Figure 3: **Slit part (shown at extreme right)**

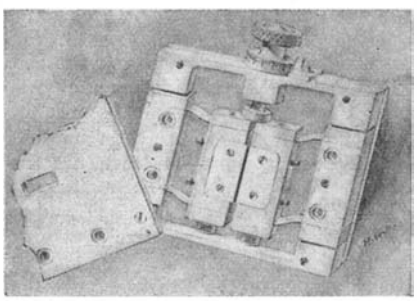
seven colors of the spectrum to violet.

SLIT for spectroscopes or other optical instruments was described by Dr. John Strong, of the Astrophysical Observatory, California Institute of Technology, in *The Review of Scientific Instruments,* Vol. 12, pages 213-214, as follows:



Courtesy "The Review of Scientific Instruments"
Figure 4: Non-uniform-speed slit

"Many types of slits have been used for optical instruments. (See H. Kayser, *Handbuch der Spektroscopie,* Vol. 1, p. 532). Among them one bilateral slit which we may term the parallelogram slit, and which is diagrammatically illustrated, in Figure 4(a), has several noteworthy features. When it is skilfully constructed, this slit is both simple and effective. The opening of the parallelogram slit exhibits an adverse non-uniform relationship to the amount of turn of the adjusting screw: The slit opening changes most rapidly when the slit is nearly closed whereas we would prefer, to have a more delicate control, that the slit opening change slowly when



Courtesy "The Review of Scientific Instruments"
Figure 5: Same slit in perspective

the slit is nearly closed and rapidly when it is nearly open. Figure 4(b) represents diagrammatically the principle of the parallelogram slit adapted to achieve this desired end and Figure 5 illustrates how we apply this principle in practice.

"Figure 5 is a sketch by Mr. R. W. Porter drawn from one of the slits of a new spectrometer under construction here. The cover plate, with the slot for illuminating the slit, is shown turned to one side. This plate is secured by screws in the four corners while the slit, as a whole, is fastened to the spectrometer by four other screws, two on the right side and two on the left.

"The micrometer screw displaces the slit jaw assemblies equally in a direction

TELESCOPTICS

parallel to the slit and, by virtue of their 0.006″ clock spring mountings, this displacement causes the slit jaw assemblies to separate and the slit to open. Two helical springs locate the jaw assemblies definitely against the hardened end of the micrometer screw. The carefully worked slit jaws are adjustably fastened to the jaw assemblies so that the jaws will close exactly.

"The advantages of this type of slit over other types are: that the jaws cannot possibly be jammed; that the slit opening is delicately controllable when the slit is narrow; and the spring mounting, as contrasted with mounting in ways, provides a definitely reproducible mechanical system. Disadvantages are: the non-uniform relation between micrometer screw setting and slit opening and certain limitations on compactness of construction. The slit is relatively easy to construct in such a manner as to yield high accuracy.

"The slit opening is given, approximately, by the expression:

$$S=2L\ [1-\cos\ (M/L)],$$

where L is the free length of the clock springs and M is the displacement of the micrometer screw from the closed position. For the slits already constructed $L=1$ cm and $M=3$ mm giving S approximately 1 mm. The slit jaws are 24 mm long while the useful length of slit is 12 mm. The over-all dimensions of the slit exclusive of the micrometer head are 3½″x3″x¾″."

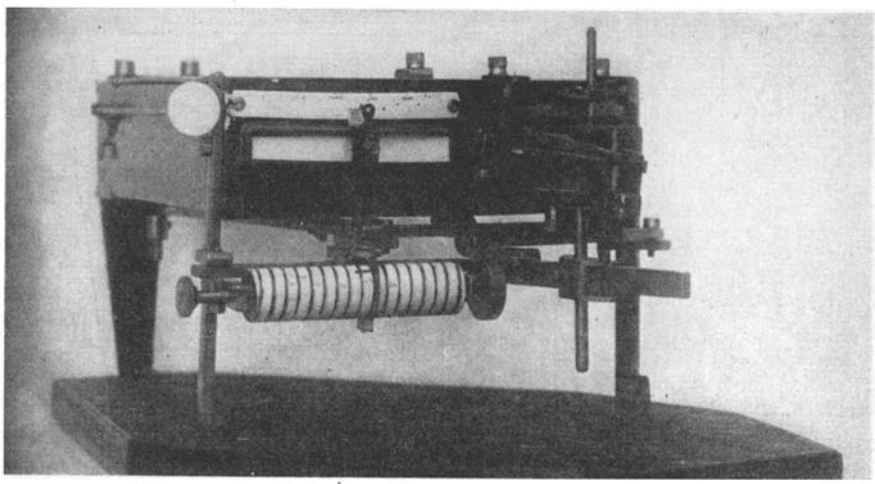


Figure 6: Smith's home-made spectroscope with calibrated drum

ANOTHER spectroscope—in fact, a spectrometer—made by an amateur is shown in Figure 6. F. P. Smith, Box 364, Ventura, California, is the maker, and he says he has followed spectroscopy as a hobby for 16 years and found it to have unlimited fascination and possibilities. "The concave grating type is the easiest," he writes, "also the most practicable to build. Gratings in the original can be obtained with a 2″ ruling and 25,000 lines per inch at $50 to $150. About $75 will build an instrument having excellent dispersion. A very good slit can be made without machine tools, the practice it gives in filing also being of value.

"In the photograph (Figure 6), the screw which is used to oscillate the cylinder, or drum, is grooved and the groove moves the eyepiece across the spectrum as the handscrew is turned. The spiral strip on the drum is calibrated in angstrom units; it also carries the symbols of the principal lines of the elements. Thus, if 15 or 20 elements are present, the user gets a line on the crosshair and then refers to the drum.

"The camera part is at the extreme right. The round white spot is the handscrew which is used to oscillate the grating."

Smith's description was shown to Watrous, who replied: "This apparatus is undoubtedly more accurate than mine, though probably more difficult to build. The more expensive gratings must give much better definition."

CONTACT: "I have long ago abandoned the pencil mark system for measuring contact between mirror and tool," Cyril G. Wates of Edmonton, Alberta, Canada, writes, "not because of the alleged danger of scratches, but because it doesn't work—at least, not for me. So I took a leaf from the mechanic's book—he uses Prussian blue in making face plates—and put a streak of dry rouge on the tool, and judged contact not by rubbing out of the streak, but by the rouge which was transferred to the mirror. This, as I mentioned in 'A.T.M.A.,' works well, but I have found, especially with Pyrex, that the faint rouge marks are difficult to distinguish.

"Recently I discovered a very satisfactory substitute in artist's Black Stumping Chalk. This is a very fine black powder—probably pure carbon—and a little may be taken on the finger tip and rubbed across a diameter of the tool. After dusting off the loose particles, one mirror is pressed into contact and rubbed gently, without pressure. When the mirror is removed, the points of contact will show on the face of the mirror like an Ethiopian on a snowbank."

NO STELLAFANE convention this year. War. Everybody busy, and local hosts busy too. Town crowded. Also tires, gas. Better to wait for the dawn of peace.

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How A Big Business Man Appears To His Wife

"LOOK at him over there, grinning to himself! Strange how little a man can change in fifteen years! The big boss one minute—and like a little boy the next!

"He was mostly 'little boy' before we were married. He'd been coming around for a couple of years, and I'd just about given him up. Then, suddenly, he was very much a *man*, rushed me off my feet and almost before I knew it, we were married.

"When we were newlyweds he was only a bookkeeper, and he'd come home in the evening all tired and discouraged. Other fellows at the office had been promoted, and he didn't know what to do about it. One night I forgot myself and said, 'If *you* don't do anything about it, Mr. Stick-in-the-Mud, no one else ever will!' Then I was sorry, when I saw how I'd hurt him.

"But it must have made him think hard, because one evening the following week he came home looking as though he'd just robbed the piggy bank. He told me he'd enrolled for a course of executive training. He thought I'd be angry, because we were still paying for the furniture. The 'little boy' and the man, all mixed up!

"After that, his whole point of view toward business seemed to change. One promotion followed another, until a few years later he became Treasurer of the company. Now he's beginning to surprise me. Says he expects to be Vice President soon!

"Of course, he's just as modest as he ever was. He'll tell you he got the breaks, but I know better. He *got* the breaks because he'd learned how to grasp them when they came. He's really smart—and so was I when I said 'I do' to a little boy turned man!"

• • •

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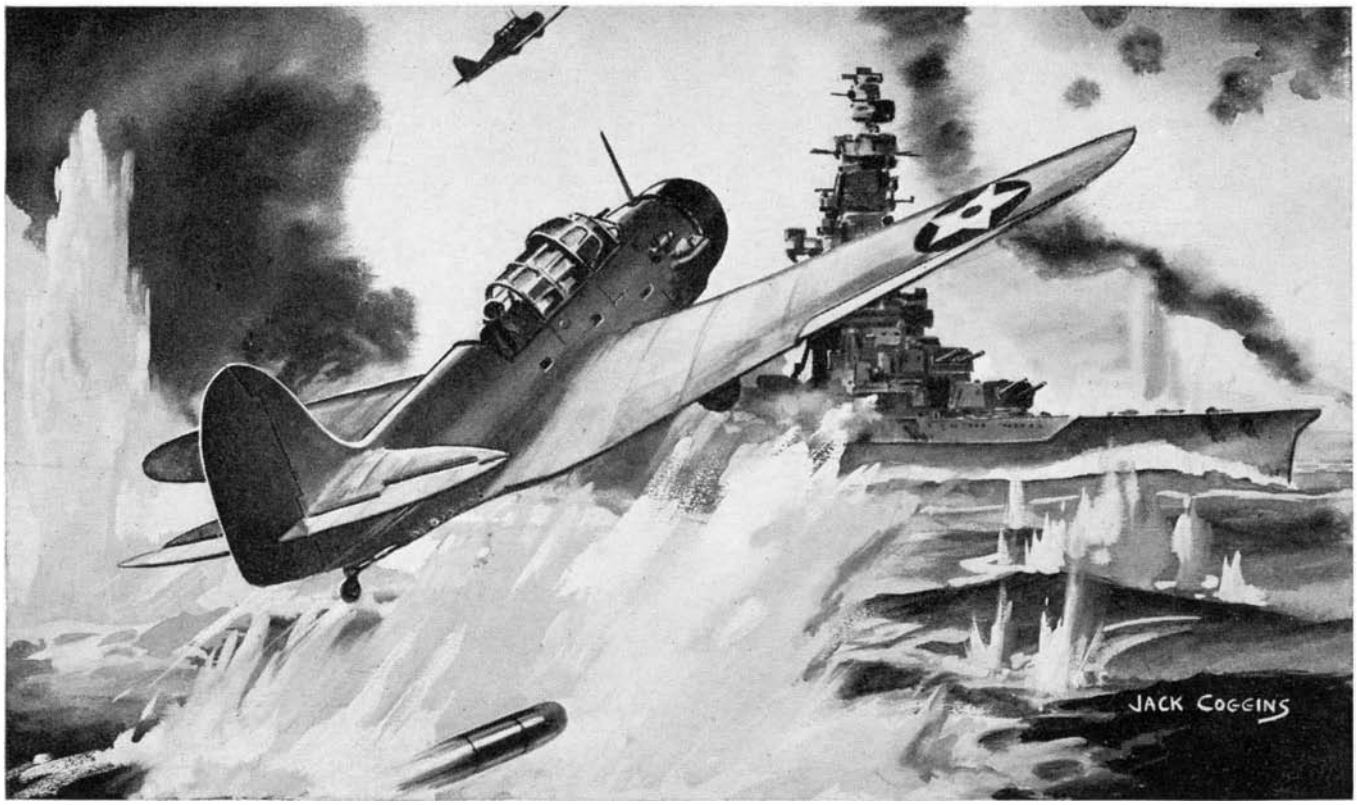

Bombers from the Bottom of the Deep Blue Sea

THERE'S a fabulous amount of magnesium in every cubic mile of sea water.

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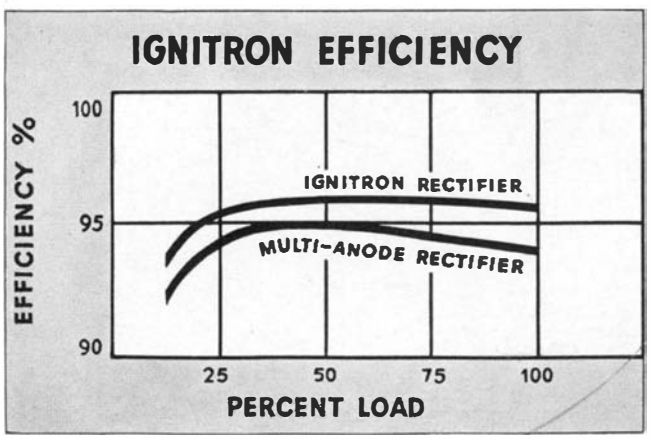
And so, the germ of an idea . . . born ten years ago in the Westinghouse Electronics Laboratories . . . is now contributing its important share in winning the war today.



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