DOMESTIC RUBBER 'PLANTATIONS' . . . Page 105

SCIENTIFIC AMERICAN

SEPTEMBER · 1942 ★ 35c. a Copy
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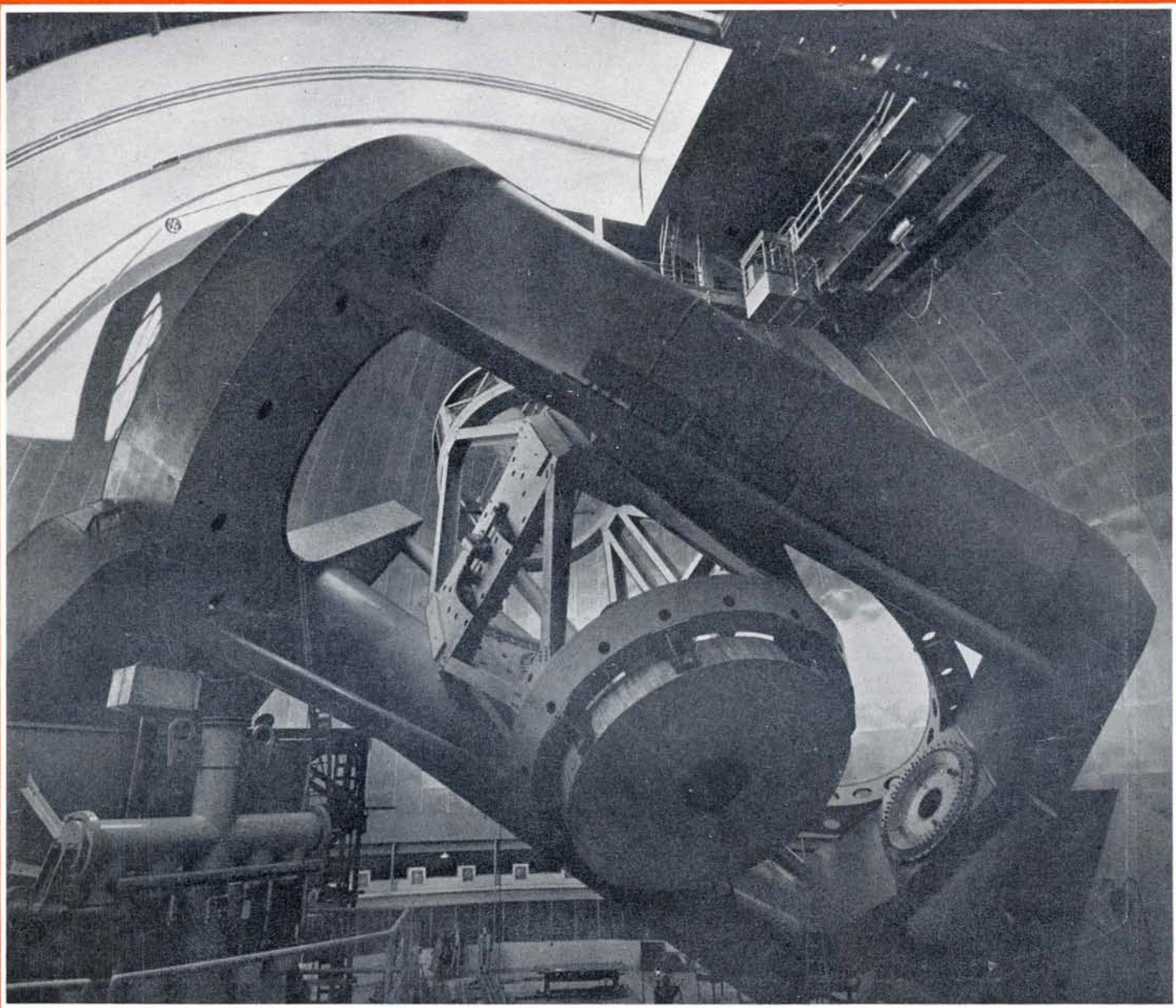

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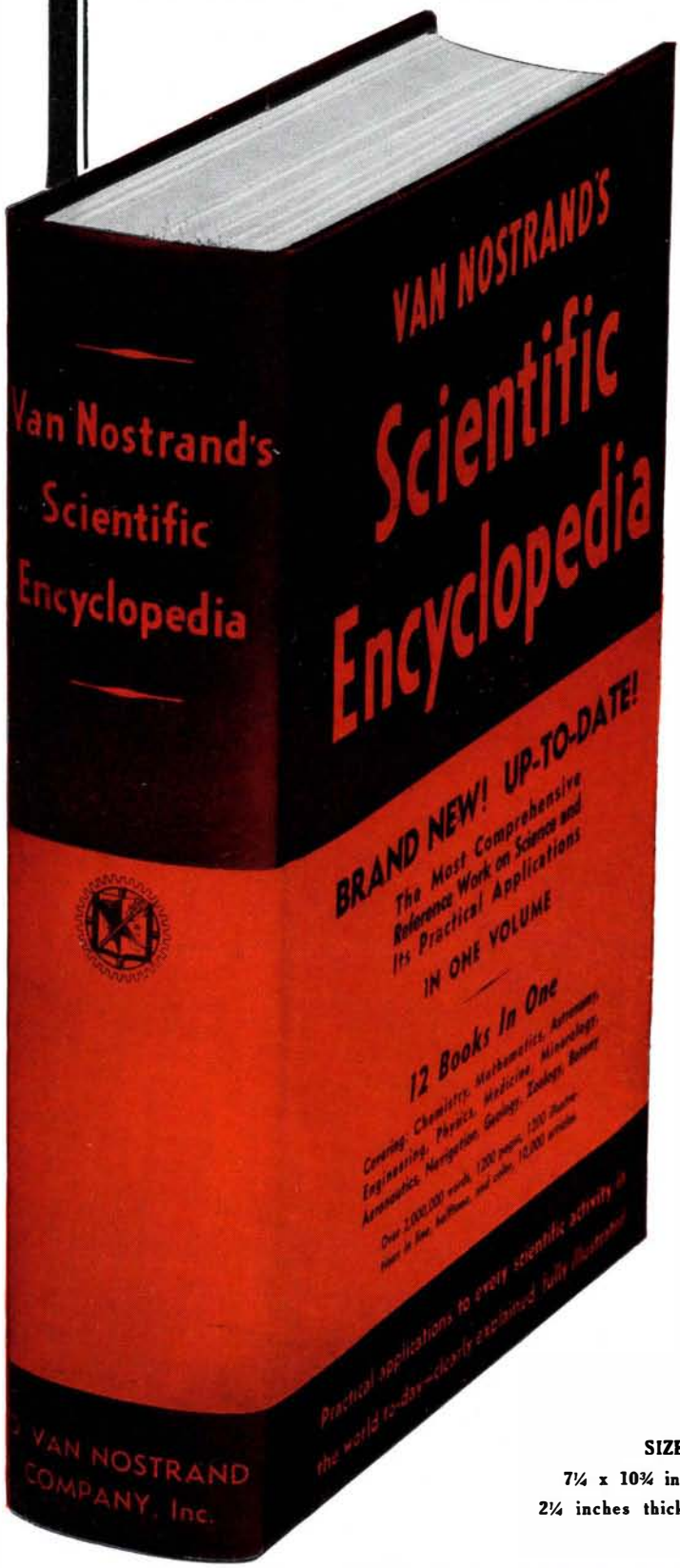

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THIS great new work presents—for the first time in one volume—a complete coverage of the terms of science and engineering. Principles are clearly explained—methods of calculation are fully described with the formulae and units—chemical structures and reactions, physical laws and instruments, engineering design, construction, and operation are merely suggestive of its tremendous scope — which extends throughout the entire range of technical knowledge up to the most recent advances and inventions. The great number of photographs, diagrams, and charts have been specially prepared and selected to show the salient facts most clearly. Innumerable tables and summaries make all this information easily available for instant reference.

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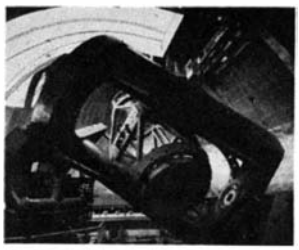

VIRTUALLY completed is the great mounting for the 200-inch telescope in California—our cover picture this month—but at least a year's work remains to be done to complete the mirror. However, both are now "put away in mothballs"—work entirely suspended—for the duration. The photograph is by George Herbig of the Griffith Observatory in Los Angeles. See also page 142.

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SCIENTIFIC AMERICAN

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

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SEPTEMBER • 1942

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OUR *Point* OF VIEW

A FLASH OF GENIUS

STRANGE things often happen in court, but seldom if ever has a stranger theme been dwelt upon than that which the Supreme Court of the United States brought forth in a recent decision in a patent case. Neither the facts of the case nor the merits of either side are of any moment here, so they can be passed by. The meat of the decision, as far as the possible future of patent law is concerned, is contained in the statement by the court that the test of patent validity is whether or not the alleged invention reveals a "flash of creative genius."

A "flash of creative genius"! Upon such a basis practically every patent ever issued in the United States or elsewhere would be invalid. Classic is the tale of Edison's long and heart-breaking search for a material from which to make incandescent lamp filaments. No flash of genius there. Bell labored long and often despairingly before wires carried speech. Again no flash. Marconi created many failures before he ultimately achieved success. No flash in that. And the list could go on and on, proving that inventive genius is not given to flashes, that the patents upon which are based our great industrial world of today have been the result of much perspiration and mental anguish, seldom if ever lightened by a helpful flash.

Now that we are at war, things of this sort go on every day, often passing un-noticed. The pressure of war, total war, frequently warps perspective to a point where it is unappreciative of the damage that can be done by a matter that seems unimportant in the face of world-shaking events. But there is a time of peace coming, a time when attention will be turned from the nerve-rending pressure of war production to the pursuits of peace. Then, when our industrial machine again shifts gears, will come the realization that new ideas, reduced to practice and protected by patents, are the basis of our industrial structure. If the test of a "flash of creative genius" is going to be applied to such patents, this nation is going to find itself in a horrible period of industrial stagnation. This must not be allowed to happen. When the period of reconstruction comes, the aid of the inventor will be needed more than it was ever needed in all the past years of technological development. Upon inventions and patents will be built the new industries needed to carry on the traditions that are so much a part of the American way. Let's forget about such manifestly foolish things as these "flashes" and concentrate on methods of encouraging the inventor by guaranteeing to him, even more than ever before, the fruits of his hard labor.—*O.D.M.*

SHARE THE "KNOW-HOW"

SINCE 1845 the pages of this magazine have been largely devoted to the dissemination of information regarding new industrial processes, new ways of doing things easier, faster, more economically, new methods of attaining new ends—in short, to spreading the "know-how."

At no time in the history of this country has there been more reason, more need, for this sharing of knowledge than there is at the present moment. Many of the larger industrial organizations are realizing this fact and are doing everything possible to spread to others, even to active competitors, news of their newest developments in many lines. Reason behind all this, of course, is the war effort. Everything possible must be done to increase production of the things needed to insure victory, and only by a vast pooling of information can this end be achieved in the quickest, most economical manner.

Outstanding proponent of the need for sharing the know-how is Westinghouse. By every available means that organization is spreading to the industries of the nation the story of what they are doing and, where it can be told without revealing military secrets, how they are doing it. Much of this story has appeared in the pages of Scientific American, and that it has been welcomed by many readers is evidenced by our correspondence.

We have mentioned only one example; there are dozens of others, but still not too many, still not even enough. The job that is being done in some small plant that no one ever hears of outside the four walls of the shop may be just as interesting, just as informative, just as important to other industries as it is to that small plant. And, too, it may have an equally large bearing on the success of the war effort.

With all this in mind, the editors of Scientific American will welcome contributions from responsible members of industrial organizations, telling of some new method of operation, some new material that has been developed for a specific purpose but which may be adaptable to other uses, some new operation performed with an old tool—anything, in fact, that will contribute materially to sharing the know-how. We cannot, of course, promise to publish all contributions. Each one, however, will be carefully considered and its value to the greatest number of readers will be accurately weighed in the editorial balance.

The door is open, the welcome mat is out. Here is your chance to share your know-how for the greatest good of the greatest number.—*A.P.P.*

LIGHTER THAN AIR

ALTHOUGH not much information about their operations appears in the press, it is an open secret that blimps are playing a large and important part in the "Battle of the Western Atlantic." While, at the time of writing, we are still losing many surface vessels to the predatory packs of submarines that infest our eastern coast, the so-far unwritten record of achievement of these versatile lighter-than-air craft is apparently an inspiring one. Where the blimp holds the advantage over the patrol plane is in its slow speed that permits more careful inspection of the water below and its ability to hover over one spot for almost any desired length of time.

Perhaps the good work of the blimps influenced to some extent the recent action of Congress in authorizing an increased appropriation for lighter-than-air craft. In any event, we are going to hear a lot more about this type of aerial transportation in the near future.—*A.D.R., IV*

50 Years Ago in . . .

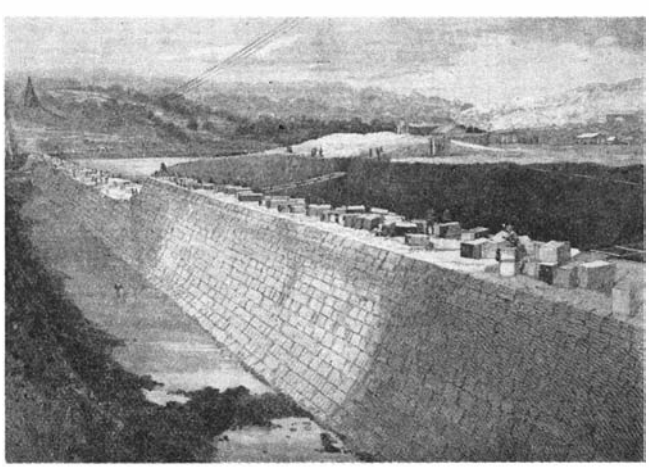
SCIENTIFIC AMERICAN

(Condensed From Issues of September, 1892)

RUBBER—"Copper salts have an injurious effect upon India rubber. . . . Metallic copper in contact with rubber causes oxidation and hardening of the gum, although no appreciable amount of the metal enters into it. Zinc does not in any way affect the rubber. Oil containing even small amounts of copper coming in contact with rubber goods is highly injurious. . . . All oils, except castor oil, exert a detrimental effect upon rubber."

TRIPLE SCREWS—"The fastest of the vessels of our new navy, the Columbia, will have a speed of 21 knots, with a possibility of doing 22 knots. She will, to do this, have greater horse power than any vessel ever before built in America, and is, with one exception, the first large vessel ever built with triple screws."

AUSTIN DAM—"There is being built across the Colorado River at Austin, Texas, a massive granite dam, the object of which is to furnish the city with water works and electric light, and to also furnish manufacturing enterprises with cheap water power. This wonderful structure is 1,200 feet in length, and 60



feet high. It is 16 feet thick at the top, increasing downward and spreading out in a broad toe or apron, making its extreme width at the bottom 50 feet. . . . The water will be drawn from the penstocks through iron pipes, pass the wheels, fall into the wheel pits, and be discharged through underground races into the river. There will be three water wheels, forty-five inches in diameter, each capable of giving 600 horse power on a head of 60 feet. . . . During the flood season the amount of water that will flow over this dam, it is estimated, will be 200,000 to 250,000 cubic feet per second, which is nearly equal to the volume at Niagara Falls."

INVENTION—"No argument is needed to show that to invention must be accorded a very high place among instrumentalities for promoting progress, but some believe that no new principles remain to be discovered, and that there is little if any unknown material; therefore, they say, great inventions in the future must necessarily be few. Such is the argument of the pessimist, which at first may seem rational, but seen in the light of modern progress must give way to the opposite view, which holds that every new discovery or invention is almost sure to lead to other discoveries and inventions of equal or greater importance; that we are only on the borders of the realm of invention, and that the possibilities of the future are far greater than those of the past. This is the optimist's view, which is backed by history, reason, and common sense."

PHOTOGRAPHERS—"Professional photography at the present time is admittedly not in a flourishing condition, and the causes commonly assigned for the depression include, of course, bad trade, severe competition, and the influence of the once despised but now potent amateur."

WOODEN—"The sailing ship Roanoke, launched at Bath, Me., lately, is said to be the largest wooden ship afloat. Her length is 311.2 ft.; breadth, 49.2 ft.; depth, 29.2 ft.; gross tonnage 3,539."

VOLCANOES—"Tropical America presents some of the most superb volcanic spectacles in the world. In Ecuador are twenty volcanoes from 16,000 to 22,500 feet high, eighteen of them being crowned with eternal snow, and eleven never having been scaled by any living creature. Fifty more exist in the Central American region, and twenty-one in Mexico, chief of which is the lordly Popocatapetl."

SPARK PHOTOGRAPHY—"Professor Vernon Boys lately explained that by the electric spark articles moving at the rate of 10,000 miles an hour can be photographed, and by the introduction of a revolving mirror a speed of 180,000 miles an hour can be coped with. The mirror makes 1,024 turns every second, worked by electricity, which is equal to about 150 times as fast as a rifle bullet travels. The whole photographic power of the spark is over in a time equal to the ten or eleven millionth part of a second, and it is during that incredible brief space that the image is made on the sensitive plate."

RAILROADS—"According to the *Street Railway Review*, there are now nearly 1,000 street railway companies in the United States, of which fully 400 are electrically operated, in whole or in part."

PYRAMID BUILDERS—"A two years' study at Gizeh has convinced Mr. Flinders Petrie that the Egyptian stone workers of 4,000 years ago had a surprising acquaintance with what have been considered modern tools. Among the many tools used by the pyramid builders were both solid and tubular drills and straight and circular saws. The drills, like those of today, were set with jewels (probably corundum, as the diamond was very scarce), and even lathe tools had such cutting edges. Of the . . . method of making the tools nothing is known."

TELEPHONE—"In speaking of the future of the telephone, Professor A. Graham Bell says: 'The telephone, as at present constructed, needs the open air to obtain the best results. To use wires placed underground, a metallic circuit will be necessary, similar to the one used now on long distance lines. To place the wires under ground and to make a metallic circuit, which means to use two wires where one is used at present, will materially increase the expenses of the company, and the public must pay for the luxury. As the number of wires is increasing rapidly, it is evident that they must ere long be buried.'"

Clear the Lines for the War

Before you make a Long Distance telephone call today, ask yourself these questions:

1. Is it necessary?

2. Will it interfere with war calls?

The weight of war on the telephone lines is heavier every day. We can't build the new lines to carry it because sufficient materials aren't available. We've got to make the most of the service we now have.

Please give a clear track to the war effort by confining your Long Distance calls to those that are really necessary.

WAR CALLS COME FIRST

BELL TELEPHONE SYSTEM

NAVAL INDISPENSABLES

Cruisers Can Perform a Wide Range of Missions

WALTON L. ROBINSON

● Third article of a series on the ships of the United States Navy. The next, dealing with destroyers, is scheduled for October publication. Former articles were on battleships and carriers and were published in May and August.—*The Editor.* ●

ASIDE from battleships and aircraft carriers, cruisers are the largest, costliest, and most formidable type of naval vessel. But unlike carriers, which are not, strictly speaking, combatant units, cruisers are fighting ships in every respect. Well armed and fast, they can perform a wide variety of missions. Their presence with the battle fleet in a major action is essential for scouting duties, for supporting destroyer attacks on the enemy, and for repelling hostile ones. Cruisers are also indispensable components of the carrier striking groups which have become such an important and spectacular feature of the aero-naval warfare in the Pacific, while on detached service they can operate very effectively as commerce raiders or as escorts to valuable merchant ship convoys. Most modern cruisers displace from 5000 to 10,000 tons, are armed with six to fifteen 6-inch guns or six to ten 8-inch weapons, and have a speed of 32 to 35 knots. Some of them, particularly those designed for very high speeds have less armor protection than battleships, but the majority do have armored water-line belts, armored decks, and plating on the gunhouses.

The United States Navy is very well provided with cruisers. At the time of the Japanese attack on Pearl Harbor we had in service 18 "heavy" cruisers armed with 8-inch guns and 19 "light" cruisers mounting 6-inch weapons. Six additional light cruisers, four of them of an entirely new design and carrying 5-inch guns, had been launched and were rapidly nearing completion. One of the 5-inch gunned ships, the 6000-ton *Atlanta,* was commissioned before the end of the year. Fifty other cruisers, including six huge units of some 25,000 tons each, were under construction or on order.

Our 37 heavy and light cruisers ready for sea on the outbreak of war had an aggregate displacement of 329,550 tons and mounted a total of one hundred and eighty-four 8-inch and two hundred and forty-five 6-inch guns, giving us a cruiser force second only to Britain's in all-'round fighting strength. Japan, with at least 40 modern cruisers, enjoyed a slight numerical superiority over us, but the Nipponese ships were generally smaller and less powerfully armed than ours. They displaced some 285,000 tons and carried one hundred and four 8-inch, one hundred and forty-four 6.1-inch, and one hundred and twelve 5.5-inch guns.

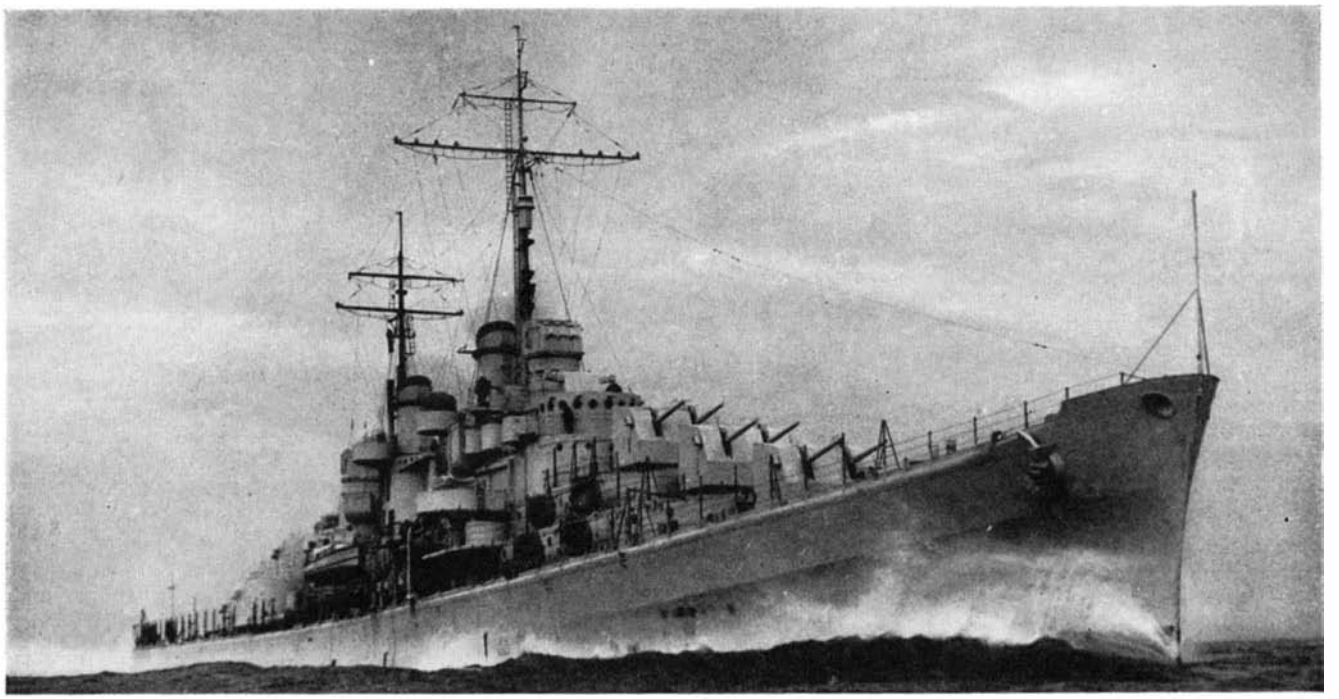
America's oldest cruisers are the ten still very servicable units of the 7050-ton *Omaha* class. They were ordered in 1916-19 and the *Omaha* and *Milwaukee,* laid down in December, 1918, entered service in 1923. The remaining ships, begun in 1920, were completed in 1923-25, the *Memphis,* last of the class, being commissioned February, 1925. All of them originally had a main armament of twelve 6-inch, 53-caliber guns firing a 105-pound shell at a maximum range of some 22,000 yards, or about 13 miles. In recent years, however, two 6-inch guns were removed from the *Cincinnati, Detroit, Marblehead, Raleigh,* and *Richmond,* and these ships now carry only ten guns. The *Concord, Memphis, Milwaukee, Omaha,* and *Trenton* still retain their original armament.

Until recently the anti-aircraft battery consisted of four 3-inch guns (six in the *Concord*) and eight machine guns, but this has now been considerably increased. Six torpedo tubes firing 21-inch "tin fish" complete the *Omahas'* offensive power, while several planes add immeasureably to their range of vision when engaged on scouting missions. In normal times only two aircraft are carried, but four can be accommodated when desired. Two catapults are provided for launching them into the air. Armor protection includes a 3-inch water-line belt and a 1½-inch deck over engine and boiler spaces.

Westinghouse, Curtis, or Parsons geared turbine engines driving four propellers and developing 90,000 horsepower, give the *Omahas* a designed speed of 35 knots. This speed, however, can only be maintained for brief periods and then with considerable difficulty. Oil fuel capacity is about 2000 tons, sufficient for a cruising radius of some 10,000 miles when the ships steam at their most economical speed (15 knots). At 20 knots their radius of action drops to around 7000 miles, and at 30 knots to some 3000 miles.

THE *Omahas* were our Navy's only modern cruisers throughout the 1920's or until the completion early in 1930 of the *Pensacola* and *Salt Lake City.* The construction of these two ships, together with that of six other cruisers, was authorized late in 1924. It was decided that all of them should be of the largest size (10,000 tons displacement) and mount the heaviest guns (8-inch) permitted by the Washington Naval Treaty of 1922.

The *Pensacola* and *Salt Lake City,* laid down in 1926 and 1927 respectively, were ready for service early in 1930 and, following their "shake down" cruises, joined the Scouting Force, U. S. Fleet. Although designed to treaty limits, their actual displacement is only 9100 tons. With their ten 8-inch guns they are, however, among the most powerfully armed



U. S. Navy Official Photo

Cruiser *Atlanta*, believed to have extraordinary armament

cruisers in the world. These guns, 55 calibers in length, elevate to 45 degrees and hurl a 250-pound shell. They are grouped in two triple and two twin mounts, the former being in the superimposed positions. The anti-aircraft battery, which for some years consisted of four 5-inch, 25-caliber guns, was recently increased; details, however, are restricted. Six 21-inch torpedo tubes were originally carried, but were removed in order to provide space for additional anti-aircraft guns.

A 3-inch belt of armor along the water-line and two decks, 1 and 2 inches thick, protect the vital engine and boiler rooms, while 1½-inch plating is on the face of the 8-inch gun turrets. Four planes and two catapults, mounted between the funnels, give these cruisers a wide range of vision.

Designed speed of 32.7 knots is obtained by geared turbine engines developing 107,000 horsepower and driving four propellers. Steam is supplied by eight boilers with a working pressure of 300 pounds per square inch. Radius of action is some 13,000 miles at 15 knots. These engine- and boiler-room data apply generally to all of our heavy cruisers except the new *Wichita*.

FLUSH decked, the *Pensacolas* suffer from lack of freeboard (height of deck above water-line), and roll at low speeds, but are remarkably steady when steaming at 20 knots or more. The greatest economy in weights was practised in their construction, aluminum alloy internal fittings replacing steel wherever possible. Electric welding instead of riveting was also employed extensively.

The six ships of the *Northampton* class, all laid down in 1928, followed the *Pensacola* and *Salt Lake City* into service in 1930-31. Differing in minor details, their displacements ranged from 9050 to 9300 tons. One of them, the *Houston,* was flagship of Admiral Thomas C. Hart, Commander in Chief, Asiatic Fleet, on the outbreak of war and was sunk by the Japanese during the night of February 28-March 1 in Sunda Strait, between the islands of Java and Sumatra. Her sister-ships are the *Northampton, Chester, Louisville, Chicago,* and *Augusta.*

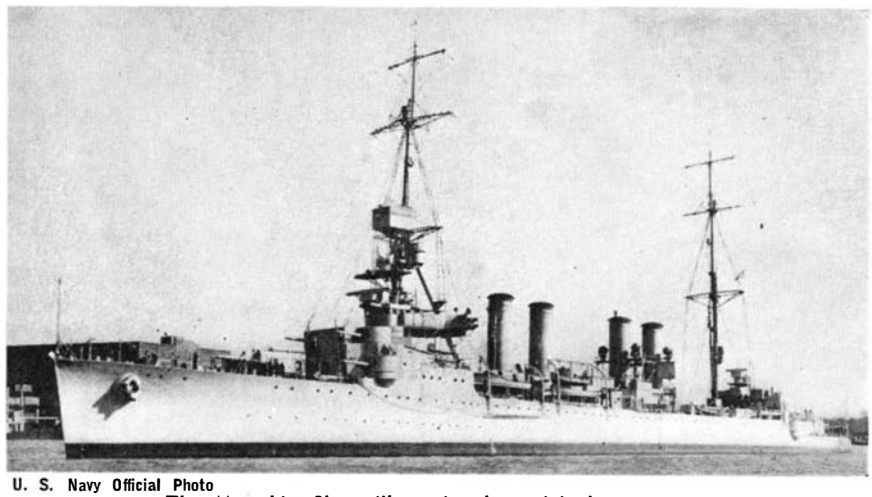
These cruisers have exceptionally graceful lines and are a considerable improvement over the *Pensacolas,* from which they differ markedly in distribution of armament and general design. They carry nine 8-inch guns disposed in three turrets, two forward and one aft, and originally had four 5-inch anti-aircraft guns. Torpedo tubes were removed several years ago and the additonal space thus made available was devoted to increased defense against air attack. Armor protection is much the same as in the *Pensacolas.*

Instead of a flush deck, the *Northamptons* have a raised forecastle deck, while a spacious hangar, accommodating from four to six planes, is located just forward of the second funnel. Two catapults, on high mounts, are immediately in front of the hangar. The *Chicago* and *Augusta,* specially fitted as flagships, have their forecastle extended aft to the catapults in order to secure the extra accommodation required.

In 1930 two more heavy cruisers, the 9800-ton *Portland* and 9950-ton *Indianapolis,* were laid down, having been authorized the previous year. Completed early in 1933, they are simply a development of the *Northampton* design with alterations in weight distribution to improve stability. The height of their masthead fire-control top is lower by 30 feet, but their bridges are higher and have some 40 tons of armor plating spread over them. Eight 5-inch anti-aircraft guns are carried. No torpedo tubes were included in the design. Aircraft-handling arrangements are as given for the *Northamptons.* The *Indianapolis* is fitted as a flagship and can be distinguished from the *Portland* by her longer forecastle.

IN 1930-31 the keels were laid for five new cruisers: the 9950-ton *Astoria, Minneapolis, New Orleans, San Francisco,* and 9975-ton *Tuscaloosa.* All were launched in 1933 and completed the following year. Two more units, the 9375-ton *Quincy* and 9400-ton *Vincennes,* begun in 1933-34, entered service in 1936-37. These seven ships are of an entirely new design, differing radically in appearance and defensive qualities from our older heavy cruisers. Their forecastle has been extended to the second funnel with a slight reduction in freeboard; bow form altered; light pole masts substituted for heavy tripods; bridges raised; anti-aircraft guns re-distributed; and plane catapults and hangar

moved aft, the latter extending to the shelter deck. Their armament is identical to the *Portlands'* but protection is much stronger, consisting of a 5-inch water-line belt, 3-inch and 2-inch decks, an 8-inch conning tower, 5 to 6 inches on the gunhouses, and plating on the bridges.



U. S. Navy Official Photo

The *Memphis*: She still retains her original armament

OUR latest heavy cruiser, the 9324-ton *Wichita,* laid down in October, 1935, and completed three and one-half years later, was originally to have been a unit of the *Astoria* class. As completed, however, she differs as much from the *Astorias* as these ships differ from the *Portlands*. The *Wichita* is, in reality, a heavy cruiser version of the *Brooklyn* class of light cruisers. She has a flush deck with a high freeboard and a square stern. Her armament comprises nine 8-inch guns disposed in the conventional manner and eight 5-inch aircraft weapons, two of which are mounted fore and aft in super-imposed positions above the 8-inch gun turrets. Armor protection is about the same as the *Astorias'* but plane-handling arrangements are utterly different. The hangar, which is located below decks in the extreme stern, can accommodate as many as eight aircraft.

The *Wichita* is powered by Westinghouse geared turbines developing 100,000 horsepower and driving four propellers. Her designed speed is 32.5 knots, which is slightly below that of any of our other heavy cruisers.

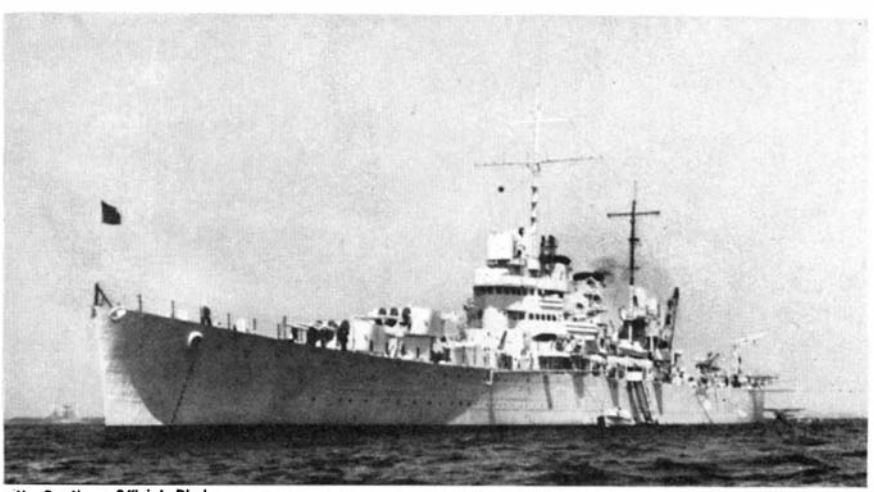
In the years 1934-39 nine large, powerfully armed, and stoutly protected light cruisers were laid down and completed for the U. S. Navy. They were a direct "reply" to the 8500-ton Japanese cruisers of the *Mogami* class, armed with fifteen 6.1-inch guns. The *Brooklyn, Philadelphia, Savannah, Nashville,* and *Honolulu* joined the fleet in 1938 and the *Phoenix, Boise, Helena,* and *St. Louis* followed in 1939. Their displacements range from the 9475 tons of the *Savannah* to the estimated 10,000 tons of the *Helena* and *St. Louis,* which are a slight modification of the earlier design. These cruisers mount fifteen 6-inch guns grouped in five well armored turrets disposed along the center-line and eight 5-inch and numerous smaller anti-aircraft weapons.

America's newest light cruisers are the 6000-ton *Atlanta, Juneau, San Diego,* and *San Juan.* Laid down in 1940 for completion in 1943, they are now entering service—a splendid example of how our shipbuilding has been stepped up. The *Atlantas,* whose design incorporates many novel features, are apparently intended to operate as leaders of destroyer flotillas and as fleet anti-aircraft escort ships. They are the fastest American cruisers ever built.

THE *Atlantas* are believed to mount an extraordinary armament: sixteen 5-inch, 38-caliber "dual purpose" guns which can be used effectively against aircraft as well as warships. These guns are believed to be disposed in eight twin turrets, three forward and three aft on the center-line and two aft on the main deck, one to port and the other to starboard. The center-line turrets are super-imposed one above the other. The anti-aircraft battery proper is believed to consist of twelve 1.1-inch pompoms in three quadruple mounts on platforms, two forward on either side of the bridge and one aft between the after fire-control tower and the topmost super-imposed 5-inch gun turret. These pompoms, together with a half-dozen heavy machine guns, will be employed against low-flying aircraft such as dive-bombers and torpedo planes. Eight 21-inch torpedo tubes in quadruple mounts complete the offensive power of these remarkable ships. On trials, speeds in excess of 40 knots have been attained.

Of our 52 cruisers under construction or on order, 32 are of the *Cleveland* class, modified *Brooklyns* with a probable armament of twelve 6-inch guns; eight of the *Baltimore* class, 13,000-ton editions of the *Wichita* design with stronger anti-aircraft batteries and greater armor protection and cruising range; six of the *Alaska* class, "mystery ships" reportedly displacing some 25,000 tons and officially designated "large cruisers"; and four additional units of the *Atlanta* class. The two remaining cruisers, authorized last December under the 5 percent increase in the two-ocean Navy, will probably belong to one of the above groups.

Many of these cruisers are scheduled for completion this year. Their entrance into service should influence greatly the course of the war at sea, for our Navy will then be able to provide stronger escorts for convoys in the North Atlantic and Pacific and strike telling blows at Japan's vital bases and extended lines of communications.



U. S. Navy Official Photo

The *Phoenix* joined the fleet in 1939

Domestic Rubber 'Plantations'

Scrap Rubber, Reclaimed, Can Go Far to Fill the Gap in Military and in Some Civilian Needs

A. P. PECK

THIS business of reclaiming various types of manufactured rubber objects and putting their basic material back into the channels of trade is not so new as the recent publicity on "rubber drives" might lead one to believe. Since shortly after the very beginnings of the rubber industry, much attention has been put to reclaiming the rubber in objects which have served their original purpose. (A brief paragraph on the reclamation of rubber appeared on the "50 Years Ago" page in Scientific American in our issue of May 1942.)

During the past few months we have heard much about three different "kinds" of rubber: Natural rubber, synthetic rubber, and reclaimed rubber. That there will be little or none of the first of these available, so far as civilians are concerned, for the duration of the war is already an established fact. Commercial production of various types of synthetic rubber is already underway but on a relatively small scale; it will be at least a year if not longer before this production approaches a point where it can start to satisfy even the immediate needs of the military forces. There is little hope that any synthetic rubber will be available for civilian purposes for a considerably longer period of time.

This leaves reclamation as the one source from which civilians may hope to get at least a part of the rubber products which are essential to everyday life and, as newspaper publicity has so well told, the amount of reclaim that will be available depends largely upon Mr. and Mrs. John Citizen themselves and on the continuing response which they make in supplying the objects from which reclaim can be obtained.

Actually, the reclaimed rubber industry is by no means the ugly duckling that its name might seem to indicate. Reclaim itself, furthermore, is certainly no object of scorn, particularly in these days of economic stress. For many years it has served an honorable array of purposes in the rubber goods market, without public fuss or fanfare. The fundamental fact to keep clearly in mind is that reclaim can be used—either all by itself or in any degree of mixture with crude rubber—for the manufacture of almost anything that can be made from crude virgin rubber, but that there is always a loss in performance in the resulting process, this loss being in direct ratio to the proportion of reclaim used.

Old tires, with the wire beads removed, are ground to powder, which is then routed to the digester tanks

As in all questions, there are two sides to this one. There are some rubber products in which it is so essential to have the maximum efficiency of 100 percent virgin rubber that reclaim cannot enter the picture at all. Innertubes for vehicle tires are the best example of this. On the other hand, reclaim can be just as exclusive in its own field. Rubber heels and hard rubber products such as battery cases and combs are examples of products in which reclaim is actually superior to virgin crude because of various mechanical reasons.

A brief survey of the reclaiming process itself will aid in an understanding of the relationship between crude and reclaimed rubber.

When scrap rubber of any kind is first received at the reclaiming plant, it is assorted according to its present form and according to the process to which it will be subjected for reclamation. Since tires are uppermost in everyone's mind today, the reclamation of them in one rubber company's plant will be taken as an example.

Before the tires start in the cycle which will reclaim the rubber content, the steel wire in the beads is removed. The tire carcass is then fed into a grinding machine where rubber and cotton fibers alike are reduced to powder. After magnets remove any small particles of iron and steel, the powder is routed to digesters where it is treated with dilute caustic soda, at high temperatures and pressures, to dissolve the fibers. This treatment, by the way, has an important effect on the quality of the finished reclaim and is varied according to the material being processed.

From the digesters the material passes through a washing screen where the caustics are removed. From here it goes to the driers, where it is subjected to heat and steam pressure for eight to twelve hours before going to the mixing mill. In that mill the powder is still further ground, then washed and dried and thoroughly mixed and kneaded on steam-heated rolls.

From the mixing mill the reclaimed rubber undergoes a "straining" process where, under steam pressure, it is forced through fine screens to remove the last possible vestiges of dirt and foreign matter. From these screens the rubber emerges looking like black spaghetti.

In the final step, the black spaghetti is rolled and formed into slabs for use in the manufacture of various rubber products. These slabs are soft and plastic; the rubber, however, is not restored, either chemically or mechanically, to the full power and life of virgin rubber. It still has a certain amount of bounce and resiliency, but the exact amount depends upon the quality of the material fed in at the beginning of the reclaiming process and upon the reclaiming process itself.

The reclaim still contains most of the chemicals—sulfur, carbon black, and so on—that were put into the original object when it was manufac-

The mixing mill. Steam-heated rolls knead and mix scrap being processed

tured from crude rubber. By the same token, it has a smaller proportion of the native rubber molecules. Thus it can be seen that if the reclaiming process were repeated a number of times the undissolvable foreign elements would eventually so far outnumber the rubber elements that the result would be a conglomerate mass that would be more like asphalt than rubber.

WHILE few authoritative figures are available regarding reclaim, it appears that in October 1941—note that this was before Pearl Harbor—the rubber industry consumed about 4½ pounds of reclaimed rubber for every ten pounds of new rubber. During the first World War, statistics indicate that a proportion of about 57 percent as much reclaimed as new rubber was consumed during 1917. Again, during 1928, consumption of reclaim climbed to a high of 51 percent of the crude rubber consumed, as a result of several years of high-priced natural rubber. It also appears that 1941 was the biggest year in history for the production of reclaim, with about 280,000 long tons being turned out. The total reclaiming capacity of the nation at the present time—on a 24-hour day seven day a week basis—is about 320,000 long tons a year. This production would be possible, of course, only if the flow of scrap rubber to reclaiming plants were such as to maintain that all-out operation.

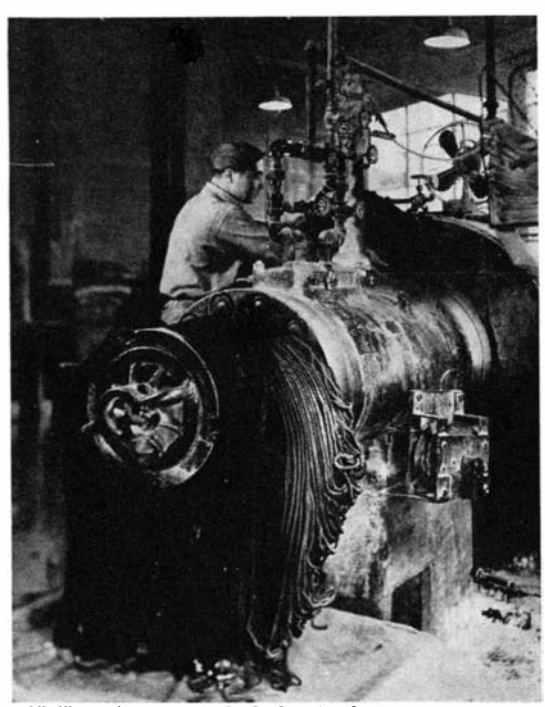
Probably what the average civilian is largely concerned with, as far as the rubber situation goes, is automobile tires. What can reclaim do to alleviate the present tire situation?

The answer at the present moment appears to be that it can't do much, if anything. In the first place, all of the rubber for tires that is obtained by reclaiming methods will undoubtedly go immediately into military, lend-lease, and other vital channels. The probabilities are that little, if any, can be spared for ordinary civilian use. Even if it could, reclaim alone is not too good for use in motor vehicle tires. True enough, there have been made for many years automobile tires in the lower price brackets which have contained sizeable amounts of reclaim. These tires have given reasonably satisfactory service but it must be remembered that they contained a relatively large percentage of crude. If, however, attempts were made—and such attempts are not even being contemplated at the moment—to make "war tires" entirely of reclaim, the use of such tires would mean re-educating the public to totally new driving habits. These tires would not give even the service of pre-war second- or third-line tires, they would have to be driven at slow speeds, and they would have to be given every consideration to prolong their inherently short service life.

Today, therefore, the most important use of reclaim, as far as tires are concerned, is in the production of wartime grades of camelback for retreading and recapping. One bright spot in the reclaim story today is the fact that present-day scrap is better than that of only a few years ago because it consists largely of rubber fortified with superior organic accelerators and with lower sulfur ratios than in earlier years. Furthermore, it is protected by anti-oxidants and the better quality of rubber products resulting from this compounding of the original crude will, of course, carry through into the product made from reclaim.

EVEN before the emergency, many articles in everyday use were (and still are) made of 100-percent reclaim. To mention just a few of them, the list would include rubber heels, floor mats, flooring, hard-rubber goods, bath sprays, jar rings, fly swatters, door wedges, weather stripping, and so on.

Qualitatively, the usefulness of reclaim can be extended today as never before, according to rubber technicians. This extension will be over and above that which the war emergency would dictate, because reclaim is being produced in grades suitable to more uses than heretofore. Quality and uniformity are under much more strict control and reclaims of different types are being made to meet certain standard specifications agreed upon by the reclaimer and the consumer. Processing qualities, also, have been so improved that the proportion of reclaim used can be increased without causing difficulty in the manufacture of rubber

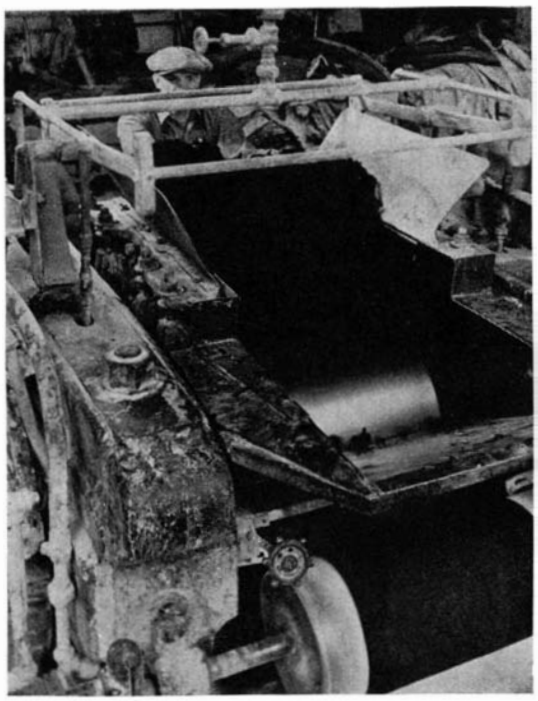


All illustrations courtesy B. F. Goodrich Company

Rubber from the mixing mill is "strained," emerges from machine looking like black spaghetti

goods by standard methods.

Parenthetically, it should be mentioned that many new uses for reclaim are becoming highly important to the industry. One of the most recent is an extensive use of reclaim in aqueous dispersions. These dispersions might be considered as synthetic counterparts of latex, except that they may be derived from either reclaim or crude rubber. Present commercial applications of these dispersions, which are quite similar to those of latex, nearly all make use of reclaim. Such dispersions are available in various colors and compositions, varying in concentration, stability, and other characteristics. It is stated by rubber technicians that the new uses for reclaimed rubber dispersions now account for a substantial consumption of reclaim.



On bottom roller is the reclaimed rubber being rolled and made into slabs for use by the trade

Unfortunately for the process of collecting old rubber from widely spread points, it is those items that do not bulk very large that are of the most value for reclaiming. Things like hot-water bottles, crepe soles, inner-tubes, bathing caps, and so on, are almost ideal for the processing and yield the highest quality of reclaim. Bulkier things such as door mats, boots and overshoes, running board mats, and so on, are less valuable. Many of these latter, because they already have so much reclaim in them, are good only for conversion into rubber products of similar properties. Auto tire casings rate in the middle group of these extremities of scrap preferability. They are not as useful as inner-tubes and the crepe rubber soles, but they are better than door mats and overshoes. On the average, a ton of better grade scrap will produce ¾ of a ton of reclaim.

Articles of hard rubber—battery cases, combs, and the like—are not reclaimable at all. They have such a high proportion of sulfur, carbon black, and other minerals in their original compounding that the natural rubber molecules have been all but smothered.

During recent months the production capacity of the reclaim industry has been substantially increased. This has been accomplished by increased efficiency in production, coupled with high-operating rates, and by installing such new equipment as was needed to balance production throughout the plants. It appears that the reclaim industry as a whole is in a position to meet the demands of abnormally high consumption of its products, provided, of course, that the scrap material needed for processing flows into the plants in a steady stream.

[NOTE: At the time of going to press there is considerable discussion in Washington on the matter of tires for civilian use, composed largely of reclaim, plus a very small percentage of crude, plus relatively large percentages of synthetic rubber. It is claimed that these tires can be manufactured without interference with the supplies of needed rubber for military requirements. Nothing has been proved so far, however, and unless the situation changes materially before this issue reaches the readers, the foregoing paragraphs relating to tires for civilian use still stand.—*A.P.P.*]

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NEW STEEL

Makes Use of No Critical Alloying Elements

IN the fuselages of certain airplanes, seamless tubing of cold-drawn chromium-molybdenum alloy steel is used because of its great strength. Chromium, however, is now on the critical list.

If certain experiments now well advanced in one steel company turn out to be successful, and the aircraft steel specifications are accordingly changed, another alloy steel may be used for the purpose. It contains no chromium and, indeed, requires no virgin alloying elements of any kind. The alloys used are all obtainable from scrap.

Furthermore, experimental lots of tubing, produced by electrically welding flat strips into tubular form, have proved to be as strong and dependable as the cold-drawn, seamless tubing now in use. Electric-welded tubing not only can be produced faster than seamless, but plenty of equipment to produce it is available in steel companies.

POLISHING BRUSH

Eliminates Stress Concentration Points

A NEW polishing brush that has the unique job of increasing the safety of fighter planes by eliminating peculiar "stress concentration points" on metal surfaces is reported to be the product of the careful analysis of 70 serious airplane crashes occurring in the United States during a period of several years.

According to R. O. Peterson, manager of the technical department of The Osborn Manufacturing Company, the brush is being produced in large quantities for manufacturers of airplane engines and engine parts under pressure of government demands.

After a study of the 70 crashes, scientists found they were due to failure of some moving or vibrating part in the plane, Peterson says, stating that he became convinced that the essential cause in most instances could be attributed to the existence of stress concentration points on the metallic surfaces.

"These points," reports Mr. Peterson, "may be nothing more than sharp scratches or nicks on the surface, not much more than eight one millionths of an inch deep. They may be tiny burrs or grooves left in machining. When stress, especially that due to high-frequency vibration, is placed on a machine part having one of these defects, the stress is concentrated there. From one of these tiny points a crack may begin that will end in a fatal plane crash. When a crack starts, it follows along the surfaces of the crystals that make up the structure of the metal. Even if a stress concentration point is situated in the strongest portion of a machine part, this defect may be a cause of failure."

Investigators found that ordinary polishing would eliminate these points satisfactorily, if they were in accessible places, but many surface areas that required polishing could not be reached by ordinary polishing equipment. More

flexible tools were required, and Peterson and his assistants at Osborn found that a brush of tampico fiber could do the work required. This met with the approval of the Army and Navy inspectors. The brushes are made in the form of cylinders or flat disks and are given a treatment with a special form of stiffening liquid to prevent their

Brush makes fighter planes safer

fluttering while in motion. The polishing material used with the brushes is usually a very finely powdered alundum, fine enough to go through a 240-mesh screen, and suspended in a suitable pasty material.

The polishing accomplished by means of the brush eliminates stress concentration points much more effectively than other polishing devices, Mr. Peterson claims.

The tampico brush does not impart a luster as high as that given by other polishing devices, but the surface is much more suitable for machine parts. The finish is so uniform, in fact, that a special instrument is necessary to test the irregularities. Inspection is made by a specially trained observer, who makes use of reflection to detect with his naked eye irregularities on the order of eight one millionths of an inch.

WELDS PHOTOGRAPHED

For Instruction and Inspection Purposes

A NEW photographic method for inspecting welding work has been developed by C. A. Dunn, Professor of Engineering at Oklahoma A. & M. College, Stillwater, Oklahoma. Airplane factories, shipyards, and many other concerns engaged in national defense work may eventually benefit from his work.

Working in co-operation with the Eastman Kodak Company, Professor Dunn found that welds could be photographed, although many difficulties were encountered in attempting to photograph such work; and that such factors as size and shape of molten pool, arc length, indication of fusion, undercutting, and so on, could be distinguished in different quality welds. The intense light produced by the electric arc necessitated the use of a camera filter. A filter permitting only 10 percent of the light to reach the film gave the best results—clear details and little glare. Color film was also tried, but the smoke from the burning electrode made a blue color to which color film was sensitive, obscuring some important details of the welding.

The automatic camera was next considered. Although Professor Dunn learned from camera experts that there was no photographic reason why a camera could not be installed in an electrode holder, as yet the design of the photo-electrode holder has not been completed.

The present phase of Professor Dunn's research is an effort to adapt sound to the picture. The sound of the arc is useful to the welder and inspector in passing judgement on the photographic process. Professor Dunn believes that the first important use of the photographic process will probably be in training courses for student welders and inspectors.—*Engineering News-Record.*

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FILLER—A new synthetic resin binder used in knot-hole fillers has been found to increase the value of low-grade lumber and to improve high-grade lumber. Secret of this filler is that it won't shrink even when used in two-inch diameter knot-holes.

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TOUGH STEEL

Armor Plate Almost Wrecks Plant

STEEL men enjoy licking tough jobs. The men in one company are especially proud of one completed job that was such a downright bad actor that for a time it threatened to wreck completely a vital piece of equipment.

The order was for a special type of armor for one of our allies—a grade of steel never before made in this country. The steel was urgently needed, so any prolonged experimentation in manufacturing methods was out of the question.

No particular difficulty came up in the process of melting the steel and meeting the specifications for chemical composition, but then the trouble started.

The steel proved to be so hard and tough that from the outset it appeared that the rolling mill would have to be operated at only one fourth its usual speed. Even that did not solve the problem, however.

As an ingot would enter between the two rolls of the mill, there would be a deafening crash, the great rolls would shudder, slow down, and finally break—disabling the mill. A new set of rolls would be installed, the speed of the mill cut still further, the amount of pressure on the ingot reduced, and the mill crew would try again—and shortly break another roll.

This kept up until the plant was down to its very last set of rolls. By that time, most of the company's top-flight production men had been mobilized for the job and they were able to figure out a proper combination of mill speed, pressure, and the various other rolling factors. On the last set of rolls available, they were able to complete the order.

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WARPING—Plywood panels constructed so that they have nearly the same stiffness in directions with and across the face grain are much less apt to warp than panels which are very limber in one direction and very stiff in the other.

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SOLDERING SPEED-UP

With Carbon Tip and Grounded Work

REPLACING a completely manual operation that formerly took a considerable amount of time and required a great deal of soldering iron maintenance, an electrically heated carbon tip has been put into use in one of General Electric's industrial control factories. In the application illustrated in one of our photographs, the carbon-tip soldering method is applied to a plate-type

Assembly-line soldering

rheostat, although it could as readily be used for other purposes where the electrical circuit can be satisfactorily completed.

In the use shown, the assembled rheostat plate is placed in a grounded fixture. The operator then lowers the carbon tip into contact with the point to be soldered, heat is quickly developed, and the solder applied and sweated in.

PRODUCTION LIGHT

Increases Give Better Vision, Better Work

AMERICA'S war effort has boosted lighting levels in modern defense plants to four times their peacetime strength, according to S. G. Hibben, Westinghouse Director of Applied Lighting. "Widespread vision defects caused by poor industrial lighting in the first World War will not recur in the present conflict because American industry is now engaged in a virtual 'battle of footcandles' to outdo enemy nations in increasing factory illumination," Mr. Hibben declares.

Since the start of the defense program, modern plants have increased lighting levels from an average of 10 footcandles to 40 and 50 footcandles, the new standard for adequate installations. These levels are 13 or 14 times greater than the average of three footcandles used by industry from 1914 to 1918. Today, these old levels of illumination would be little better than the lighting found on a busy city street.

NICKEL SAVING

In Electronic Equipment by Lining Up Crystals

ENOUGH nickel to make armor-plate for 55 medium tanks—20,000 pounds of it—will be conserved during 1942 by the Westinghouse Electric and Manufacturing Company through substitution of Hipersil steel—developed originally for electric transformers—for a nickel alloy in the manufacture of Ignitrons. These are electronic devices which convert alternating current electricity into the direct current required in the manufacture of aluminum and magnesium and for electric locomotives, steel mills, street cars, subway cars, printing plants, spot welding, and so on.

One part of the Ignitron equipment—a doughnut-shaped device known as a reactor—was formerly made of an alloy containing about 50 percent nickel. But when it became apparent that more and more nickel would be needed to make the steel alloy used in armor-plating tanks and battleships, the search started for a substitute material.

Seeking a magnetic material which did not contain scarce metals, reactors made of ordinary magnetic iron were first tried. This failed to work satisfactorily because the iron got hot and wasted too much power and failed to

Hipersil replaces nickel alloy

provide the magnetic qualities required by Ignitrons. When Hipersil steel was tried, the first reactor made with this metal not only performed as efficiently as nickel alloy reactors but turned out to be more satisfactory under changing temperature conditions.

The magnetic properties of Hipersil steel are not materially affected by temperature changes, which range in the reactors from 70 to 200 degrees, Fahrenheit. A special silicon steel, it is produced by certain melting, heat treatment, and rolling techniques that rearrange its crystals and improve its magnetic properties—a process that enables a small amount of Hipersil steel to do the job of a larger amount of ordinary electrical steel. This method of steel treatment trains the metal's invisible crystals to "fall in line" and become better magnetic paths, with the result that Hipersil steel carries one third more magnetic flux or magnetism than ordinary steel. For example, an electromagnet made of Hipersil steel will do the same amount of work as an ordinary silicon steel magnet one third larger.

FIBER CONTAINER

To Replace Cans, Made on Same Machinery

AFTER many months of experimentation, the American Can Company has developed a method for making "cans" with fiber bodies on machines used for the manufacture of metal containers. This new method, which will be made available to the entire industry as soon as it has been thoroughly tried and perfected through actual production, is considered the most important development within the can manufacturing industry during the past decade. The method brings the first ray of hope to the vast number of American manufacturers of dry products whose merchandise was packed in cans, and whose business is threatened with dislocation by restriction of metals.

The greatest merit, perhaps, of the new method, is that no new machinery is required. At a time when it is impossible to get new machinery or tools and materials with which to construct it, a method has been devised of feeding fiber sheets into existing machines geared for manufacturing metal cans and obtaining a reasonable facsimile of the old container. Another factor of merit is that the manufacturer of a product which uses the cans also may use his existing packaging machinery.

The new container will come to the rescue of those products known in the trade as "dry" such as drugs, cosmetics, spices, powders, and so on. A few liquid products may also be affected.

Under the new manufacturing method, paper will be run through the various tin can lines. The fiber, cut to sheets of tin plate size, lithographed on the regular presses formerly used for lithographing designs on tin plate, will then be sheared and formed into bodies. The black plate ends will be seamed on to the container with the regular seaming machine now in use.

SOAP FLAKES

Solve Industrial Production Problem

THE ladies who "Lux" their dainties daily may not find themselves up against priority problems quite yet because of war industry demands, but, in one instance, their soap flakes have been drafted for war production.

In broaching a hole in a pressure-pump valve part in mass production, difficulty was experienced in obtaining the desired smoothness of finish. Numerous cutting fluids were tried with indifferent success until the engineer from the Colonial Broach Company, makers of the broach, and the valve manufacturer, hit on the idea of experimenting with a solution of ordinary Lux and water. The result was completely satisfactory, the finished hole was as smooth as the ladies' dainties, and the Lux soap solution is now being used in regular production.

INDUSTRIAL TRENDS

LIFE LINES

If there is one thing this war has taught the public in general and the oil industry in particular it is that the most important factor in the whole problem of petroleum, from the drilling of the well to the use of the final product, is transportation. Too well known to warrant discussion here is the shortage of gasoline along the eastern seaboard and the threatened shortage of fuel oil for the coming winter. Everyone is familiar with the fact that these shortages are not due to any shortage of petroleum or petroleum products. It is a case of getting these materials to the ultimate consumer, the means for which are now limited by the exigencies of war.

As has been told in these pages and elsewhere, there are four main methods of transporting bulk shipments of the liquids which make up the stock-in-trade of the petroleum industry. These are the tank ship, the pipe line, the rail tank car, and the highway tank truck. Three of these have been hard hit indeed by the war. The oil tanker has found an implacable enemy in the submarine, the railroads are overburdened by the demands of shipments of other materials of war, and the tank trucks—smallest units in the transportation system—do not have the physical capacity to take over much of the burden and are getting short on the rubber tires so sorely needed for their continued operation.

This leaves the pipe line as the one method of getting liquids from here to there that is still functioning full-time in its original role. Unfortunately, however, this method is one that has, for one reason and another, not been developed sufficiently to carry the full brunt of the present situation. Ever since the first pipe line was built some 75 years ago, this method of transportation has been subjected to the indignation and bitter enmity of, in early days, the teamsters and, then as well as later, of the railroads and water-borne carriers. If it were not for this enmity there would undoubtedly be ample pipe-line capacity for all requirements and there would not now be any question about oil or gasoline shortages in some localities.

Be that as it may, even the tens of thousands of miles of pipe lines that are in active use today are still not sufficient to act alone as carriers of all the petroleum products demanded by the public, let alone the requirements of the armed forces. Thus it is that, because various elements opposed—and still oppose—the construction of pipe lines, this country finds itself with a surplus of petroleum products in some regions and a complete dearth in others.

When the economics of oil transportation are considered, it is a wonder that even the powerful opponents of the life lines of the petroleum industry were able to hold down the construction of pipe lines as much as they did. A pipe line is tucked away safely underground. It works 24 hours a day, seven days a week. Its operation is not hindered by ordinary storms and it is relatively cheap to build and operate. Many hundreds of miles of pipe lines can be built in the length of time required for constructing a tank ship and, averaged out over a long period of time, the pipe line will carry more oil per year than will the tanker.

Here's about how the figures work out. Although a tanker may carry up to 150,000 barrels per trip, the vicissitudes of the sea, and the distances involved, are such that a tanker with this capacity will average only some 4000 barrels per day, on a yearly basis. This is estimated on the average Atlantic Coast run. On the other hand, a 12-inch pipe line can handle some 60,000 barrels per day and can continue to do so with a regularity that spells fuel to consumers wherever the lines are available and as long as the pumps continue to operate.

Although tens of thousands of miles of pipe lines were mentioned a few lines back, it is necessary to understand what these lines are used for in order to appreciate the over-all picture of this phase of one of our most important industries. First, there are some 54,000 miles of gathering lines that carry the crude from the fields to the trunk lines. These latter, about 62,000 miles in total length, move the crude to refineries, storage tank "farms," and even to railway and ship terminals for further handling. About 10,000 miles of lines carrying refined products—gasoline, lubricating oil, and so on—complete the total of oil pipe lines. These products lines, by the way, are a comparatively recent innovation in the industry. Originally, pipe lines carried crude alone. Then, only a decade or so ago, gasoline was transported for the first time by pipe. Still later other products were pumped through pipes and, today, it is the products pipe line that is receiving the greatest attention. Such a line may carry, by correct manipulation of the control equipment, Diesel fuel, any one of many grades of gasoline, kerosene, lubricating oil, or other petroleum products. This flexibility is of distinct advantage to the operating companies and the products line is a development that has a promising future. Innovation that it is, there is every indication that the products line is so successful in operation that more and more of them will come into existence by conversion of crude lines. The probabilities are, also, that the end of the war will find this type of transportation so firmly intrenched in the petroleum industry that, as soon as materials are available once more, products lines will spread over the map of the United States like oil on water.

A hint as to the future possibilities of pipe lines in petroleum transportation of all kinds is to be found in the activities of securities analysts when they evaluate investments in the petroleum industry group. They pay careful attention to the pipe line holdings of the companies under consideration, thus pointing directly to the value of these lines now and in the future.

CARGO BY AIR

Something to get excited about, as seen from this vantage point, are the future possibilities of transportation of cargo by air. Dr. Klemin, our aviation editor, has treated this general subject in his monthly notes, and many far-seeing designers are working steadily on the special problems involved.

One thing to keep in mind when considering this specific trend in the aviation industry is that, according to informed engineers, it will not be practical, when peace comes, to convert military planes to cargo operation. Planes for fighting purposes, whether they be pursuits, bombers, or what-not, are designed for high performance with little or no thought of economy of operation. For the cargo plane of the future, performance will become entirely secondary, and main emphasis will be placed on economy. So long as the plane has high speed and safety and can fly long distances with fuel economy, it will have at least an even chance of competing with other forms of transportation. Thus, completely new designs are and will be forthcoming.

—The Editors

The Scanning Electron Microscope

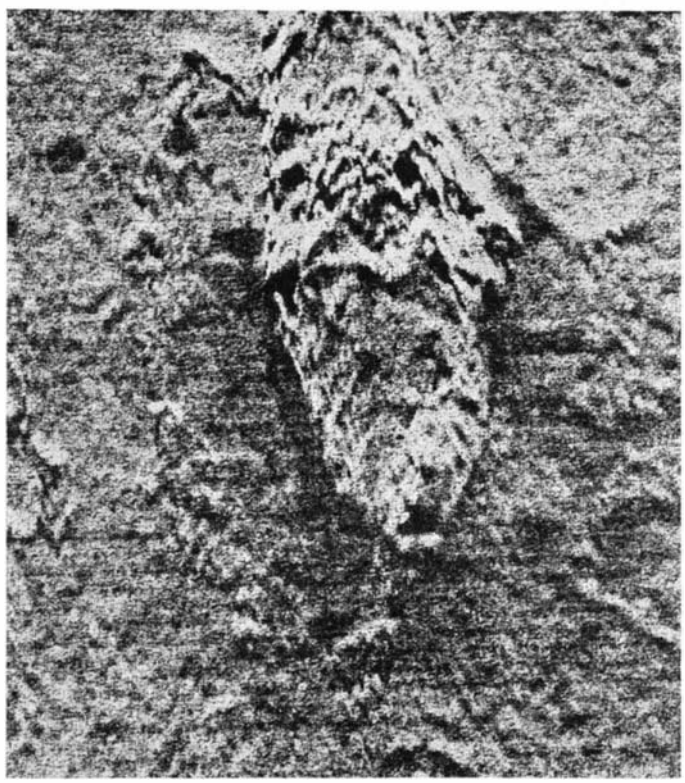
High Magnifications of Opaque Objects With New Instrument Combining Developments in Many Fields

Dr. VLADIMIR K. ZWORYKIN
Associate Director, RCA Laboratories

IMAGES of objects may be formed in two basically different manners. Either the picture as a whole may be projected simultaneously on the recording surface, as typified by the photographic camera, or it may be formed by the sequential recording of its elements, as a painting takes shape under the successive brush strokes of the artist. Practically all optical instruments, including the standard RCA electron microscope, utilize the first method for image reproduction. Television and electric picture transmission or facsimile, on the other hand, analyze the picture to be transmitted into a large number of minute picture elements, successive signals derived from adjacent elements, and proportional to their brightness, serving to control the intensity distribution in the re-synthesized image on the viewing tube screen or recorder paper. The scanning electron microscope belongs to the same class of image-forming devices.

The special sphere of usefulness of the scanning electron microscope lies in the observation of surfaces of opaque objects, just as the standard electron microscope is primarily adapted for the viewing of transparent specimens. The boundary between transparency and opacity for electrons of the order of velocity normally employed in electron microscopes lies in the neighborhood of 1/100,000 of an inch. The standard electron microscope cannot be adapted to the direct observation of surfaces without a great loss in resolving power. It is thus the aim of the scanning electron microscope to extend the range of observation in metallographic microscopy as the standard electron microscope has already extended it in the bacteriological, chemical, and related fields.

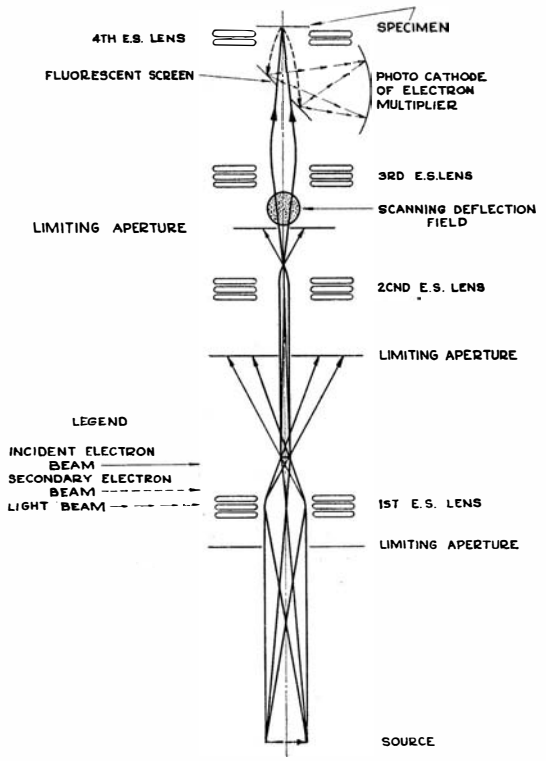
Various researches concerned with the application of the methods of electronic television to problems of microscopy have been carried on in the RCA Laboratories over a period of over eight years. Thus, at an early stage a directly coupled television pick-up and receiver unit was combined with an ultra-violet microscope so as to yield a visible image of readily controlled brightness and magnification. Here the television equipment served primarily to convert an invisible into a visible image and did not participate in the formation of the original magnified image. In order to obtain a genuine scanning microscope it was necessary to replace the ultra-violet-sensitive mosaic in the pick-up tube by the object itself. If, with the latter arrangement, the scanning amplitude in the pick-up tube—that is, the scanning area on the object—is reduced, leaving the scanning in the viewing tube unaltered, an enlarged image of the object is formed on the fluorescent screen, the variation of brightness in the latter corresponding to the variation in the secondary emission sensitivity of the specimen. The magnification of the image is simply equal to the ratio of the scanning amplitudes on the object and on the screen of the viewing tube.



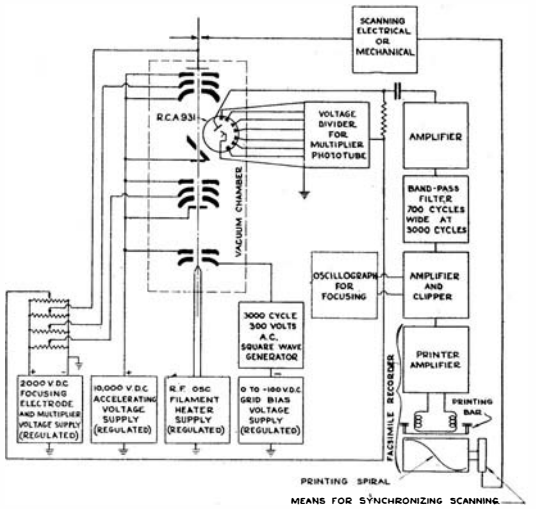
Etched brass, as pictured by new microscope

Simple as the basic principle of the scanning electron microscope may thus appear, the realization of an instrument with a resolving power comparable with that of the standard electron microscope meets very great difficulties. These arise primarily from the necessity of making the scanning spot no larger than the least separation which is to be resolved—that is, no larger than approximately one two-millionth of an inch (or 100 angstrom units) in diameter. A spot of this size may be realized by forming a reduced image of the "crossover" in front of a hot cathode by two short-focus electron lenses operating in two reducing stages; in short, the source is placed at the center of the image plane of a high-power compound electron microscope, the spot being formed where, normally, the object is located. As the electron lenses of this "microscope" are afflicted with spherical aberration in the same manner as other electron lenses, the requirement of a fine spot demands not only a high reduction ratio, but also a restriction to very narrow imaging beams. It may be shown that under these circumstances the current in the spot of the required size has a fundamental upper limit of the order of one millionth of a microampere. The variations in the secondary emission of the specimen which are responsible for the image detail may normally be expected to have an amplitude of the order of 1/10 of this amount.

IF it should be attempted to amplify this signal current of 10^{-13} amperes or less with a regular television amplifier, and to apply the amplified current to the control grid of a television receiving tube, no picture whatever would be obtained—the picture detail would be completely lost in picture "noise" since, with the speed of scan-



Left: "Ray" diagram of the scanning electron microscope, showing beams and lenses



Right: Schematic arrangement of the various parts of the scanning electron microscope

ning required, only about one secondary electron is given off on the average by each picture element, making it quite impossible to transmit information regarding a fractional variation of the secondary emission sensitivities of the picture elements.

Accordingly, although scanning microscopes of relatively low resolution (down to 1/20,000 of an inch or one micron) were successfully constructed even with the image observed directly on the fluorescent screen of a kinescope, high-resolution instruments required a slower method of recording. A facsimile receiver, registering an image in eight minutes (as compared with 1/30 of a second for a television receiver), proved to be a satisfactory solution. By this means the number of electrons emitted per picture element was increased by a factor of about 6000, the total number of picture elements in the image being, simultaneously, doubled.

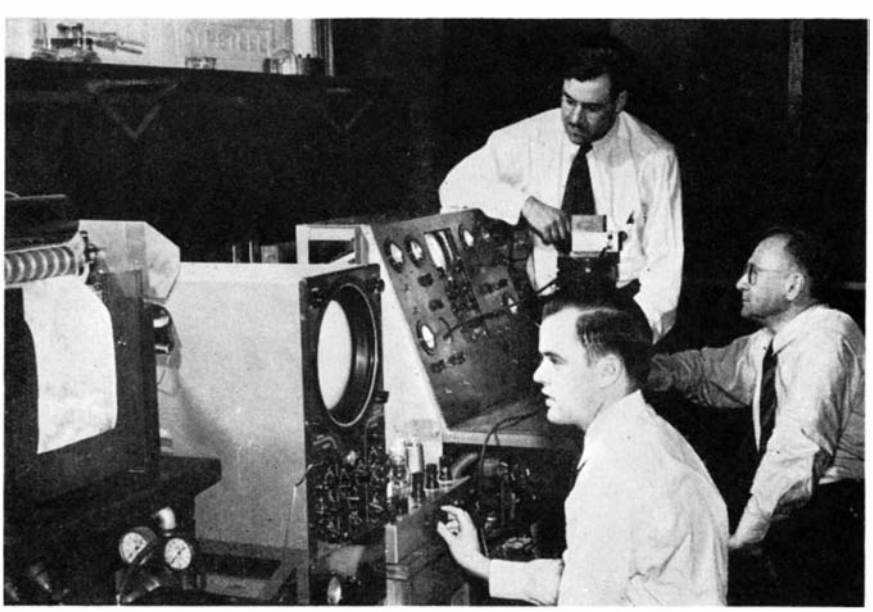
EVEN so, a satisfactory image could only be obtained by the employment of a practically noise-free amplifier—the electronic secondary emission multiplier tube. The secondary electrons, in place of being collected directly, are permitted, after suitable acceleration, to fall on a fluorescent screen, whose light emission is concentrated on the photo-cathode of the multiplier. By matching the spectral sensitivity variation of the photo-cathode to the emission bands of the fluorescent material it is possible to attain a photocurrent in the multiplier which exceeds by a considerable factor the electron current incident on the fluorescent screen.

The general arrangement of the scanning electron microscope is shown schematically in one of the drawings; certain modifications of this arrangement, incidental to a replacement of mechanical scanning by magnetic scanning in the final instrument, are evident on the "ray" diagram.

Referring to the general arrangement drawing, the electron source, at the bottom of the microscope, consists of a thin tungsten wire fed by a regulated radio-frequency power supply. It may be oriented with respect to a two-element electrostatic lens comprising the grid and the anode of the electron gun by means of three micrometer screws. A 3000-cycle square voltage wave is applied to the grid so as to give the beam, and hence the signal current, a 3000-cycle modulation. In addition to this, a variable D.C. grid bias is provided to regulate the current in the beam.

The anode, as well as the remainder of the channel through which the beam passes, with the exception of the center electrodes of the two reducing lenses and the specimen itself, is normally maintained at a potential of 10,000 volts with respect to the cathode, the voltage supply being stabilized by negative feedback to within .001 percent.

After traversing two masking apertures, the beam passes through the first electrostatic reducing lens, which forms an image of the crossover of the beam, the reduction factor being of the order of 50. It may be adjusted by varying the potential of the center electrode with respect to the cathode, a stabilized 2000-volt supply being provided for this purpose. About halfway between the first and second lens, at the end of a narrow tube acting as



Shown here with the recently perfected scanning electron microscope are Dr. James Hillier (foreground), Richard L. Snyder, and Dr. Zworykin, the author, at the right

an electrostatic shield for the beam, is another aperture of the final lens, placed approximately at the center of an inclined fluorescent screen. The final lens, similar in construction to the first lens, forms the scanning spot, imaged on the specimen. The latter may be translated in three directions in the same manner as the source.

On striking the specimen, the primary electrons eject secondary electrons from it. These have low initial velocities, corresponding to accelerating voltages between 0 and 10 volts. The strong accelerating field between the specimen and the uppermost electrode of the final lens draws them back through the final lens, which focuses them at some point between it and the inclined fluorescent screen. Due to the smaller initial velocity of the secondary electrons, the lens action of this lens is much stronger for the secondary electrons than for the electrons of the original beam. The secondary electrons, diverging from their point of focus, form too wide a beam to pass through the fine aperture in the fluorescent screen. They fall on the screen instead and their energy is, to a considerable extent, converted into the bluish light characteristic of the luminescent substance employed. A large fraction of this light falls on the photo-cathode of the electron multiplier placed in a favorable position relative to the screen and gives rise to a photo-current which, suitably amplified and filtered, forms the signal current controlling the printer bar of the facsimile recorder.

In the earlier instruments the scanning was accomplished by the mechanical displacement of the specimen, the motion of the latter being linked electrically or hydraulically with the displacement of the recorder drums with the aid of suitable cams mounted on the axes of the drums. Since adequate precision in the scanning could not be obtained by this means, magnetic scanning was provided in the final instrument. The deflecting yoke is placed directly below an auxiliary lens of approximately unity magnification, the primary purpose of the latter being to provide space both for the deflecting yoke and the fluorescent screen. After passing through a hole in the screen the primary beam traverses a decelerating lens and strikes the object. The returning secondaries spread out over an area about the hole, causing the screen to fluoresce in proportion to the intensity of the secondary emission current. The light from the screen, finally, is concentrated by a wide-aperture lens on the photo-cathode of the multiplier. The area of the specimen which is scanned is normally only about 1/1000 of an inch in diameter.

A picture of an etched brass surface obtained with the scanning electron microscope is reproduced in these columns. The resolution is here of the order of 500 angstrom units, representing a great improvement over the optimum obtainable with the light-optical metallographic microscope. As with any new device, it is not possible to judge the full range of utility of the scanning microscope at the present time. It is an interesting fact, however, that its perfection has been made possible only by a large number of concurrent developments encompassing the fields of television, facsimile, secondary emission multipliers, fluorescent materials, and electron microscopy.

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METAL DETAILS

Reproduced in Film for Electron Microscopy

PLASTIC films one five hundred thousandth of an inch in thickness, equal to about a tenth of the length of yellow-orange light waves, have been found best by General Electric scientists for revealing details of metal surfaces under the electron microscope. A full account of the technique by which these films are made and used is published in the *Journal of Applied Physics,* in an article by Vincent J. Schaefer and Dr. David Harker.

After the metal sample is polished and etched for a few seconds with acid, it is dipped into a dish containing a solution of Formvar, a plastic, in dioxane, a commercial solvent. The authors point out that it is necessary to do this within a few minutes after the sample has been etched and dried Otherwise an infinitesimally thin film of grease or other contaminating material may start to form.

After dipping in the Formvar solution, the solvent evaporates, leaving the plastic film, which is then stripped off, and on which are reproduced the microscopic hills and valleys of the metallic crystals. The film can then be placed in the electron microscope for examination.

Mr. Schaefer and Dr. Harker find that the exact thickness of the Formvar film is important, and this can be regulated by the strength of its solution in dioxane. Very thin films, about a millionth of an inch, do not show much contrast in the final electron picture. This seems to be because the film both on top and bottom follows the hills and valleys of the metal. Thus it is all nearly equally transparent to the electron beam. If the film is as thick as 1/250,000 of an inch, contrast is also poor.

Best thickness is around 1/500,000 of an inch. Such films are just thick enough to make the top of the film level, while the bottom reproduces the hills and valleys.

• • •

HEAT—A temperature of 45,000 degrees, Fahrenheit, has been momentarily produced at the National Bureau of Standards by discharging, through a quartz tube with a one-tenth inch bore, 40,000 kilowatts of electrical energy over a period of five millionths of a second.

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WOMEN IN SCIENCE

Interest In Tackling Problems Is Essential

THERE are plenty of opportunities for women in science, and an interest in tackling problems is essential for those who want to take up such work, according to Dr. Katharine Blodgett, physicist of the General Electric Research Laboratory.

"The requirements for work in a laboratory are not so different from the requirements for successful work in any vocation," she said. "For laboratory work you need formal training, of course; and, in addition, you need persistence, patience, and a knack at solving problems—and the most important of these is the knack at solving problems.

"Often college students come to my laboratory to ask if I think they would make good laboratory workers. They are complete strangers to me—I do not know if they would make good laboratory workers. And so I ask a student this question: Is she interested in tackling problems—not just laboratory problems, but everyday problems outside of the laboratory—all those commonplace, unexpected, and sometimes unenviable problems that come up that somebody has to solve? For example, if the plants in the garden at home are being eaten at the root by cutworms; or if she has caught her dress on a nail and doesn't know how to mend the tear; or if her favorite summer camping spot is becoming carpeted with poison ivy—does she tackle the problem?

"There are people," Dr. Blodgett continued, "who are never interested in solving problems. I think that one reason is because they never outgrow the childhood complaint of saying, 'I can't,' which is just another way of saying, 'I won't try.' "

The Nebular Spectrum

More Impressive Grows the Evidence for the Uniformity of Composition of Matter in Space

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

ONE of the ablest of the younger group of American astronomers, Dr. Arthur B. Wyse, lost his life in the service of his country on June 9th in the collision of two naval airships. The nature of the technical problem upon which he and several colleagues in other sciences, who were also lost, were engaged has not been revealed. But the record of his astronomical work, in the brief span of nine years, provides a worthy and permanent memorial.

Twice within the last few months we have had occasion to describe, in these columns, work in which he had a share. He was the first to discover the remarkable bright lines in the spectrum of RW Tauri, which later revealed the existence of the ring of gas rotating around it, of which we told in July, and his skill in intricate mathematical analysis had a large part in the successful interpretation of the rotation of the Andromeda nebula, and its neighbor spiral, Messier 33, which we described in June.

His principal contributions to science, however, were in the study of spectra. Three years ago, he and Dr. Bowen—the discoverer of the nature of the "forbidden" nebular lines—published an admirable study of the spectra of three bright planetary (gaseous) nebulae, finding for the first time evidence that atoms of metals as well as of permanent gases were present in them. A continuation of this work, extending the observation of ten nebulae, was fortunately completed by Dr. Wyse just before he left the Lick Observatory for war service, and was published but a few days before his death. Quite apart from this tragic interest, it well deserves our consideration this month for its inherent scientific quality.

Nine of the nebulae included in this study are "planetaries." Few, if any, more inappropriate adjectives have survived from old times to confuse modern astronomical language. These nebulae show visible disks, sometimes of considerable size, and thus far have a slight resemblance to planets; but the resemblance goes no further, for they are usually oval, and often considerably irregular, in shape. Practically all such nebulae possess a central nucleus, appearing like a faint star, much brighter on photographs than when observed visually. There is conclusive evidence that they are actually shells of gas, enormous in size and of excessively low density, which surround the nucleus, and are set shining by the effects of very short-wave ultraviolet light emitted from the nucleus. The nuclei themselves appear to be exceedingly hot stars—the hottest so far known. The tenth of Wyse's nebulae was an object of very different type—the Great Nebula in Orion—a huge chaotic mass of luminous gas, of very irregular form, which is set shining by radiation from a group of bright hot stars near the middle.

THE main purpose of the investigation was to observe as many as possible of the faint emission lines which are known to exist in these spectra, and all known light-saving devices were applied. For example, the image-slicer, which concentrates the light from different parts of the nebula into narrow strips of spectrum, side by side, was used on all the planetaries. (The Orion nebula is so big that this was not necessary.) In an ordinary spectrograph, much light is lost by reflection at the many successive surfaces of the lenses and prisms through which it must pass. By coating these surfaces with exceedingly thin transparent films of fluoride of lithium or of magnesium —evaporated upon them in a high vacuum—the reflection loss was so much reduced that the photographic speed was more than doubled. An additional gain was made by increasing the sensitivity of the plates by exposing them to mercury vapor shortly before use.

All these devices together did not escape the astronomer's usual requirement of long exposures—they made these give better results. For almost all the nebulae two exposures of from 14 to 19 hours' duration, on two or three successive clear nights, were made—one for the red, the other for the violet end of the spectrum. The brightest lines could be recorded in a few minutes. A limit to the search for faint lines is set by the fact that most of the nebulae show a faint continuous background of emission spectrum. In some, this comes from the nucleus, but in others—notably in the Orion nebula—from the nebulosity itself.

To show faint lines against this background can best be achieved by using a spectrograph of quite different proportions from those employed in the study of faint extra-galactic nebulae. The latter have a camera of very short focus, so that the spectrum on the plate is but a small fraction of an inch in length. The resulting concentration of light is just what is needed to bring out a faint continuous spectrum crossed by dark lines. But in the nebulae the lines are bright, on a less luminous background. Here it pays to use a rather high dispersion. This draws out the continuous spectrum, and makes it fainter, while the images of the narrow bright lines are set farther apart, but are no wider, and so they are easier to see.

THESE pains were well rewarded. Wyse's final list contains 351 bright lines, observed in one or more of his ten nebulae between 3704A in the near ultra-violet and 6755 in the red. Some of these were observed only in a single object, at the very limit of visibility. Omitting these (which were included to make a complete record) the list contains about 270 bright lines which are undoubtedly present in the spectra of gaseous nebulae, or of their nuclei. This is three times as many as were known when the investigation was begun by Bowen and Wyse in 1938. The great lenses of the Lick 36-inch refractor, with which the observations were made, are practically opaque to ultra-violet light below 3700. With reflecting telescopes, aluminized mirrors, and quartz prisms, many additional lines have already been found in the ultra-violet, and the extension of the thorough survey would probably raise the number of known nebular lines well toward 350. Observations with plates sensitive to the deep red and infra-red, both by Wyse and by others, have revealed very little.

On the whole, the spectra of the ten nebulae are remarkably similar.

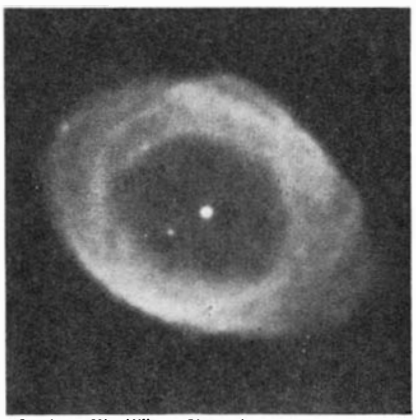
Some of them show a greater degree of excitation than others, and lines emitted by highly ionized atoms are confined to these. This may be connected with very high temperature of the central star. The Orion nebula indicates a rather low excitation.

Two close pairs of lines—of neutral nitrogen at λ5199, and of singly ionized oxygen at λ3727—are known, from calculations based on atomic theory, to be much more strongly forbidden than the rest; that is, an atom would have to be let alone much longer before it "got around" to performing the transition which produces these lines. There are one or two nebulae in which these strongly forbidden lines are brighter, in comparison with the others, than in the rest. It is very probable that these nebulae are of exceptionally low density, so that the atoms in them are less frequently disturbed by collisions with other atoms, and have a better chance of emitting the strongly forbidden lines.

When allowance is made for these factors, there remain remarkably few outstanding differences between the ten nebulae, and Wyse concludes that "the variation in line intensities, among the nebulae observed, arises primarily from differences in physical conditions rather than from differences in chemical composition."

COMBINING his results with those of earlier observations, he gives the following long list of ions represented in the spectra of one or more of the nebulae observed: *H* I, *He* I, *He* II, *C* II, *C* III, *C* IV, *N* I, *N* II, *N* III, *N* IV, *N* V?, *O* I, *O* II, *O* III, *F* II?, *F* IV, *Ne* III, *Ne* V, *Mg* I?, *Si* II *Si* III?, *S* II, *S* III, *Cl* III, *Cl* IV, *A* III, *A* IV, *A* V, *K* IV, *K* V?, *K* VI, *Ca* V, *Fe* II, *Fe* III, *Fe* VI, *Fe* VII, *Ni* VIII?. This is an impressive list in many ways. Sixteen elements have now been identified (two doubtfully) in the nebulae, including several metals, and silicon (which behaves spectroscopically like a metal). These metals show strong lines and must be abundant in ordinary stellar atmospheres. There are, however, two elements—fluorine and chlorine, which have been found spectroscopically in the nebulae, and not, so far, in the stars (except for fluorine compounds in the Sun). This is easily explained. Elements with strong forbidden lines have an enormous spectroscopic advantage in nebulae, and fluorine and chlorine are definitely of this sort. In stellar spectra, however, the spectroscopic conditions are against them. Their strong lines are inaccessible in the far ultra-violet and the only available ones would show only in hot stars.

Similar allowances for favorable and unfavorable spectroscopic conditions have to be made in the case of many other elements. When this is done, Wyse confirms, from much more extensive data, the conclusion that he and Bowen reached in 1939—namely, that the relative intensities of the spectral lines in the nebulae are very much what would be expected if their actual composition was similar to that of the atmospheres of the Sun and the stars. For a detailed discussion of individual cases, the interested reader may be referred to the original paper (*Astrophysical Journal,* May, 1942). About 40 percent of the observed nebular lines remain unidentified. Most of them are very faint, and the unidentified lines, taken together, contribute less than 5 percent of the total energy of the nebular radiation; but there is a good deal of work still to be done in finding their origin.



Courtesy Mt. Wilson Observatory

What is a planetary nebula, in relation to the total of astronomic objects? The great units of the universe are galaxies of stars of which the spirals are the most familiar. Our galaxy, the Milky Way, is one of these. Like the rest, its most familiar units are suns—billions of them. In addition, there are some oddities, relatively very small in number: diffuse nebulae (formless clouds of gas, glowing or dark) and the egregiously misnamed "planetary" nebulae (formed clouds of gas surrounding central stars). The "Ring" Nebula in Lyra, above, is one of these but it is not a ring. A sphere surrounding a central star which caused it to glow might photograph as a ring; there is more substance in the "ring" portions to send out light, a matter of geometry. As Professor Russell pointed out in December, 1937, planetary nebulae are utterly unlike planets in every way

It requires no great technical training to recognize that the metals definitely found in nebulae—silicon, potassium, calcium, and iron—are among those which are most abundant, not only among the stars, but in the composition of terrestrial rocks. It is well known, too, that the permanent gases are more abundant in the stars than are even these metals—hydrogen and helium being far ahead of the rest—and this again fits perfectly with the nebular spectra.

A few years ago, the statement that the Orion nebula was partly composed of iron would have appeared to be incredible, if not absurd. Now, 10 forbidden lines of *Fe* II, and about 15 of *Fe* III, have been definitely observed by Wyse, so that there can be no doubt about it. In the meantime, all surprise has been removed by the even more remarkable discovery that atoms of iron, very thinly distributed, form part of the gas which is distributed throughout inter-stellar space. Calcium and potassium, too, are known to be present in the inter-stellar gas.

Year by year, the evidence for the general uniformity of composition of matter, throughout the regions of space accessible to our observation, becomes more and more impressive. The Orion nebula, according to Wyse, appears to be very similar in composition to the planetaries. Yet, as he remarked. "While little is known of the origin of planetary nebulae, it seems likely that they consist of matter that has been thrown off from the central stars. The diffuse nebulae, on the other hand, as typified by the Great Nebula in Orion, have presumably never been in the form of stars."

At first glance this appears surprising, in view of the evidence that atomic transmutation occurs inside the stars and provides them with their energy. But it may be remarked that of the elements characteristic in nebular spectra, hydrogen is the as yet unexhausted fuel of the atomic process; helium the slowly accumulating ashes; carbon and nitrogen the self-renewing catalysts by whose aid the process is carried on; while oxygen, and all the heavier elements, are unaffected at the temperatures and densities which so far as we can judge prevail inside the stars.

THE light elements—lithium, beryllium, and boron—would give us diagnostic evidence. But, unfortunately, the structure of their spectra makes it certain that they can have no forbidden lines. It also is very unfavorable to detecting them at all spectroscopically (except for neutral lithium) in the heavenly bodies. The similarity of the Orion nebula and the planetaries is therefore not so remarkable after all.

One cannot close this sketch of a very beautiful piece of research without the expression of profound regret that so able an investigator has been lost alike to the service of science and of the nation.—*Princeton University Observatory, July 3, 1942.*

Pumps For Home Protection

Simple Units for Use in Combatting Incendiary Bombs and Fires Can be Made from Available Material

GEORGE H. STAHLER

A CONSTRUCTION "project" that will interest many home owners as well as civilian defense units, Boy Scout troops, and so on may be built up around home-made pumps for protection against fire and incendiary bombs.

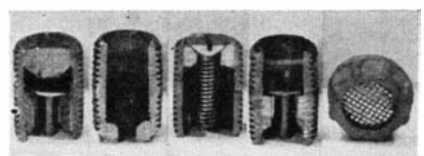
The author has found that galvanized pipe and fittings are perfectly satisfactory for these pumps; even scrap material, if cleaned thoroughly, will serve. The drawing at the bottom of the page shows the essential parts of the pumps, the letters on the sketch corresponding to these in the specifications which follow:

Pump No. 1. A—1" by 8" pipe. B—1" by ½" by ½" tee. C—½" st. elbow. D—½" by ⅜" by ½" tee. E—½" by 1" st. elbow. F—1" by 9" pipe. Height of pump overall 34". Stirrup arrangement is separated from main board a distance of 2" and the upward opening for insertion of pump in pail is 15". The main board is 4" wide. Nozzle opening—5/64". Maximum stroke—6".

Pump No. 2. A—¾" by 8½" pipe. B—½" thread tapped inside bottom end of A. C—¼" pipe nipple which screws into tapped hole in A just above intake valve, plus a ½" pipe cap which has been drilled and tapped for the other end of nipple. D and E; a ¼" tapped hole has been made in F just above the valve. Into this hole a short ¼" nipple has been placed, to which a piece of ⅜" pipe is attached to provide a hose connection. F—¾" by 9½" pipe threaded internally at one end to provide threads into which the valve can fit. Height overall—34". Nozzle opening—5/64". Maximum stroke—6".

As the photographs of the valves show, a ½" galvanized pipe nipple is the basis on which they are made. To this has been added a valve seat and stopper which should be of non-corrosive metal. The top of an electric light socket may be used for the valve seat, and a brass flat-head screw or bolt for the stopper, as shown in the center valve photograph. A modification of this type, also shown, uses a brass ball, while still another employs a copper rivet. The unit at the right is a ½" pipe end used by electricians. Into it is pressed a piece of brass screen. This is used as an intake valve strainer.

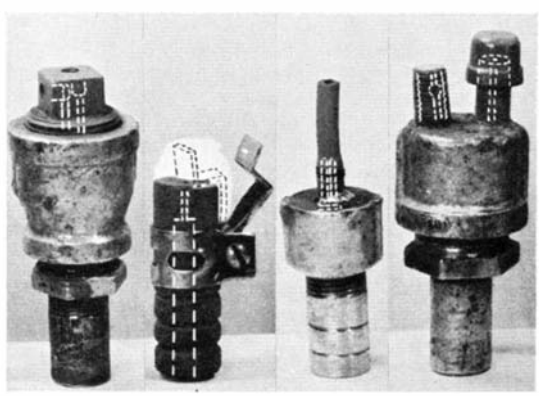
Nozzles for these pumps are show in the center photograph on this page. These illustrations are practically self-explanatory, the dotted lines showing holes drilled to produce a spray or stream as desired. In the first nozzle control is by shutting off either one hole or the other with the thumb. The body of the second valve illustrated is made from a piece of oil-soaked wooden dowel with a metal lever control. Control of the third valve is accomplished by squeezing the rubber tube, and of the fourth valve by changing the cap from one jet to the other.

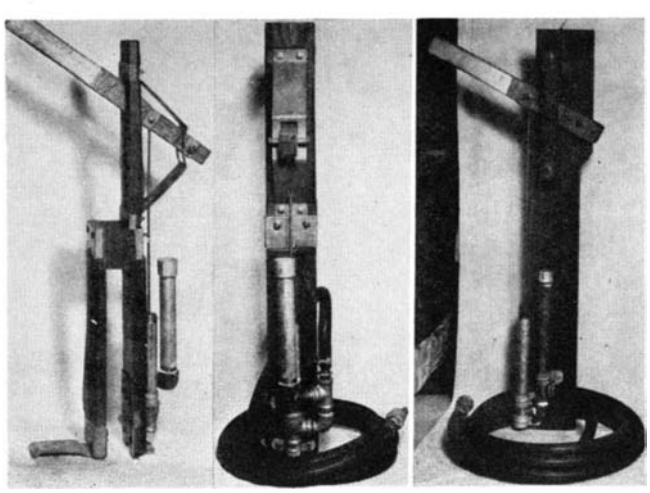


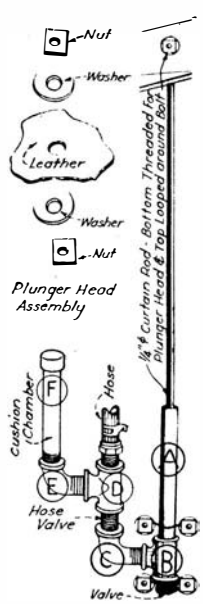
Four valves and strainer

Both of these pumps are designed to be used with 12 feet of ⅝" garden hose.

[More complete data on these and other types of pumps are available from the author. Address him in care of this magazine.—*The Editor.*]







Below: **At left, side and front views of pump No. 1. At right, pump No. 2.** ***Drawing:*** **Essential parts of both pumps, with letter references to the text.** ***Above:*** **Four types of home-made nozzles.**

BOMB SNATCHER

An Effective Tool for Handling Incendiary Bombs

To get rid of incendiary bombs before they have a chance to do damage is the object of the "Bomb Snatcher," made by the McGraw Electric Company, shown above. A lever controls the two semi-cylindrical refractory-lined jaws.

SIMPLE PUMP

No Strategic Materials Enter its Construction

A COMMERCIAL pump for home protection against incendiary bombs and fires, designed to replace the conventional stirrup pump which requires priority materials, has been developed by The Zadig Patents. This unusual new pump, shown at the right, is made entirely of wood and fabric, even the two lengths of hose containing no rubber. The operator stands on the base of the pump when using it and works the handle back and forth. The handle can be detached and the pump folded flat for storage when not in use.

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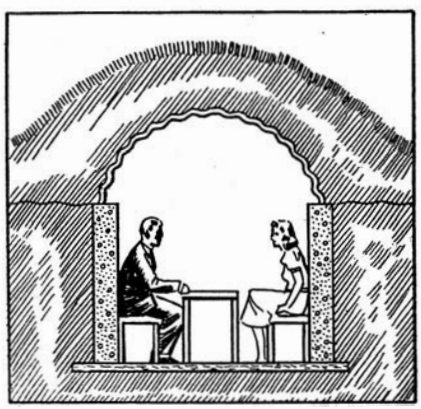
Air-Raid Shelters

Primary Consideration Should be Given to the Possibilities of Private Types of Shelters

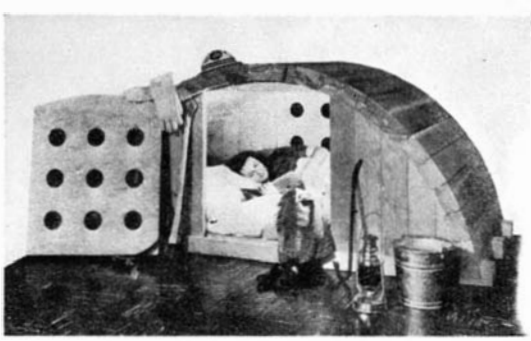
A. D. RATHBONE, IV

WHEN and if the bombs come to American cities, there will not be enough air-raid shelters for everyone who thinks he should be in one.



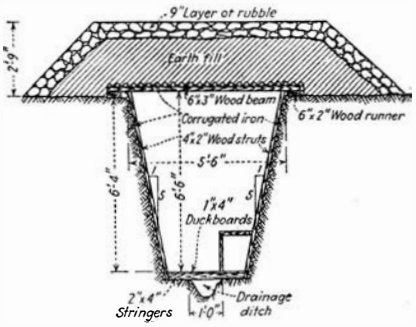
Above: Anderson type of domestic shelter. Inexpensive and effective against blast and splinters. Poor on heat, sanitation. Reproduced by permission from "What the Citizen Should Know About Civilian Defense," by Messrs. Binger and Railey, published by W. W. Norton & Co.

Right: Solid Timber Shelter, for indoor use, has room for standard double bed mattress, with space for equipment at both ends. It is constructed of non-priority materials throughout

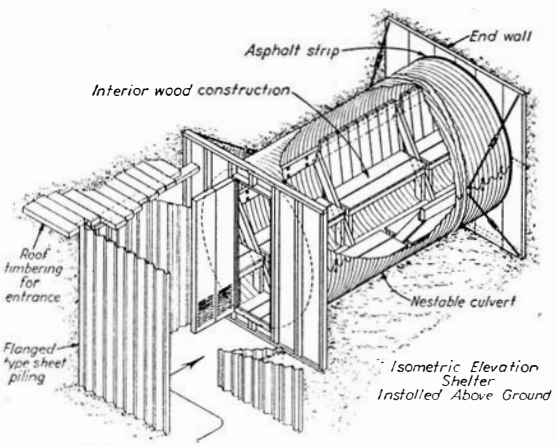


We have no time, labor, or materials to spare from war production for the construction of public shelters in sufficient number and variety to offer even the minimum of safety for all civilians on coastal cities, not to mention inland manufacturing centers. Furthermore, and contrary to popular American belief, we don't need *public* shelters. After 12 months of the most intensive bombings, England found the risk of death from the air was only about six times that of death from automobile accidents. Current writers on civilian defense report that British experience with public sleeping shelters has produced more negative arguments than positive for the well-being of the public—they are dangerous to public morale, liable to cause development of psychoses, and tend toward heavy concentrations of civilians, rather than toward the safer policy of dispersion. A census, taken in January, 1941, showed but 5 percent of London's population using public shelters, only 19 percent utilizing communal or domestic types. The rest slept in their own beds.

Inasmuch as Mr. Average Citizen is not going to find a specially constructed shelter at every street corner, what precautionary measures should he take? First, arrange for protection at home, for that's where Mr. Average Citizen spends most of his time each week, that's where his family is most likely to be, and, if he or any member of his family should be away from home when bombs come, there are just two simple rules: (1) Avoid panic; (2) Obey instructions from police, firemen, air raid wardens, or other qualified protective forces.



A covered trench shelter, from "Civil Air Defense," by Prentiss, by permission of Whittlesey House



Armco 72-inch diameter nestable pipe air-raid shelter, reproduced from "Aerial Bombardment Protection," by H. E. Wessmann and W. A. Rose, published by John Wiley and Sons

In his book, "Civil Air Defense," Col. A. M. Prentiss states: "The importance of home protection is appa-

(*Please turn to page 141*)

Buckets of Blood . . .

Your Blood Donation, an Absolutely Painless Procedure, May Help Save a Warrior's Life

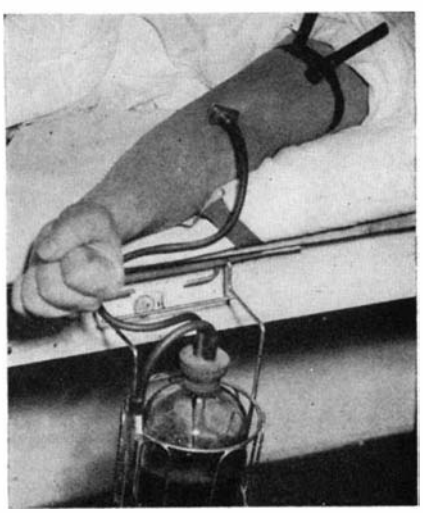
HOWARD C. FORST

IMAGINE a train of 18 railway tank cars filled to capacity, not with gasoline or other conventional cargo, but with human blood. This, were it to retain its original bulk, approximates the space which would be required to transport the blood reserve now being gathered for use by the United States Army and Navy medical staffs. 1,215,000 units is the figure which expresses the actual quantity—a unit being about one pint, the average amount taken from a donor in the course of a single transfusion.

Volunteers stream steadily through Red Cross headquarters in all cities where blood donations are accepted, New York alone accounting for more than 400 daily. The entire procedure—harmless, painless, and devoid of virtually all discomfort or unpleasant after-effects—requires only about half an hour; the transfusion itself, not more than ten minutes. Upon its completion, the donor returns immediately to normal activities, unmarked by his experience save for a small pat of adhesive tape on the inner side of his elbow joint, and the memory of a merciful contribution which may well save an otherwise lost human life.

Down through the centuries, physicians have fumbled with the idea of curing the sick with potions or injections of blood from the healthy. Though such efforts resulted often in serious after-effects or even death for donor and recipient alike, there were occasional outstanding successes—rare to be sure, but frequent enough to taunt the curiosity of the scientist, and to keep alive his interest in transfusion. Then, in 1900, Karl Landsteiner, a young Viennese bacteriologist, began a series of experiments, mixing blood serum and red corpuscles from different individuals—serum being the liquid which remains after clotting. Shattering accepted theory of that day, which held that all human blood is identical in structure, these experiments led to the ultimate emergence of the now well-known four blood groups or types, each of which is quite distinct from the others. The red corpuscles of each group contain substances which react unfavorably when serum from another group is introduced into the circulatory system. Thus, the disastrous outcome of most previous transfusion attempts had been due in large measure to this random intermixture of opposing blood substances.

In the light of this surprising discovery it seems strange that, for the better part of two decades, little attention was given the therepeutic value of properly grouping blood donors



All photos New York Chapter, American Red Cross
Taking donor's blood. Painless

and recipients. During the first World War, however, the procedure was adopted by the A.E.F. and proved highly beneficial. General acceptance followed quickly and before long the treatment was applied for a wide variety of conditions, running the alphabetical gamut from "bleeding in haemophelia" to "wasting anemia."

Until less than five years ago, the chief difficulty in the way of transfusion therepy lay not in failure of physicians to appreciate its merit, but rather in the very conditions which so often created most imperative need for its application. Frequently, where blood was urgently required—as in major disasters—a ready supply of suitable donors was not available.

Gratifying results had been obtained in a few cases by transfusing only plasma—a blood liquid differing in but minor chemical degree from serum. Unlike whole blood, which was known to be unfit for use after a week's storage, plasma could be preserved from six months to a year, and had the additional advantage of being safe for transfusion without the necessity of typing. Serious laboratory experiments were forthwith begun, and soon, again, the ill wind of war intervened to blow humanitarian good. The 1940 London bombings, with their consequent heavy civilian casualties, pressed home the need for readily available and easily transfusable quantities of blood. To such demands plasma seemed the logical answer. Since, under stress of war, England could not complete the essential donor organization with sufficient rapidity, it was agreed that plasma should be furnished by the United States. The New York Chapter of the American Red Cross took over recruiting of donors, while the Blood Transfusion Association supervised technical procedure.

THIS campaign lasted five months—over 15,000 persons giving approximately a pint of blood each. Such, indeed, are the unpredictable twists of circumstance! Almost before the program was well under way those serious laboratory experiments, so cautiously begun, had grown, because of great and sudden need, into a full scale, mass-production activity, serving an international cause.

Blood was taken from donors by means of a hollow needle inserted into a vein in the arm. It flowed directly into a sterile glass container and there the red and white corpuscles (which are not used in plasma transfusion) settled in a thin layer. Later, the liquid plasma was drawn off. Where a centrifuge was available, the settling process could be greatly accelerated; for, by whirling the jar on this wheel-like apparatus, the corpuscles, instead of requiring several days, were precipi-

Drawing off plasma into big bottle

tated in about half an hour, after which the plasma could immediately be removed. As soon as laboratory tests had approved individual specimens of each blood, the plasma of several donors was pooled into a kind of sanguineous cocktail which was then subjected to further tests, before final shipment abroad.

While the campaign for Britain was still in progress a new project was organized to experiment with the drying of plasma. It was reasoned that a dry product could be compressed into far smaller space than that required for liquid (an important factor in shipping), while at the same time it would be in less danger of contamination. Technique was developed rapidly and, as has now been positively established, dry plasma has the further advantage of being safe for use after as long as five years storage, with indications that it can probably be preserved indefinitely.

Soon the Army and Navy stepped in with consecutive requests for the huge quantities of "powdered plasma" now in process of being gathered. From the donor's viewpoint, present procedure is (with a few elaborations) much the same as that employed for

Removing bottles from centrifuge which whirled them at 2500 rpm

the British. The newly-taken blood is refrigerated, and within 24 hours subjected to the drying process. Tested and separated by centrifuging, the plasma is pooled and frozen in a dehydrator at a temperature of 150 degrees, Fahrenheit, below zero. Moisture is extracted by means of a vacuum pump, and the residue—a dry powder—is then portioned out and vacuum-sealed in sterile containers. Each of these, with essential needles, tubing, and a bottle containing specially distilled water, is separately packaged for shipment; the whole comprising one complete operating unit. When it is to be used, the doctor simply mixes the powdered blood with the distilled water—the result being a thickish liquid having about the consistency of condensed milk. He then adjusts needles and tubing, and proceeds with the transfusion.

As things stand at present, dried or liquid plasma does not serve in every case where transfusion is required. Still greater improvements are hoped for, as may be seen by experiments being carried on with the red corpuscles (wasted in plasma transfusion), in an effort to devise means of putting them to therapeutic use. An additional "conservation note" may be observed in the recent suggestion that corpse blood—from fatal accidents—be gathered for storage against emergencies. To the gratification of the more squeamish, however, most medical leaders do not appear to favor this practice, holding that it would necessitate such exhaustive tests and precautionary measures as to nullify its possible value. More likely of adoption is the proposal to accumulate plasma in connection with the Civilian Defense Program—an idea which would seem well founded, since military supplies could scarcely be released for civilian needs.

To insure an adequate reserve of plasma for the duration, the Red Cross "Blood Donor Service" is already taking "blood gifts" in an ever-expanding number of cities throughout the country. Several chapters also operate "Mobile Units" which daily visit small communities within a radius of 100 miles of the permanent headquarters, enabling volunteers in these localities to participate. Any man or woman in average health between the ages of 21 and 60 is acceptable and there are many who make donations periodically, present regulations specifying that these be spaced at least eight weeks apart, not more than five being permitted within one year. Donors are asked to avoid eating for four hours before giving their transfusions, in order to prevent absorption by the plasma of food substances to which the recipient may be alergic.

As you chat informally with doctors and nurses at Donor Service Headquarters, you hear of persons who travel considerable distances in order to give their donations. You hear also of soldiers and sailors on leave, coming in to give their little "extra bit." And of course you hear the irrelevant but classic story of the maiden lady, who, some years ago required a transfusion, but, upon learning that only a male donor was available, declined the treatment—or at least so says the legend—insisting that she would not permit herself to be contaminated by masculine blood.

Dr. Landsteiner, who solved the mystery of the blood groups, back in that other Vienna—the Vienna that was, at the turn of the century—now

Bottle of plasma, bottle of distilled water, for the Navy and Army

pursues his serological investigations at the Rockefeller Institute for Medical Research. Talk with him in his laboratory and you are profoundly impressed with his patience, his self-effacing modesty. In unstudied sincerity, he minimizes the significance of his discoveries, pointing out that his investigations were so basic that it seems strange some other researcher had not embarked upon them long before. He tells you, too, that with the increasing acceptance of plasma, which need not be typed before transfusion, the usefulness of his findings will rapidly diminish. And as you listen with respectful interest, you fully appreciate the conscientiousness of these assertions. But—you do not accept them.

You do not accept them when you ponder the extent of serological and other scientific progress traceable either directly or indirectly to his ground-breaking work.

You do not accept them when you remember the 1500 transfusions administered in London during that sinister, bomb-bedeviled September, 1940.

Nor do you accept them when you contemplate the nearly one and a quarter million units of dried blood with which our own Army and Navy Medical Staffs hope to save innumerable lives in the yet-to-be-fought battles of the present conflict.

No, in spite of Karl Landsteiner's claim that the importance of his discoveries is already waning, you soon realize with increasing clarity that, as a result of his work, America is daily growing more transfusion-con-

scious, and is turning out in ever larger numbers to do its part toward alleviating the ravages of the dictators on this poor, war-scourged planet.

• • •

BLEEDERS

New Hope for Those Who Bleed Excessively

NEW protection for hemophiliacs against danger of excessive bleeding, and effective help for physicians, surgeons, and dentists in staunching the flow of blood from small wounds is provided by a new, powerful agent for clotting blood recently announced by Lederle Laboratories, Inc.

The new material, called clotting globulin, is the natural clotting constituent of blood separated in highly concentrated form from clear blood plasma (blood from which the corpuscles have previously been removed).

Many persons bleed excessively from minor wounds because their blood contains too little of the clotting principle (prothrombin). This condition may be inherited and permanent (hemophilia), or it may be temporary, the result of the ravages of disease or other causes. When it exists, even slight wounds may become serious through excessive loss of blood. No satisfactory method has been known before to control bleeding in persons thus afflicted and even pulling their teeth has involved serious hazard to their lives. Previous treatments employed have included transfusions of normal blood, applications of snake venom (fer de lance), and the use of various substances having hemostatic action.

The new clotting globulin supplies the constituent in which the blood of "bleeders" is deficient and places in the hands of the medical and dental professions an effective means for stopping the flow of blood from minor wounds in a few seconds. The procedure is simple. A few drops of a solution of clotting globulin are applied to the surface of the wound either by spraying or on sterile absorbent cotton or gauze, followed by gentle pressure. By making up the deficiency of the patient's blood, this treatment causes it to clot in the capillary blood vessels within a few seconds.

The method is not effective against bleeding from veins or arteries—this requires surgical treatment—but it has been shown by clinical tests at Boston City Hospital and elsewhere to stop bleeding from minor wounds quickly. Excessive bleeding following the extraction of teeth and the oozing of blood from surgical incisions are stopped within a few seconds by the proper application of clotting globulin.

Clotting globulin possesses true thrombic activity in coagulating the fibrinogen of the blood. It acts by supplementing the prothrombin naturally present. Clotting globulin can be used only locally and under the supervision of a doctor or dentist. Its effect is solely to coagulate the blood at the point of application, and it does not remove danger of excessive bleeding from other wounds.

• • •

ANISEIKONIA—A special study of 400 aviation cadets showed that two out of every 25 men had aniseikonia—a condition which produces unequal images in the two eyes—to the extent of 0.5 percent, or more, according to the Better Vision Institute. Differences in visual images, however, in no case were more than 1 percent.

• • •

TIRED FEET

The Home-Made Foot Pad May Help Rest Them

STANDING at work is the most important single factor in the production of industrial fatigue. Human feet are much better designed for walking than for standing; in standing on a plane

Foot rester

surface, the body weight is constantly borne by the same groups of foot muscles and ligaments. These groups gradually become fatigued and begin to protest.

In an effort to prevent this torment, Dr. Robert Sacks, New York osteopath, has used weight-shifting footpads made by cementing various rubber objects to sponge rubber (dimestore) kneeling pads. "In standing on these I frequently change the position of my feet," says Dr. Sacks. "With each shift of position the feet find a differently tilted plane. In this way the weight is constantly shifted from one group of muscles and ligaments to another; and so no group is subjected to undue strain. This simulates the positions of the feet in walking over turf."

BEAT THE HEAT

Vitamin C Staves Off Heat Prostration

TWO tablets a day are keeping heat-prostration away for many war production workers this summer. The "beat-the-heat" pills contain Vitamin C, which physicians of the Du Pont Company's Medical Division have found effective in protecting the human system against heat cramps and prostration, even in places where the temperature rises above 100 degrees and the humidity is oppressively high.

Dr. John H. Foulger, director of Du Pont's Haskell Laboratory of Industrial Toxicology, at Wilmington, Delaware, believes the preventive might well be employed in many other plants, including steel mills, foundries and shipyards, where high temperatures are encountered. It should also prove useful in the engine rooms of naval and transport ships and among troops in the tropics.

The procedure is to give twice each day a tablet consisting of 50 milligrams of Vitamin C and 250 international units of B-1, plus other B vitamins. B-1 is also believed to play a part in protecting against heat attacks but its action, in this particular situation, is not yet so well understood as is that of Vitamin C.

This measure is directed chiefly against the heat cramps and heat exhaustion, or heat prostration, and not against sunstroke or thermic fever, in which there is no sweating and the individual's temperature rises. The two former conditions are by far the more prevalent in industry, however, and prevention of them would save many hours and days of lost time in the production race against the nation's enemies.

An important part of the picture is that Vitamin C is drained from the body in perspiration, just as salt is. Salt pill dispensers have in recent years been installed alongside nearly every factory drinking fountain, so that workers may replace the salt they have sweated out. This has helped ward off heat cramps and heat exhaustion, but many cases have still occurred. Therefore Vitamin C, which prevents other aspects of the condition, should also be given. In other words, salt alone does not appear to be nearly as effective in preventing heat attacks as does a proper combination of vitamins and salt.

Little Pictures—Big Savings

Microfilm Has Joined the War Effort, Lending its Advantages to Civilian and Military Uses Alike

LUCILE N. McMAHON

MICROFILM joined the war effort well qualified for a vital task. Its unique services in peacetime to librarians and businessmen are proving of great value to the war industries. Among the more important and timely benefits are: Release and saving of valuable and much-needed space; protection of irreplaceable records against loss from sabotage, bombing, fire or theft; increased availability of all records. Microfilming can serve the interests of every company concerned about any or all of these problems.

This phase of photography is not new; in fact, the process of making tiny reproductions of drawings and documents on film originated during another war. In 1870, Paris was beseiged by the Prussians and cut off from communication with the outside world except by balloons carrying outgoing messages and carrier pigeons for the return mail. These slim threads of contact were the only hope of organizing resistance in the French provinces and of possibly securing aid from other countries. Balloon flights were infrequent, and the weight of mail, particularly incoming, was very small.

Then an idea came to Dagron, a photographer who had been making his living selling opera glasses having a miniature photograph of a Parisian scene on the lens. He printed the messages for the pigeon post on large sheets and photographically reduced them in size until film representing 3500 folio sheets could be carried on the leg of one bird. A strip of his original film is now in the Library of Congress. That was the first recorded use of microfilm for documentary reproduction.

Today, the same principle is used to lighten the load of mail shipments overseas, is being used for soldiers' letters to the folks back home, and our Army and Navy have other uses for microfilm that come within the category of military secrets. But what is microfilm's part in civilian life during war?

Suppose a bomb or a saboteur's torch destroyed the central office of the telephone company—or the light, gas, or water company—and its records, maps, and charts were lost. Civilian life and industrial production alike would be at a standstill until these vital services could be restored; and that would require a long time if there were no engineering drawings from which to work.

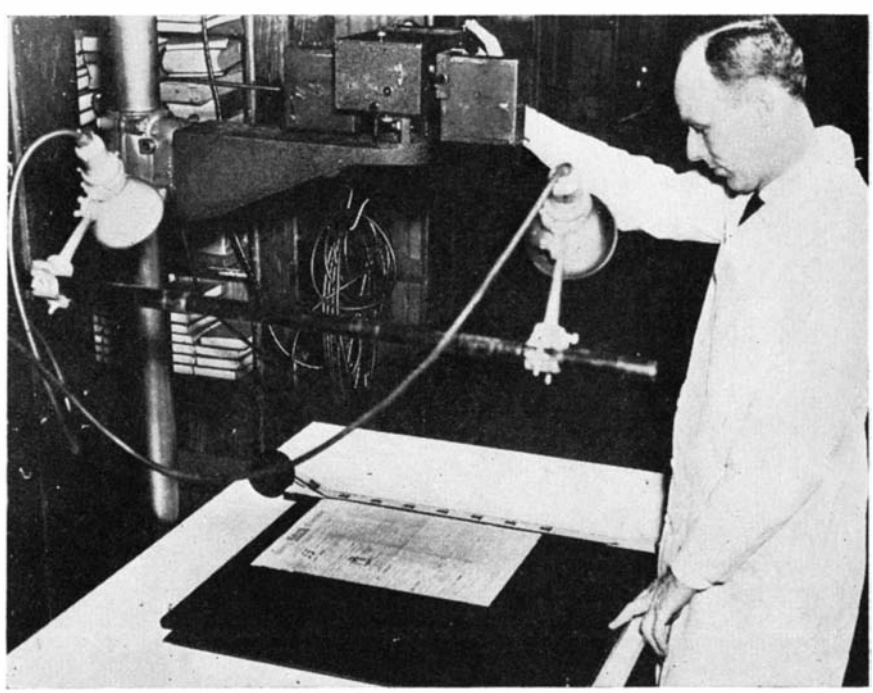
A logical precaution is to make duplicate copies of the irreplaceable cable records, maps, charts, and blueprints, and to keep them in bombproof shelters or at inland points where the risk is less. But facsimiles of all such documents would represent a large bulk, and would involve heavy expenses for transportation and safe storage. Even then they would not be readily accessible.

Microfilm best meets the situation. Condensed into roughly 3 percent of the original space, microfilm prints can be sent by air mail to several places for additional safety, if desired. Because facilities for microphotography are readily available and inexpensive, the records can be refilmed periodically and thus kept up to date. Some New England utility companies are now doing this every six months.

The service which microfilm renders to the utilities also meets the needs of concerns turning out war materials. The air-raid menace has caused some talk of moving industrial plants in coastal regions further inland, but that can be done only to a limited degree. For the most part we shall have to depend on anti-aircraft defenses, camouflage, and strict precautions against sabotage to protect our all-essential production. Yet, the most vulnerable spot of all—the drafting room, where design drawings are made, kept, and used—can be further safeguarded.

If fire or bomb should destroy a plant now producing, say, airplane detectors, weeks of valuable time could be saved in reconstructing it if duplicates of the engineering designs were available—details of each complicated and specialized piece of machinery. Drawings in work covering new plant construction, enlargement, and conversion are too valuable at this stage of the race for production to risk their loss by fire, theft, sabotage, or accident.

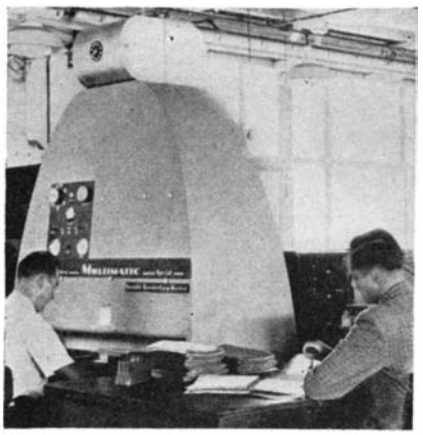
PUTTING the drawings on microfilm makes it possible to guard them like crown jewels. The Du Pont Company is among those which have taken this precaution. Another firm producing machine tools had some 400,000 charts, occupying 1500 square feet of space, with the number mounting daily. Reduced to microfilm the whole lot could be put into two drawers of a regular letter file, leaving 97 percent of storage space free for drafting-room ex-



Many public libraries are resorting to microfilming of newspaper files in order to conserve storage space and overcome problems of paper deterioration

pansion. About 9000 drawings, six by eight inches, were duplicated on a reel of film the manager could slip into his pocket or, more desirably, into a small safe-deposit box.

Apart from safety, economy of space itself is a contribution to the war effort, at a time when materials and labor are at a premium. Office space in



Camera that can reproduce on microfilm drawings 20 feet or more long

Washington is so scarce that many employees work in hallways or converted bathrooms. It is estimated that 25 percent of the total space in the Federal buildings is used for storing files. If records in inactive files were microfilmed, with a saving of 95 to 98 percent of this space, not so much new building construction would be necessary. To this end, a recently-passed law permits permanent public documents to be thrown away if microfilm copies are available.

The importance of microphotography is recognized by the draft-deferred status granted to employees in this field, which was one of the first explored by members of the National Defense Research Committee. Cameras, readers, and film were already on the market. Librarians may take much of the credit for that. About ten years ago, they had found that microfilm was the solution to the vexing problem of what to do with those dusty, crumbling, unwieldy files of old newspapers. As historical records they were too valuable to be thrown away, so their vast bulk was reduced to compact little reels of film that could be kept in drawers instead of storage rooms—that could be consulted and projected to legible size instantly when needed.

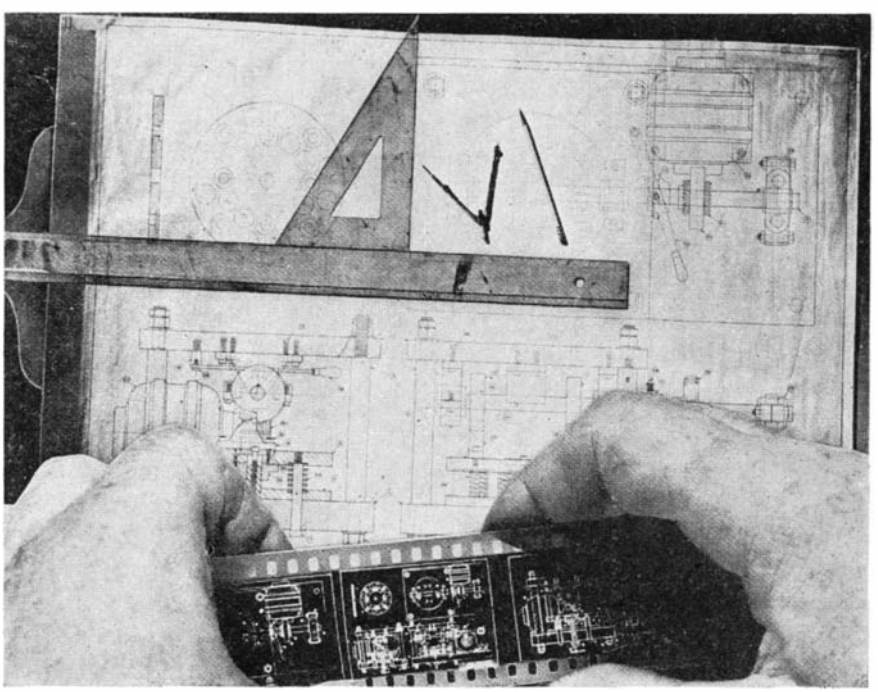
Then the practice extended to rare books and manuscripts, in order to make their contents available to readers without wear and tear on the original. Today, the Library of Congress can furnish a microfilm copy, or a positive enlargement, of any part of its nearly ten million volumes. Newspapers from 37 different lands, war or no war, are available through Harvard's microfilm subscription service for other libraries. Brown University has undertaken to film the ancient archives in Latin America. All English books in the British Museum, written before 1500, have been put on microfilm by a project sponsored by American universities. Microphotography has reached the stage where it now has its own magazine, *The Journal of Documentary Reproduction*. More and more libraries have secured equipment, and the development of both apparatus and film has been rapid.

Microfilms, in protecting cans, are stored in a safe-deposit box

CULMINATING years of research on photographic emulsions, Du Pont chemists have perfected a new type of microfilm which is being introduced to photographers as Du Pont Safety Microcopy. It is described as "an ultra-fine grain, panchromatic, negative film with a high inherent contrast and outstanding resolving power." In case you're not a camera fan, the resolving power refers to its ability to register fine detail. Safety Microcopy permits documents to be reduced to one nine-hundredth the original area and later reproduced to full size without significant loss of legibility. High contrast is particularly important in photographing line drawings and printed matter. By varying the type of developer used, the contrast of the film can be reduced as may be necessary to reproduce screen halftone prints, paintings, and X-ray radiographs. A special treatment of the film emulsion produces a tough surface that minimizes scratches and abrasions, and greatly prolongs the life of films subjected to constant use.

You could even put Du Pont Microcopy in your candid camera and microfilm a few of those old love letters in your attic. But if the microfilming job is a big one, you had better employ a company that specializes in such service. For a moderate fee it will not only guarantee the technical part of filming and processing but will also collate and check the material and recheck the film after completion to make sure that it exactly reproduces all of the original material.

The president of one such firm, in discussing microphotography, has this to say: "The hundreds of industrial and business firms which are turning to microfilm for their valuable records now have safety uppermost in their thoughts. But they almost always find



One tiny frame of microfilm—the space between the fingers above—accurately reproduces a complete engineering drawing, such as the one shown in the background

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!"

• • •

What does the lady in *your* life think of *your* success? Get more of the Alexander Hamilton Institute's story in the famous little book, "Forging Ahead in Business." Tells how the Institute's timely training is helping thousands of men to do a better business job in these wartime days. Just clip and mail the coupon—today!

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other important advantages which are impossible to get with any other form of duplication. I mean economy of space, availability, convenience, permanence, and, when any considerable number of pages is involved, actual cost economy. Banks and insurance companies have already made wide use of microfilm to protect their customers' interests. Department stores are finding that microfilming all invoices is a safeguard which more than pays for itself. Inactive but valuable files of all sorts are being consigned to microfilm. Business and industry were discovering these advantages without the added urge to safety which war has brought. War conditions, by causing microfilm to be tried by more people, have only hastened its widespread adoption."

Industry, business, and government are not the only prospective users of microfilm. For instance, hospitals are required by law to keep records covering each patient admitted—ordinarily fifteen to twenty pages each. A large institution like Cook County Hospital, in Chicago, averages 50,000 admissions a year. Many a superintendent wonders how soon the records will crowd out the patients! Microfilm reproduction is the answer for X-rays, charts, laboratory tests, and all the rest. Not only does it save space, but often serves medical research as well. For one medical center may have few or no case records of a rare disease for study, but if the records of several hospitals are assembled on microfilm, the combined information may have more than statistical significance.

Music students at the New England Conservatory now study microfilmed scores of symphonies and operas. The Frick Museum in New York has put on microfilm its leading paintings for the benefit of art schools throughout the country. These are but arrows pointing to the vast possibilities of microfilm in education, apart from scholarship.

Some day the curator of the Hall of Fame may ask Mr. Gutenberg, inventor of the printing-press, to move over and make room for a French photographer named Dagron!

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GLASS STOVES

Loom as Possibilities as Result of Research

KITCHEN stoves made of glass have now moved within the realm of post-war practical possibilities as the result of intensified research into applications of new types of flat glass to release critical materials for the war program.

A thought-provoking step was taken when the idea of a glass observation port in a kitchen range door, introduced prior to the war as an innovation to reduce temperature loss and jars resulting from repeated openings of the door to check baking progress, was extended to include an all-glass door.

Intended to increase such vision efficiency, and temperature control, the

You can watch the food cook

all-glass door suddenly blossomed as an important idea in metal conservation.

War-stimulated design then expanded the idea to make a vision-top, utilizing the same heat-strengthened Tuf-flex plate glass as was used in the door to make vision possible from above.

A further metal-conservation move came with the idea of using a colored opaque structural flat glass—the very same glass that has become popular as a facing for storefronts, corridors, kitchen and bathroom walls, and other applications—to line the inner walls of the oven, to save more metal. It was then discovered that such a glass-lined oven actually retained heat better and utilized it more efficiently and evenly than metal-lined ovens.

Happy about the whole thing, the glass technicians still weren't satisfied. They used still another type of glass, a heat-strengthened plate glass in translucent color, for the inside back wall of the oven, with lighting back of it, thereby achieving shadowless illumination.

Finally, in their hope to conserve still more metal for the battle fronts, they designed an instrument panel of the translucent, heat strengthened glass (the glass men call it "vitrolux") and thus was born still another use for glass in and on a kitchen range.

Can they go further? The glass boys just grin at that query. Will they go further? Well, not right now. The glass technicians point out that their glass stove design at this time is a sort of after-hours form of relaxation when they are not ears-deep in designs for the job in their and everybody's lap—the job of winning the war.

Still, what they have accomplished, even if it is an after-hour form of relaxation, makes for some fascinating visions of what can be expected in the post-war era — not only the possibility of glass stoves, but glass most-anythings.

TRACTOR LUGS

Made of Wood to Conserve Rubber

A PARTIAL solution to the tire problem has been worked out for Kansas wheat farmers in the rationing office of the OPA. When wheat was ripe for the harvest many of the farmers found they could not get tires for tractors and combines, so the OPA office in Wichita had a trial set of wooden lugs built of 3 by 5 inch white oak and attached to the rims of tractor wheels with 3/8 to 5/8 inch iron rods held in place by turnbuckles. The lugs are applied at an angle of 35 to 40 degrees across the rim, approximately 15 to each wheel and are 18 to 24 inches in length, depending on the width of the tractor rim.

These substitutes for rubber tires gave the required traction. Cost of the make-shift equipment runs from $35 to $50 a pair. While it was only anticipated that the wooden lugs would insure the use of tractors through the present wheat harvest, if the wood is creosoted or dipped in oil they will, in many instances, serve the farmers next year.

RAYON IN TIRES

For Military Use, Conserves Rubber

AMERICA'S army is rolling to war on rubber—and rayon. Rubber has commanded the public's attention, because of the acute nation-wide shortage. But a special type of rayon, an all-American development using only American raw materials, has been conserving important tonnages of rubber.

Tough sinews of this high-tenacity rayon lie beneath the precious rubber skin of military tires—for bombers, combat cars, or transport trucks. Possessing greater strength than any other tire fabric beyond experimental stages, and retaining its great strength under the high heat of heavy-duty driving, this rayon permits tires to have thinner but stronger walls and adds thousands of miles to their life.

The high-strength yarn, developed by Du Pont chemists and marketed

under the trade-mark "Cordura," must take an almost unbelievable amount of punishment. The huge tires of the heavy bomber are required to stand up under the jolt of tons of metal landing at high speed, without a blowout. The combat car is driven over the roughest terrain, a severe test in itself, but the Army demands as well that the combat car tire have sufficient structural strength so that, if punctured, it can run flat for many miles so the car can complete its mission or reach a place of safety.

Invention of high-tenacity rayon was the culmination of ten years of research effort to improve the strength of viscose process rayon. It was a high spot, too, in the history of viscose rayon itself, which is observing its fiftieth anniversary this year.

Ordinary rayon is usually made from the cellulose of purified wood pulp. "Cordura" high-tenacity rayon is made from the cellulose of cotton linters, the short fibers remaining on the cotton seed after the longer, spinnable fibers have been removed in the ginning. The difference in the raw material is not so important, however, as are certain steps in the process, particularly the stretching of the filament immediately after it is formed.

As in the case of the so-called cold-drawing of steel or nylon, this stretching causes the molecules of the material to line up parallel to one another so that powerful intermolecular forces come into play, which lead to greater strength by preventing the molecules from slipping apart under tension. The final product of careful chemical and physical control, and of stretching, is a filament having a tensile strength of 70,000 pounds per square inch. In fact, the rayon cord tire has a skeleton as strong, for its size, as the skeleton of a skyscraper.

In building a tire, several dozen cords are unwound simultaneously from a rack of spools (known as a creel) and brought out to lie parallel with one another in a broad ribbon. There are no cross-threads in most modern tire fabrics. They are not woven materials, although the cords of successive plies run in different directions, to give strength. The ribbon of cords passes through a dip of liquid latex, formaldehyde, and resorcinol, which insures a firm union of the cords and the rubber. A layer of semi-soft plasticized rubber is then applied to each side of the ribbon of cords, and is pressed firmly into the spaces between the individual cords. Other plies are similarly built up and assembled, covered with the tread, and the whole vulcanized in the tire mold.

Chief advantage of "Cordura" high-tenacity rayon is that heat does not sap its strength as it does the strength of cotton cords. Consequently it can be used more sparingly in building a tire. Also, the tires are more resistant to blowouts when hot. The walls are very strong but thin. Thin walls dissipate heat and keep the tire cooler. Rayon cord tires average to run 15 percent cooler than other tires. Because the rayon cord tire carcass lasts longer, it can economically take a thicker tread and can also be re-treaded more times.

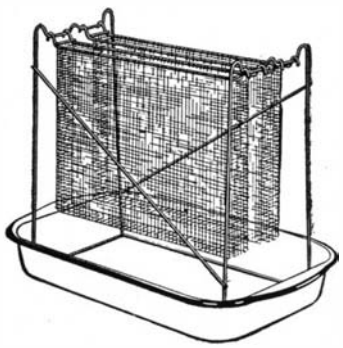
The lighter-weight tire made possible by rayon cords is of particular importance in aviation, where the tire is needed only for taking off and landing and is simply extra weight during the flight. Obviously the saving of tire weight, to give more maneuverability and sky mileage or to make room for more guns and bombs, is of tremendous importance in military planes.

EXCESS MOISTURE

Absorbed from Air in Damp Rooms

BASEMENT workshops, photo darkrooms, closets, vaults, laundry rooms, can be kept free of damp and musty air with Dri-Air powder, a chemical

which is exposed to the air at all angles so as to do a maximum air-drying job. After the powder has absorbed all excess moisture in air it remains ready to remove dampness as fast as it forms. The chemical is placed in a special container made up of a one-piece, triple "V" shaped basket, that holds ten pounds of powder. As



It makes the air drier

moisture is drawn from air, the drippings are deposited in a metal pan below the basket.

One container is recommended for each 800 to 1000 cubic feet of space. Even the chemical drippings are valuable and should be saved for melting ice on slippery sidewalks and in eaves and waterpipes; it is also useful for settling dust in gravel driveways and for killing weeds.

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SHIP POWER—Over 400,000 Diesel horsepower, including propulsion and auxiliary engines, were installed in 391 vessels added to the United States Merchant Marine in one 12-month period.

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ELECTRONIC SEPARATOR

Points Toward Use of Low-Grade Ores

ELECTRONICS research engineers recently demonstrated an "electrical spray" that "washes" war-needed metals from low-grade ores, and which may prove to be a valuable aid in easing America's tin shortage. In laboratory experiments the device, a new electrical ore separator, has successfully refined ores of such metals as tin, iron, and gold, most promising results having been attained with low-grade ore samples from a recently developed tin deposit in a southern state. By spraying electrical charges on this ore, which contained only 1.5 percent tin, the new Westinghouse device separated the metal from rock and sand, concentrating it into an ore containing approximately 70 percent tin—suitable for smelting.

As the foot-wide metal drum of the laboratory model of the separator turned with a surface speed of 12 miles an hour, in the demonstration, it sorted in one minute the 10,000,000 particles making up ten pounds of ore. The particles were deposited in two neat piles. One of these piles contained rock and sand and a small percentage of tin; the other, nearly all the tin, mixed with a small amount of rock and sand.

The ore had been ground to the fineness of sand, dried, and then poured into a trough at the top of the two-foot-tall experimental separator. As the particles of sand, rock, and tin trickled through the bottom of the trough, they fell onto the rotating metal drum, where they received high voltage electrical charges from a series of fine wires a short distance from the drum's surface. Since the tin particles are good conductors of electricity, the electrical charges seep through them and into the metal drum. The tin particles thus lose their charges before the drum has made more than one half turn, and fall off the drum. But the poorer conducting sand and rock particles retain their charges and cling to the drum until pulled off—during the second half revolution—be a series of oppositely charged wires.

Though it is necessary to dry the ore before it can be separated by an electrical spray, the new device may prove to be more efficient than present ore concentrating methods which do not require drying.

Other possibilities for the electrostatic separator arise, since it can sort mixtures of any two materials provided one component is a conductor of electricity and the other such a poor conductor that it is in effect an insulator. In addition to experiments with low-grade tin and other strategic ores, the machine may be used to purify foods.

In foods, the good conductors are usually the ones which contain the most water, and the poor conductors those which contain oils and little water. In trying to separate shells from the meats of nuts, for example, it was thought at first that the dry shells would be poorer conductors than the moist meats. It was soon discovered, however, that because the meats got their moistness from oils, they were little better as conductors than the shells.

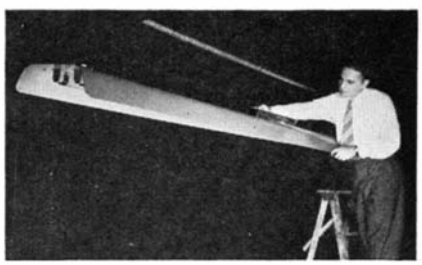
Sorts, separates, saves

The Westinghouse research men are now planning tests to separate foreign materials from grains and stems from raisins with the electronic unit.

FLUORESCENT FIXTURE

Steps Up Lighting Efficiency

DEVELOPMENT of a new circuit for fluorescent lighting fixtures and a specially designed ballast control unit—a system which makes possible a saving of millions of pounds of critical metals and also improves lighting efficiency—was announced recently by the



Conserves metals, improves lighting

General Electric lamp department at Nela Park.

The new fluorescent circuit permits the use of only one ballast—or control unit—with four 100-watt Mazda fluorescent lamps in place of the present 100-watt fluorescent fixtures which require two ballasts for four lamps. The two lamps on each phase of the new circuit start in sequence and operate in series. Thus, one ballast does the work of two, effecting important economies in any fluorescent installation where the new circuit can be used. Although it is designed for use only with 100-watt fluorescent lamps and on 254, 265, and 277 volt circuits, many of the new war industry plants have these voltages available and other plants now being converted to war work can be changed over to take advantage of this circuit.

While the increase in efficiency in producing fluorescent lighting to speed wartime production cannot be overlooked, the saving of critical materials by this new cicuit is of major interest at present. For instance, in one large airplane plant where fixtures using the new hook-up are under consideration and in which more than 35,000 100-watt fluorescent lamps will be installed, engineers estimate that 23,275 pounds of copper, 80,960 pounds of iron and steel,

and 3250 pounds of aluminum will be saved. The overall saving in the weight of the ballast equipment would total about 132,000 pounds and a total of 303 kilowatts of current would be released for other war uses.

ERROR-PROOF

Radio-Telegraph Printer Put Into Service

ALL possibility of error from defective signals in radio-telegraph transmission is eliminated by a new error-proof radio printer put into operation in the international communications field recently on the direct radio circuit of R.C.A. Communications, Inc., between New York and Buenos Aires. Product of RCA Laboratories, the new printer works with brain-like facility. It automatically rejects false signals and prints an asterisk in place of an incorrect letter.

Present secrecy restrictions necessitated by the war prevent a full description of the printer. RCA Communications officials say that it could be revealed, however, that the device operates with a special code so constructed that a defective character is immediately recognized as such by the printer.

With ordinary telegraph printers as used on the radio, errors may be caused by spurious signals, RCA engineers explain, and this was one of the primary motives that led them to develop the new machine. The appearance of an extraneous signal, or the absence of part of the correct one, will cause printing of an incorrect letter on the ordinary instrument. Unless the error is obvious, it may go undetected.

CAMOUFLAGE

Art Competes With Photography's Revealing Eye

CAMOUFLAGE of military and industrial installations, which has flourished since Shakespeare's Birnam Wood moved on Dunsinane in the famous sneak-punch attack on Macbeth, has assumed a new and widespread importance as World War II progresses.

Currently referred to as "protective concealment," the art has developed into a contest of wits between the camouflage experts and a new type of military technician known as a photo-interpreter whose duty it is to view aerial photographs of suspected camouflage and endeavor to pick it to bits, a study by the Aeronautical Chamber of Commerce of America reveals.

The essential objective of camouflage is, of course, to puzzle the bombardier, delaying his recognition of his target for the split second that may determine the success or failure of his mission.

Thousands of dollars are daily being spent as America seeks to confuse potential enemy sky bombers and protect industrial plants, factory buildings, railroad yards, airfields, communication routes, conspicuous landmarks, and transportation systems. It is the aerial camera, such as those developed by the Fairchild Aviation Corporation, which has put the old types of camouflage on the spot and rendered the task considerably more complicated—and costly—than was the case during World War I.

While the camouflage technicians aren't revealing many details about newly-devised concealment measures, they will nevertheless talk about some of the tricks of their trade. They are using dummy or decoy installations, false highways, considerable smoke or fog-generating equipment, "disruptive painting," and structures built of salvaged lumber, chicken wire, and cheap textiles, artificial tree planting and foliage hung from nets or wire guys. Flood lighting often helps eliminate artificial shadows which do not keep step with the sun's progress. A fixed shadow is a dead give-away to the photo-interpreter who may be studying an aerial photograph of the decoy installations.

Airport installations are often toned down by darkening roofs, runways and taxiways with paint, cinders, or some other medium which will make them photograph the same tone as the surrounding area. Many airport facilities have now been placed under ground and there are numerous tricks for concealing grounded planes. The pilot

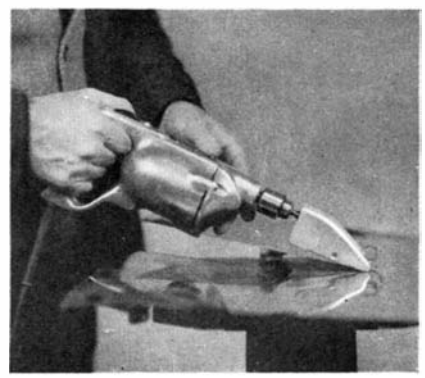
may park his ship under trees out of sight, in foliage-covered tents, or under elaborate netting structures. Aircraft may be parked in gaps cut in hedges so that their wings will carry on the line of the hedge.

METAL CUTTER

Operates From Electric

Or Pneumatic Drill

ROTARY motion is converted to reciprocating motion in a metal cutting attachment recently developed for use with any ¼-inch pneumatic or electric



Makes clean, fast cuts

drill. Shown in use in one of our illustrations, this Royal Clipper metal cutter, manufactured by E. W. Timper & Associates, will cleanly cut sheet metals up to .040 of an inch in thickness and will cut not only straight edges but will also follow patterns and curves. For cutting out sections of panels, the cutter can be started from a ¼-inch hole. The blade removes a strip less than ⅛ of an inch in width.

AIR SCHOOL

Trains Men to Keep

Bombers Flying

A "COLLEGE OF AIRPLANE KNOWLEDGE" has been set up at the Glenn L. Martin Company plants at Baltimore —a college where soldiers study the best methods of "keeping 'em flying." The teaching staff is made up of Martin company men and includes experts

They study its insides

in hydraulic, electrical, and power installations. Every 12 days 175 graduates of the Army Air Forces Technical Training School are enrolled at the school. These men take a 34-day course designed to teach them to apply in practice to Martin B-26's what they have learned in theory during their earlier training. When they are graduated they know all there is to know about the maintenance of the Martin bomber.

Once they become thoroughly acquainted with the inner workings of the B-26, graduates of the school are assigned to bomber squadrons equipped with this particular type of plane. Wherever the squadrons go, these men who have learned the secrets of maintenance will go also. When the B-26's come home from battle, these mechanical doctors will bandage the wounds and get them back into fighting condition once again. It is one of the vital phases of aircraft warfare.

In the past, one of the most serious problems confronting the Air Forces was based on the lack of trained personnel for maintenance. As production increased, the problem became even more critical. Thousands of planes, ready to fight, are of little value unless there is available an adequate supply of maintenance men thoroughly trained in the art of "keeping 'em flying." There must be several ground crew men to each flight crew member.

In adopting this program, the Army Air Forces have moved swiftly. Where could they find better teachers than at the plant where the ships are made? The men who "get 'em flying" also know best how to "keep 'em flying."

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CROSSING DEATHS—Fatalities resulting from highway-railroad grade crossing accidents in the first four months of 1942 totaled 708, an increase of 78 fatalities compared with the corresponding period of 1941, the Bureau of Statistics of the Interstate Commerce Commission points out.

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SEA 'PHONE

By Underwater Cable, Seen As Possible

A TRANSOCEANIC telephone cable, carrying 12 conversations at once and utilizing delicate vacuum-tube amplifying apparatus that would function on the ocean bottom, is described as feasible by Dr. Oliver E. Buckley, president of Bell Telephone Laboratories.

Such a cable, employing the "carrier" principle, would be much like the coaxial cables now in use between New York and Philadelphia and elsewhere in this country. Vacuum-tube repeaters would be an integral part of the underwater cable. They would be placed at 40-mile intervals, supplied with current by lines within the cable, and would be expected to function for as long as 20 years without attention.

Actual construction of such a cable, Dr. Buckley said, is well in the future because many construction details must be tried out under field operating conditions. He emphasized, however, the need for another type of transoceanic communication system to be used in combination with the radiotelephone channels which are now becoming crowded. It was the strain in the last pre-war years on these radiotelephone facilities that led telephone scientists to resume experiments carried on in the 1920's. A short section of such a cable built and tested during the earlier experiments proved technically satisfactory, but the project was abandoned because of the business depression and advances in shortwave radio.

"From purely physical considerations," Dr. Buckley states, "it now appears feasible to provide all of the facilities for telephone connection between all points on the earth that its inhabitants are likely soon to require."

CURRENT BULLETIN BRIEFS

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

WHAT ARE WE FIGHTING FOR? is a booklet reproducing a series of advertisements which—clearly, concisely, and dramatically—emphasize America's part in the present-day scheme of things. *SKF Industries, Inc., Philadelphia, Pennsylvania.—Gratis.*

THE JOB IS BEING DONE is a 32-page report to the nation of present-day operations of the automotive industry. It covers completely the industry's war production progress since Pearl Harbor. Illustrated with a number of outstanding photographs. *Automotive Council for War Production, New Center Building, Detroit, Michigan.—Gratis.*

FLASHES, No. 242, is an eight-page bulletin which illustrates applications in war production of localized lighting fixtures, infra-red drying units, and coolant filters. Request this bulletin on your business letterhead. — *Fostoria Pressed Steel Corporation, 1219 Fisher Road, Fostoria, Ohio.—Gratis.*

THREE NEW ADDITIONS is a four-page leaflet describing new non-magnetic radial and pivot bearings of extreme precision and small size.—*Miniature Precision Bearings, Keene, New Hampshire.—Gratis.*

FUNDAMENTALS OF INDUCTION HEATING is the first of a series of data sheets which will completely cover the subject of the title. Sheet No. 1 presents the elementary theory of this method of heating which is finding more and more applications in various industrial processes. Request, on your business letterhead, that you be placed on the mailing list to receive these sheets as issued.—*Induction Heating Corporation, 389 Lafayette Street, New York, New York.—Gratis.*

IT'S THE LITTLE THINGS THAT COUNT! is a 12-page booklet which points out the present-day importance of conserving even the most minor office supplies, right down the line to pins and clips. It also goes into detail on the best methods for prolonging the life of items commonly used in the office. *Allis-Chalmers Manufacturing Co., Milwaukee, Wisconsin.—Gratis.*

NUTRITIONAL VALUE OF CANNED HAWAIIAN PINEAPPLE JUICE is a four-page folder analyzing the content of this fruit juice. Tabulated are the vitamin and mineral contents. *Hawaiian Pineapple Company, Ltd., 215 Market Street, San Francisco, California.—Gratis.*

SENSITIVE LABORATORY AND PRODUCTION INSTRUMENTS is a four-page folder aimed directly at America's wartime industry. It describes a sensitive electronic limit bridge for precision resistance test-

ing, a highly versatile multitester for production line use, and other industrial equipment of similar nature. *Engineering Department, Radio City Products Co., Inc., 127 West 26th Street, New York, New York.—Gratis.*

"CATERPILLAR" DIESELS GO TO WAR! is an illustrated booklet which describes both combat and non-combat use of these versatile tractors. The booklet gives an excellent picture of the wide range of conditions under which they can perform. Request Form 7610. *Caterpillar Tractor Company, Peoria, Illinois.—Gratis.*

HELPING INDUSTRY HELP AMERICA is an illustrated booklet that presents actual case histories of how engineering service, in applying petroleum products in metal working, general lubrication, textile manufacturing, and other operations is speeding up production. The facts presented should not go unheeded by anyone concerned with industrial production. *Sun Oil Company, 1608 Walnut Street, Philadelphia, Pennsylvania.—Gratis.*

THE CARE AND CLEANING OF HANDS AND ARMS IN THE INDUSTRIAL PLANT is a 24-page booklet which concerns itself with the problems of the title and with protection of workers against industrial dermatoses. One section is devoted to the use of protective creams and another suggests a routine for on-the-job protection. *Magnus Chemical Company, Garwood, New Jersey.—Gratis. Please request this bulletin on your company letterhead.*

BLACKOUT CONTROL FOR MULTIPLE STREET LIGHTING AND HIGHWAY LIGHTING is a series of illustrated articles which gives wiring diagrams for lighting control circuits and presents a description of their application under varying conditions. *Automatic Switch Company, 39 East 11th Street, New York, New York.—Limited free distribution to engineers, contractors, and operators of war bases and large plants.*

UNIVERSAL HORIZONTAL BROACHING MACHINES is a 12-page illustrated folder which describes a complete line of these machines and presents descriptions of typical applications. These machines range in rating from three tons, 36 inch stroke, up to 25 tons, 90 inch stroke. *Colonial Broach Company, Detroit, Michigan.—Gratis.*

ARC WELDING INSPECTION CHART is a wall chart illustrating different types of welds under normal conditions as compared with those obtained when various factors are not normal. Also included is a table giving valuable welding information and other data of interest. *Lincoln Electric Company, Cleveland, Ohio.—Gratis to inspectors of welding and others concerned with welding.*

PROPELLAIR is a 72-page illustrated catalog describing a wide range of fans and fan applications. It contains technical data on ventilation, designed to be of assistance in the satisfactory selection of equipment for any specific purpose. Request Catalog No. 10. *Propellair, Inc., Springfield, Ohio.—Gratis to executives and engineers.*

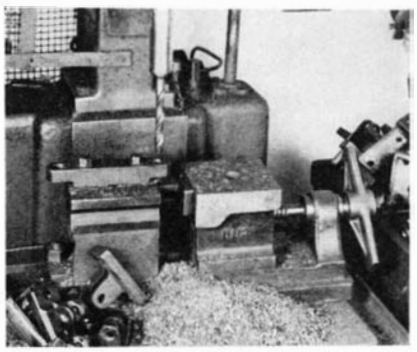
Industrial Growth

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

TIME SAVING

Vise Has Turret Jaws to Hold Many Shapes

TOOL room and other machinists can frequently reduce the amount of time necessary for turning out a special or a routine job by the use of the turret-jaw vise shown in one of our illustrations. The rear jaw of the vise can be



Set-up for duplicate drilling

turned through quarter circles, thus presenting four different faces, each of which has a surface adapted for holding various types of work.

Supplementing these jaws, which are unusually deep, are auxiliary jaws which can be bolted to the tops of the main jaws to hold almost any of the odd shapes constantly encountered in repair and tool work.

With the auxiliary jaws removed, drill or reamer bushings can be attached to the tops of the jaws and, with length stops attached at the sides, duplicate work can be turned out rapidly. The vise, known as the Jackson Time-Saving Vise, is made by the Brown Engineering Company.

PLASTICIZER

For Ethyl Cellulose, Has Excellent Solvent Action

FOR sheeting, molding, and extruding ethyl cellulose, as well as for use in lacquer films, a new plasticizer known as Theop has been developed by the Glyco Products Company.

Theop is a light-colored, synthetic ester which is commercially available. It is non-volatile, non-drying, non-corrosive and is completely compatible with ethyl cellulose. It has excellent solvent action and will dissolve ethyl cellulose in the cold. In ethyl cellulose formulations for molding, 30 percent Theop exhibits no exuding, discoloration, or other deleterious characteristics, either initially or on aging tests.

SOAP

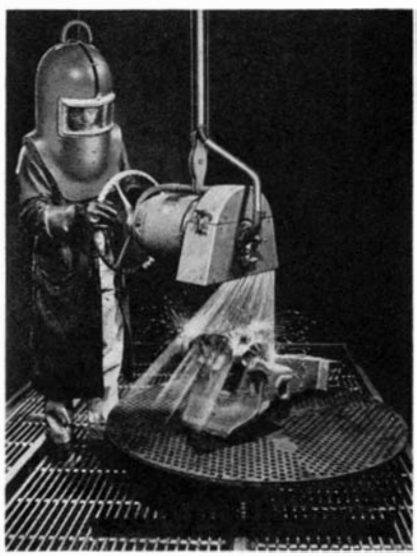
For Commercial Laundries Now in "Complete" Form

MODERN washing technique has resulted in the development of a "complete soap" whose introduction is rapidly supplanting the rule of thumb method of mixing soap and alkali, according to researchers of the National Oil Products Company, who have evolved a compounded mixture of anhydrous soap and a series of especially selected alkalies to which have been added solvents and penetrants. This complete soap was prepared for use by launderers in commercial and institutional work where maximum cleanliness, whiteness, and clean odor are essential. It possesses a uniform balance of alkali and soap plus solvent action and penetration.

BLAST CLEANER

Portable, Uses No Compressed Air

ADAPTABLE to the cleaning of a wide range of large and small, intricate or



Versatile in metal cleaning

irregularly shaped work, a new portable metal cleaning unit has recently been introduced by the American Foundry Equipment Company. This blast cleaner, known as the Portable Wheelabrator, is suspended from the ceiling of a blast cleaning room, while objects such as lathe beds, flywheels, furnace castings, and so on, rest upon a perforated flooring or grill. The operator can quickly and easily direct the blast of abrasive from the nozzle of the unit so as to clean completely and thoroughly all surfaces of the work.

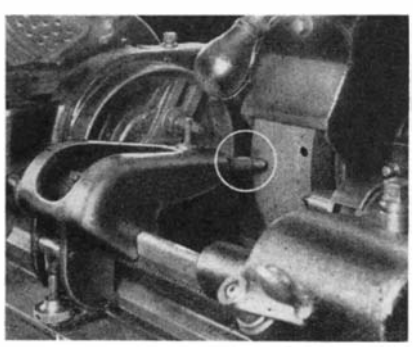
The abrasive—metallic shot or grit—is fed through a pipe from an overhead hopper. This abrasive is picked up by a wheel-like element within the unit, and is thrown by centrifugal force out through the mouth and against the work. Hence no air compressors, pressure tanks, or other equipment typical of air-blast cleaners are necessary.

WHEEL DRESSER

Alloy Matrix Holds

Diamonds for Life

INDUSTRIAL diamonds embedded in a Carboloy matrix are used in the grinding wheel dresser shown in one of our illustrations. Because the Carboloy matrix is virtually impregnated with



Wheel dresser (in circle)

the diamonds, the dresser becomes a permanent fixture giving the greatest possible diamond utilization per carat, with no resetting expense throughout the long and useful life of the dresser.

RESIN INSULATOR

Bakes to Coating Resistant

To Hot Oils, Water, Alcohol

METALS, fabrics, and various compositions may be given an electrical insulating coating with a new synthetic resin material recently announced by David C. Brown Company. This coating, which requires baking after application, withstands hot oils, salt spray, high voltages, and varying temperatures, is known as Resi-Flex. The coating has high dielectric strength and low power factor; one coat over any clean surface will stand up under 500 volts at 25 amperes.

The original liquid is of low viscosity and is furnished in water-clear solution only. Baking time runs from six to 30 minutes at 275 to 350 degrees, Fahrenheit, depending upon size of unit and type of material.

PYROMETER

For Industrial Temperatures,

Is Direct Reading

CALIBRATED directly in degrees of temperature, an entirely new type of optical pyrometer is now available for

Telescope of new pyrometer

measuring temperatures accurately and conveniently.

Optically, this instrument, recently announced by Leeds and Northrup Company, employs the "disappearing-filament" method for precision temperature measurement.

The instrument consists of two parts: the telescope shown in one of our illustrations and its attendant potentiometer which is housed in a strong, light-weight casting equipped with straps to be suspended from the shoulders. On the potentiometer housing are the electrical controls.

To measure temperature of an incandescent object, the operator looks at it through the telescope which contains a glowing filament. He sees the filament either lighter or darker than its background. While he watches, he adjusts filament current, and consequently brightness, by turning a knob until the filament disappears—matches and merges with the object. Thus he adjusts filament brightness to equal that of the object. A slight turn of a second knob balances the potentiometer which is used to measure filament current, and which is calibrated directly in temperature degrees.

For temperatures from 1400 to 2250 Fahrenheit, filament and object are compared directly. For higher temperatures, the operator introduces an absorption screen.

Aircraft Engines Get New Heads

Aluminum Forgings Replace Castings, Speeding Up Production and Releasing Needed Equipment

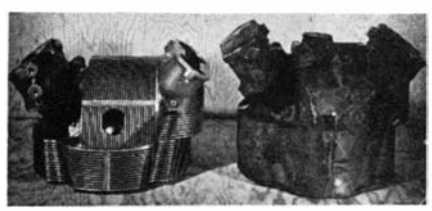
ALEXANDER KLEMIN
**Aviation Editor, Scientific American
Research Professor, Daniel Guggenheim School of Aeronautics, New York University**

AFTER five years of research, the Wright Aeronautical Corporation has developed a revolutionary technique in aircraft engine manufacture, whereby the aluminum heads of the cylinder are forged instead of being cast.

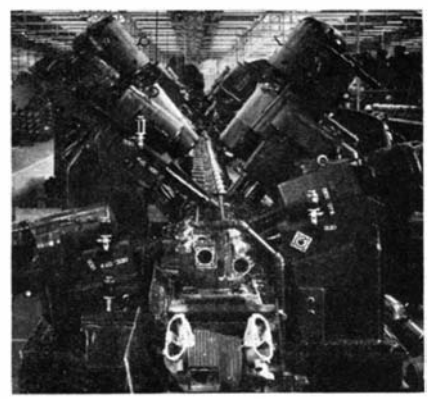
Here are the striking advantages of the new process: Nine separate drop-hammer operations required with the cast head are eliminated, thus leaving the now critically scarce drop hammers free for other uses in our war production program. Fabrication is speeded up, and there is a very large saving in material rejections. The forged head is much stronger, owing to its closer and more uniform grain, so that higher compression ratios and more power per cylinder become possible. In fact, on test the forged heads have withstood hydraulic pressures double those of the cast cylinder heads now in use. Still another advantage lies in the fact that the fins can be milled very closely so that cooling is greatly increased, an important point for the aircraft engine with its high specific output. Altogether, an increase in power of 12 or 15 percent may be expected which may mean definite superiority in a combat airplane.

In the fabrication of the forging, aluminum bar stock is extruded—that is, forced through a die—and emerges roughly in the shape of the desired forging. Then sections of the extruded bar are pressed in a die to final shape. The forged cylinder head and the rough stock from which it is made are shown in one of our illustrations. Hand in hand with the design of the forged head came the development of machine tools which made it possible to turn out these heads much faster and more cheaply than the cast heads. To keep pace with the increased manufacturing speed of the forged head, the Wright Aeronautical Corporation installed many of the huge Greenlee automatic cylinder head transfer machines shown in another photograph. These machines are 154 feet long and combine the operations of 39 older type machines. Originally designed to operate on cast cylinders, the huge transfer unit performs automatic operations on the forged heads without any alteration of the multiple tooling.

There is, besides saving in time, a saving of valuable material, because 95 percent of the forgings will be turned into cylinder heads, while only 80 percent of the castings made the grade.



Forged cylinder head; rough stock



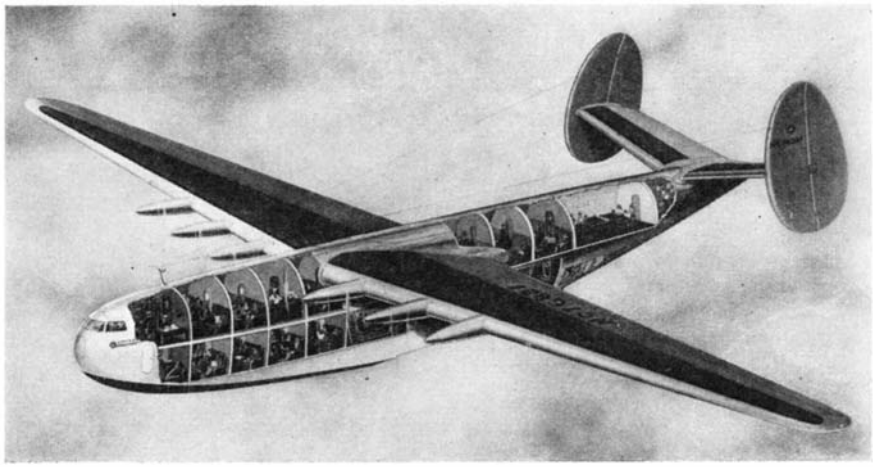
Does work of 39 machines

AIR ADVICE

Needed by the United States Army

SEVERSKY'S book, "Victory Through Air Power," has been reviewed so extensively and so favorably, that we shall not attempt a lengthy notice in these columns. We do feel impelled, however, to add the following remarks to the record:

It is quite possible that Seversky may have a feud with the commanding generals of the Army Air Force, but the younger men in the Air Force—the flying colonels and majors who are actually going to do the work of bombing—have tremendous respect and admiration for Major Seversky. They



For military or commercial transportation of troops or cargo

approve his analysis of the Battle of Britain; they agree with him fully on the superiority of land based aircraft; they are with him completely on the argument that an air offensive is *the* weapon to be used against Germany. They do not advise him to seek a commission in the Air Force, even with the rank of a general officer. At present, so these young and enthusiastic officers say, Major Seversky can say what he pleases and give the nation his immensely valuable views. Once inside the Army, he would be silenced and the United States would lose the benefit of advice from one of the few really noted air strategists of the world.—*A.K.*

AIR TRANSPORT

Can Rival Surface Ships in Yearly Volume

ALMOST every day some item of news confirms the view that air transportation is of vital importance to our war effort, and now, under the War Production Board, a committee has been formed to study the cargo plane in relationship to war transport. Grover Loening and other authorities point out that a large airplane could, because of its far greater speed, deliver more goods in a year than a large but slow freighter. The Army Air Transport Command and the Army Air Ferry Command have been combined into one unit. The subject of the towed glider is very much to the fore, and the German Junkers Ju-52 continues to haul men and materials to Libya, with and without the addition of the aerial trailer. Thus the announcement by Glenn L. Martin of a cargo plane of 250,000 pounds gross weight is quite timely.

One of our illustrations shows an artist's conception of the projected giant. Apparently it will be a land plane with six liquid-cooled engines submerged within the wing. It would be capable of carrying 102 passengers, each with 80 pounds of luggage, plus 25,000 pounds of mail and cargo, to London in 13 hours. As military transports such planes could carry large numbers of troops and heavy supplies. As commercial vessels, they would be able to rival, in a year of operation, the payload carrying capacity of surface vessels.—*A.K.*

THE "LEANS"

Caused by the Human Ear

A CURIOUS sensation sometimes experienced by pilots, and termed the "leans," has recently been described by Harold G. Crowley of the Safety Bureau of the Civil Aeronautics Board. Professional pilots have considerable reticence in discussing this phenomenon; they seem to think that experiencing the so-called "leans" may indicate some physical abnormality. As a matter of fact, there is no such question involved, and the sensation may be experienced by anyone. Here's what leads up to it: During instrument flight, a slow lateral tilting of the aircraft remains unnoticed and uncorrected up to a certain point. When finally the tilting has become pronounced enough for the pilot to be aware of it, he corrects the attitude of the plane in a much shorter period of time than that which was required for the original tipping.

Now the human ear is so constructed that it readily notes rapid acceleration but not slow acceleration. The ear, therefore, does not recognize the slow tilting but does take cognizance of the rapid recovery motion. The result is that, if the gradual tipping was down on the right side, the pilot ends up with the sensation (called the "leans") that the plane is now tipping down on the left side, even though the instruments tell him that the airplane is on even keel.—*A.K.*

CAMERA ANGLES

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

When You Can't Get Close

THE one-lens photographer, which means most of us, has to make that one do for everything, whether close-up or otherwise. What to do at the zoo, for example, when photographers must remain at some distance from the subject, as in the case of the fawn in this picture. You can do

"... to concentrate the eyes"

one of two things: crop the portion you want, which frequently is not feasible because the wanted material occupies but a small portion of the negative area, or keep the subject relatively small and include the surroundings. The latter usually is not feasible either because so many distracting elements appear. Occasionally, however, inclusion of surroundings lends atmosphere, as well as identifying locale, as in the illustration. A couple of ducks in the water were spotted out, as were also some insistent highlights on the rock. Partial burning in of the upper half of the picture as well as the foreground helped to bring down the tones in these areas and to concentrate the eyes on the fawn.

New Exhibit Method

WITH direction by Lieutenant Commander Edward Steichen, U.S.N.R., and descriptive-interpretive captions by Carl Sandburg, an unusual photographic exhibition designed by Herbert Bayer was recently placed on view at The Museum of Modern Art, New York City, under the name, "Road to Victory." The show is not an exhibition in the ordinary sense of the term, which is understood to mean a collection of prints on mounts displayed uniformly on a wall, but something more in the nature of a still travelogue of America's resources and how these are being put to use in the gigantic war effort to back up "the man behind the gun."

The unique feature of the show is the variety of display ideas. The majority of the pictures, all of which were taken from the files of governmental agencies, large news picture agencies, and other sources, are huge enlargements, or murals. The arrangement is given a three-dimensional atmosphere by such devices as suspending prints by wires from the ceiling, by arranging the pictures on the floor suitably tilted for convenient viewing, by ingenious juxtaposing of prints on walls and floor, by a planned viewing sequence routine, by the use of railings to fix the viewing distances, and other means.

A copy of a booklet containing many photographs showing the arrangement of the show as well as the text, can be obtained by writing the museum at 11 West 53rd Street.

Where Have You Filmed?

IF you have ever taken travel movies, still pictures, or transparencies outside the United States, your Government is interested in what you have. Your pictures may be instrumental in helping win the war. Such pictures sometimes prove invaluable in piecing together vital information. Acting on the request of authorities of the United States Government, the Amateur Cinema League, Inc., has assumed the task of soliciting these pictures and to make them available to the Government. "Quality is unimportant; subject matter is paramount," writes Roy W. Winton, managing director of the League. Questionnaire forms may be obtained from photographic dealers or from the League, 420 Lexington Avenue, New York City.

Contreflash

CONTREJOUR, or against-the-light photography, has its counterpart in flash work. One example is illustrated. The flash reflector was used on extension, and the legs of the foreground subject, the "frame," provided the necessary shield. As a result, the photographer and camera were in perfect silhouette, while the photographed subjects received the illumination. This technique lends itself to many variations and has frequently been employed for unusual effects in flash photog-

The frame provides the shield

raphy. As in contrejour work, two important precautions must be watched: make sure the light does not hit the lens; shield the light appropriately so that it does not spill over into the area that is to remain dark.

Hair Aids Composition

IN COMPOSING portraits, the hairdress of the woman subject usually receives little attention aside from the use of a

"Portrait of a Ballerina"

spotlight to give sparkle and body to the hair and to provide separation from the background. Sometimes, however, it is possible, in the case of subjects with long tresses or curls, artificial or otherwise, to make use of hair in arranging the composition a little differently from the ordinary shot. In the present instance—a portrait of the ballerina, Miya Slavenska—the curls resting on the shoulder not only help the arrangement but are almost necessary in view of the pose. The tilt of the head is on the border line between strain and naturalness; the curls seem to relieve strain and help balance the composition at the same time.

Reducing Chemical Fog

IF YOU have been consistently getting aerial or chemical fog in your negatives, the fault may be minimized by adding a little desensitizer to the developing solution. Be sure the desensitizer is the type that may be mixed with developer, such as Pinakryptol Green.

Separation Negatives

SOME beautifully done color prints we saw the other day, at a demonstration of color printing, gave us revived hope in the future of color photography for the general worker. The results left nothing to be desired. As one person remarked, they were "better than paintings." However that may be, satisfaction was universal. Nevertheless, the question was put to the demonstrator: "The separation negatives from which you are working were made in a one-shot color camera, of course?" intimating that separations made from Kodachrome transparencies could not have produced such excellent color values in the print. "Not at all," said the demonstrator. "While it is more convenient to use the one-shot color camera and thus obtain three separations direct and at one time, I personally prefer to make my own separations from Kodachromes because then I can control the exposures for the individual separations, whereas in the one-shot I have to take what I can get, which is frequently a compromise."

ASA Computer

DESIGNED for the Army and Navy photographers for use in any part of the world, any time of the year under all daylight conditions, a Photographic Exposure Computer, produced by the American Standards Association, is now available for civilian use as well. A 24-page booklet with fabricoid cover, the computer has a movable dial calculator which correlates light condition, the scene's reflective powers, and the speed of the film used, offering the photographer a choice of lens stops and shutter speeds for the particular conditions involved. Compiled from observations by the Smithsonian Institute and the United States Weather Bureau over a period of years, the computer includes tables indicating the amount of light available at any point on the earth's surface for a given month and hour, as well as other useful data.

Opposing Diagonals

GROUP pictures, especially when taken semi-candid-wise, as this one was, are not easy to compose. In this flash shot of Bruce Downes, newspaper editor and camera columnist, and his wife, Bruce

"Laughing Diagonals"

sat on the arm of the chair and leaned over at a rather acute angle. When someone cracked a joke, both looked his way, the lady characteristically tilting her head a bit, with the result that the camera caught two sprightly diagonals. Spontaneity of pose and expression plus unusual composition were both well served.

Our Book Corner

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

FUNDAMENTALS OF RADIO

By Jordan, Nelson, Osterbrock, Pumphrey and Smeby. Edited by William L. Everitt

INTELLIGENT organization of the text has been applied in the preparation of this complete book aimed at those who must or who want to know how to maintain and operate all types of radio apparatus. With this one volume alone, men with no previous radio experience or knowledge can, by virtue of some diligence of application, obtain a thorough grounding in radio principles. The first chapter gives a concise, easily followed review of the mathematics necessary for an understanding of the text. Then are treated A.C., D.C., and electronic fundamentals, vacuum tubes and associated instruments, wave propagation, frequency modulation, and all the other phases of the science needed for an understanding of the subject. In thoroughness, this book is outstanding; in the authors' appreciation of the reader's outlook and problems, this reviewer nominates it as the one book unique in the radio field. (400 pages, 6½ by 9¼ inches, over 300 diagrams, flexible binding.) — $5.10 postpaid. — *A.P.P.*

THE PROGRESS OF SCIENCE

REVIEW of sciences, arts, engineering, and industry, for 1941. Combined with it is a series of biographies of men of science and of industry who are at the forefront of present progress. The many subjects are arranged alphabetically, like an encyclopedia; for example: air conditioning, chemistry, highways, engineering, heart, inventions, merchant marine, physics, plastics, psychology, radio, seismology, zoology. (404 pages, 6½ by 9½ inches, illustrated.)—$3.10 postpaid.—*A. G. I.*

INDUSTRIAL CAMOUFLAGE MANUAL

By Konrad F. Wittmann, A.I.A.

NOT a book in the usual sense of the word, but rather a comprehensive, detailed report on this significant war technique, based on experiments and experiences in classrooms and the camouflage laboratory at Pratt Institute, where an Industrial Camouflage Program has been under research for two years. Profuse in photographs, drawings, and diagrams, this practical publication will be a valuable adjunct to efficient application of the art of camouflage to industrial centers and installations that need protective concealment in war time. Problems concerning decentralization, factory sites, roofs, storage tanks, dockage facilities, railroad terminals, and other vital points are posed and solved in photograph and diagram. Through collaboration with the Pratt Institute faculty, the author has obtained both architectural and engineering viewpoints, thereby immeasurably adding to practicality and value of the publication. (128 pages, 8 by 11 inches, thoroughly illustrated.)—$4.10 postpaid. —*A. D. R., IV.*

THE COPYRIGHT LAW

By Herbert A. Howell, Member, New York Bar

AN excellent book, recommended for both the layman and the lawyer. Written in a most understandable manner by an author who for many years has been a member of the Copyright Office in Washington, and who only recently resigned as Assistant Register of Copyrights. Mr. Howell's long experience with copyrights and his ability to present the subject to his readers in a simple and interesting way indicate to this reviewer that his book should receive wide acceptance. It covers registration, notice, protection, infringement, and procedure. Many recently decided important cases are cited and the appendix covers numerous amendments to the Copyright Act and committee reports, together with a table of cases cited, and a topical index.—$5.10 postpaid.—*O. D. M.*

THE CASE OF THE DROWNING DUCK

By Erle Stanley Gardner

MURDER mystery. But why reviewed here? Because plot has scientific angle. Murder mystery fiends assert this author is famous as murder mystery writer. (284 pages, 5 by 7½ inches, unillustrated.)—$2.10 postpaid.—*A. G. I.*

GET TOUGH!

By Captain W. E. Fairbairn

THIS is not for the fastidious, but it is something America can use. Author was with Shanghai Police 30 years; recently was an instructor of British Commandos; is now on loan to American troops. Methods described in this "How-to-win-in-hand-to-hand-fighting" book were worked out by the author, with some credit due Japanese judo (ju-jutso) and Chinese boxing. Contents: Blows; Releases; Holds; Throws; Miscellaneous

(Including Various Attacks); Use of the Knife; The Smatchet; Disarming an Opponent of His Pistol. (120 pages, 5 by 7½ inches, many detailed drawings, paper cover.)—$1.10 postpaid.—*A. D. R., IV.*

AN OIL BURNER HANDBOOK

By L. J. Whelan

Now is the time, before cold weather creeps up and catches you unaware, to find out something about that oil burner in your celler: How it works, what to do about its ills, how to get the greatest efficiency from it, how to conserve fuel. If you get any fuel oil at all this winter, every drop of it is going to be precious. This book tells all, in simple, understandable language, for the home owner or technician. (245 pages, 5½ by 7½ inches, thoroughly illustrated with drawings and photographs.)—$2.50 postpaid.—*A. P. P.*

WHAT THE CITIZEN SHOULD KNOW ABOUT CIVILIAN DEFENSE

By Walter D. Binger and Hilton H. Railey

Opening with a chapter "The Civilian is in the Front Line," the authors discuss all types of bombs and protection against them. They describe British experience from an eyewitness standpoint. There is a chapter on germ warfare, in which they point out it is "the least probable" type of all-out civilian attacks, but they warn that Germany and Japan are "ruled by megalomaniacs." The A. R. P., the effects of bombs on civilians, and a glossary of facts the civilian must know round out this valuable and well-written volume. (183 pages, 5¼ by 8 inches, 19 illustrations.)—$2.60 postpaid.—*A. D. R.*

IT WORKS LIKE THIS

By Captain Burr Leyson

Plain, direct explanations of the automobile engine, airplane, Diesel engine, steam engine, locomotive, turbine, waterwheel, blast furnace, open-hearth steel furnace, electric generator, motor, battery, camera, photography, electric lighting, telephone, telegraph, vacuum tube, radio beams, radio compass, television, refrigeration, air conditioning. Each explanation proceeds in so carefully a worked out manner that anyone should be able to carry away a clear comprehension of it. (224 pages, 5¼ by 8 inches, illustrated.)—$2.60 postpaid.—*A. G. I.*

BYWAYS TO ADVENTURE

By Edwin Way Teale

Nature hobbies—bird watching, meteorology, amateur astronomy, microscopy, shell collecting, herpetology ("snake-ology"), trees, plants, microscopy, geology, mammology, pond life, conservation, nature photography—all are charmingly discussed in separate chapters in this chatty book which is the answer to those who, having little scientific background, seek a scientific hobby. It consists largely of human interest accounts

The Editors Recommend

Best Sellers in Science

JANE'S FIGHTING SHIPS, 1941. This is the latest edition of the world-famed London authority on all world navies. Contains discussions, data, photographs, silhouettes, details of construction. Now, more than ever before, this is a "must" reference for all who have naval interests. **$19.00**

ELEMENTS OF ORDNANCE—A textbook prepared for cadets of the United States Military Academy. Covers manufacture, the chemistry of explosives, types of weapons, mathematics of ballistics, etc. **$6.60**

THE TRISECTION PROBLEM—**By Robert C. Yates.** Embodies mathematician's answer to would-be trisector. Gives chief dependable data on this never-ending dispute. Compact, crisp, concise. **$1.10**

PLASTICS CATALOG 1942—More than a catalog, this book contains a group of informative articles that makes it an invaluable source of information and reference for anyone interested in plastics. **$5.00**

SUPERSONICS—By Prof. R. W. Wood. A great deal of data on science of inaudible sounds, their every aspect, physical and biological, by a noted physicist-inventor. Has bibliography of articles on subject in many journals. **$2.10**

AIRCRAFT INSTRUMENTS—By George Ellis Ervin. All types of instruments for aircraft use described for students, pilots, inspectors. Fundamentals, instructions. **$5.10**

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MACHINERY'S HANDBOOK—Eleventh Edition. "Bible of the mechanical industry," enlarged to 1815 pages of latest standards, data, and information required daily in the shop and drafting room. **$6.10**

FIRE FROM THE AIR—By J. Enrique Zanetti. Pertinent facts regarding incendiary bombs. History, modern types, materials, and the strategy and tactics of their use in modern warfare. **$.60**

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of people who have discovered joy and contentment from the hobbies discussed, with data for doing likewise. It is not a very profound book—aimed more at entertainment. For each hobby there is a special list of the principal books. The chapter on amateur astronomy states that the architect, Russell Porter, was a machinist—an error copied evidently from another book which so stated. (*222* pages, 4½ by 8 inches, 16 illustrations.)—$2.85 postpaid.—*A.G.I.*

HOW TO READ ELECTRICAL BLUEPRINTS

By Gilbert M. Heine and Carl H. Dunlap

A KNOWLEDGE of many types of blueprints is necessary for the electrical worker. Hence the text of this book, after describing briefly how blueprints are made, is presented in nine sections. These are concerned with architectural blueprints, diagrams for bell and signal wiring, administration building blueprints, automobile wiring diagrams, diagrams of generators and motor symbols for control diagrams, motor control diagrams, and power station blueprints. Complete explanations are given of all the various symbols used in these different types of blueprints. In a pocket in the back of the book are nine typical full-sized blueprints. (318 pages, 6 by 8½ inches, a large number of diagrams and photographs pertinent to the text.)—$3.10 postpaid.—*A.P.P.*

THE STORY OF THE AIRSHIP

By Hugh Allen

THE present war has certainly shown that the non-rigid airship has a definite sphere of its own in submarine patrol near our coasts. Mr. Allen's brief historical review is therefore very timely. It is technically correct but also manages to be concise, interesting, and informative. Modern improvements in the airship are well covered. The story of the Goodyear fleet in commercial operation indicates that there are real possibilities for the small, lighter-than-airship in peacetime activities. Finally, Mr. Allen describes fleet operations and also discusses the vulnerability of airships. There is no doubt that utility in submarine patrol is definitely proved by the author and there is even some argument in favor of huge airships to act as a species of aircraft carrier. While Goodyear activities loom a little large, this is still a book of considerable general interest. (74 pages, illustrated.)—$1.10—*A. K.*

ATOMIC THEORY

By Albert Cushing Crehore, Ph.D.

HYPOTHESIS of the stationary atom, offered by a physicist who believes that the electrons in atoms, when the atoms are not stirred up like bees in a bee's nest by the very experiments employed for observing them, are substantially all nucleus. His interpretation includes an explanation of gravitation, valency, and the reasons for other phenomena which still remain unsatisfactorily explained. (*69* pages, 4¾ by 7 inches, *2* illustrations.)—$1.80 postpaid.—*A. G. I.*

AIR RAID SHELTERS

By A. D. Rathbone, IV

(*Continued from page* 117)

rent when it is remembered that, of the 168 hours in the week, the average citizen works at his place of business 40 to 48 hours, and spends 12 to 20 hours in the streets and other public places, and the remainder of the time (about 100 hours a week) at home. This means that during the weekly cycle of urban life the chances are about three out of five that if the community is bombed, the attack will occur while the working people are at home. Actually, the chances of an individual being bombed at home are even greater than three out of five, since the large majority of the urban population work in the daytime, whereas most air raids are carried on at night, and since the non-working members of the family spend an even larger percentage of their time at home."

For the householder, there are three general methods of shelter protection: (1) Underground, either in the yard or beneath the house; (2) surface, or semi-surface, either attached to or inside the house; (3) a "refuge" room. The latter is not as effective as the first two, especially in houses of light, wooden construction, but it is much less expensive and can be accomplished by anyone with a little ingenuity. In this latter category comes the British Morrison "mouse-trap," regarded in the opinion of some professional engineers as the most adequate indoor method of protection. Designed for ordinary use as a table, the Morrison has a steel roof, or top, mounted on steel legs. It is 30 inches high, four feet wide, six and one-half feet long, its sides are of steel or heavy wire mesh, and it will accommodate a man, his wife, and one child. This offers only emergency and primary protection from falling debris and should not, therefore be expected to withstand more of a load than the collapse of an average two story dwelling. By the same token, there should be no cellar or other excavation beneath it into which it could fall.

A British type of semi-surface shelter, the Anderson, is shown in one of our illustrations. These are constructed in various sizes, they have proved reasonably safe and satisfactory as protection against bomb blast and splinters, but they require a considerable amount of heavy galvanized sheeting, or elephant iron, to build. An American commercial prototype of the Anderson which obviates the use of our precious steel supply is The Solid Timber Shelter, made in either table form or arch shape, the latter being shown in one of our illustrations. Both are designed for indoor use, and it is claimed the arch shelter has withstood tests which prove it capable of protection against 10 tons of debris, while the table style is reported built to take almost double the load of the Morrison. Constructed of four-inch timbers, either type is designed to safeguard dwelling occupants from dangers of falling debris, flying glass, and, to some extent, bomb concussions. Any house type of shelter, either indoor or outdoor, helps in the vitally important problem of keeping the civilian population thinly spread out during an air raid and of keeping parents and children from becoming separated.

As to private shelters in yards, just about anything from an open trench, wide enough and long enough in which to lie flat, to the more complicated, more expensive steel (if you can get it), concrete, or sheet-iron constructions will provide splinter protection and reasonable safety from the devastating blast of a bursting bomb. Although bombs in this war are bigger, more destructive, and more varied in type than in the last conflict, this writer inscribed the following in his diary under date of August 21, 1917, after his first experience with German bombs, and it is as applicable today as then: ". . . every man who could conscientiously leave his post ran like mad for cover. 'Cover' usually consisted of throwing oneself as forcibly as possible upon the ground in a gutter or close to a building. The man who could throw himself most forcibly and cling the closest to earth was the safest." That technique, in the absence of any form of physical protection, is still recognized as good—and it requires little or no practice to attain perfection!

As to modern office buildings, skyscrapers, apartment houses, the problem is different and varies with the structure. Again, and above all else, obey the regulations established for your particular building, keep cool, and obey the warden in charge. Go to any interior rooms or hallways above the first, and preferably above the second floor, but avoid the roof and upper floors. If no interior rooms are available, stay away from windows, but open them.

Lack of space prevents presentation of complete details on this many-sided subject of civilian protection in case of enemy air-raids. There have been, however, a number of excellent books published, some technically inclined for guidance of those responsible for providing safety to the public, and others designed primarily for public consumption. The Office of Civilian Defense in your locality can also help.

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"

As THE little note on page 98, explaining the cover picture, states, the 200" telescope on Mt. Palomar, California, is now locked up tight as a drum for the duration of the war. The former working force is doing things that directly help win the war, in order that we may continue to have astronomy according to science and not according to the Nazis. No doubt, if the Nazis won, all the astronomies would be called in and burned, and new ones issued teaching all coming generations that the Sun is Hitler in Heaven.

George Herbig, one of the more prominent amateur telescope makers in Los Angeles and now connected with the Griffith Observatory (planetarium) there, writes that he visited Mt. Palomar Observatory before it was closed up, and took the cover picture.

This is no ordinary photograph. As anyone knows, who has tried to photograph a telescope within its observatory dome, it is most difficult to obtain points of view that take in the whole instrument—usually one gets only various parts. Herbig did not knock out one wall of the building, but luckily found the yoke and tube so positioned that he could shoot partly upward from below and get an excellent general view of the whole. The ladders propped against the mounting give the scale. The object in the lower left foreground is the aluminizing tank—really a gigantic affair, Herbig states.

There is no use arguing that the 200" is beautiful. It's a plug-ugly, like a big square-toed, hobnailed boot. But it wasn't designed for sex appeal. Functionability was the true governing principle in the design and no real sacrifices were made to beauty, as this would be criminal. So it's simply a he telescope, unashamed.

Figure 1 shows the main worm wheel for the R. A. drive of the 200" telescope. This is 11' in diameter and the spacing error of the teeth is one second of arc, or one part in about a million and a half. The man shown worshipping is M. K. Baughman, technician of the Griffith Observatory. George Herbig took this photograph also.

GENERALLY, in precision optics, surfaces are worked to a tolerance of one eighth of a wavelength, or around 1/400,000". But not all of them. Suppose light is to be reflected from two surfaces, serially; or three, serially. The tolerance then becomes smaller. The 200" mirror, for example, is to be worked to a tolerance of 1/20 wavelength—just about a millionth of an inch. This is to be done because in certain combinations of its auxiliary mirrors there will be six reflections, serially.

This 1/20 wavelength is simply an attenuated case of the famous Rayleigh tolerance, described in Conrady's "Applied Optics and Optical Design." For one reflecting surface the tolerance is ⅛ wavelength. For n surfaces in series it becomes $1/(8\sqrt{n})$ and where there are six reflections this is approximately 1/20. Summarizing the matter, H. H. Selby says in a letter:

"Maximum phase difference at ultimate focus for all rays should be less than ¼ wavelength, ⅛ for perfect definition.

"Assuming a smooth surface, a zone one wavelength out of position will introduce two wavelengths' path difference at focus, for one reflection.

"If $(n-1)$ surfaces are interposed between the first surface and the focus, least squares treatment indicates that a total of n reflections will have an average of the square root of n effect.

"Assuming that each surface adds an error in a common direction (either plus or minus), the summation of path differences must be less than 1/8 wavelength, and the first surface must contribute no more than $1/(8\sqrt{n})$. For six reflections this is approximately 1/20 wavelength."

All of this being the case, but often lost sight of, it seems that where two

Figure 1: **Worm wheel of 200"**

surfaces are involved, the tolerance should be pushed up a bit, to about 1/11 wavelength—at least where perfection is the high aim. It is one argument against tackling Cassegrainians lightly.

OWNERS of the book "Amateur Telescope Making—Advanced" will recall, in that book, page 319, a description of a drive for a fine 12½" telescope made by Alan Gee and C. Carvel Diller, the former then a cadet at the West Point Military Academy. Gee, now a Captain in the 18th Engineers at Vancover Barracks, Washington, where he is working on a 20½" Cassegrainian in conjunction with two Portland amateurs, sends in the following, with the statement that by the time it is in print he may be elsewhere.

"Here is my contribution to the Cassegrainian secondary problem.

"It is impracticable to test the hyperboloidal convex through the back, so as

Figure 2: **Gamble's ideal hideout**

to consider it a concave. However, it is practical to test a concave hyperboloidal test mirror and then use this mirror to test the convex by means of interference fringes.

"What I propose is this. Determine radius of curvature of the secondary by the usual method. Grind and fine grind to this curve. Then set aside the convex mirror and polish the tool, which of course is of the same curve as the secondary except it is a concave. The tool need not be polished to the perfect degree required of the finished secondary, but should be fairly well polished.

"Then figure the concave tool to a hyperboloidal curve, using the good old Foucault test and the following formula to determine the radii of the various zones.

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

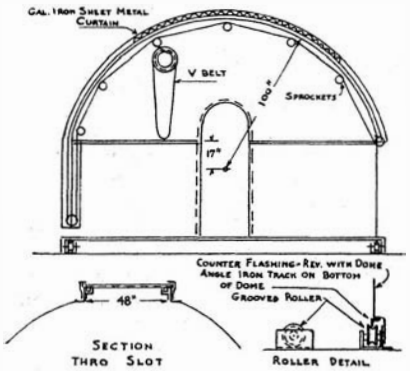
[The symbols are the standard ones of Ritchey—see "A. T. M.," page 62.—*Ed.*]

"Obviously, the same procedure would work for testing the spherical convex of a modified Cass. The test mirror would of course be figured spherical.

"This method sounds long and difficult, but remember that you already have the concave test mirror fine ground to the correct radius, and that only a few hours of polishing will be sufficient to permit figuring and testing by interference fringes. Also the test mirror need not be wasted after the job. It can readily be refigured into a good paraboloidal primary.

"I inclose my derivation of the above formula in case some of your math nuts would like to try to pick it apart." [Available to math maniacs, on request.—*Ed.*]

Gee says he and his co-workers are using this test on the 6" secondary of the 20½" mirror, which is an old Tinsley replica of the 200" mirror with prime focus 80". Secondary focus is to be



Redrawn by R. W. Porter

Figure 3: Gamble's dome details

240", hence overall *f* ratio is about 12. English type mounting. Split ring outer bearing, allowing the Pole to be reached. It will be extremely heavy and rugged, he adds.

On a bluff just outside Moline, Illinois, overlooking a valley and with an excellent horizon, stands the observatory shown in Figure 2, built by Carl H. Gamble, R.F.D. 1, that city. It contains a 5½" Zeiss refractor on a Clarke mounting.

Lower story of the observatory houses the owner's science library in a room 18' by 20', which also will accommodate the members of the local club of amateur astronomers. Above is a deck 22' by 32', and on this is the spacious dome, 16' 8" in diameter—just the size, by the way, of the 200" *mirror* in California!

Details of this neatly designed dome and slot cover are of especial interest (Figure 3). The former is a steel silo top made by Lamneck Products, Inc., Middletown, Ohio—similar to domed silo tops made by a number of manufacturers. For example, The Independent Silo Co., of St. Paul, Minn. Entire dome rotates on eight rollers near the floor level, the conventional fixed wall thus being eliminated. In this respect it is similar to the type shown in "Amateur Telescope Making—Advanced," page 493, Figure 13.

During the soul-trying work of making a first telescope mirror, when it is altogether natural to entertain misgivings whether the claim that an amateur can make his own telescope mirror is true, something is needed to bolster or shore up the morale of the poor, lonely, and perhaps wavering worker.

A mirror-maker who has "been there" in his own time but wishes to remain anonymous, writes the following: "It is practicable to use a mirror in your mounting before it is aluminized, before it is figured, before it is even fully polished.

The famous Brashear, in his Autobiography (page 49), tells of doing this. I, too, have done it. Sunspots can be studied (always using two pieces of smoked glass between eyepiece and diagonal), the Moon's major features can be seen, likewise the phases of Venus. I saw all those fairly well when the figure still was a rank hyperbola. It renewed my courage."

The tyro may, however, encounter one lesser discouragement in connection with doing this—collimation of the mounting to hold the mirror. This usually is a tough, cussed job. Perhaps, if told in advance that it usually is such, and thus led to expect it—for most owners have been through that same mean stretch and few have found it otherwise—this setback to morale won't seem so big.

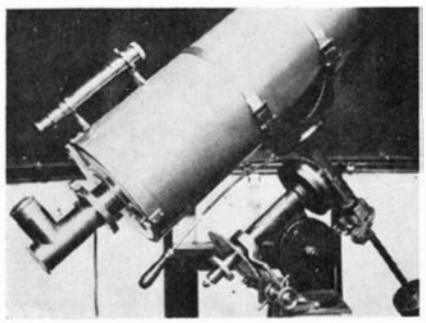


Figure 4: Coates' 8" Gregorian

After completing an 8", *f*/8 Newtonian, a 6" Richest-field telescope, and a 10" Gregorian (Figure 4), Ernest L. Coates, 6432 Perry Ave., St. Louis, Mo., built the attractive backyard observatory shown in Figure 5.

He made the patterns for the castings used in the mounting of the Gregorian and had the castings made and machined outside. The telescope has a motor drive and is equipped with setting circles. Coates made a battery of eyepieces, from ⅛" to 2½" efl, using Crystallex glass obtained from the Pittsburgh Plate Glass Company, and found this choice, clear, plate glass sufficiently satisfactory. The Gregorian proved to be successful—sharp images—but Coates finds the field of view rather small, the only complaint he named.

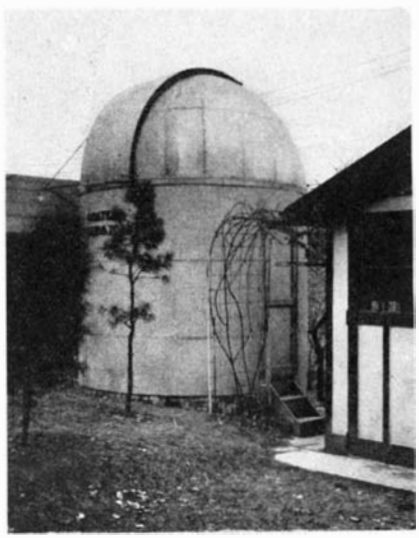


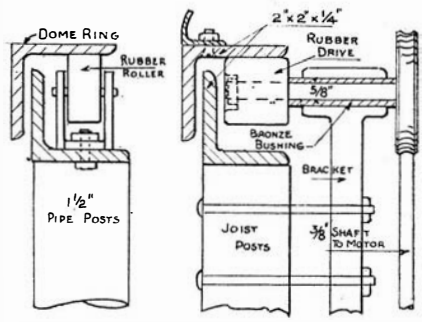
Figure 5: The Coates Observatory

The Coates Observatory is all metal, 10′ in diameter, and is supported on eight 1½" iron pipes set in concrete. Its sides are of 26-gage galvanized iron. Both circles—the one on the dome and that on the fixed base—are of iron and are welded in one piece. Dome ribs are 1/8" x 1" flat iron stock. The one-piece shutter rolls to one side on grooved rollers running on angle iron track and Coates states that it does not clog with ice. A 1/6 horsepower motor rotates the dome at one turn in two minutes.

The dome is mounted (Figure 6) on 18 rubber rollers and is noiseless when moving. There are six guide rollers to hold it in position. The slot opening is 30" wide. The drive (Figure 6) is of the friction type.

The dome is painted dull black inside (lampblack, alcohol, enough shellac for binder), and with aluminum outside.

Profanity is traditionally the chief by-product of making a pitch lap—at least during the first 10,000 attempts. New stunt (so far as is known) is offered by



Redrawn by R. W. Porter

Figure 6: Coates' dome details

A. Rowland, 909 Easton Bldg., Oakland, Calif.

The two disks are warmed, the face of the mirror disk is given a thin coating of common vaseline, and the two disks are stood on edge, side by side, separated by the thickness of the desired lap, on a strip of heavy adhesive paper. Next, the paper is rolled around the disks and is stuck fast to them. Some kind of props can be used to hold the disks in place for the pouring, if desired. A pouring cup or funnel, of modeling clay, is set on top, over a hole punched in the paper, and the melted pitch is poured in till it reaches the top and ceases to settle. The whole unit is then set in a cool place for the pitch to set *fully*.

To remove the mirror, Rowland states, he first rests the unit on small blocks in a basin, with the mirror disk down, and then pours in enough cold water to submerge its lower half. He brings the water slowly up to about 100° (average hand-washing water) in not less than 20 minutes—otherwise, risk of cracking. He next removes the unit, lays it on a bench, tool side down, and places a strap or strip of cloth around the tool, half a turn with the two ends extending in the direction of an assistant whose job is to hold them. Then he places a similar strip around the mirror and pulls in the opposite direction.

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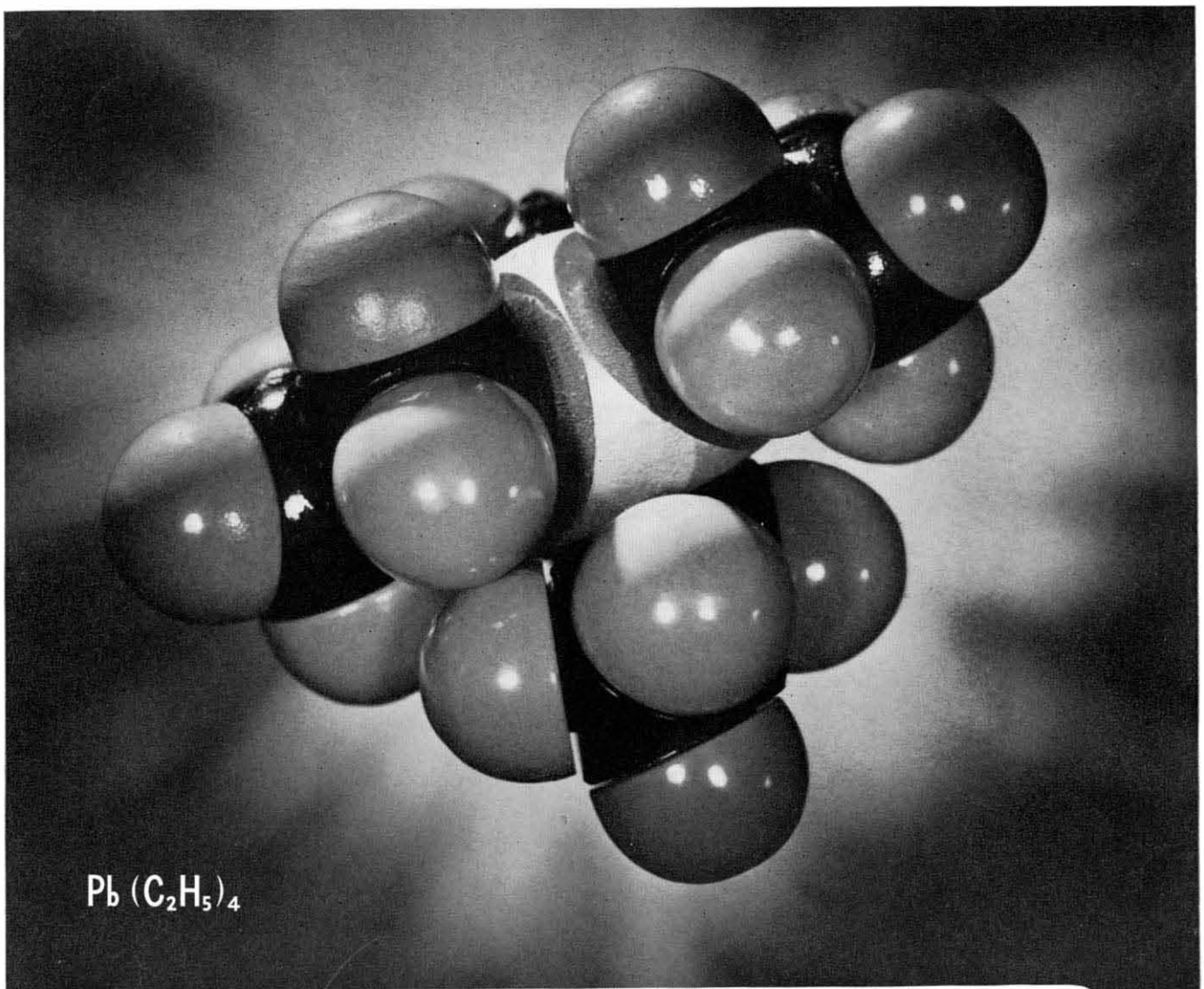

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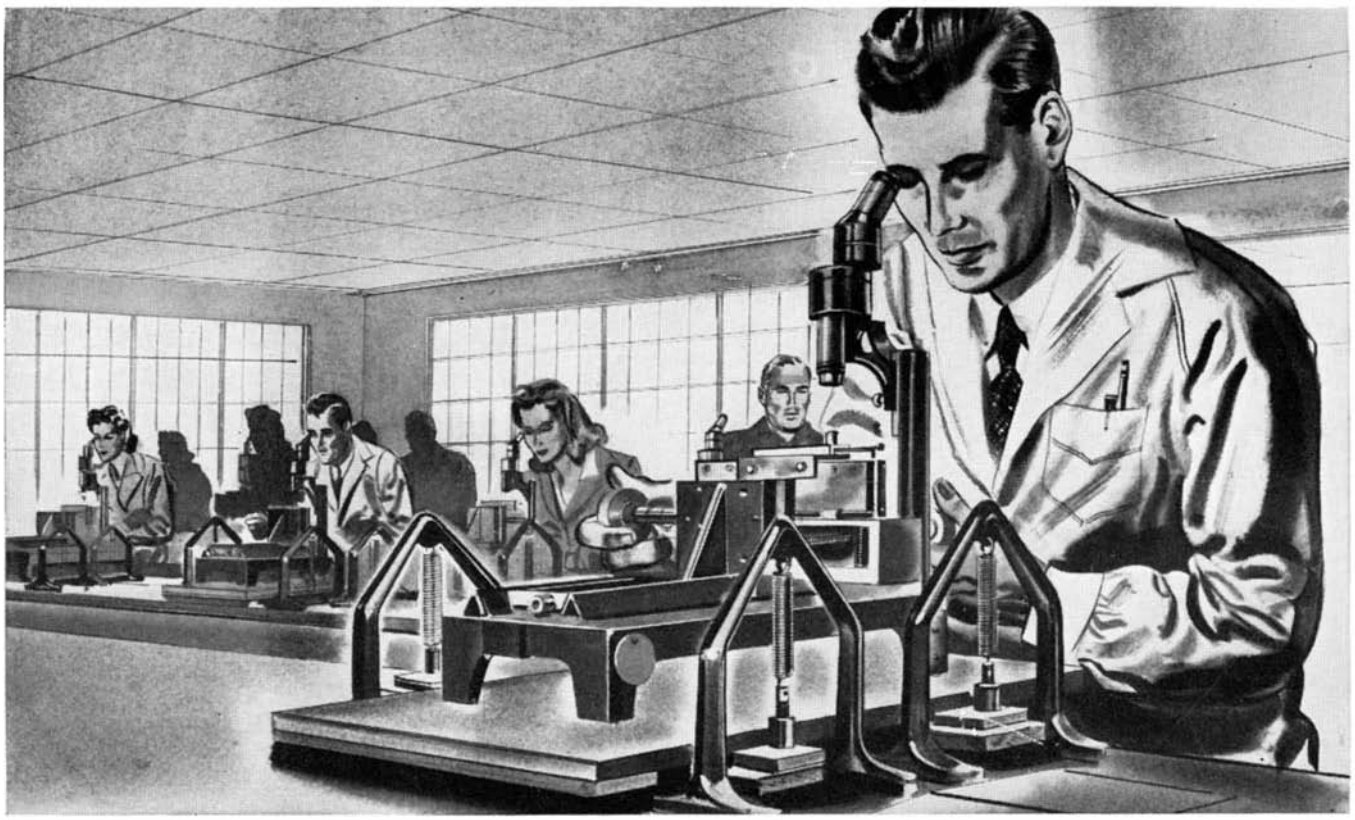

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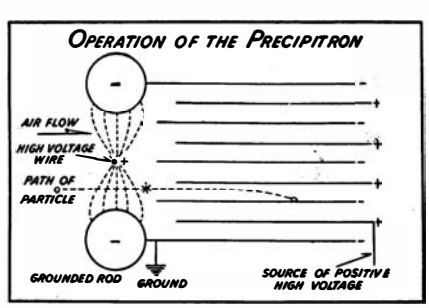

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