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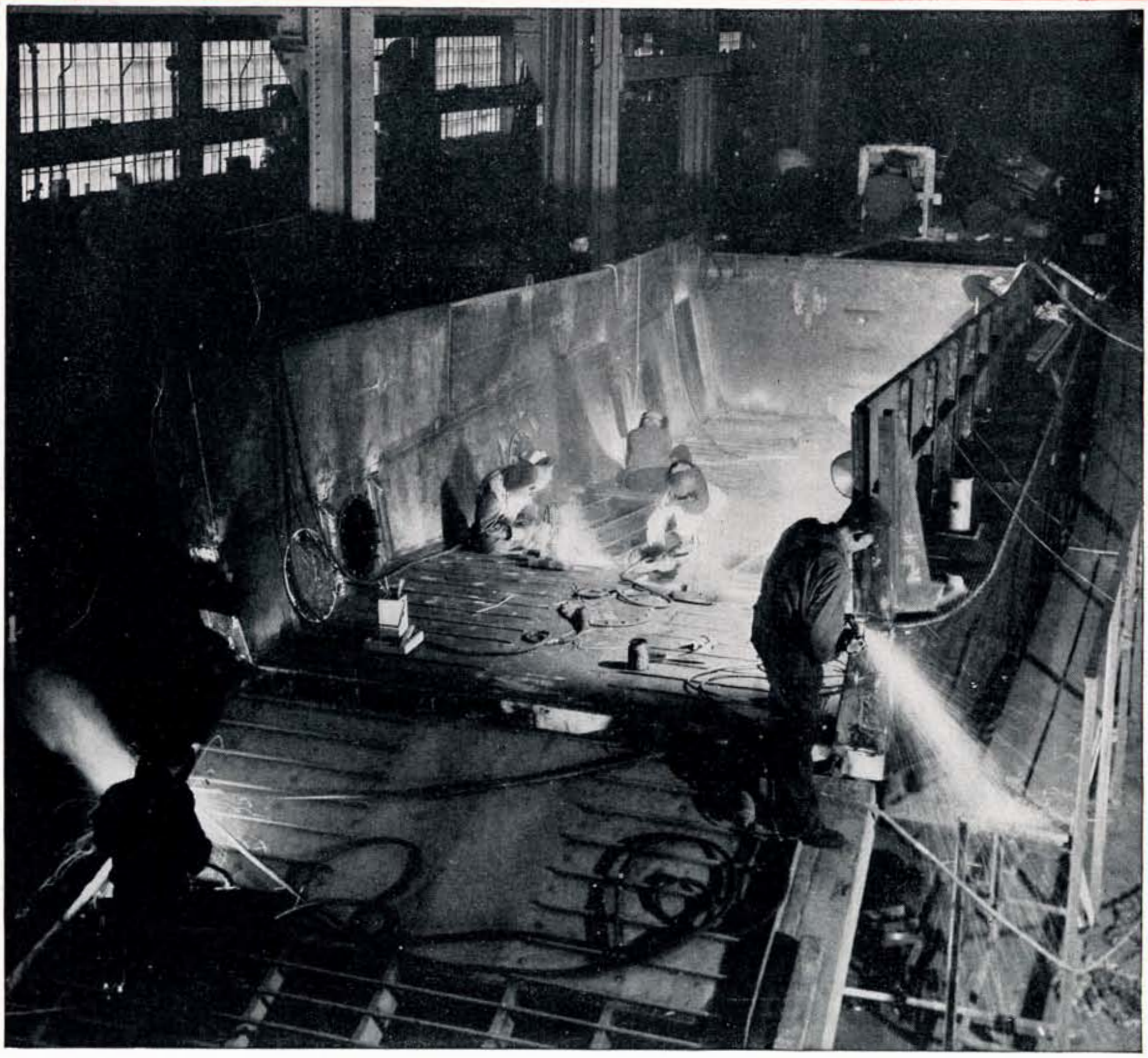

Welding Has Many Marine Uses . . . See page 194

The Story of
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(Continued on next page)

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by J. E. Thompson, B. S. in E. E., A. M., Dept. of Mathematics, Pratt Institute

(continued from opposite page)

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Our Cover: Welding as a major tool of the ship builder has been amply proved during World War II. How early troubles in the process have been overcome is told in the article on page 218.

SCIENTIFIC AMERICAN, October, 1945. Vol. 173, No. 4. Owned and published by Munn & Co., Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; A. P. Peck, Assistant Secretary; all at 24 West 40th Street, New York 18, N. Y. Entered at the New York, New York, Post Office as second-class matter June 28, 1879, under act of March 3, 1879. Additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York 18, N. Y. Manuscripts are submitted at the author's risk and cannot be returned unless accompanied by postage. Files in all large libraries; articles are indexed in all leading indices. Subscription $4.00 per year. Canada and foreign $5.00.

Why one husband kissed his wife four times!

"Here's a kiss for the money you're saving . . . while it's coming in faster through the war years. I know in my bones jobs like mine may not last forever. Who can tell what's going to happen day-after-tomorrow? Thank God you've got sense enough to see that today's the time to get a little money tucked away.

"Here's a kiss for the War Bonds you're making me hold on to! I'd never do it without you, honey; it's too easy to find reasons for cashing 'em in—but when it comes time to put the children through school or pay for an emergency operation, we'll be thankful.

"Here's a kiss for the insurance you talked me into buying. I've felt a lot easier ever since I've known our future is protected—you and the kids would be safe if anything happened to me—you and I won't have to spend our old age living on someone's charity. And every cent we put in insurance or War Bonds or other savings helps keep prices down.

and

here's a kiss for being *you*—a woman with brains enough in your pretty head to make sure we don't buy a single thing we *don't* need in times like these—because you know a crazy wave of spending in wartime would march America straight into inflation. Baby, I sure knew how to pick 'em the day I married you!

ONE PERSON CAN START IT!

You give inflation a boost

—when you buy anything you can do without

—when you buy above ceiling or without giving up stamps (Black Market!)

—when you ask more money for your services or the goods you sell.

SAVE YOUR MONEY. Buy and hold all the War Bonds you can afford—to pay for the war and protect your own future. Keep up your insurance.

HELP US KEEP PRICES DOWN

A United States War message prepared by the War Advertising Council; approved by the Office of War Information; and contributed by this magazine in cooperation with the Magazine Publishers of America

Previews of the Industrial Horizon

By A. P. Peck

TRANSOCEANIC

MORE THAN one shipping man believes, and with excellent justification, that the days of huge, fast, transatlantic liners are past. These luxury ships, never wise investments from a financial standpoint, served their greatest purpose in building up the national prestige of the country of origin and in inflating the ego of some of the passengers. To a certain extent they were valuable means of transportation for a few to whom time really meant money, but for those few the airplane now offers even greater time savings and with a high factor of safety.

This is not to say that the airplane is going to supersede the steamer for transocean travel. As Dr. Klemin points out in the article starting on page 228, airlines offer many desirable features but there will be vast numbers of travelers who will prefer the slower, more leisurely pace of the surface ship whether pleasure or business bound. And those ship operators who provide average-size vessels, of moderate speed and with comfortable accommodations, are going to carry the great bulk of transocean traffic for a long time to come.

SKY-HOOK TELEVISION

WHAT SEEMS, at first glance, to be a brain-child of a wild-eyed dreamer is the recent proposal to put television transmitting equipment in airplanes, send the planes to an altitude of six miles, and broadcast television programs from that vantage point where the electrical limitations of ultra short-wave transmission almost vanish. But the proposal has the backing of Westinghouse and The Glenn L. Martin Company and therefore merits more than passing attention.

Aircraft reliability has been proved. To keep a fleet of planes in the air 24 hours a day, day in and day out, can easily be done by providing "spares" and operating the ships on an eight-hour schedule with one broadcasting and one stand-by plane in the air at each station at all times.

Not only would the six-mile altitude of the transmitters extend the line-of-sight range of ultra short waves to over 400 miles, but the power required to cover that range would be relatively small. Thus, with only eight "Stratovision" stations in operation, a coast-to-coast network could be established that would require about 100 ground relay stations to provide comparable service. The television programs would be beamed to the planes from low-power ground stations.

Airplanes are expensive to build and maintain; so are short-wave radio relay stations or co-axial cable systems. In Stratovision a number of television and FM programs would be broadcast simultaneously from each airplane. When the technical possibilities of airplane versus ground television networks are considered and the comparative costs are carefully balanced, it appears that the "brain-child of a wild-eyed dreamer" is actually a view of the not far distant future as seen by a group of realistic engineers.

PACKAGED POWER PLANTS

COMPLETE steam plants, assembled at the factory, tested, and shipped ready for operation as soon as fuel, electric, and water connections are made, promise to furnish competition to Diesel and gas turbine plants in the future. These steam plants, far more compact than conventional units of the same capacity, depend for their efficiency on a baby boiler of the flash type employing forced circulation of feed water. By coiling the boiler tubing into a compact pancake shape, the hot gases from the fuel reach all parts of the tubing simultaneously; the result is rapid steam production at high pressures and at high efficiencies. The tubes used are relatively small in size but the reduction in water capacity is made up for by the use of circulating pumps. The steam goes directly from the boiler to the turbine, so that no steam storage is necessary.

Such small steam generating plants have wide possible applications. Because they are made in sections, they can be tailored exactly to fit any need. The sections give the added advantage of rapid repair in case of failure; the damaged section is merely cut off and fixed while the remainder of the plant remains in operation. Chemical plants, laundries, food processing plants, yachts, and so on, will be potential markets for these plants.

ELECTRICITY ON THE FARM

ELECTRIFICATION of America's farms interests many people. The farmers themselves, the manufacturers of farm equipment, electrical power companies, and a number of allied industries all have a stake in it. Simply stated, more power on the farm means more efficient production of farm commodities and hence more farm income. And when the farmer prospers, so prospers the nation.

From published reports it appears that farms in California will be practically 100 percent electrified within the next three years; New Jersey and Rhode Island will run almost neck and neck, but many other states will still be far behind. Texas, as of now, has less than one third of its farms electrified, as do also several of the mid-western states. From this it can be seen that there is a wide-open rural market for power and power-using equipment.

Diesels are going to make a strong bid for much of this market, and it is still a question as to whether these prime movers or the power companies will get there first. One available set of figures runs like this: During 1944 the production of Diesel power for the American merchant marine alone totalled 136,850 brake horsepower. Just this one phase of the Diesel engine industry thus produced facilities sufficient to furnish electric power to more than 3 percent of the total number of American farms now lacking that power.

FOR FUTURE REFERENCE

CONCRETE to which has been added a lignin product made from paper-mill waste is reported to be stronger, less porous, and to last longer than when made from conventional ingredients. . . Watch for a tremendous increase in the number and variety of coin-in-the-slot machines vending everything from bread, stockings, and fresh orange juice to sizzling "hot dogs"; watch out also for rackets connected with these machines. . . Containing no petroleum, a new synthetic lubricant is reported to have unusual stability at high and low temperatures; it will be high in cost but for many uses will have overbalancing advantages. . . "Protective coatings," all-inclusive name for paints, varnishes, and lacquers, are taking into the fold many of the newer resins and will soon offer outstanding protection under most adverse conditions of exposure. . . Styrene, wonder-child of chemical industry and ingredient of synthetic rubbers for many uses, can be the base of foamed insulating material, high-quality varnishes, plastics of various types, water-emulsion paints, water-proofing compounds, and many other industrially important substances. . . Midget tractors, from 10 horsepower up, selling for around $500, will shortly appear literally in droves from a number of manufacturers, offering the farmer versatile equipment for lightening his labors. . . No atomic bomb or power story on this page; it's on page 238.

Outwitting the weather

How science copes with Old Man Weather is illustrated by these ideas and devices from General Electric laboratories.

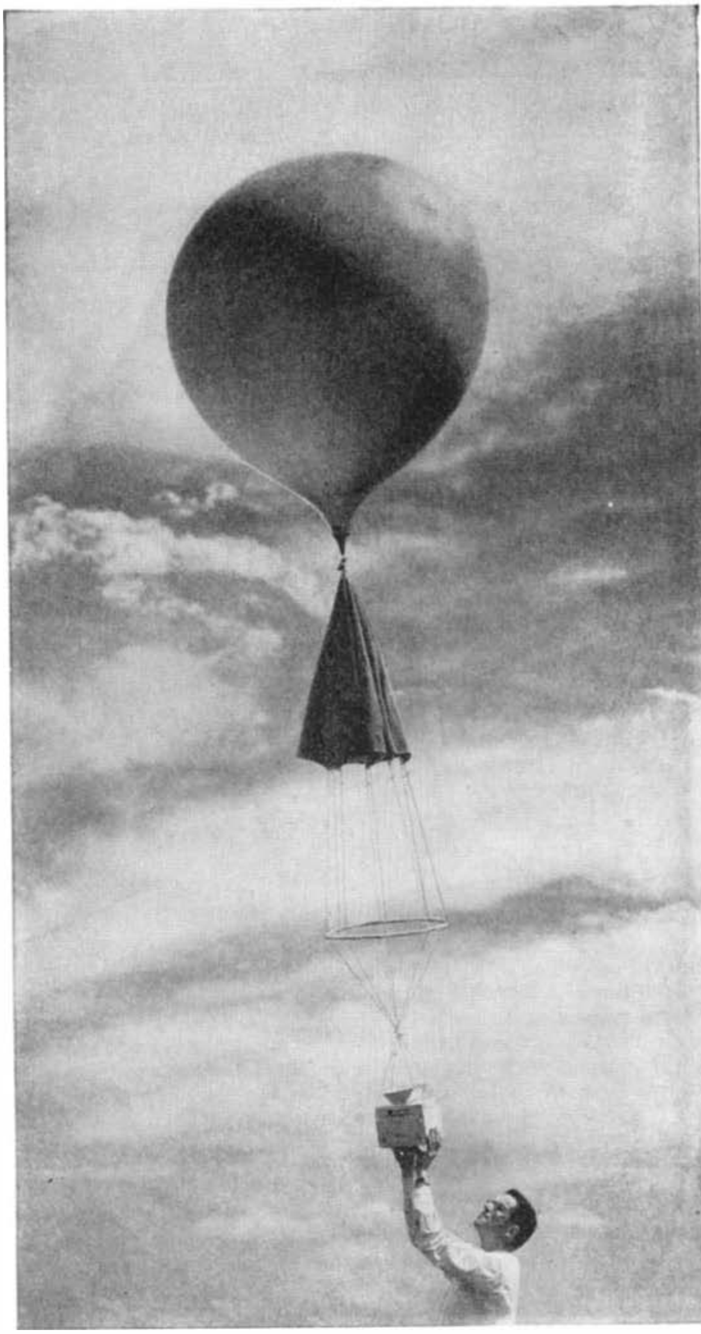
How high are the clouds? A ceilometer measures this for airmen. How wet is the weather? Hay can now be stored in barns before it is dry, with a new hay-drying system with G-E control. And one G-E laboratory makes weather—with or without rain, wind, sleet, snow—to test G-E turbo-superchargers.

On this page are a few more examples of the way General Electric research and engineering are being devoted to this phase of human comfort and health. *General Electric Company, Schenectady, N. Y.*

Cloudy but bright. When clouds darken the sky, lights come on in this schoolroom. No one has to remember; a General Electric automatic light control with an "electric eye" keeps constant watch, safeguards young eyes by turning on the lights whenever needed.

Cucumber magic. Vines in electrically heated soil (right) grew twice as tall, and bore one month earlier. A heating cable, developed by G-E engineers, is buried in the soil and thermostatically controlled. More than 15,000 commercial growers use G-E soil-heating cable.

Spring weather. Cool, mountain-top comfort in your bedroom, or anywhere else in your house, will be provided by G-E air conditioning units. Nor have G-E engineers forgotten winter problems; they have applied G-E research and engineering to home heating systems, too.



Weather detective goes aloft in the small box suspended from the balloon. Some 12 miles up the balloon bursts, and the box is parachuted back to earth. On the way up, this electronic device, called the G-E Stratometer, gives a running commentary on the weather—temperature, humidity, air pressure—and sends this information back to earth by radio signals. The information gathered by the G-E Stratometer can be used to help predict weather.

★ ★ ★

Hear the G-E radio programs: The G-E All-girl Orchestra, Sunday 10 p.m. EWT, NBC—The World Today news, *Monday through Friday 6:45 p.m. EWT, CBS—The G-E House Party, Monday through Friday 4:00 p.m. EWT, CBS.*

FOR VICTORY—BUY AND HOLD WAR BONDS

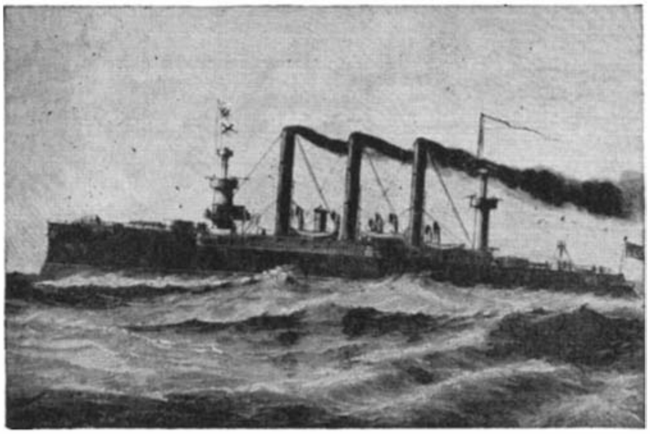
GENERAL ELECTRIC

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of October, 1895)

"BROOKLYN" — "In the building up of our new navy, the United States government have reaped much benefit from the fact that they were a little late in starting. While other nations have expended large appropriations on ships that were largely in the nature of experiments, we have been in the position of the critical onlooker; and the costly failures of other naval boards have been valuable object lessons to our own as to what to avoid. The outcome of this observation is seen in a class of ships which, while they embody the best features of European practice, are yet marked by the strong originality which ever characterizes American design. The *Brooklyn* is spoken of as a sister ship to the *New York*. . . She should be more properly called an enlarged and improved *New York*, being 14 feet longer and of 1,000 tons more displacement."



LOCOMOTIVES — "Is the electric locomotive to supersede the steam locomotive as the future tractive power on our railroads? . . . Unless a system of stationary boilers and engines can be produced that will furnish the electric locomotive with its power for one-half the coal consumption that is necessary for the generation of the same power in the steam locomotive, we may rest assured that George Stephenson's invention will remain among us for years to come as the greatest triumph of the modern mechanical world."

OPTICAL WORKS — "Some idea of the magnitude of the Carl Zeiss Works may be gathered from the fact that it requires three hours to pass through the various wings and departments, without leaving much leisure for inspection of details. Upward of 500 workpeople are employed, a curious feature being that there is no difficulty in obtaining skilled workers in metals, but the optical hands have to be trained within the works from boyhood."

INVENTION — "Young men of an inventive turn of mind should be constantly on the alert, observant in everything. Note where a saving of time or material can be effected by improved methods. If you cannot make two blades of grass grow in the place of one, invent some method to do certain things quicker and better than by present methods. Time is money, and any method by which time is saved has a commercial value. If the operation is performed better and quicker, the commercial value of the method or means enhances accordingly. The simplest inventions are of the most value, comparatively. A recent report from the Patent Office states that the majority of successful patents were for articles that retailed for one dollar or less."

VENTILATION — "Although the summer of 1895 has now departed, the ever-present and perplexing question of the ventilation of passenger cars is still here. It is true that the question of ventilation will soon assume a different phase; will become a question of how to get warmth into a car instead of how to get it out; but the troubles of the day car passenger in summer are very real, and will recur again next summer as surely as the world rolls round."

PASTEUR — "If the measure of human greatness is to be found in the amount of blessedness that a man's life and work bring to his fellowmen, there has lately passed from our midst one of the greatest of all great men. The moral philosophers tell us that the pursuit of pleasure and the avoidance of pain are chief among the natural instincts of man. If this be so, Pasteur has done more to ameliorate the condition of the race than any one man, living or dead."

HYDRAULIC POWER — "In the course of a paper read at the recent summer meeting of the Institution of Mechanical Engineers, at Glasgow, the author, Mr. E. B. Ellington, gave some very significant figures regarding the cost of running the London Hydraulic Power Supply. This is by far the largest municipal supply in the country. It includes 75 miles of mains, carrying a pressure of 750 pounds to the square inch, which deliver 9,500,000 gallons of water at this pressure per week. This serves to operate 2,300 machines. This plant has now been in operation for twelve years, and it yields an annual revenue of $250,000."

NEWS BY TELEPHONE — "The telephone newspaper organized at Pesth, Hungary, has now been working successfully for two years. . . It has 6,000 subscribers, who receive the news as they would ordinary telephone messages. A special wire 168 miles long runs along the windows of the houses of subscribers, which are connected with the main line by separate wires and special apparatus which prevents the blocking of the system by an accident at one of the stations. Within the houses long, flexible wires make it possible to carry the receiver to the bed or any other part of the room. To fill up the time when no news is coming in, the subscribers are entertained with vocal and instrumental concerts."

RECLAIM — "The business of gathering waste rubber is chiefly confined, so far, to cast-off foot-wear. The methods of reclaiming rubber were first applied to scrap of this class, and the organized channels through which 18,000 tons of scrap annually trickle from the hands of country peddlers into larger streams, until the rubber reclaiming factories receive it in carload lots, have all been planned for the collection of old shoes."

NIAGARA — "The Niagara Falls Hydraulic Power and Lifting Company have recently contracted with James Leffel & Company, of Springfield, Ohio, for four of their improved double discharge water wheels, to be of eight thousand horse power capacity, under a maximum head pressure of 218 feet, which is far the highest head under which turbines of large capacity have ever been applied in this country or elsewhere. These wheels will drive eight electrical generators, which will be connected direct to the turbine shafts, without gears or belting."

DUST EXPLOSIONS — "Flour, coal dust, and other fine organic dust, explode when certain outside causes are present. Professor Tobin demonstrated before the Kentucky Millers' Association this fact, and further showed that dampness destroyed the explosive tendency. Live steam was recommended as a preventive, by damping the air of the mill. The same would apply to the air in a woodworking factory, where it is full of dry dust."

PARIS GREEN — "It is estimated that more than two thousand tons of Paris green are annually used as an insecticide in the United States, since it is the most rapid and effective of the arsenical preparations used for this purpose."

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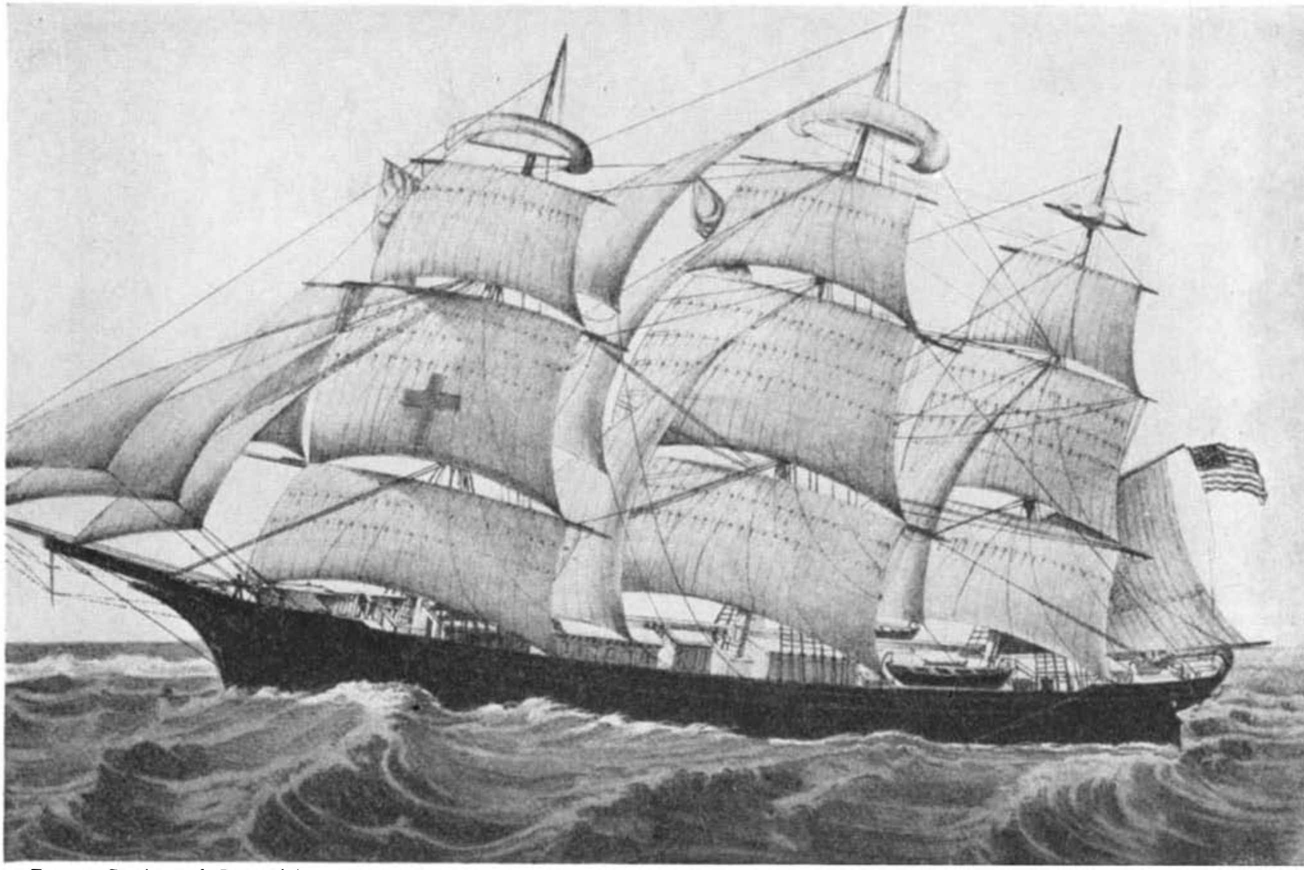


From a Courier and Ives print

The Clipper Ship *Dreadnought*, of 1854

America on the Sea

After Finding that Wooden Ships and Sail Could Not Compete with Iron Ships and Steam, American Shipbuilding Progressed Slowly Until the Turn of the Century Brought in the Practical Use of Fuel Oil and the Development of Better Engines. America's Background of Technical Knowlege has Made it the Greatest Marine Power in the World, but What Will be Done, Post-War, With the Ships now in Being or Being Built?

By **HARRY BOTSFORD**
Editor of "Ships"

FROM earliest Colonial days to the present, American shipbuilders have been pioneers, rather than being content to follow traditional practices. As early as 1527, shipwrecked explorers, led by Luis Vasquez D'Allyon, built a vessel on the banks of the Cape Fear River, not far from the site of one of the busiest present-day shipyards. This was probably the first ship constructed on what is now American soil. Eighty years later settlers of the ill-famed Popham Colony of Maine built *The Virginia*, a ship of 30 tons burden, which made at least one recorded voyage across the Atlantic.

Americans became a nation of shipbuilders because ships were the major form of transportation in an era when few roads or trails existed. Colonial expansion followed a very definite and explicit pattern because the growth of the colonies was at first confined exclusively to coastal areas. From the coast, the migration was inland, up the great rivers. Trading and communication between various points was made possible by a large variety of specialized local craft, built to fill special and urgent needs as to size, draft, and type of service in which the ship was to be used. This naturally was responsible for a large number of small but busy coastal shipyards, manned by men who were real craftsmen, highly skilled in the use of shipbuilding tools.

Out of these yards came vessels that gave this nation maritime prestige and stature in a world that was a trifle skeptical as to whether the New World was important.

From Colonial days until 1845, our ships played an important part in the economic growth of the nation and in its defense when forced to fight two major wars with a great and aggressive enemy to establish the right of all peace-loving nations to share the sea commerce of the world.

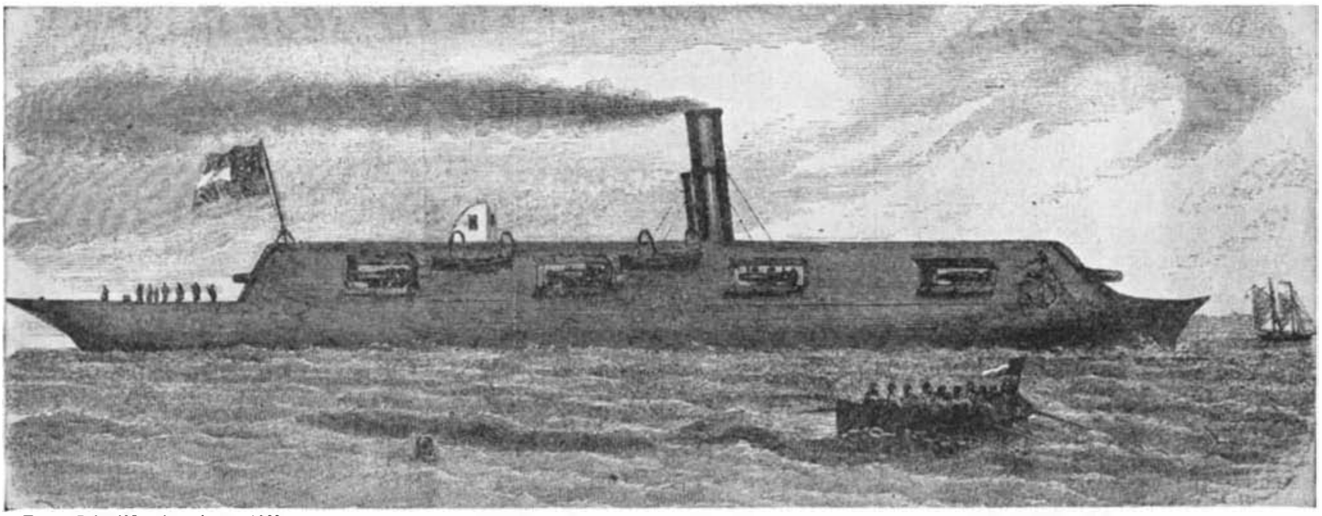
In the interim, so many wooden ships were built in the United States that fine forests were partially denuded in the coastal areas. However, American ships of sail were known and respected throughout the world. They were fast, able to weather storms, to carry what is today known as a "pay load." They were manned by men to whom the sea was an honorable career and a profitable one.

American whalers were specialized ships, the best of their kind. There were hundreds of them. They were to prosper until 1859, when the world's first artesian oil well was drilled in Pennsylvania, giving the world a cheap lubricant and illuminant. The decline of the whaling industry was rapid from this time on.

Packet lines to Europe excited the admiration and envy of other nations; American mariners were venturesome, courageous, and intelligent.

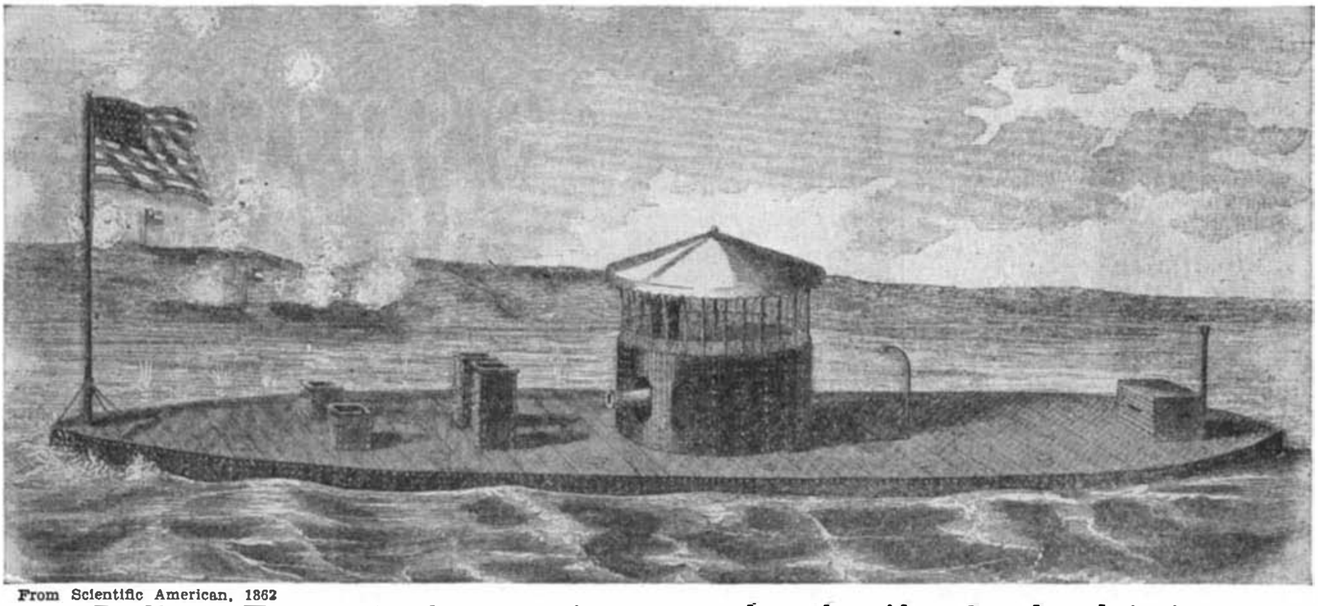
The clipper type ship was born of necessity. By 1848, the demand for such fast sailing ships had reached a new peak. The discovery of gold in California created an active and urgent demand for fast passenger and cargo ships to ply between the East and West coasts. Rates were high and ship owners prospered.

Before this time, however, a curious and expensive error had been made. The rest of the maritime nations, including England, were starting to build iron ships, powered with steam. True, America had built a few such ships, but they were largely looked upon as mechanical innovations, ingenious toys that were interesting, but probably not profitable nor practicable to operate. The vast but shrinking timber resources of the United States were weighed, together with the thousands of men trained in the art and science of building superlative wooden ships of sail—and the canny New England ship operators viewed the cost of boiler fuel as against



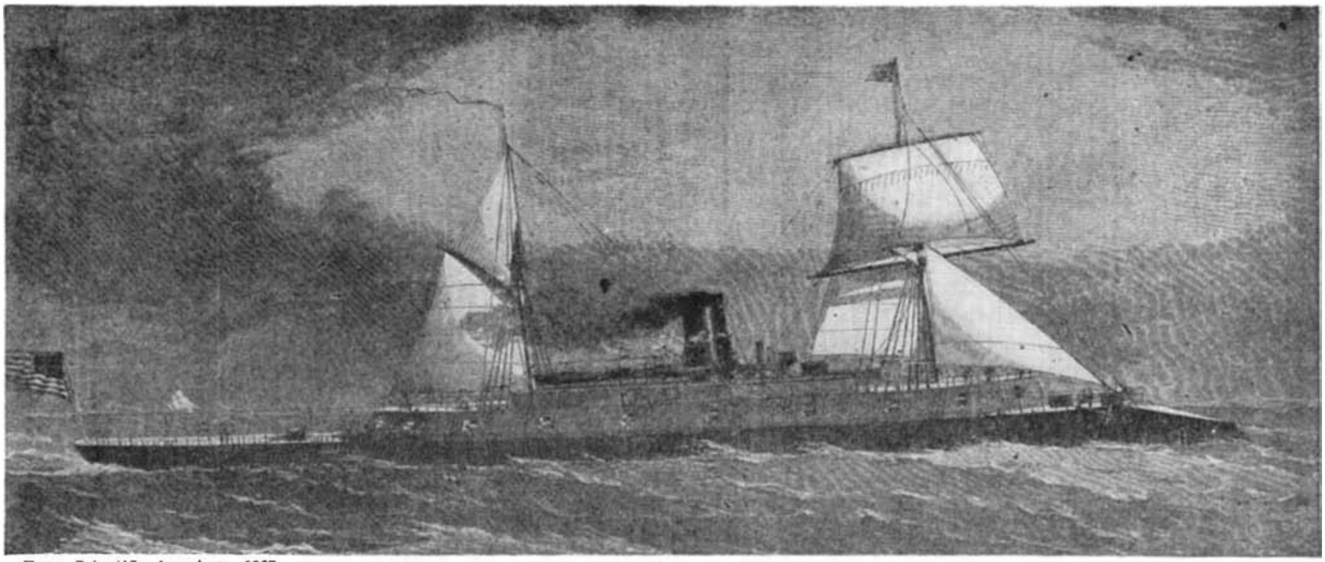
From Scientific American, 1862

The iron-plated rebel steamer *Merrimac*



From Scientific American, 1862

The *Monitor*. When in action, the turret awning was removed, together with smokestacks and air pipes



From Scientific American, 1867

The steam ram and battery *Dunderberg*, built in America for the French government

free wind. The result was a solid front against doing anything toward the adoption of steam and iron ships.

Americans clung stubbornly to sail, pinning their faith on fast clipper ships. It was an unwise decision. Slowly but inexorably, Britain and other steamship-minded nations started to take the maritime business away from the United States. Ship operators discovered, to their horror, that a ton of steam was equal to three tons of sail. American maritime industry could not compete with iron and steam. It was not dissimiliar to trying to use draft horses to compete with a motor truck.

STEAM RECOGNIZED—By 1840, reluctantly and belatedly, the value of iron ship construction and steam propulsion was recognized by some in the United States. Shipyards workers did not relish the change. A man trained in the use of woodcutting tools looked with scorn on iron as a basic ship material. He was forced, however, to lay aside the adz, broadaxe, plane, and other woodworking tools for the sledge, the forge, the wrench. It was not an easy transition, and progress was pitifully slow.

Several shipyards were forced to have parts of small iron ships fabricated in England and brought to this country, where they were joined together. Naturally, this was an expensive process. It was one that was limited and restricted to small craft for coastal purposes.

It was not until 1843-44 that America really became a factor in the construction of iron steamers. Harlan & Hollingsworth, a Wilmington, Delaware, shipbuilding concern, were the pioneers. They constructed the *Bangor,* the first iron sea-going steamer built in this country. The stem and forefoot were of advanced design. The ship was of 231 tons burden, 120 feet between perpendiculars, with decks 131 feet in length.

The power plant consisted of independent engines, one for each of two propellers. The cylinders were 22 inches in diameter with a 24-inch stroke. The propellers were of the Topes type, 8½ feet in diameter. The boilers were in the hold, 20 feet long, of the drop-flue type.

Commissioned in 1844, the trial trip was made from Wilmington to Cape May, to Philadelphia, and return. About 150 passengers were aboard. The ship performed well, but the engines proved to be rather inefficient. However, it was not necessary to resort to sails. The *Bangor* carried three wooden masts, schooner-rigged. Caution dictated their installation, for steam was still something of an experiment, and the owners were taking no chances.

In a measure the trial run was satisfactory. At no time did the boilers carry more than 46 pounds of pressure. The average speed was 10.61 miles per hour. The *Bangor* went immediately into coastal service, but burned and was beached within the year. She was salvaged and reconstructed, and for four years operated profitably on the East coast, between Maine and Texas. After that, there is no record as to what happened to the *Bangor,* the first American iron steamer.

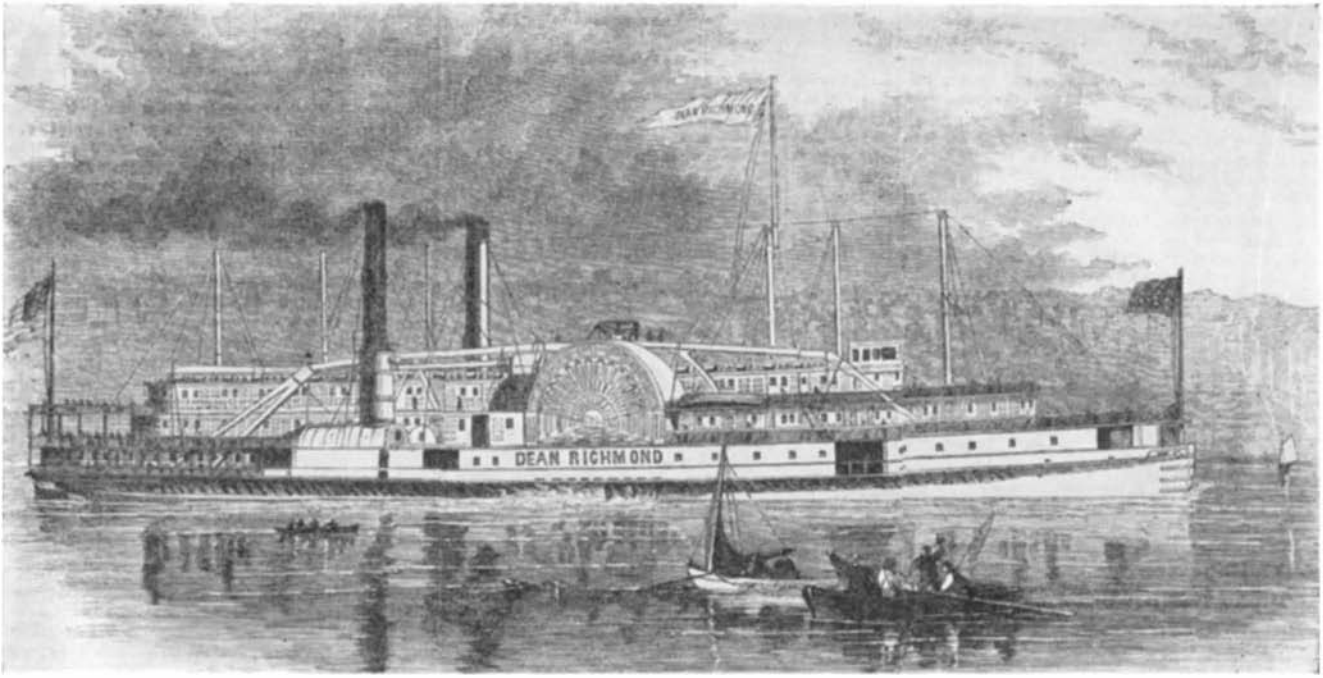
The first dramatic years of the Civil War marked a sharp drop in American merchant tonnage, due to sinkings. It likewise marked the advent of the blockade runners of the South, fast vessels that were competently handled and often managed to elude Federal gunboats and take precious cargoes of cotton to England.

During the war period, however, there was little if any advance in merchant ship construction. On the other hand, American naval design did make one highly important advance, one so radical that two newly designed warships figuratively sank every wooden navy in the world.

The *Monitor,* designed by Captain John Ericsson, was laid down at the Continental Iron Works in New York in October of 1861 and was completed in 100 days. The design incorporated at least 40 patentable features, and the completed ship was a curious appearing craft, the most important advance in naval construction to that time.

The turret of the *Monitor* was a startling innovation. It consisted of a short cylinder nine feet high and twenty feet in diameter resting on the deck. It was covered with a grating of iron rails, equipped with sliding hatches. The turret was constructed of wrought iron plates, eight in number, each one inch thick. The plates were accurately faced and firmly bolted together. A flat, broad ring of bronze was let into the deck, making a water-tight joint for the turret.

Ericsson's own description of the machinery was: "The motive engine, the construction of which is somewhat peculiar, consists of only one steam cylinder with pistons at opposite ends, a steam-tight partition being introduced in the middle. The propeller shaft has only one crank and one crank-pin, the difficulty of 'passing the centers' being overcome by the expedient of placing the connecting rods, actuated by the steam pistons, at



From Scientific American, 1867

The steamer *Dean Richmond* of the People's Line, New York to Albany

right angles to each other. The propeller being of the ordinary four-blade type needs no description . . . ." The diameter of the propeller, according to the records, was nine feet. The height of the smokestacks, under non-combat maneuvering, was six feet, and the blower pipes extended above deck a matter of about two feet. In action, however, stacks and blower pipes were cleared away.

While the *Monitor* was being hastily constructed, the Confederate ship *Virginia,* formerly the U. S. Frigate *Merrimac,* was being converted to an ironclad of a different and radically new design. Before the arrival of the *Monitor,* the completed *Virginia* created havoc by destroying several Federal warships of wooden construction, their cannon fire glancing harmlessly off the *Virginia's* slanting armor. It was the *Virginia,* in reality, that first proved to a startled world that wooden warships were helpless under the attack of an ironclad. The fear aroused by the evident power of the *Virginia* was the main factor that caused day-and-night work on the *Monitor,* which was still far from complete as a tug towed her to Hampton Roads, leaving New York on March 6, 1862.

On March 9th, the two completely new types of warships met, the first historic encounter between ironclads. The resulting engagement proved only that, essentially, one ironclad was a match for another.

The activities, the evident potentialities of the ironclad, however, completely revolutionized naval architecture, spelled the doom of wooden warships, and ushered in a new era of naval warfare.

OIL AS FUEL—Following the end of the Civil War, American maritime progress, in both merchant and naval vessels, was slow and cautious. Yet only a few of the experiments failed. Notable was the Navy's first experiment in 1867 of burning fuel oil. The test proved to be abortive and the adoption of fuel oil was delayed for at least a quarter of a century.

Crude oil as a fuel was first used in a Russian ship in 1861. The atomizing principle, introduced a few years later, had a shipboard trial in 1870. It was used in some American warships as early as 1902, but at least another decade was to pass before it came into general use in boilers on merchant ships of the United States.

At first, because of the high price of fuel oil, cost was prohibitive. However, as refining processes improved and as the production of crude oil increased, fuel oil became a by-product of refining and became available at extremely low prices. Low fuel costs gave American ships a small but important economic advantage over foreign flag ships owned by nations not fortunate enough to have a great and expanding oil industry.

The growing oil industry demanded specialized types of ships for the transportation of their products. From 1870 through to the present day, American tankers have always been the finest ships of their type ever designed or built. A modern tanker may cost as much as $3,000,000 and be able to carry 140,000 barrels of petroleum products thousands of miles. The modern tanker is fast, able to slide alongside a modern warship and refuel while both ships are under way. This practice has given American ships an extreme cruising radius. Time was when a warship could only steam so far from a coaling base and then had to return for refueling. Oil is a cheap, dependable fuel, easy to store, and, above all, relatively easy and fast to handle at all times.

In some respects, advancement in naval architecture stemmed from the United States Navy. In 1850, the Navy first tested out forced ventilation, an innovation that later was generally adopted in all types of mechanically propelled ships and one which gave engine-room crews a comfort they never dreamed was possible.

One of the most forward steps in the maritime field was the passage in 1883 by Congress of a Bill which authorized the construction of the first all-steel warships for the United States. The measure specifically stated that all steel to be used in the construction of the warships *Atlanta, Boston, Chicago,* and *Dolphin,* was to be of domestic manufacture.

The steel industry immediately responded, and the encouragement given it by this measure was to be a major factor in the subsequent growth and skill that today characterizes the American steel industry and which makes it the best and biggest in the world.

Metallurgy played an important part in the development of shipbuilding in the era from the Civil War to the turn of the century. Steel-making was rapidly advancing and new techniques of rolling in the mills had a direct influence on the size of the steel plates for the hull. On the famous *Great Eastern,* launched in 1858, these plates could be but 33 inches wide and 10 feet long. Forty-one years later in the second *Oceanic,* the plates were 4½ by 25 feet; 11 years later the plates used in the *Olympic* were 6 by 30 feet. Riveting, later to be largely displaced by welding, became faster. Once it took five men to head one rivet; now it is done by two men, and done faster.

BETTER ENGINES—About 1881, according to historical records, the triple-expansion engine began to replace the compound engine. As a result, the speed of some American warships increased to 19 knots. Later, several naval craft were equipped with vertical triple-expansion engines. On the torpedo boat *Ericsson,* these engines performed magnificently, according to accounts of the day. With a steam pressure of 250 pounds, and at 264 revolutions per minute, the ship was driven at a speed of 21 knots. The boilers were regulated by blower engine throttles in the engine room. In a three-hour test run, the *Ericsson* was driven at 22.5 knots and two pounds of coal were burned per hour per indicated horsepower, a notable record for the period.

The application of the steam turbine engine to our steamships dates back to 1894, but the development was necessarily slow because of certain difficulties encountered. For example, the turbine principle could not be put into practical use until modern alloys and metallurgy permitted the necessary high peripheral speed—this in turn could not be brought about until electronics developed in certain directions.

In 1894, the *Turbinia* was built, fitted with turbines. The ship was not accepted, however, until 1897. The *Turbinia* proved to be a power laboratory which speeded up the development of this type of ship.

The first Diesel engine was used as a power plant on a ship in 1902. The Diesel, using a cheap fuel and with no complicated electrical units, became popular by 1910 when the first ocean-going motorship, the Dutch tanker, *Vulcanus,* a 1200 deadweight ton ship, made a successful crossing of the Atlantic.

The following year nearly 400 Diesel-powered ships were in process of construction by various nations. Probably the most famous Diesel-powered ship known today is the *Gripsholm.*

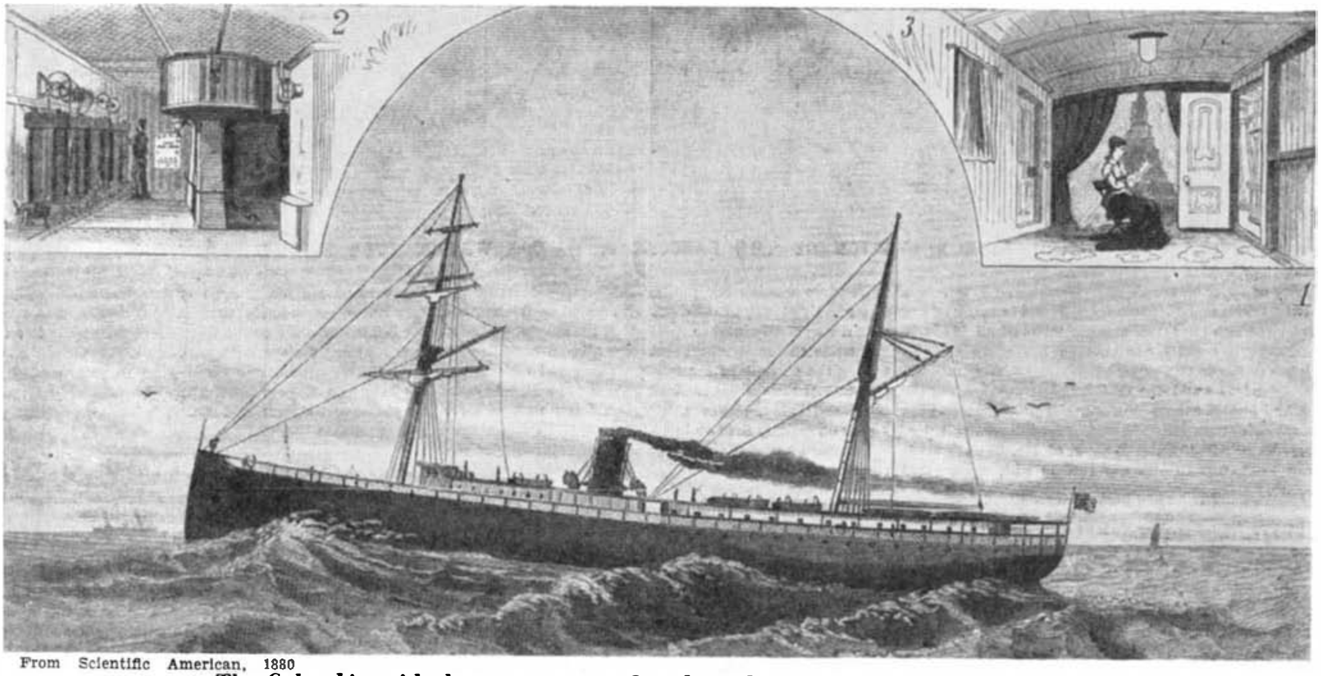
During World War II, Diesel development showed great and impressive advances in efficiency and economy. Most of our landing craft are so equipped, including the famous LST's that performed so notably.

TONNAGE SHRINKS—The interval between 1870 and 1900 was one in which the American merchant marine did not prosper. A combination of circumstances was responsible for a shrinkage of tonnage over the period. As evidence of the decline experienced, in 1870, our total merchant ship tonnage was about 1,448,000. In 1880, this had dropped to about 1,314,000; by 1890, the total tonnage was approximately 928,000; by 1900, it had dropped to about 816,000 tons.

Obviously, in such an era, hull structure and engine and boiler design did not show any startling developments. Most American merchant ships, struggling for existence against the faster, larger, and heavily subsidized foreign flag liners, had extreme difficulty in operating at a profit. Only the innate courage and the high ambition of ship operators and shipyard management kept the American merchant marine alive.

From the Civil War to the turn of the century, progress in marine engineering was slow. Each advancement of new things for strictly land use eventually find themselves on a ship. Electricity today plays a major role in ship operation. Its use was slowly and patiently developed.

Modern merchant and naval vessels incorporate improvements that have been an entire century in the making. As time has passed, American shipping has had many ups and downs. In the background, however, it has, fortunately, been possible to preserve an American shipbuilding industry, so vital to the economic and physical welfare of the nation. The many advances and improvements that today characterize American merchant and naval ships, owes much to the privately operated shipyards of the nation. These yards performed miracles of production in World War I — but their stature grew immeasurably during the period of World War II.



From Scientific American, 1880

The *Columbia*, with dynamo room at 2 and an electrically lighted stateroom at 3

Thanks to enabling legislation, American shipyards have been able to outbuild the rest of the world. In one year (1943) nearly 20,000,000 deadweight tons of merchant ships were built—employment in shipyards was 1,723,000 in 1944.

In normal times, when only one or, at most, a few vessels of a type are under construction at the same time in a shipyard, skilled employees will represent about 50 percent of the total employment. In the war program, however, a very small percentage of those who were employed had all-round shipbuilding experience, or had spent any considerable time in the business. The ability to build ships with less experienced men and inexperienced women arises from the multiple production of ships; that is, the production of a large number of ships of only one type, or of a very limited number of types, in any one shipyard, and it has made possible the adoption of some of the methods of production that are used in the mass-production industries, such as the automotive, sewing machine, farm machinery, and other industries, although the multiple production of two or three hundred ships of a type can hardly compare with the mass-production of 300,000 or more automobiles of one model.

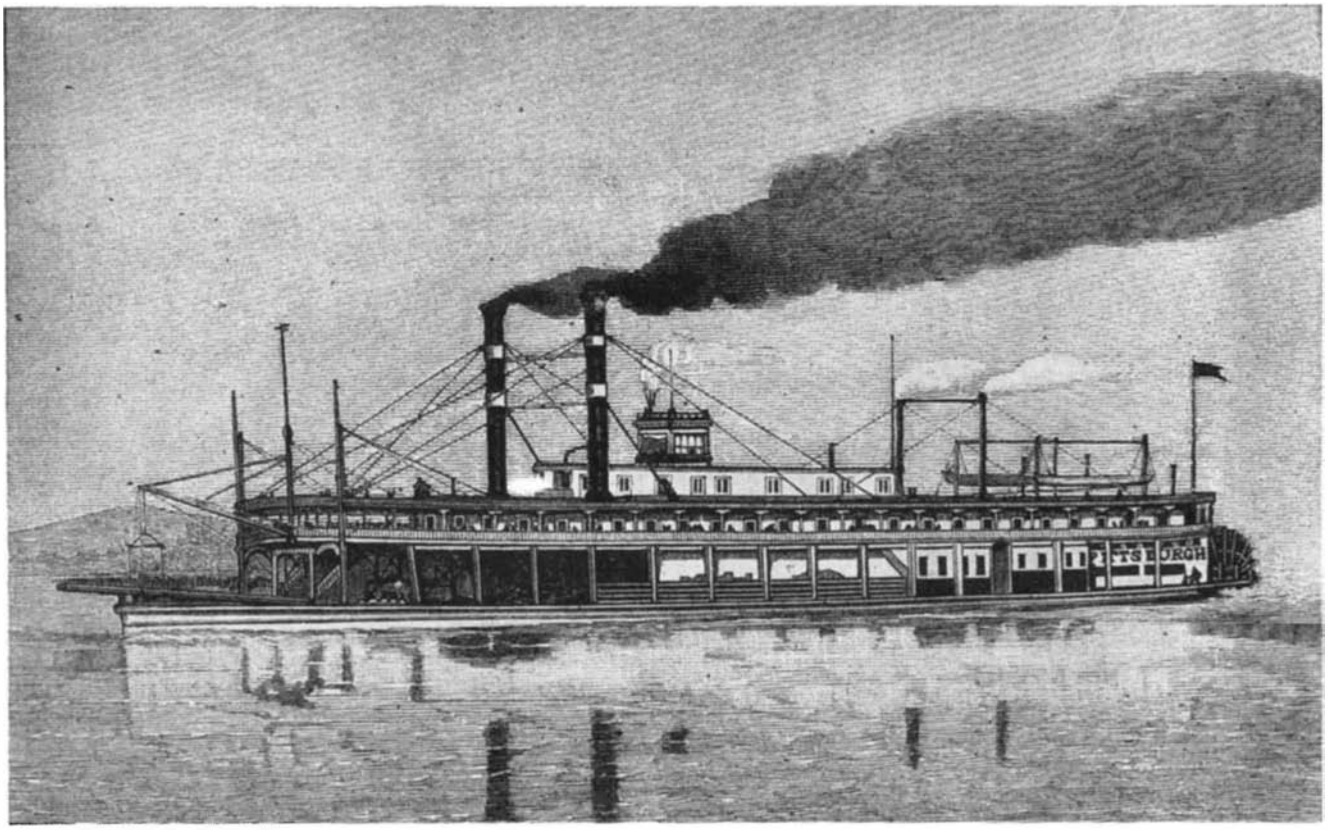
BRAINS AND SKILL—The shipbuilding and shiprepairing industry takes great pride in having met the demands both of the Maritime Commission and the Navy in the call for ships for the war emergency, but it would have been impossible to accomplish this result unless there had existed in the industry, at the outbreak of the war, a group of technical men experienced in the design of ships and a nucleus of skilled mechanics versed in the problems of construction.

As already known, men and women can be trained quickly to perform repeat jobs in the building of ships, but they cannot be trained, except over a long period of years, in the design of ships. Without men experienced and proficient in the art and science of naval architecture and marine engineering, the program of World War II could not have been carried out; it is most fortunate that for a period of ten years such opportunity was afforded to the industry in both the commercial and the naval fields.

One of the most fruitful opportunities for the naval architect and marine engineer resulted from the Merchant Marine Act of 1928, under the provisions of which 31 high-class combination passenger and cargo vessels were built in the United States. These ships were the last word in merchant ship design and equal to the best produced by any other maritime nation in the same period. This opportunity in the merchant field was implemented by a similar opportunity in the naval field. A small volume of construction of naval vessels was maintained in the period following World War I, and from 1933 to the outbreak of World War II there was an accelerated building program giving the naval architect and marine engineer an opportunity for continuous work in the development of designs of the highest classes of naval vessels.

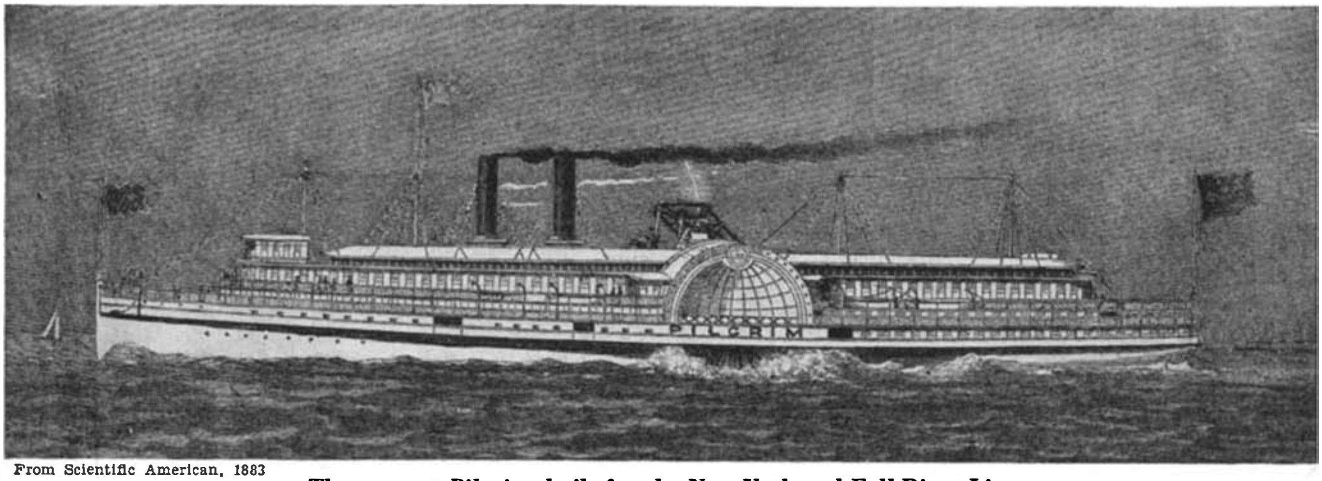
New tasks were imposed on our growing fleet of warships during World War II. This was responsible for certain changes in design to meet new conditions. In the Pacific, for example, it was necessary for our warships to be able to cruise at least 6000 miles without refueling. Our fleet tankers are the largest and fastest, designed to keep pace with a battleship and carry out the refueling while at top speed, a delicate maneuver made possible by American ingenuity.

INVALUABLE LESSONS—Two world wars have taught both American shipbuilding and shipping interests great lessons that should be more generally recognized. First of all, to have a great and useful Merchant Marine, it is necessary to have always a basic and vigorous shipbuilding industry, one that will have personnel and management to plan the best, to be able to meet every possible emergency. If the shipbuilding industry of



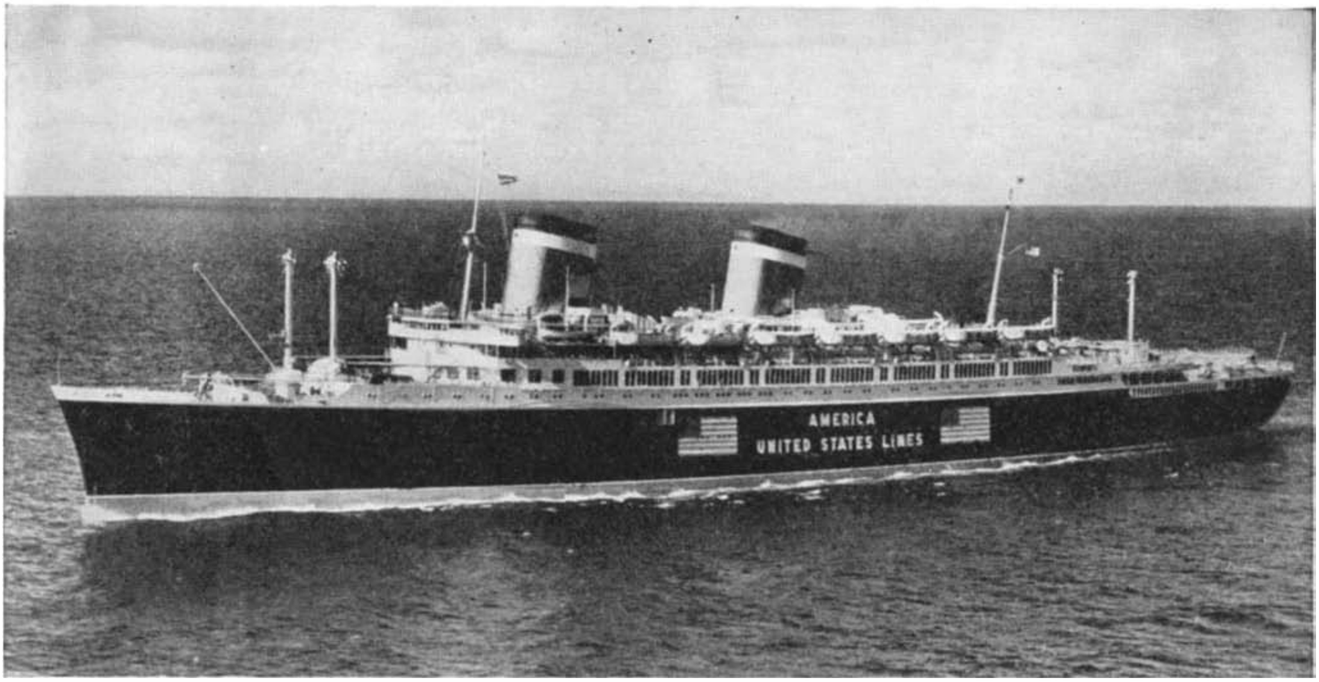
From Scientific American, 1880

The light draught steamer *Pittsburgh*, a perfected stern-wheeler



From Scientific American, 1883

The steamer *Pilgrim,* built for the New York and Fall River Line



The *America,* largest and finest passenger liner ever built in the United States

this nation, now the greatest in the world, is permitted, through lack of business, to disintegrate, the economic and physical welfare of America may be endangered. Privately operated shipyards have built a very high percentage of the country's fighting ships—built them fast and well. America can ill-afford to lose the men and the management that has made this possible.

The future of the American Merchant Marine and of the vast and valuable shipbuilding industry of the nation must be viewed with much consideration of all of the facts that are involved. There are so many indeterminates in the balance that any appraisal is virtually a guess.

America ended the war with about 50,000,000 deadweight tons of merchant ships. That is, on paper, the largest merchant marine in the world. However, despite the quantity, the peace-time economic operation of such ships is a manifest impossibility.

POST-WAR—Estimates vary as to the extent of America's post-war merchant marine. One estimate, largely acceptable to many of the interests involved, includes the following: 7,500,000 deadweight tons in foreign trade; 3,800,000 deadweight tons in coastal and intercoastal operation; 3,500,000 deadweight tons on the Great Lakes and 2,500,000 tons on the rivers.

What will happen to the surplus ships? Here again is an important indeterminate. Plans have been advanced for the disposal of the ships, aside from those which will probably be retained by the Navy as auxiliaries. With a Five-Ocean Navy, American naval requirements will be heavy. Before Congress is a Ship Disposal Bill, the status of which is still unsettled. What ships will be sold, to whom they will be sold, and under what terms, are only a few of the factors involved in this all-important piece of legislation. Will the United States follow a plan that has many proponents and sterilize millions of deadweight tons of merchant ships in some fresh-water sanctuary, against a possible emergency? If so, how much tonnage? Will the slow Liberty ships, which will constitute a large proportion of our ship resources, be junked? Or will they be sold to foreign nations?

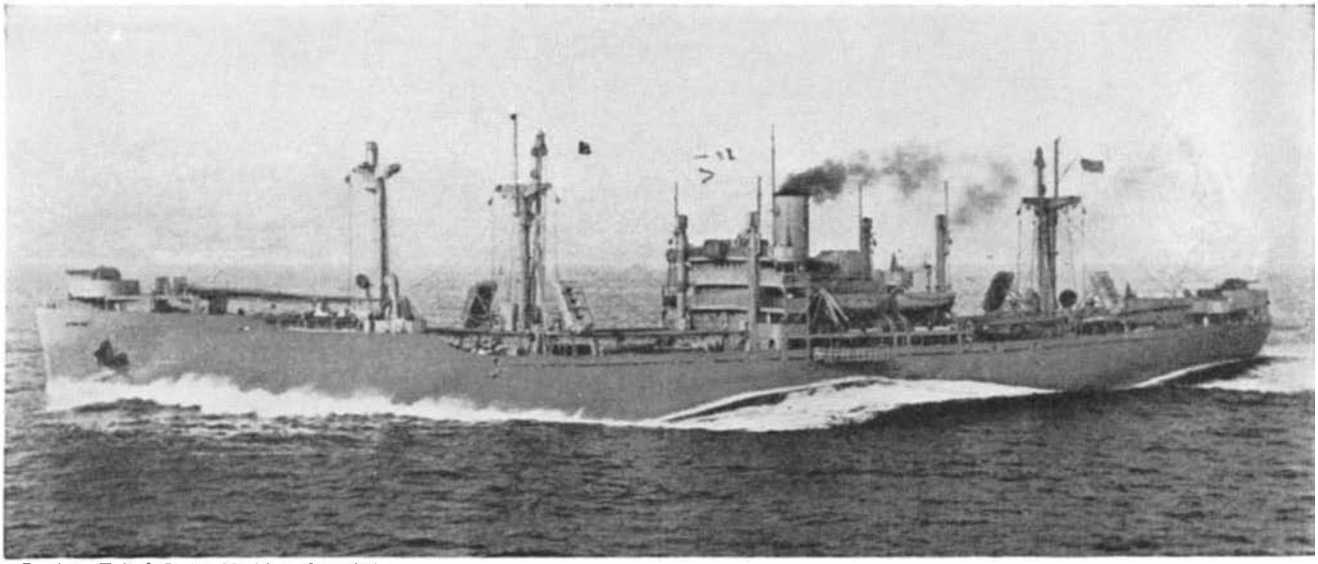
How many privately owned ships that were in war service will be worth reconversion? Certainly, it is doubtful if some former passenger ships can be economically reconverted. Cargo ships, in many instances, can be reconverted, according to some authorities.

What about the foreign flag competition which American merchant ship operators will have to face? It will undoubtedly be severe. It is bound to be alert and very aggressive. To date, fully 26 foreign shipping lines have announced that in the near future they will operate planes over the routes traveled by their ships, offering the public a combined service, under single management. Such services, according to every American survey, will prove popular. They are already in demand. Unless similar privileges are granted to American steamship lines, American air passenger service overseas will be driven straight into the arms of foreign competitors and American passenger lines will suffer serious losses of revenue.

How about the volume of foreign trade? No one knows or can even estimate the volume and flow of future foreign trade. Some claim it will be the greatest America has ever had; others take an opposite view.

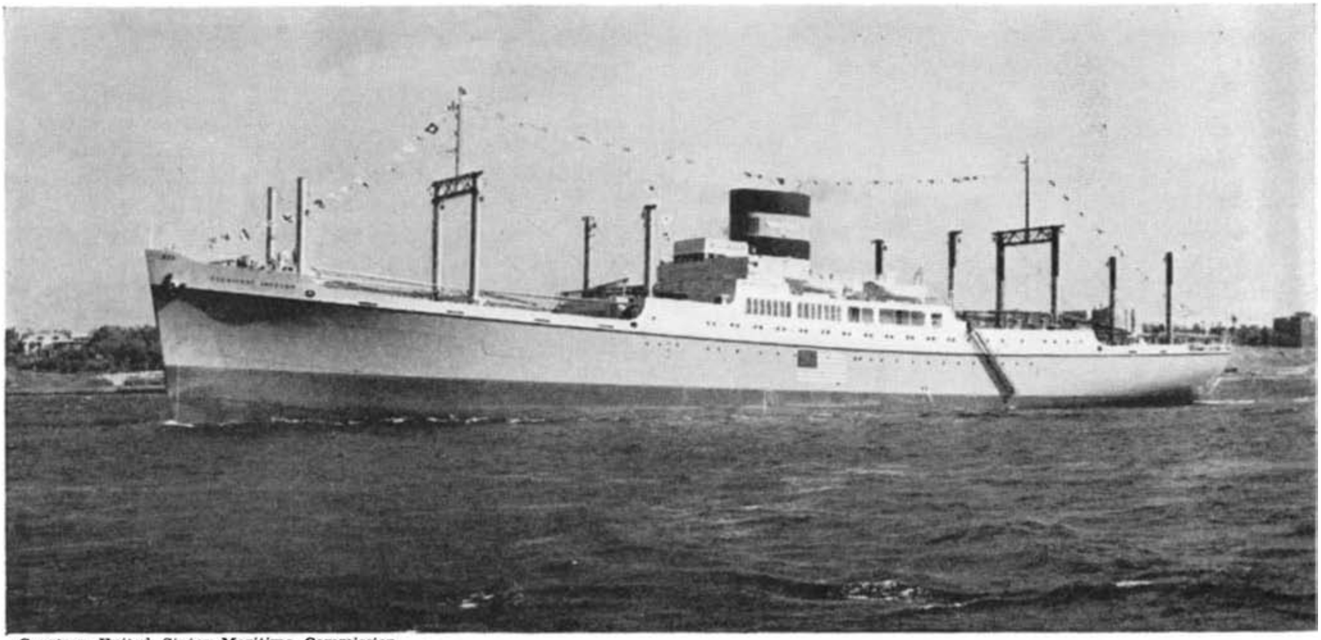
The indeterminates are many and important. American ship operators have to consider all of them, to weigh just how each will influence their particular spheres. Above all, they must be able to operate with a sufficient profit to enable them to replace their ships when the time comes for such action. Big cargo or passenger ships represent a heavy investment. It is an investment the shiplines are willing to make if the future is clearly charted. They want to build new and better ships. No one plans, to the best of this writer's knowledge, to build ships of a size equal to the *Queen Mary* — but several lines are willing to build fine passenger ships of at least 40,000 deadweight tons, providing they have a chance to operate such vessels at a reasonable profit. Many will build passenger ships of 20,000 deadweight tons.

Many of these factors have a distinct urgency about them. Some of them will have to be settled soon — and in the public interest. In the meantime, the only possible prediction in regard to the future of American shipbuilding and the shipping industry, is to say that they have the personnel and the facilities to produce fine, safe, efficient, dependable ships — and they have the trained personnel to man them. What the ships will need will be American passengers and cargo — and the wholehearted support of the nation.



Courtesy United States Maritime Commission

A Victory Ship of World War II



Courtesy United States Maritime Commission

Passenger and cargo ship, *President Jackson*

Plastics Take To Water

Conventional Materials and Methods of Boat Building Are Yielding to the Newer Plastics. Advantages Offered in Boats Big and Small Include Resistance to Corrosion and Fungi, Easy Workability, and High Strengths. Paints, Plywoods, and Laminated Wood all Enter the Picture

TO WHAT extent you will be aware of plastics in boats of tomorrow will depend upon whether your interests center on luxury liners, freighters, yachts over 60 feet in length over-all, or smaller boats and cabin cruisers.

If your concern is with the bigger ships, you'll need to delve into the ship's operating mechanisms before you realize what a vital role plastics have come to play. In a battleship, for example, the entire nerve system of the ship is encased in plastics. In a typical battle-wagon, insulating materials made of plastics protect from 850,000 to 1,000,000 feet of wiring.

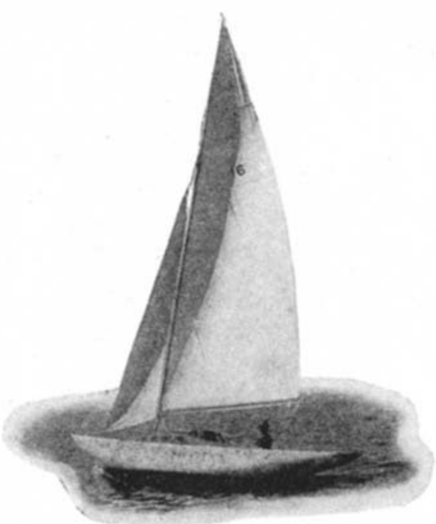
In large part, the sensational performance of these wires and cables can be attributed to the wedding of electronics with plastics. Without plastics' dielectric qualities, many of today's electronic miracles would be impossible. The principal plastics used in Navy cable are the vinyls and polyethylene. A great portion of this cable is armored; sometimes there are two layers of armor with insulation between. Vinyl resin has generally replaced rubber as insulation material in these applications, particularly in coaxial cable. As for polyethylene—very little can be told at the present time relative to its use in cable. Greatest significance, perhaps, lies in the fact that a comparatively thin layer has high insulation qualities.

In this same electrical field, polystyrene is performing almost unbelievable feats in insulator equipment, and phenolics and phenolic laminates—the old standbys—are much in evidence. There are, too, melamine and glass fabric control panels and switchboards.

PAINTS — Synthetic-resin paints have proved their worth on large and small boats alike. Their most important property for marine use is their exceptional hardness. Synthetic resins in special formulations for wood and metal, for interior and exterior, for topside and bottom, for enamels and varnishes, also offer superior weathering qualities, resistance to alkalis and corrosion, and to moisture and vapor.

Fighting "seabeard" by keeping anti-fouling paint films soft and thus allowing the poisonous ingredients to attack barnacles and other fungi freely is the job of methyl dihydrobitate and tricresyl phosphate plasticizers and cuomarone indene and vinyl resins used as paint extenders and softening resins.

Plastics also play an important part in propeller shaft and rudder bearings. Actual operating experience has demonstrated the advantages of laminates made up of cloth impregnated with phenol-formaldehyde resin for these applications. Tests show that bearings of this material wear three times longer than those made of wood. On one ship, for example, after approximately 70,000 miles travel, the resin bonded composition bearings showed only 0.045 inch wear, with almost no wear on the shaft liner. Lignum vitae bearing, used under precisely the same conditions, showed 3/8 inch wear with the shaft liner worn up to 3/16 inch.



Courtesy Luders Marine Construction Company
Molded plywood for pleasure craft gives greater latitude in hull design and fewer owner maintenance problems

The laminated material also weighs less, even when compared with aluminum, has a lower water absorption, and is easier to install and replace.

Polystyrene, phenolic resins, laminated molded macerated plastics, methacrylate resins, and others, will find even more extensive use in direction finders, electric telegraphs and general power equipment. Fog-penetrating devices, automatic steerers, impeller-type logs, supersonic depth finders and ship-to-shore telephones will make use of both polystyrene and phenolic materials for coil insulators as well as for housings. And there are other plastics units that have seen successful service in big boats.

UNDER 60 FEET—It appears at present that the use of plastics afloat will be in inverse proportion to the size of the boats. Thus, the rosiest field will be in the smallest types—that is, dinghies, top-o'-car boats, outboard motor boats, racing shells, canoes, small sloops, and large rowboats. In the larger types of sailing boats and cabin cruisers, plastics will be used both inside and out to reduce costs and to increase comfort and luxury as well as ease of operation and maximum efficiency.

The anticipated extended use of plastics in smaller boats is tantamount to a minor revolution in boat building. Naval architects and builders have long been considered incurable traditionists. Skilled craftsmen painstakingly have built sea-worthy boats from teak, mahogany, and brass. Persons fortunate enough to own one of these boats have brought it through the seasons by caulking, sanding, painting, and polishing. Boats have been expensive; demand has, therefore, been small. None dared to challenge tradition.

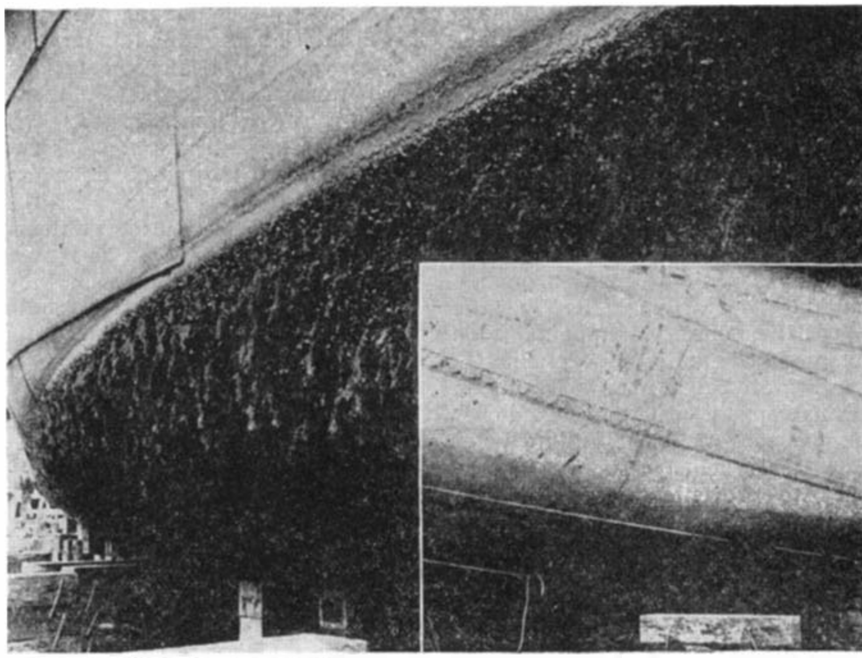
But with Pearl Harbor came the need for PT boats that could take the buffeting of choppy waters at incredible speeds, for life-boats light enough to be airborne and strong enough to drop on heavy seas, for hundreds of coast guard, landing, river crossing, and other small craft to be constructed by the thousands in record-breaking time with no sacrifice of sea-worthiness.

Traditional production techniques were too slow, traditional materials not always suitable. Under the stimulus of this emergency the boat industry began to break with the past, to adopt plastics for hulls, superstructures, and decks.

There are some, of course, who are reluctant to abandon the old methods of boat construction. It is the claim of this group that you can never tell how a material will behave until it has been exposed to a season's wear followed by a winter in storage. They add that it is one thing to test a material for weather exposure or submersion, quite another to put it into actual use where motor vibration, high speeds, heavy seas, and any number of unforeseen conditions might prove it unseaworthy.

The greatest controversy rages around the question of hull materials and construction. The introduction of plastics into the exterior of pleasure boats came with sheet plywood used in such non-structural parts as cabin walls and roofs, for decking, planking, and side-plating. This early plywood, which was bonded with albumin and casein glues, had several shortcomings. But the picture has been altered since the development of phenolic and resorcinal-formaldehyde resins which impart greater strength and resistance to water and fungi.

It is estimated that about 5000

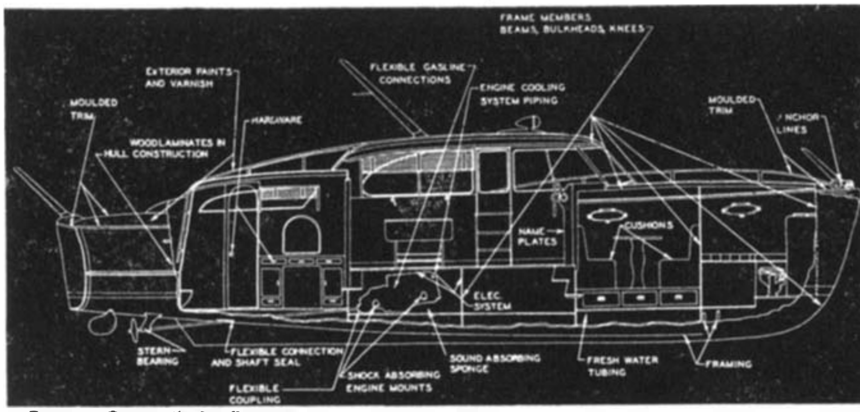


Courtesy Hercules Powder Company

Heavily fouled section of the hull of a steel ship and, inset, another portion of the same hull, treated with anti-fouling paint, after comparable period of exposure

boats of molded hull construction have been produced for the various services during the war. In this process, wood veneers are spread or sprayed with resin, secured over a male form whose outlines conform to the shape of the boat. After this assembly is sealed in a rubber blanket, it is placed in an oven where it is subjected to rigorously controlled heat and pressure to polymerize the resins. After a specified time it is removed from the oven, stripped of the rubber bag, and cooled with a water spray.

HULL DESIGN—The use of resin-bonded plywood allows considerable latitude in hull design. In the L-16, for example, 25 or which were delivered to racing enthusiasts this last Spring, it was possible to construct a pointed bow and a rounded stern since plywood can be formed into such shapes without wastage of material such as there would be if conventional lumber were used. It is claimed that the stressed skin



Courtesy Owens Yacht Company

Some of the possible uses of plastics on a de luxe cabin cruiser

construction means that the boat is better able to withstand the stresses of choppy waters and high winds. Further, there is a considerable strength-weight gain when plywood is used—plywood being the strongest material for its weight that is known. Plywood has high rot and teredo resistance due to the protection the resin gives the wood fiber, and its use minimizes boat upkeep because the material stays put once it is in place.

An important factor with regard to the use of plastics laminates in pleasure boat hulls is the amazing increase in the strength of plastics moldings when a fiber reinforcement is added. These reinforcing materials include glass cloth, canvas, paper, manila fiber, rope yarn, and needled felt.

Sandwich constructions — with outer canvas covers or mahogany veneers combined with low-density cores of air-filled regenerated cellulose, honeycomb glass fiber construction, or styrene fiber—offer promise that a buoyant structural material is on the way. However, in models which have been developed up to the present time, buoyance compartments—in many cases filled with expansion plastics—have been incorporated as the principal safety factors.

An experimental 17-foot centerboard-type, sloop-rigged sail-boat molded of phenolic impregnated sisal rope fibers shows the refinements of design possible with this material at the same cost, when produced in quantity, as conventional wood hulls. The ease with which the material is formed makes possible any streamlining deemed practical by the designer. A wide-curved bow—a dry type of construction seen in many new boats—is easily produced from the material, as are the combination round-and-vee-bottom hulls.

LAMINATED TIMBERS—When the Navy small-boat program ran into difficulties in procuring enough suitable timbers for its gigantic needs, laminated timbers were adopted. Synthetic glue manufacturers were called upon to formulate resins capable of setting at a lower temperature than the boiling point of water. Such a resin was necessary to prevent excessive loss of moisture from wood in large laminated cross sections during drying, which would tend to weaken the structure. These laminated members permit the use of up to 60 percent low-grade and short-length material in the interior section.

Parts and sections produced to advantage by laminating include aprons, deck beams, binding strakes, booms, cappings, deadwood, frames, horn timbers or counter timbers, keels, keelsoms, knees, risers, shaft logs, side fenders, spars, stems, stern posts, stringers, towposts, transoms, and so on.

Laminated structural timbers have, of course, been in use over 10 years. But prior to the war they were useful only when they could be protected from weather and humidity. Improvement and development of various types of resins made possible laminated parts capable of withstanding the severest kinds of exposure. Properly used, these resins form a joint stronger than the wood itself.

Whatever the future holds, plastics materials will be bound up with boat building. And the prestige that will emanate from their acceptance by conservative boat builders will be felt in many ways. The yachtsman's approval is a goal to work toward.

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MOLDED WOOD

Uses Plastics to Mutual Advantage

WOOD has now become so closely allied to plastics that it can be molded in dies under heat and pressure in a way that greatly enhances its natural physical properties and beauty. S. H. A. Young and R. A. M. Palese, of Engineering Associates, in discussing this development, point out that brush backs, knife handles, knobs, and handles of various types which are formed from impregnated and molded solid wood not only possess the beauty inherent in the original wood but are rendered water, acid, alkali, and heat resistant as well. The pieces are also said to possess improved dimensional stability.

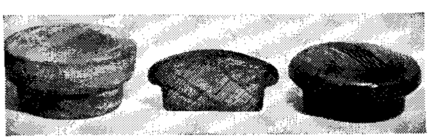
The process is relatively simple and the final cost of the article is moderate. A large factor in the low cost is the elimination of the costly finishing necessary on natural wood.

Photos courtesy Engineering Associates

Knife handles made in two parts of molded wood have high strength and hardness, and natural wood beauty

It is also possible in many cases to eliminate as much as 90 percent of the preshaping work. A relatively rough preform develops full mold contour and a high mirror-like finish that is much more than skin deep.

After drying, the wood is placed in a sealed chamber and a vacuum



Preform and finished molded wood knob, with knob section in center

applied and maintained at from 23 to 28 inches for 30 to 60 minutes. After evacuation, resin is admitted to the chamber, and pressure ranging from 150 to 300 pounds per square inch is applied and maintained from one to three hours. Immediately upon removal from the impregnation chamber the treated pieces must be air dried. It has been found that a 12 hour air dry is adequate for most woods, depending, of course, upon the surface area-volume ratio. Then comes oven drying.

The temperatures used in the molding depend upon the type of resin used. Urea, melamine, and phenolics lend themselves readily to the impregnation method. The molding time required for impregnated wood is comparable with that required for equivalent thicknesses of conventional compounds. Mold closing time, however, is somewhat longer for impregnated wood, due to a greater rigidity in the preform. The use of electrostatic preform preheating and of a split molding cycle are two promising possibilities as far as the molding time factor is concerned.

While molded wood falls within the classification of high-impact molding compounds, it is interesting to note that the required molding pressures are far below those required for its conventional counterparts. Pressures in the range of 200 to 1000 pounds per square inch have produced very satisfactory high-strength molded-wood pieces of excellent quality.

Up to the present time this technique has been successfully developed in the laboratories of Engineering Associates for use on such products as knife handles, toy parts, textile items, knobs, pot handles, and other products. While these articles are generally small, there appears to be no reason why molded wood may not be equally successful for much larger units through the use of multiple preforms. This would indicate a potential use in furniture components, such as arm rests, high-chair trays, caster wheels, and table tops.

PLASTICS COATINGS

Applied by Use of Dipping Lacquers

COVERING articles such as handles of kitchen utensils and tools, long bars, and the blades of screw drivers with a plastics coating can be quite a problem. This is particularly true when the items do not justify the use of expensive dies which would be needed were they to be covered by injection molding. Again, the shape and character of the pieces may be such that spraying would involve substantial solvent loss.

If such is the case the solution may lie in the use of cellulose acetate butyrate (Tenite II) dipping lacquers. These lacquers, which are made by dissolving cellulose acetate butyrate granules and pellets in suitable solvents, produce hard, thick, tough protective coatings varying in thickness from 0.005 to 0.010 inch. Greater thickness of coating is obtained by increasing the solution viscosity or by repeated dipping. The lacquers are available in any color and any degree of opacity. Suitable as a covering for articles molded of cellulose acetate butyrate as well as those molded from certain other types of plastics, they can also be used to coat metal and wood.

Export Packaging Is Different

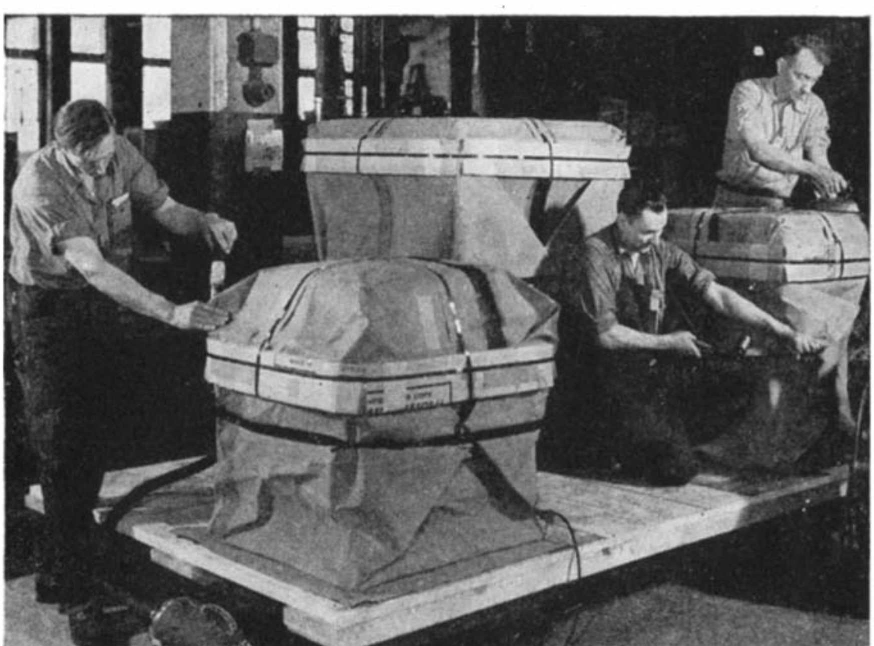
Attention to Important Details Assures that Instruments, Machinery, and so on, Will Reach Their Destinations Undamaged, Mechanically or by Corrosion. Product Protection for Many Items is More Necessary Today than Ever Before. Many Problems Must be Studied and Solved

A MANUFACTURER of fine precision instruments recently shipped a dozen of them to a tropical country. Soon after their arrival he received a number of complaints from the customer. Polished steel surfaces had corroded enroute, electrical insulation was failing, supersensitive bearings were sticking instead of turning at the slightest application of power. To save time and trouble he had them all returned for full credit.

This incident started a complete restudy of that manufacturer's export packaging and anti-corrosion protective methods. Similar studies must be made by thousands of manufacturers if our country is to do the volume of foreign business which nearly everybody anticipates.

First of all was the corrosion problem. The rust preventive methods which were perfectly adequate for shipping within the United States would not do at all for foreign markets. The extreme changes of temperature which the packages might meet while being shipped abroad—all the way from far below zero in a high flying airplane to more than 120 degrees above zero in the hold of a river steamer—would defeat the rust preventives which had been used for shipments to local markets.

A more effective type of corrosion preventive might solve this. But there was another problem. The electrical troubles had been caused largely by using an improper solvent to clean the corrosion-preventing compound from the steel and letting the solvent spill onto electric wiring and insulation. It was plain that the new corrosion preventive would have to be a type which could be wiped off without the use of solvents.



Courtesy Western Electric Company
Heat sealing and exhausting of excess air from an export package

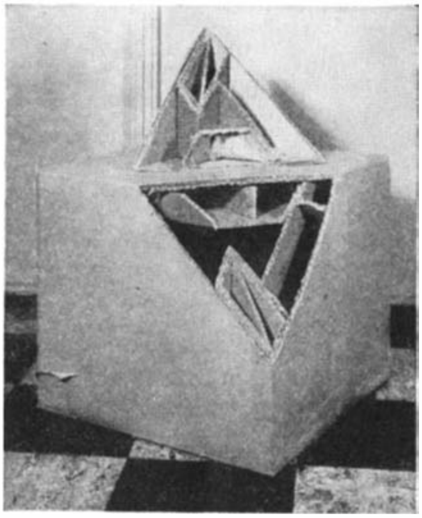
There also was the problem of where the corroding moisture had come from. The exterior of the package seemed to be adequately moisture resistant. Some moisture might have been exuded from the packaging materials, since the fiberboard and paper commonly used in packaging depend upon high moisture content for strength and will give off moisture at certain temperatures. But no one explanation seemed to furnish the complete answer.

The bearings had been damaged partly by the solvent, partly by moisture, and partly by the fact that the packaging materials and the structural designs of the members which braced the instruments within the packages were inadequate for the rough handling and other shocks of export shipping.

PACKAGE ATTACKED—The first attack upon this problem was directed at the package itself. A moisture-proof, heat-sealed, envelope was designed to enclose the entire instrument. With this, any moisture which, due to shocks that might rupture or weaken the moisture-proof barrier at the outside of the package, penetrated into the interior, would have to pass a second barrier before reaching the instrument itself. The inner envelope would protect against moisture exuded from all but the small quantity of cushioning materials which had to be within it.

The structural bracing within the package was improved in design. Formaldehyde-urea impregnated corrugated fiberboard was used for the bracing—a material which is stiffer, more moisture- and wear-resistant than the kraft boards used for domestic shipping. This assured that even under severe handling the braces within the package would not break down, with resultant damage to the instrument.

Studies were made of the possibility that the inner envelope might be so chafed by the structural bracing which would rub against it that it would lose its protective properties. It was found that at the highest temperatures which the package might reach the air pressure within that envelope would increase to the point where the envelope was stretched or expanded outward toward the bracing, thus increasing the chafing danger. A vacuum line was rigged to remove the excess air from the envelope, with the envelope immediately being heat sealed to prevent re-entrance of air. No attempt was made



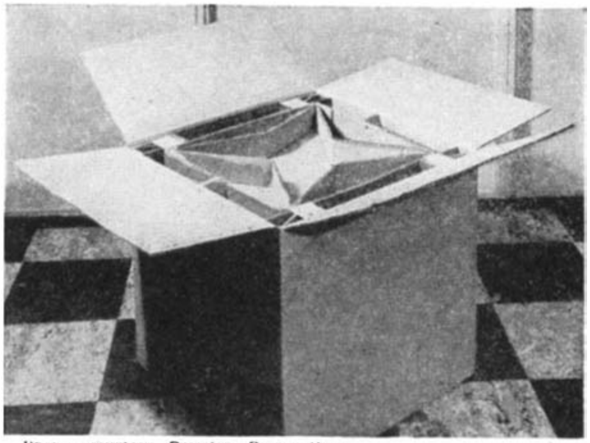
to create a vacuum; the object being only to collapse the envelope about the instrument so that the drawn-in portions would be available as expansion areas when the remaining air became heated.

To reduce still further the possibilities of chafing, flat sheets of corrugated fiber board were placed between the bracing members and the inner envelope. This made the entire package a "box within a box," a floating construction which would be shock absorbing to a high degree.

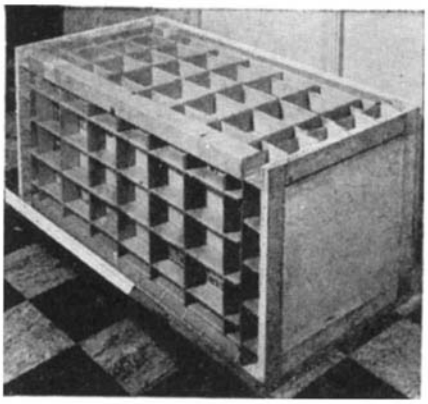
With this arrangement the outer walls of the package could actually be punctured by rough handling and the instrument would still have a high degree of protection.

The inner box then was redesigned so it also could be sealed against moisture, providing a third barrier. Within this would be placed activated silica gel which would absorb any moisture that might be exuded by the packaging materials themselves. The package then had

Right: Bracing members of this strong package lift out as a unit. Lower left: Interior package bracing needs careful structural design. Below: One of the last packaging operations before the final sealing



Photos courtesy Crossley Corporation



four-way moisture protection—outer wall, inner wall, silica gel, and inner envelope.

RUST PREVENTION—A new rust preventive compound was adopted for the fine steel surfaces—one which required only to be wiped off with a clean rag and which would be an excellent lubricant for the bearings if it got into them. This compound, although light and thin, was high in its water and moisture displacing abilities. If water actually got to the steel, the compound would tend to lift it off and let it flow away. And although the new preventive was not so completely protective as the old, harder, and heavier one, the instrument maker knew that any handling of the package which was rough enough to puncture the inner envelope and let large amounts of water get at the instrument would be likely to do enough mechanical damage to ruin the instrument so that further damage by rusting would be of no consequence.

The electrical parts were protected by a compound which is resistant to oils, solvents, and moisture, and which would continue to protect through long periods of service. Heat would only harden this material. Similar materials give long-time protection to the exteriors of spark plugs and other electrical parts even when in service on airplane engines.

The completed package received the usual drop tests to observe the effects of rough handling. But the company wanted to be sure that a machette-wielding laborer, left to his own devices to open the package, would do no damage.

The top end was marked plainly on the package exterior, and in the language of the country to which shipment was to be made. There was more than three inches of bracing material between the outer box and the inner one, and this would keep any ordinary cutting tool from penetrating the inner box while the outer one was being opened.

The bracing members nearest the cover were arranged so that sections of them would lift out as a unit. Before this was done there was a temptation for the laborer to cut through them with chopping strokes of his machette, and he easily could cut clear through to the instrument and do damage.

The fact that the inner box was to be lifted out as a unit, rather than being torn open while still surrounded by bracing members, was made clear by printed labels which included cartoon drawings of how to lift out and open it. To emphasize the point, and to provide still greater structural strength, the inner box was provided with crossing bands of steel strapping. The directions showed that the inner box was to be placed on a firm and level base, the steel bands cut, the sealing tape torn away at the corners and the sides allowed to fall down. After that the inner envelope could be torn away and the instrument mounted for use.

REDUCED COSTS—Next on the planning schedule was to turn the corrosion protective applications and the packaging into a progressive or "production line" operation to reduce costs.

Every steel part had to be cleaned thoroughly. Thorough corrosion pro-

Courtesy Robert Gair Company
Package and product brace each other

tection is very nearly impossible if there is foreign matter of any kind on the material to be protected. Any finger prints which might be on the materials had to be cleaned off or neutralized, since perspiration is often highly corrosive. And for greatest economy and safety all corrosion protective operations on steel parts had to be performed in an air conditioned, dust-proof room.

There are wide differences in the drying or "setting up" time periods required by various corrosion-resisting compounds. A compound was found for the bright steel parts which required no more setting up time than was needed to drain off the excess after the parts had been dipped in it. This was considerably less time than had been needed for the compound previously in use. It reduced floor space needed for draining and drying the parts, equipment needed for hanging them while they dried, and other costs.

Parts were handled with steel hooks and other metallic devices while being dipped, drained, and dried. With the previous compound these had left bare metal spots which had to be "touched up" by hand. The new compound spread over the bare spots after being released from the holding devices so this cost was eliminated.

The compound used on the electrical parts required eight hours to set up thoroughly, but would form a dust-proof outer skin within a few minutes of application. This, therefore, was applied in a separate room, with the finished electrical assemblies being pushed along a gravity conveyor to an ordinary storage room where they could stand and dry.

Final assembly required taking the finished steel assemblies and the finished electrical ones to an air conditioned room which was kept at 65 degrees, Fahrenheit, so there would be no tendency for the operators to perspire. All of these operators wore clean white gloves. And as a final precaution a perspiration corrosion inhibitor was included in the protective compound for the steel parts.

The instruments were sealed within the inner envelopes and again sealed and strapped within the inner boxes before they left this room, these operations being performed immediately after final assembling and final inspecting to make sure that no metal surfaces had been left unprotected. Storage was in these boxes, the bracing members and outer boxes not being put on until final shipment—a method which saved shelf space.

Companies facing such export packaging problems as these can draw to some extent upon Army and Navy war experiences in shipping of materials to battle areas. But there are two important ways in which the civilian requirements differ from the military. First, commercial goods will not have to meet such severe conditions as military. Second, commercial companies cannot depend upon the openers of packages to be specially trained, specially selected men who are accustomed to following instructions.

Export business will be a larger factor in the future than it ever has been in the past. And thousands of manufacturers will have to make intensive studies of export packaging before they can compete for this business.

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MACHINING PLASTICS

Requires Application of Special Techniques

A HIGH percentage of plastics are made in sheet, rod, or tube forms and must be machined to produce finished articles, and molded plastics pieces often require secondary machining operations such as tapping.

In machining operations, provision must be made for the thermal expansion of the material. Plastics are frequently high in coefficient of thermal expansion, and the methods of removing heat by copious flows of cutting oils, as practiced in metal working, may not be suitable for them. Female centers are preferred to male ones and tolerances on machined surfaces must allow for shrinkage on cooling.

Chip pressures and temperatures generally are not so high as those of metal working. Adequate hardness of the tool therefore can be more important than temperature endurance. When the plastics contain extremely abrasive materials, such as glass reinforcements, the very hardest tool materials (diamonds, cintered carbides, cobalt alloys) may be required.

The pressures which the tools exert against the material may need to be applied in the directions of the greatest volume of the material, or in such directions as to tend to press sheets of laminated plastics together rather than tear them apart. Unlike most metals, many plastics are stronger in some planes than in others (section thickness for section thickness) and so far as is practical the greatest tool pressures should be in the direction of the greatest strengths.

Chip scavenging can be a problem. The chips of many plastics tend to pack rather than to flow freely along the scavenging passages of the tools. The use of cutting oils at ordinary feeding pressures may only increase this packing tendency. Compressed-air blasts can help, and so can streams of cutting oil blasted at high pressure from beneath the tool points. Scavenging passages should be deep and smooth.

WIRING WITH INK

Possible for Low-Priced Radio Sets

IT HAS long been known that various materials could be mixed with printers' ink and then printed on ordinary materials for various effects. Among the common uses are the printing of abrasive mixed inks to produce abrasive paper surfaces which at least are good for match scratching, and the printing of metallic inks to produce striking effects.

Latest in this field is the printing of metallic inks in diagrams which will act as electrical conduction circuits in low priced portable radios.

The base stock upon which the printing is done must be stiff and strong enough so it will not bend or break to rupture the printed lines and thus break the circuit. It also must be non-hygroscopic enough so that it will not absorb enough moisture on humid days to cause short circuits. And it must be dimensionally stable so it will not expand and contract enough under ordinary temperature changes to cause trouble.

All of these properties are to be had in treated cardboards and other base stocks which in peace-time sell for quite low prices. As a result, the printed metallic electrical circuit is on its way. But the developers of it are sitting on the lid; they are keeping its present stage of development secret.

Ship Welding Wins

Despite Early Troubles, Welding Techniques Have Advanced to a Point Where they Will be Used in Many New Designs. Locked-up Welding Stresses, Usually Caused by Incorrect Procedures, Can Exert Explosive Rupturing Force. Now Such Stresses Can be Controlled

RIGHT this minute the engineering department of many a shipbuilding company is working out the final details of its post-war all-welded steel ships. This is in the face of the fact that three short years ago welded steel ships were splitting their plates in mysterious ways and some ships were splitting apart and breaking in two.

Ships now on the drafting boards have contours more beautiful than any pre-war designer ever thought practical for production by shipbuilding methods. They will be lighter, faster, get more speed from the same power, be more seaworthy. They will roll less, pitch less, have plenty of room for air conditioning plants for the comfort of passengers and the protection of cargo. There will be plenty of materials-handling equipment aboard; cargo will go into and out of holds much more rapidly, thus cutting down the time during which ships are tied up in ports and increasing their sailing and earning days per year.

None of these features — and plenty of others — is in the dream stage. All of them are solidly practical, made so by the ability of welding to fabricate strong and lightweight structures. And the way in which ship welding licked its early problems is one of the sagas of industry.

Right from the start of their production in a big way for war service, all-welded ships had some amazing successes to go along with their failures. There was, for example, the "Anne Hutchinson." This Liberty ship was torpedoed and broke in two. Both ends continued afloat until the after section was sunk in a storm. The forward end was torpedoed a second time, the engine being knocked loose and moved ten feet from its base by the explosion. In spite of that, the forward end continued to be buoyant and was towed safely to port. Dozens of other ships made voyage after voyage, their only troubles being an occasional ruptured plate.

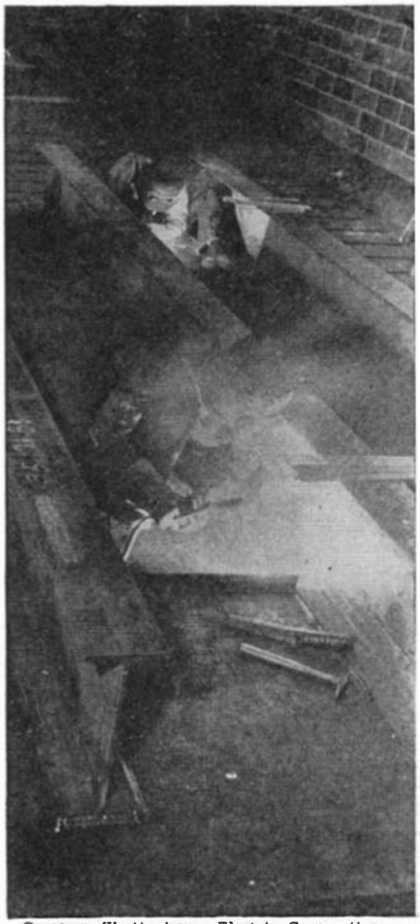
Search for the cause of the ruptured plates quickly found it in locked-up or residual stresses. And right here the shipbuilding engineers had to face a plain metallurgical fact. Locked-up stresses exist in any steel which is heated to a red temperature or hotter and then allowed to cool. There are residual stresses in any steel which is cast, hot rolled, or welded. They cause any steel which is heated and then cooled to change its shape. As a laboratory demonstration a cube of steel which is heated and cooled enough times will ultimately become a sphere.

STRESS RELIEF — Most of such stresses can be relieved by annealing. But there is no way to anneal the thousand-foot-long hull of an all-welded ship. And the locked-up stresses caused by the heating and cooling of welding were so strong in some ship plates that when they concentrated in small areas of the plates they sometimes acted with the speeds of explosions. Plate steels which, under the slow actions of tensile testing machines would stretch several inches before they broke, would fracture as cleanly as cast iron when these stresses ruptured them.

Observation of many ruptured plates disclosed an important fact. There almost always was a "detonator," a starting point which weakened a definite area of the plate, invited the stresses to concentrate there, and instigated the rupture.

A square-foot by square-foot search of ships' hulls and other members was made to find and eliminate these detonators. Some of them were sharp points or re-entrant angles where plate met plate—ship design practices which had been quite all right for riveted ships. Others, strange to say, were caused by the very zeal of sub-contractors who had forgotten that the thickness of a weld is governed by the thinner of the two metal pieces to be joined. These contractors were putting on too thick welds, thus subjecting the thinner pieces to far greater heat stresses than were necessary, and their sole purpose in doing so was to put in plenty of welding rod—that is, plenty of joint metal—for the sake of the war effort.

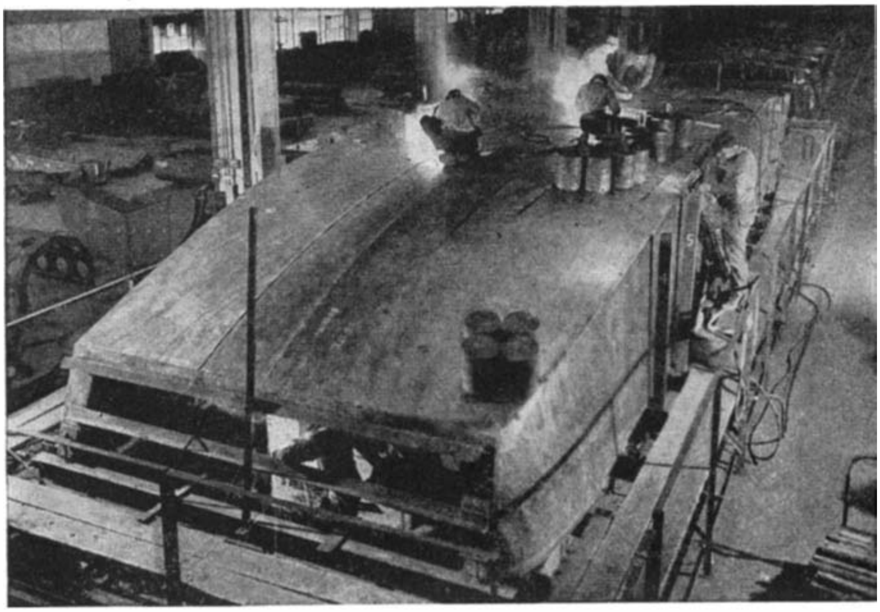
Re-design went hand in hand with changes of methods. In some cases



Courtesy Westinghouse Electric Corporation
Arc welders fabricating a heavy fixture used in assembling marine turbines

a new design of a section would eliminate the joining of thick sections to thin ones. In others the welders and the sub-contractors had to be instructed.

Fitting methods were found to be faulty. The engineers had to rediscover the old truth that welding is only one of a series of operations which results in a welded structure. Plates would fail to meet, and the welders would saddle-weld to cover the crevices, thus practically guaranteeing that trouble would ensue. Bulkheads would be made slightly small and would be moved from their fair lines (proper positions) to take advantage of the curvature of the hull so that metal would meet metal and welding could be done. This put the bracing of the hull in positions and at angles not intended by the ship designers.



Weights hold down the bottom plates of this barge until welding is completed

TROUBLES ELIMINATED — Limits and tolerances on all parts were then tightened. Mechanical controls were applied to flame cutting of plates in preparation for welding. Trouble after trouble was eliminated.

Some of the worst problems were found in the welding itself. Overwelding to make sure of strength made sure of weakness instead. Bad spots in welds were burned out and rewelded, thus vastly increasing the application of heat to small areas and setting up additional stresses. Excess heat was applied to finish-off welds, make them look better. This also put unnecessary locked-up stresses into the plates. The idea had to be sold to the welders that the only good weld is the one which is done right the first time. With new welders being trained at rates as high as 700 a month for a single shipyard, this selling had its problems.

Such improvements prevented many a ruptured plate, kept many a ship out of dry dock. Rupturings bad enough to sink a ship, unless caused by enemy action, became non-existent — there never had been many of them. But even so, the corrective measures had not gone far enough.

Methods engineering had to be applied. Management or staff engineers, working exactly as they would in large factories, had to take from the welder and his foreman all authority to decide what should be welded, at what time, and in what sequence.

The sequence in which welding operations are performed is highly important. If the operations proceed from the middle of the structure toward its edges or open ends, then the locked-up stresses can be kept to their fewest and lightest. Two or more operations can be timed so that the welders work together in team play to draw most of the shrink stresses into a single direction instead of causing them to oppose and multiply each other. Problems like these had to be worked out by engineers.

The engineering, too, had its limitations. One of them was the sizes of individual welded assemblies. After an assembly gets to be just so big and complex it is hard to plan sequences of weldings which will keep down the locked-up stresses, harder still to handle or "position" it so that the most rapid welding techniques can be used. This is the main reason why ships are built of welded sections which later on are welded together.

Laying out the individual assemblies, laying down the methods by which they were to be welded together into sections and the sections in turn into entire hulls and superstructures, was an engineering design problem. A single ship might be made up of more than 500 welded assemblies which were made into over 50 sections.

The process was hard for any one man to visualize. But every executive from top-flight engineers to foremen had to see just how the ship would go together and just what his part of the job would be.

DRAWINGS AND MODELS—Some companies solved this problem with isometric drawings. Others made plastics scale models. Lofting to scale, as is done by aircraft companies, found its way into the shipyards too. But in every case there were clear lines and figures showing every operation. And as so often is the case with industrial products, the best liked device was the scale model which the men could take apart and put together with their hands.

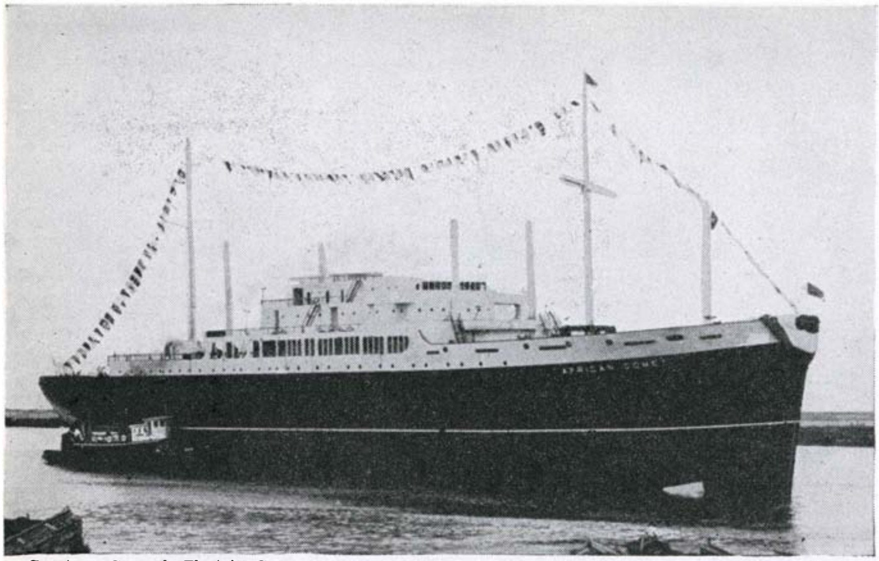
Meetings of design engineers, production engineers, and foremen were held to discuss the drawings and models. There was many a suggestion. Here a change could be made to eliminate a weld in a tight corner, there a joint which was nearly inaccessible for welding could be made easy to get at.

Production methods were worked out just as carefully. Flat horizontal or "down position" welding is by far the fastest and easiest to do, therefore it is likely to be done best and to result in the fewest locked-up stresses. By using materials handling devices, welding positioners, jigs, and skids, some yards were able to do nearly 80 percent of their work in this position.

Automatic or "machine" welding was substituted for hand welding wherever possible. There were two reasons for this. One was the saving of time; the machine process can be seven times as fast as manual welding on butt-welding operations, two to three times as fast on fillet welding. The other reason is that machine welding is more subject to exact control. With it the human errors which lead to locked-up stresses could be reduced.

Experience showed that machine welding did not require the work to be completely level. Provided the weld progressed up hill so that the puddle flowed away from the arc the work could be as much as eight degrees out of level in the direction of the welding and considerably more than that in other directions. This increased the number of machine-welding applications.

Devices such as magnetic chucks to hold work, chill bars, electronic



Courtesy General Electric Company

The *African Comet*, first all-welded American passenger-cargo ship

controls, and so on increased the automatic control of welding and with it the certainty that the locked-up stress problem would be greatly reduced.

WELDING RODS—Experiments with larger-sized welding rods brought out a new technique which still is being developed. The old theory was that the smaller the rod the less the heat and therefore the less the stresses. But with larger rods the welding is faster and the heat is applied to any one point for a shorter time. The result of the higher welding speed is that extremely high temperature is applied to a far smaller area of the plate. There is less buckling, less warping, less changing of the size and shape of the plate, and therefore less residual stress.

With all of these improved methods the all-welded steel ship still is full of locked-up stresses. But these stresses are small enough so they do no damage unless someone adds to them or throws them out of balance.

And here is the final problem: There is inevitably somebody wanting to weld something to the plates of a completed ship, or cut something off with a gas flame, or make a welded repair. The brand new thermal stresses thus introduced often are enough to set loose the stresses of welding and warp or rupture a plate. Such work has to be done by skilled men, men who know the forces with which they are dealing and can follow safe practices.

In spite of its problems the all-welded steel ship has reached the point where in many respects it surpasses anything else that ever has floated. Shipbuilders have their newest designs all ready. And they know that with welding they can make their new ideas work.

BEARING ALLOY

Backed Up by Steel Strip

DURING the last few years the Ford Motor Company has developed and used a new type of engine bearing able to stand up under heavy loads at high speed. In road tests, some of the new bearings and crankshaft journals showed no measurable wear at the end of 50,000 miles, according to *Automotive and Aviation Industries.*

The bearing material is called "tri-alloy" and contains 35 to 40 percent lead, 4½ percent silver, and the remainder copper. Bearings are made by a continuous process in which hot-rolled steel strip is pulled through a coating bath of the molten alloy and thence through a die that leaves exactly the right amount of bearing metal on the strip.

MILLING CUTTERS

Economically Made by Precision Casting

ONE of the fast-developing uses of the lost-wax precision casting method is for making high-speed steel milling cutters.

Milling cutters of such hard steel are difficult and expensive to make, either by direct machining or by the inserted blade method. The precision casting technique has saved one automotive manufacturer thousands of dollars in the manufacture of thousands of milling cutters.

The precision-cast cutters are made to very close tolerances and require no finishing, except sharpening of the cutting edges.

SUTURES

Made of Stainless Steel Exhibit Desirable Qualities

TO THE list of metals used as "human hardware"—to mend and repair man's fragile bones and joints—has been added stainless steel sutures, made of a specially heat-treated chromium-nickel stainless steel called "Surgaloy" by its developers, the Davis and Geck Laboratories, Inc., according to Vanadium Corporation of America.

The stainless steel wire has been used in sizes down to 0.003 inches in diameter and is non-absorbable, pliable, high in tensile strength, kink-proof, and non-breakable in this service, and can be easily tied into knots. It is also non-magnetic, corrosion resistant, electro-passive in body fluids, and well tolerated by body tissues. It can be exposed to diathermy and X-rays.

The stainless steel sutures have been found ideal in surgery of nerves, tendons, thyroid glands, and hernia, in plastic surgery, in bond surgery, and as dermal and tendon sutures.

VALVE FACING

Improved by Use of New Alloy

HIGHER-COMPRESSION engines, taking advantage of new fuels, have created new problems for valves and valve-facing materials. Today's and tomorrow's materials must be highly resistant to elevated temperatures, and especially to deformation and corrosion at operating temperatures.

For this heavy-duty service the Wilcox-Rich Division of Eaton Manufacturing Company has developed a new valve-facing alloy containing chromium, nickel, tungsten, and cobalt. The alloy is reported to be superior in corrosion resistance to the cutting-tool alloys frequently used, although somewhat inferior to nickel-chromium facing alloy. In resistance to deformation in the "red zone" above 1000 degrees, Fahrenheit, the new alloy (called "Eatonite") is described as superior to other materials so far tested.

Engine tests on heavy-duty L-head automotive engines and high-output supercharged aircraft engines show the new material to be the best yet developed for such use.

Electronics Afloat

Radio Adds to Safety at Sea in Many Ways. Radio Buoys Mark Channels, Radar is in the Offing, Radio-Telephones Help to Conquer Weather Hazards, Automatic Alarms Pick Up Distress Signals and Warn of Fire. Other Marine Uses of Electronics are in Being or Projected

By JOHN MARKUS
Associate Editor, *Electronics*

First action entry in the diary of maritime radio was made during the early morning hours of March 3, 1899, when the *East Goodwin* lightship, off the shore of England, was rammed by the S. S. *R. F. Matthews*. Before this, a ship going to sea was alone from the time her masts sank below the horizon until she entered her next port or perchance sighted another ship—alone with a fire, alone with the hull stove in after running into shoals, alone when the wind blew a hurricane and mountain-high waves tossed her around like a match in a whirlpool. But on this history-making day tugs were on their way in a few minutes to tow the damaged ship out of danger, because four months earlier Guglielmo Marconi had equipped the English lightship with wireless equipment and in her distress she had flashed her message of appeal to South Foreland. The age-old solitude and silence of the sea was broken by radio, forerunner of electronics.

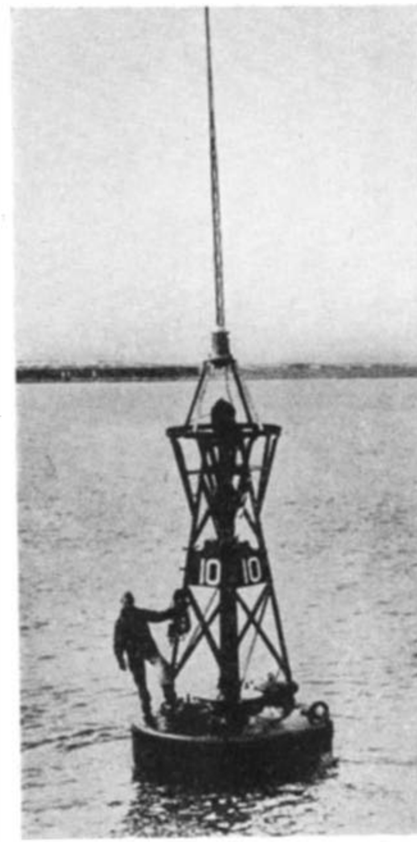
Midget Western Electric radio-telephone set intalled on a merchant-marine training ship. Units like this are also widely used on pleasure craft

The earliest ship transmitters were little more than a battery, a spark coil, gap, key, and antenna. The receiving equipment recorded incoming messages on a tape by means of a Morse inker. By 1902 the unreliable inker gave way to magnetic receivers with tuned circuits and headphones for reception. In 1907 crystal rectifier receivers were brought into use. The big spark-gap transmitters then were operating with a roar that could be heard for a mile and had a spark that looked like a thunderbolt.

The Poulsen arc transmitter was introduced to the United States in 1911 and carried on until vacuum-tube transmitters were perfected shortly before World War I. From then on, tube transmitters have gradually edged out earlier types of equipment, and now the changeover is complete, except possibly for a few small ships still carrying spark equipment. Today, tube equipment has an almost unlimited range on short waves.

Modern tube transmitters command instant silence when they send out the international distress call SOS (... ——— ..., adopted because of easy sending and recognition, not because the letters stand for "Save Our Ship"). Similarly, CQD, the first recognized distress signal, was formed by the addition of D for "Distress" to the general call CQ and did not mean "Come Quick Danger."

In the early days of radio navigation, a ship got a position "fix" by turning on its transmitter, calling land stations having direction-finding equipment, then holding down the sending key while these stations manipulated loop receiving antennas and determined the compass bearings of the ship with respect to their own positions. They sent this information to the ship by radio. The navigator then drew lines on his chart corresponding to the bearings received from two or more widely-separated land stations and read off his position where these lines intersected. All this took a lot of time.



Coast Guard type TB-113 buoy radio-beacon installed near a harbor entrance. Twin transmitters and their storage batteries are stowed below the waterline in a sealed pocket within the buoy. The 15-foot vertical antenna is connected to the transmitters below

Later, many ships were equipped with their own radio direction-finders and the process was reversed. The ships merely tuned in identi-

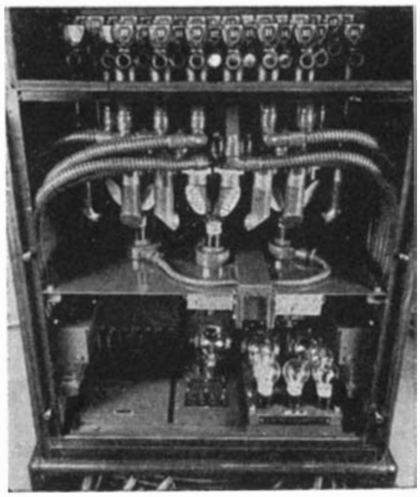
The number on the outlet from which smoke emerges in the Rich-Audio fire detection equipment for ships shows the location of the fire. At the same time, the smoke interrupts a light beam to a photocell and an alarm is sounded. Thus smoke can be detected visually, by smell, and by electronics

fiable radio-beacon shore stations, determined the bearings of such stations, and plotted their positions from these data. Certain selected shore stations and lightships transmitted continuously for this purpose during fog or thick weather, constituting radio "lighthouses" or radio-beacons.

RADIO BUOYS—Ships attempting to locate the entrances to narrow channels when visibility is poor could theoretically use their radio direction-finders in this same manner. Location of position by the intersecting line method is, however, often too slow where distances to be sailed are short and land is near at hand, or when in restricted channels. The inshore piloting problem has been very much simplified in recent years by the use of unattended radio transmitters housed in buoys anchored near channel and harbor approaches. These latest Coast Guard radio-beacons guide ships through difficult waters when abnormal conditions reduce the effectiveness of lights, bells, and horns. Pilots identify these radio buoys by their characteristic dot-and-dash code. Ships equipped with direction-finders can tune in such radio-beacon buoys and use the signals emanating from them to "home" on, riding down the radio waves to their source. The course is set to pass safely clear of the buoys and avoid collision with them.

The radio-beacon signalling equipment for a buoy consists of a 14-volt storage battery supplying all necessary operating power and capable of running the apparatus for three to four months without removal for recharging. A pair of radio transmitters feed alternately into a 15-foot monel-metal antenna, and a motor-driven flasher mechanism keys each transmitter automatically and alternately at intervals and controls the buoy light characteristic as well.

The twin transmitters are a safety precaution, required because reliability is essential in navigation aids. Failure of either transmitter would not put the buoy off the air, and such failure would be apparent only if it was noted that there were longer-than-normal periods of silence between transmissions from the automatic radio beacon.



Smoke-detecting cabinet with front panel removed to show the pipes going to various parts of the ship. Large lamp in the center provides the light that actuates the photoelectric cell

Great Lakes shippers, equipped with the world's most extensive non-military radiotelephone system, are now planning to use radar for further protection against the peculiar perils that beset their vessels.

The radar system is expected to minimize the danger of collision in blinding fogs of early spring even as the radio-telephone has helped reduce the hazards of wind and current. The ship-shore telephone system has been developed to the point where it keeps 580 vessels in constant touch with each other, home offices, Coast Guard stations—any point with a telephone.

Because the sets are operated by navigation officers generally unskilled in radio, fully automatic equipment has been developed for ship use. Lifting the handset turns on the transmitter.

The channel appropriate to distance and conditions is selected by dialing two digits, and the land call is placed with the shore station operator. Calls cost 75 cents, station to station, or 90 cents person to person, plus long-distance toll charges on land.

Ship-to-ship calls are free because there is no way of metering them. Shipmasters call each other frequently with queries on wind and current conditions and other matters of schedule and navigation. Weather reports are broadcast at frequent intervals throughout the day to all ships.

In another Great Lakes marine application of electronics, an automatic radio compass in the wheelhouse of a Pere Marquette Railroad car ferry keeps pilots "on the beam" during shuttle trips across Lake Michigan. Ship-to-shore radio-telephones are to be added to help direct the vessel's movements in all kinds of weather.

AUTO-ALARMS—The inability of ships such as the historic *Titanic* to contact the nearest rescue ship because its lone radio operator had just gone off duty underscored the need for continuous radio watch on all ships for safety purposes, and now auto-alarms are installed on all single-operator ships. These are receiving devices which will respond automatically to the international alarm signal sent by a ship in distress, sounding an alarm to notify radio operators and deck officers that a distress call is on the air. The international alarm signal consists of 12 four-second dashes spaced one second between dashes, sent on the international distress frequency of 500 kilocycles. The auto-alarm is chiefly intended for operation on ships carrying only one radio operator, but it may be installed on any vessel to guard the distress frequency during such times as the operator on watch may not be listening on that frequency.

The auto-alarm is placed in service by the radio operator during such times as he is not on watch and the vessel is under way. Upon receipt of an alarm signal, the auto-alarm will cause bells to ring. The ringing of the bells also serves to indicate when the auto-alarm receiving equipment becomes inoperative due to a failure of power or to the burning out of a tube. Only two models of auto-alarms are found on ships of the American Merchant Marine; one is produced by Mackay Radio and Telegraph Company, has a mechanical selector for picking out the correct signals for response, and is installed on Mackay ship stations. The other, having an electronic selector, is used on ship stations of the Radiomarine Corporation of America.

FIRE AT SEA—The addition of photoelectric smoke-detecting apparatus to the older Rich system for detecting smoke by sight and smell provides for ships at sea an automatic fire-alarm system comparable in speed and effectiveness with the finest modern installations in buildings.

Air samples from each protected space are drawn through individual pipe lines to the detecting cabinet, usually in the wheelhouse, by an exhaust fan. The pipe outlets are positioned in concentrated beams of light that illuminate smoke particles and provide visual detection. The air samples are discharged into the wheelhouse, so that smoke will also be detected by smell when present.

Each pipe line is provided with an automatically controlled solenoid valve that momentarily diverts the air sample to a long tube for photoelectric observation. A light beam is directed through this tube to a photovoltaic cell connected to a meter-type relay.

A motor-driven selector switch energizes one valve after another at four-second intervals, and drives a number-wheel indicating which line is being diverted at any instant. If no smoke is present, the number changes and another line is diverted for photoelectric inspection. Smoke causes operation of the alarm signals and stops the selector switch so that the number remains on the control panel to indicate the source of the smoke. This Rich-Audio fire-detecting system is made for ship use by Walter Kidde and Company, Inc.

The United States Navy has long recognized the value of electronics in the conduct of warfare, with the result that the vacuum tube is now one of the most important weapons of our Navy.

The year 1923 was marked by the opening of the Naval Research Laboratory at Anacostia, D. C. New developments achieved here include the first high-frequency and the first ultra high-frequency radio sets used by the fleet, the first multiple-reception radio system permitting the operation of a large number of receivers from one small antenna, the technique of producing quartz crystals for the frequency control of radio transmitters, the first crystal-controlled high-frequency, high-power transmitters (1924), special radio transmitting and receiving equipment for the dirigible U. S. S. *Shenandoah,* the sonic depth finder for measuring ocean depths from a ship under way, use of the hull and other parts of a ship's structure for the radiation of radio energy without a conventional antenna, an underwater sonic device to detect enemy submarines at considerable distances, and a system for the radio control of aircraft in flight that resulted in use of a considerable number of obsolete Naval aircraft as targets for anti-aircraft gun practice. A host of other research projects can be added to this imposing list, including many of the latest refinements of radar and sonar.

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MARINE RADAR

Will Give Navigators "All-Weather" Eyes

WHAT is probably the first practical civilian use of radar is found in the General Electric "electronic navigator" that can detect through darkness, fog, and storm the position of any above-water obstacles, such as lighthouses, buoys, icebergs, derelicts, other ships, and land, at distances up to 30 miles, depending upon the size and shape of the object.

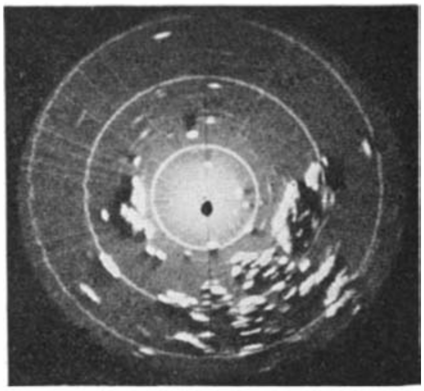
This device operates on the radar principle of radio waves which are reflected from objects and are measured to give true bearing and distance of the object from the point of sending. It will revolutionize "thick weather" navigation by providing the mariner with an instrument to plot a safe course, even though his normal visibility is

strongly limited by natural conditions.

The distances of objects from the ship are shown on the viewing screen of the electronic navigator in true proportions, being measured by a series of concentric "marker rings" electronically super-imposed on the picture screen. According to General Electric engineers, the measurement of distance so given is accurate to 1 percent.

Basis of the electronic navigator is a rotating antenna, located on the top deck of the ship and analogous to a searchlight, in that it sends out beams to locate obstacles in the ship's path. The difference, however, is that beams from the radar antenna, which are actually powerful radio micro-waves, are capable of penetrating fog or any other atmospheric conditions without hindrance. Moreover, they are sent out as "pulses" or surges of extremely short duration and at a very rapid rate.

As the radar waves locate an obstacle in the surrounding waters, they bounce off and are scattered, no matter what material the object is. Some of these echoes—or scattered waves—will return to the rotating antenna, which also acts as the receiving antenna during the time intervals between the outgoing pulses. After being amplified, these echoes are made to appear as bright spots on the face of a cathode-ray tube, which is somewhat similar to a television screen tube. The image thus formed gives the operator a



Left: Watching the screen of the electronic navigator, first peace-time version of war-time radar. Above: A photograph of the cathode-ray screen, showing how obstacles in the path of the ship are indicated. The operator can interpret quickly the kind of objects represented by the radar spots and their distance from the ship

"radar picture" of the obstacle, and the marker rings tell him how far away it is.

By controlling internal circuits, the operator may change the scale of the field to cover either a 2, 6, or 30-mile radius. Thus, when a ship is sailing in the open sea, the operator will use the 30-mile range until an object approaches to within 6 miles. Then, by turning a knob on his radar set, he is immediately presented with a larger scale chart, the outer radius of which is 6 miles. For very close work another turn of the knob provides a 2-mile radius chart on which objects may be observed down to about 200 yards.

Oil For Ships' Turbines

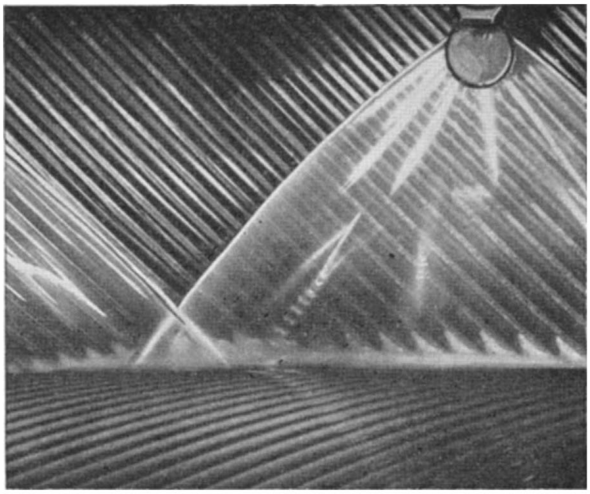
When Turbines Go to Sea, Lubrication Requirements are Complicated as Compared With Turbines on Land. Water Becomes a Major Problem by Intensifying Such Undesirable Features as Rust and Emulsification of the Lubricant. Can Petroleum Technology Keep Pace With Demands?

FAR different are the marine turbines of today from those which propelled the ships of only a generation ago. Early marine turbines were operated at low steam temperatures and pressures. Since they were usually large and slow, lubrication was relatively simple. Specially refined oils were not required and, furthermore, none was available. With the introduction of the newer alloy steels in the construction of marine steam turbines, a rapid increase in steam pressures and temperatures was made possible. Present-day turbines operate at pressures of from 400 to 450 pounds per square inch and, in some instances, 1250 pounds. Several ships are now building that will carry steam pressures of 1500 pounds gage. The old cast-iron machines of yesteryear were limited to 350 pounds pressure. Temperatures today range from 700 to 850 degrees, Fahrenheit, as compared to 450 degrees a generation ago.

The increase of steam pressure and temperature has depended on and has followed closely the development of materials suitable for high temperature application. While higher pressures and temperatures mean greater turbine efficiency, they brought problems in design which necessitated more elaborate and at the same time more efficient lubricating systems.

In early turbines the oil was used merely for lubrication, and its cooling function was of secondary importance. Old type lubricants lacked stability toward oxidation and rapidly became inefficient through deterioration. As turbines progressed, even the better refined oils proved unsuitable under the severe and exacting operating conditions. Deterioration of the oil resulted in emulsification with water and deposition of sludge. Such oils thus became unsafe for marine use. As turbine designs called for higher temperatures and pressures, thus attaining greater turbine efficiency, the demands on the lubricating oil became more exacting; they were required to not only lubricate but to act as highly efficient coolants as well. The chemists of the petroleum industry, through the medium of modern refining processes and the use of additives, improved turbine lubricating oils to keep pace with mechanical progress. In fact, some authorities now predict that the best grade of modern marine tur-

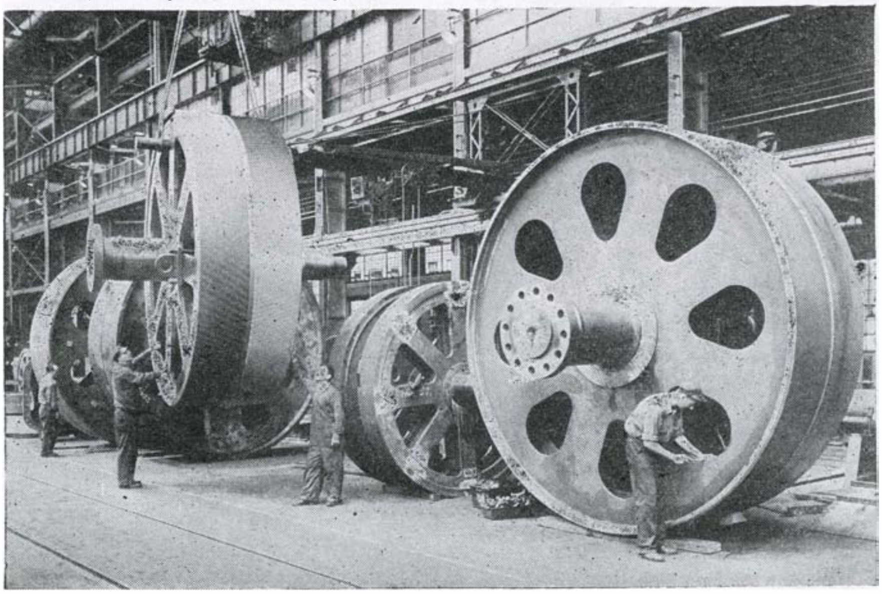
Right: Oil is sprayed evenly onto meshing teeth of rapidly moving turbine gears



Courtesy General Electric Company

Below: These gigantic turbine reduction gears require same care in lubrication as a chronometer

Courtesy Westinghouse Electric Corporation



bine oils, if properly cared for in service, will last for the life of the turbine. Contrary to the belief of many, lubricating oils do not wear out; they are rendered unsuitable for continued use by contamination.

SPECIFIC PROBLEMS—Lubrication of marine steam turbines presents problems similar to those encountered in lubricating land turbines, except that condensation of moisture and infiltration of salt water into the oil system is greater in marine installations. Also, the reduction gears of marine propulsion units are lubricated by the same oil used in the turbine bearings. Because of this, it is necessary to compromise in oil viscosity. Hence a somewhat higher viscosity oil is used for marine turbines than for stationary land units. An oil viscosity of from 300 to 500 seconds Saybolt Universal at 100 degrees, Fahrenheit, is generally used at sea today.

Marine turbines are essentially high-speed units, operating at from 3600 to 12,500 revolutions per minute. The rubbing speeds of turbine spindles are among the highest found in heavy mechanical equipment. Through finely finished reduction gears, these high-speed prime movers turn propellers that rotate at only 90 to 100 revolutions per minute, although propeller speeds of 400 revolutions per minute are not uncommon.

Some of the most accurate manufacturing processes in heavy industry are required to build marine turbines and gears. The precision requirements are such that the big marine gears are cut in air-conditioned rooms so that temperature changes cannot distort the metal and affect the finish accuracy. So delicately balanced are these gears that a pressure of one four-thousandths of their weight is sufficient to turn them. Gears measuring 12 feet in diameter and weighing 25 tons are not unusual in marine propulsion units. These gears are machined to limits within three tenths of a mil, or about one fourth the thickness of a cigarette paper.

Naturally, high speeds and close tolerances limit the viscosity of the lubricating oil that can be used. Oil of high viscosity will result in unnecessary internal friction and increases in temperature generated within the oil itself. This again demands that the lubricant show the least body change through the operating temperature range.

ATTRIBUTES OF OILS—There are four important service factors in marine turbine lubricating oils: the possibility of the oil being overheated; the possibility of water contamination; the occurence of oxidation; and the ultimate formation of organic acids and sludges.

Only an oil that can withstand all of these adverse conditions is effective in turbine lubrication. It should readily separate from water with which it may come in contact and it should be of such viscosity as to function satisfactorily in the particular size and type of turbine being lubricated.

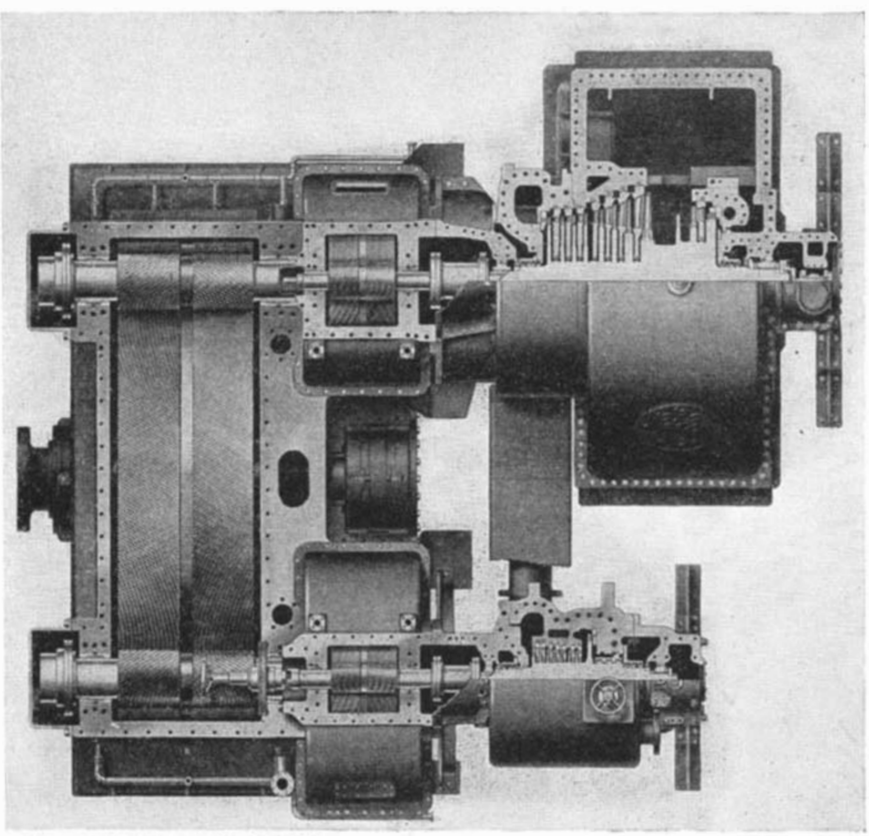
Marine turbine oils are so refined and processed that they are free from easily oxidizable compounds, dirt, or other impurities. They are filtered through special clays or other purifying materials after they have been subjected to a number of special refining stages. Anti-oxidants and anti-corrosion materials are added to improve stability. Incidentally, some of these additives are extremely expensive.

OXIDATION—Despite the selection of the best grades of crude petroleum, the highest degree of refining, and the use of protective additives, however, a certain amount of oxidation will occur in turbine lubricating oil. Petroleum, like all organic matter, will oxidize slowly in the presence of air. This rate of oxidation can be successfully retarded and controlled.

The rate of turbine oil oxidation generally increases with a rise in operating temperature. The importance of temperature control is therefore obvious. Oddly enough, low temperature operation can also produce disastrous results, such as foaming, formation of emulsions, and corrosion.

Severe churning, which occurs in gear cases, together with contamination by extraneous impurities such as metallic particles, or water and dirt, accelerates oxidation of oils. The rate of oxidation depends in great part upon the ability of the oil to resist the action induced by the impurities and upon the extent to which these impurities are present in the oil system. Products of oxidation may be formed which are inert and have little or no detrimental effect on the operation of the turbine. But some deterioration products may produce sludge and deposits due to oxidized hydrocarbons. Such deposits may interfere with the heat transfer in the oil coolers, foul the oil system, and, in severe cases, may result in interruption of the oil supply to the bearings and gears, causing damage to the unit.

Water in turbine oils induces formation of rust, both black and red. These metallic oxides, being catalytic, promote oil deterioration. The black oxides differ from the more



Courtesy General Electric Company

Looking down on a geared marine steam turbine, with covers removed. In lower part of the photo is shown a high pressure turbine, in upper part a low pressure turbine. Lubrication of this high-speed, precision built machinery is an intricate problem

common scaly, amorphous red rust in that they are crystalline, magnetic, and form most readily at elevated temperatures where excess air is present with limited moisture. Consequently, black oxide is more frequently recognized on such surfaces as governor pilot valves, operating cylinders, oil submerged areas, and occasionally on the main journals. It is quite hard and abrasive and adheres to the surfaces on which it forms. Infrequently it will be found that scales of red rust have been subjected to conditions that result in conversion to the much harder crystalline black oxide, which then presents the multiple hazard of abrasion of bearings, stoppage of small orifices, and interference with movement between parts having close clearances.

EMULSIFICATION — Water, in other ways as well, is the greatest source of trouble to marine turbine operation. Water itself does not harm the lubricant. Its reactions with metals and oil deterioration products, however, are most harmful. Steam from leaking gland seals and condensation of humid air in oil tanks and gear cases are the most frequent sources of water contamination.

When water is churned with an oxidation stable oil, a mixture is formed which quickly separates into its component parts—water and oil. Although limited oxidation is not in itself detrimental to the lubricating value of an oil, excessive oxidation will reduce the oil's ability to separate from any water that may be present. The presence of dirt and metallic particles in the oil accelerate its deterioration through oxidation. This results in permanent emulsification and causes the eventual formation of harmful deposits and sludge.

Emulsions also impair the lubricating qualities of the oil. In extreme cases actual rupture of the oil film will result, followed by inevitable scoring of bearings and gear teeth. Emulsified oil sludges deposited in the supply passages to bearings and gears may restrict oil flow, thus reducing the rate at which induced and frictional heat is removed. Increased oil and bearing temperatures result in oil thinning and decreased film strength.

FOAMING—A characteristic of all oils when subjected to extreme agitation and churning is foaming. Since this action has the effect of increasing the volume of the oil, it is apt to overflow the reservoir and return oil lines, resulting in loss of valuable oil as well as creating a fire hazard. If foaming oil is delivered to the bearings, it may break down under pressure, with resulting bearing failures. In addition, foaming oil, presenting a much larger oil surface to air at elevated temperatures, increases the rate of oxidation.

TOMORROW?—The successful operation of over a thousand ships of our merchant marine, propelled by steam turbines, is apt to overshadow the part American petroleum companies are taking in the manufacture of lubricants essential in keeping these ships running under all conditions of weather and climate.

What faster speeds, higher temperatures, and greater pressures marine turbines of the future will have no one can foretell, but as in the past and today, petroleum research will undoubtedly provide adequate lubricating oils for their safe and successful operation.

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OIL RESOURCES

Increased by Research As Well as Drilling

ADVANCES over the past 25 or 30 years in the techniques of recovering oil from its natural underground reservoirs have been great, Mr. E. Holman of Standard Oil declared in a recent article in *The Journal of Commerce*. The industry actually has "found" as much oil, by bringing about higher recovery through research and engineering studies, as has been located by the drill. This has been a real achievement.

It is interesting to reflect that, around the time of World War I, recovery of 20 percent of oil in place was generally accepted as normal. Today, in contrast, recovery of some 80 percent of original oil in place is regarded as possible in modern, efficiently operated fields—a fourfold increase. Whereas in early days gas and water were considered only nuisances, today careful observation of reservoir pressure trends is standard practice and the control of gas-oil ratio and the movement of edge and bottom water is recognized to be of paramount importance for high ultimate yield.

An important factor in the progress of this science has been the open discussion of new theories and findings before the several industry associations and technical societies through which the results of various laboratory and engineering studies were exchanged and compared. The ensuing discussions, and even the controversies which arose, have served both to educate others and to spur work along new lines of thought.

HELIUM GAS

Traces Movement of Underground Oil and Gas

A NEW and valuable application for helium is currently being investigated by the United States Navy in co-operation with the United States Bureau of Mines, says *Oil Weekly*. The new application for helium is as a ferret to trace the underground movement of reservoir fluids in gas and oil fields, thereby enabling gas and oil producers to operate their properties more efficiently and to increase their recovery of these natural resources.

This use of helium involves injecting it into the underground gas and oil reservoir at one or more carefully selected locations, through well bores, and detecting its presence in the gas and oil produced from adjacent wells. The length of time required for the helium to travel from the injection well to each of the producing wells, and also the quantities of the injected helium found in each producing well, will enable petroleum engineers and geologists to determine reservoir conditions between wells and the pattern of drainage of the gas and oil through the porous reservoir rock. Because helium is chemically inert it is uniquely valuable for this purpose in that its identity, which can be readily determined by laboratory analysis, is not lost by combination with reservoir rocks or fluids.

RAW MATERIALS

Found by Dozens In Petroleum

PETROLEUM yields dozens of raw materials from which chemistry may build an infinite number of useful organic chemicals, Cary R. Wagner, consulting chemist, declared at a recent meeting of the American Chemical Society.

More than 200,000 different compounds have been produced from the dozen or more hydrocarbons found in by-product coal tar, he explained. But he listed 38 hydrocarbons, "only six of which are identical with those found in coal tar, which may be used as raw materials in manufacturing organic chemicals from petroleum."

To find further raw materials, Standard Oil Company (New Jersey) is planning to build two research laboratories costing $8,000,000.

To Europe By Air

With the Post-War Era Now Upon Us, Americans Will Want to Go to See What is Left of Europe. To Many the Ocean Steamer is Too Slow But the Plans of the Big Transatlantic Airplane Companies Will Enable Anyone to Take a Vacation in Europe at a Surprisingly Small Cost

THOUGHTS of many Americans are now turning to a possible visit to Europe. So it is quite timely to speculate on what the airplane has to offer people who wish to fly across the Atlantic Ocean. Will there be sufficient safety and comfort, and will the fare be reasonable enough to make such a flying visit to Europe possible for most people?

SAFETY—Perhaps the first question in everyone's mind is—safety. To anyone who has gazed at the wide expanse of the ocean from the deck of a steamer, especially during a storm, its vastness and power are apparent. The would-be air traveler can well imagine the hazards of an emergency landing in rough weather.

But for years exhaustive research has been made of climatic and meteorological conditions over the Atlantic Ocean, in Iceland, Greenland, Labrador, Newfoundland, and the Azores. Flight engineering surveys were made back in 1937, and since the inauguration of transatlantic service in 1939 much additional data have been obtained to ensure the safety of such flights.

Among the first of such safety developments was the inauguration of the "multiple flight crew" by Pan-American World Airways. In the Caribbean Sea operations of aircraft, a four engined flying boat was manned by a standard crew of only four. For the more hazardous transatlantic flights, larger and more specialized crews were found to be necessary. The primary personnel requisites of Atlantic flights are expert direction of flight, piloting, navigation, control and care of power plants (engines), maintenance of communications, and passenger service. All are under the command of a captain who is also an experienced pilot. His duties and responsibilities are in a way equal to those of the captain of any huge surface liner. He holds the rank of Master of Ocean Flying Boats, is a qualified aeronautical engineer, a meteorologist, a radio operator, and a mechanic. And above all, he is a man of courage, cool judgment, and decision. Directly responsible to the Captain are five officers, specialists in the primary departments of piloting, navigation, engineering,

TRANSATLANTIC AIR SERVICE

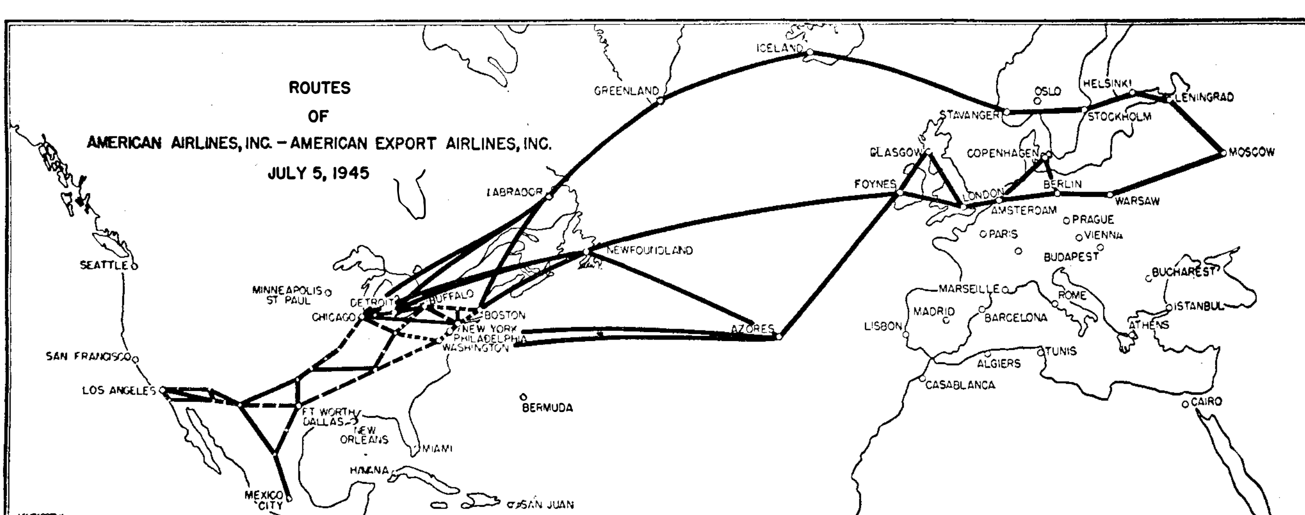
1945 Summer Schedule

U. S. A.—Newfoundland—Eire—England and connections beyond
Service operated with The Famous Four-Engine "Flying Aces"

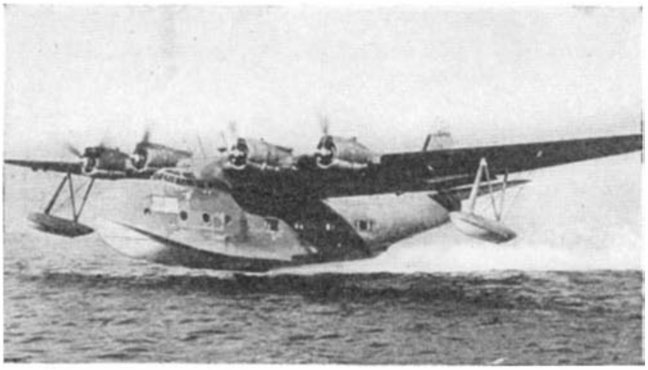
MILES	GREENWICH TIME	LOCAL TIME	*3 ROUND TRIPS WEEKLY	LOCAL TIME	GREENWICH TIME	MILES
0000	1200 (READ DOWN)	8:00 A. M.	Dep. . . . NEW YORK, N. Y., LaGuardia Field (Marine Terminal) . . . . Arr.	2:45 P. M.	1845 (READ UP)	3502
1111	1915 2100	4:45 P. M. 6:30 P. M.	Arr. / Dep. . . . . BOTWOOD, NEWFOUNDLAND . . . . Dep. / Arr.	9:00 A. M. 7:15 A. M.	1130 0945	2391
3112	0830	9:30 A. M.	Arr. . . . . . FOYNES, EIRE (Shannon Airport) . . . . Dep.	8:00 P. M.	1900	0390
3502	Direct Connection by British Overseas Airways. Flight Time 2½ hours.		FOYNES, EIRE LONDON, ENGLAND (Airways House)	Direct Connection by British Overseas Airways. Flight Time 2½ hours.		0390 0000

Connections to Continental Europe, Scandinavian Countries and Mediterranean Area upon application.
Schedules shown above are not guaranteed, and are subject to change without notice.
*Departures from New York, Tuesdays, Thursdays and Saturdays: From Faynes, Wednesdays, Fridays and Sundays.

Time-table of American Export Airlines



Two combined airlines produce a one-system over-land and over-seas service



Above: A B-314 of Pan-American World Airways, now being used in transatlantic service.
Upper right: A Vought-Sikorsky Flying Ace of American Export Airlines.
Right: The projected Consolidated-Vultee six-engined plane designed to carry 204 passengers at 310 miles an hour

communications, and passenger service. Each of these five has a fully qualified assistant to relieve him during rest periods.

The crew have available to them every known navigational aid. Drift of the plane, caused by side winds, is checked by the use of thin glass flasks containing pulverized aluminum which, when dropped from an airplane, break on striking the ocean surface and produce a bright silvery slick visible for miles. This aids the navigator to check the plane's "ground speed" as well as the drift. Celestial "fixes" are made at least once every hour, dead reckoning position is computed every half hour, while radio bearings from direction-finder stations ashore or bearings on ships at sea provide an additional check.

Transocean aircraft like the B-314 have four engines, but can fly indefinitely on only two. All engines of the big ocean flying ships are accessible by means of companionways built through the interior of the wings. This permits periodic inspection of the engines during flight, and, if necessary, repairs and servicing. Hundreds of such repairs and servicing operations have been made during flights across oceans.

"Scientific Control of Flight" is a process by which the most efficient performance of the aircraft is charted on a course under the most favorable flying conditions. Before each Atlantic flight the crew assigned to the plane, together with ground maintenance and service engineers, put the plane through a series of flying tests in which the air speed, fuel flow, engine revolution and oil flow indicators, and other instruments including the compass are carefully checked. Weather reports from all sources are obtained and a final weather map is prepared for the flight. Careful computations of efficient speed and altitude, and of fuel consumption, yield the best three dimensional flight path. The flight-time analysis is checked during the actual flight by what is known among flying men as a "Howgozit Curve." This scientific flight control is kept up to date by continued research.

GROUND SERVICES—The ground services which ensure the continued safe operation of the great transatlantic aircraft are elaborate, their details carefully worked out, and the maintenance and overhaul service so thorough that a separate article would be required adequately to do it justice. This ground service, plus efficient flying technique, has made possible not hundreds but many thousands of Atlantic flights. Millions of miles have been flown already, carrying thousands of passengers on schedule, as well as mail and air freight. There have been one or two minor accidents, but when one considers the flight miles in comparison with railroad and steamship mileage, the comparison is favorable to the airplane.

The recent announcement of the availability of a flame-proof gasoline for use in all passenger carrying aircraft transports will increase the safety factor of ocean flying to an unprecedented degree. This new gasoline is as safe to handle as ordinary kerosine, and if a plane should crash into the ocean, the danger of tons of gasoline spilling and igniting is negligible. Also, if fueling in the air is adopted on transocean flights, it can be accomplished with safety and minimum risk of fire.

COST—A ride on the modern "Magic Carpet" is surprisingly cheap, as shown by the list of fares submitted to the Civil Aeronautics Board by the transatlantic flying companies. To London via Newfoundland and Ireland is $148, to Leningrad $167, to far-off Calcutta only $332. When one considers the time saved and the never-ending number of "tips" dispensed with, these fares are remarkably low. For luxury travel the airplane is much cheaper than first class steamer.

At present the flying time from New York to London is roughly twenty-four hours, depending on weather conditions. This time will be considerably reduced when and if jet-propelled planes are perfected for ocean travel. In fact, it may be possible to fly westward at the same speed as the earth revolves, in which case a plane would leave London at, say, noon, and arrive in New York at noon the same day! But that is still in the future, although perhaps not so far off.

TYPES OF PLANES—While at present the two American companies engaged in transatlantic flights use flying boats, the Pan-American

World Airways using the Boeing 314, and the American Export Airlines the Vought Sikorsky Flying Aces, the newer types will in all likelihood be land-planes. This may sound surprising, but there is excellent justification for the selection of the land-plane. As has been pointed out before, when four engines are used, it is possible to fly on only two. And with the new types designed to use six engines, there is little likelihood of engine failure sufficient to compel the plane to alight on the ocean. And if a land-plane should have to alight on the water, it could remain afloat in a rough sea fully as long as a flying boat. However, a great safety factor is that transocean planes will fly over well frequented ship lanes and in the event of an accident which should necessitate the passengers having to take to the carbon-dioxide inflated life rafts, it would not be long before they would be picked up by one of the many passing steamships. There would be little need for the use of the safety kits with which the rubber life rafts are provided. These include fishing tackle, portable radio signalling devices, sunburn protection equipment, and so on.

The flying boat has, of course, the advantage that it can use coastal waters for take-off, so that when heavily loaded it is not impeded by the shortness of a runway. In other respects the advantage lies with the land-plane which is faster, more economical to operate, costs less, and is cheaper to maintain.

Much mystery surrounds the details of some of the new planes being projected for transatlantic flight. The Amex Model VII, as it is called, will fly 4000 miles non-stop at a cruising speed in excess of 296 miles per hour. It will carry 108 to 125 passengers, depending on the interior arrangements. The largest is apparently the six-motored Consolidated-Vultee Aircraft Company's plane, which is said to be able to carry 204 passengers at a cruising speed of 310 miles per hour. Cabins will be supercharged, enabling the plane to fly at an altitude of 30,000 feet, well beyond the reach of storms. Payload will be 50,000 pounds at 4200 miles cruising range. Flying time to London will be a little more than nine hours. This plane will be double decked, with lounges, rest rooms, and other facilities for the passengers' comfort.

Enough has been said to show how full of confidence and energy are the operators of overseas airlines. In the not far distant future there will be unbelievable schedules, complete safety, an enormous increase in the number of travelers by air to Europe. As far as business travel is concerned, flying will be first choice. And to those on pleasure bent, but with only a limited time at their disposal, the airplanes will be the answer. Now a business man or woman who can only spare two or three weeks from work will be able to take a vacation trip to Europe, see most of the leading capitals, traveling in Europe by air also, and be back in the United States without overstaying the time limit. This was impossible before the war. Thousands will, thanks to the airplane, be able to visit Europe for the first time in their lives, and do so at a remarkably low cost. But there will be many who will still wish to savor the luxury and freedom from care of a ten-day boat trip across the Atlantic in the heat of the summer as perhaps the very best part of the whole European trip.

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SUPERCHARGER

Built in Small Size Yet Highly Efficient

A REMARKABLE turbo-compressor, engineered by Wright Aeronautical Corporation and no bigger than a hat box, is shown in a cut-away model being operated by W. E. McClure. It is said to be lighter, more compact, and better adapted to varying aircraft conditions than any previous model. Within its clam-shaped housing, the exhaust of a Wright Cyclone 9 of 1200 horsepower will turn the turbine of the supercharger at 25,000 revolutions per minute and develop the equivalent of 150 horsepower. The turbine, in turn, will drive the compressor to provide ground level engine-operating conditions at high altitudes.

Model of "hat-box" supercharger

The beneficial effect of the turbo compressor on performance is well known; it is perhaps not so generally recognized that it is also helpful to passenger comfort. The baffling of the exhaust in its surge through the turbo helps to reduce the noise level of the aircraft considerably, so that passenger fatigue is reduced. Also, the turbo compressor may be employed in cabin pressurization.

PRIVATE FLIGHT

Will be Reasonable in Cost

THE NEW private planes will be safer, more efficient, more easily controlled than anything available before the war. They may be provided with only two controls (that is, elevator and ailerons alone without rudder) and tricycle landing gears which will permit cross-wind landings.

But the question still remains: How much will it cost to own and operate a private plane? John W. Friedlander, president of Aeronca Aircraft Corporation, a pioneer in the development of the private plane, discussed the question in a paper presented before the Society of Automotive Engineers.

If the airplane is little used during a year, its cost of operation will be prohibitively high. Thus, for a 65 horsepower, two-seater airplane selling at $1500, cost per annum will be $641 for 50 hours flying, but the cost will be only $1286.55 for 300 hours of flying per year. And 300 hours seems to be a reasonable amount of use.

The actual distribution of cost, on a basis of 300 hours a year, is as follows: Hangar, $180; insurance, $122.25; depreciation, $240; gas at 25 cents a gallon and 1350 gallons a year, $137.50; oil, $16.60; inspection and miscellaneous repair, $300; overhaul, $90.

All these figures and the total itself seem reasonable, but not cheap. And what will be the cost per mile? On a 300-hour basis, it will be about 4½ cents a mile, which also is reasonable but not cheap.

The greater costs of flying are compensated for by its greater speed as compared with the automobile. Mr. Friedlander has presented a most authoritative analysis of private plane costs. It will be interesting to see how the public will finally act when, with the favorable factors listed above, there are coupled these reasonable, though by no means cheap, figures of operational cost.

Water—A Marine Problem!

Design of Boilers for Ships of the Future May be Radically Affected by Present and Continuing Work of Chemists on Methods of Boiler Water Treatment. Proper Steaming Conditions Can Be Maintained Only if the Chemical Balance of the Boiler Water is Suited to the Installation

By A. C. PURDY

FRESH water supply presents one of the gravest problems encountered at sea. No way yet has been found to utilize directly the boundless water of the oceans for many of the important needs of marine transportation. As a consequence, the handling of fresh-water supplies is a prime marine problem. Water for steam boilers of ships must not only be conserved, but it must also be treated as necessary to minimize corrosion and to prevent scale and thus to give boilers the highest possible steaming efficiency. Obviously, the results of such treatment conserve space, always at a premium aboard ship, by saving both water and fuel.

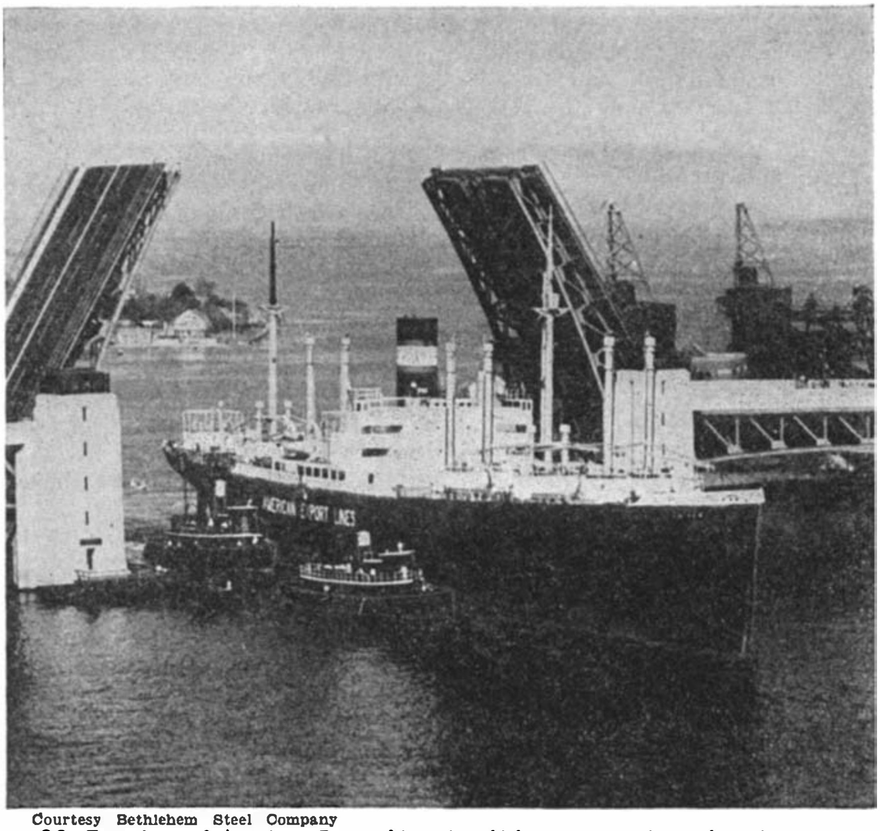
Certain problems of modern high-pressure stationary plants may become acute in the marine field when pressures, temperatures, and ratings move upward in future ship design. No radical increases in pressures, temperatures, and ratings have occurred recently in American merchant ship construction. Pressures of 350 to 400 pounds per square inch were typical of 1933 construction, while 450 pounds per square inch is representative of present design, excluding experimental installations such as the *Examiner* and some naval vessels.

During the decade 1923-1933 the theory and practice of water conditioning by control of chemical balance in the boiler water to prevent scale was developed and expanded in stationary installations. It was introduced into marine units in 1930. During this same period there was a rapid upward trend in operating pressures and steam output and square feet of heating surface per boiler unit in stationary practice, which apparently is related to these advances in water conditioning.

By controlling the excess soluble phosphate in the boiler water, the scale-forming calcium and magnesium salts in the feedwater will be deposited as non-adherent sludge rather than as adherent boiler scale. During the past ten years this use of phosphate for scale prevention has become quite generally accepted in marine boiler operation.

Foaming and priming probably gave more trouble in the old Scotch boiler and reciprocating-engine installation than in present-day water-tube boilers. However, it is still necessary to limit concentrations of dissolved and suspended solids, particularly the former, and of boiler water alkalinity to assure proper steaming conditions in modern installations.

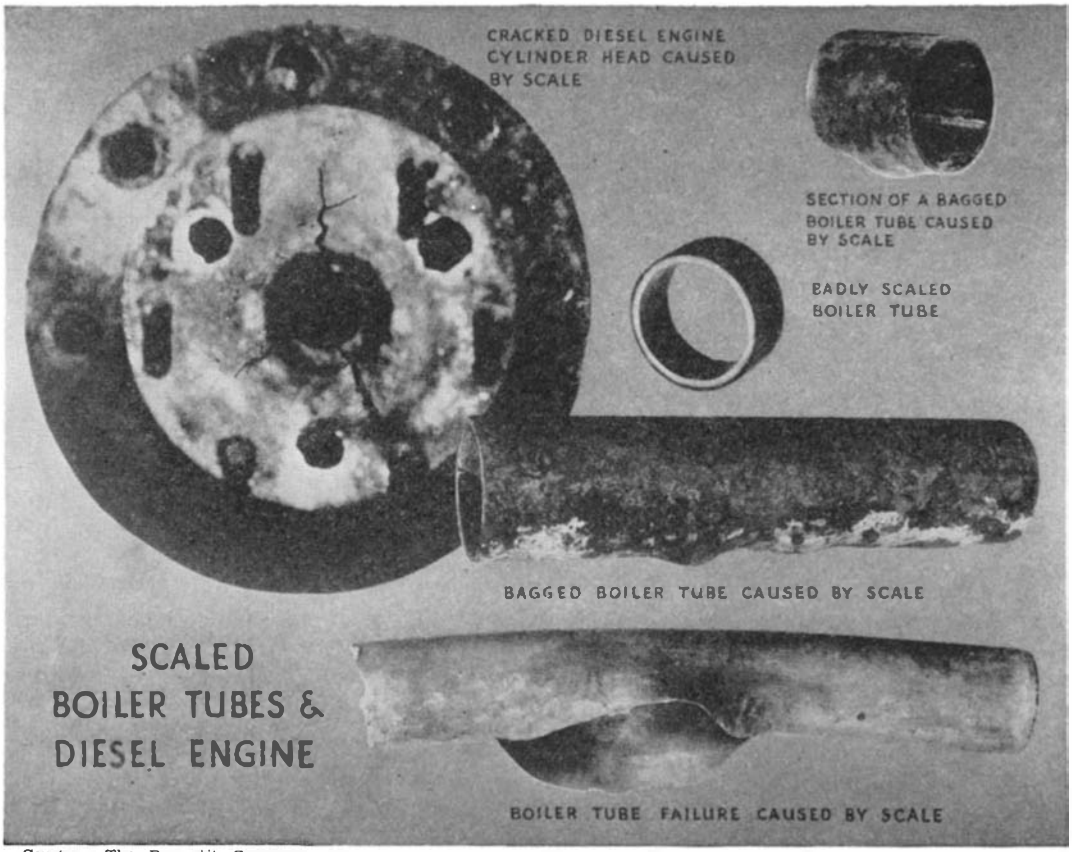
The importance of maintaining adequate protective alkalinity in the boiler water is generally recognized. The best alkalinity range varies with the installation, the aim being to establish and maintain a thin non-reactive iron oxide film



Courtesy Bethlehem Steel Company

S.S. *Examiner* of American Export Lines in which many experimental engine-room installations were tried, including a boiler with 1200 pounds pressure per square inch

Abstract of an address delivered before the Society of Naval Architects and Marine Engineers. The author is connected with the firm of Bull and Roberts, consulting chemists.



Courtesy The Permutit Company

A few examples showing the effects of water in boiler tubes and other parts of marine installations. Scale is a constant source of trouble to marine engineers

between steel and water which prevents any reaction between them. However, the caustic concentration must not be so excessive as to promote intergranular cracking of the metal or dissociation of the steam generated.

Of prime importance in preventing corrosion is the satisfactory deaeration of the feedwater. General acceptance of the deaerating heater in modern marine installations has been of great assistance. When properly operated, several available types have given excellent results.

METAL CRACKING—The basic factors causing boiler metal cracking are static or dynamic stresses acting in conjunction with corrosion. The corrosion may result from caustic or acid water conditions or from dissolved or bonded oxygen; and it can be retarded by water conditioning. Static stresses are inherent in the boiler as erected while dynamic stresses are set up by operating conditions.

Experience and study have established that caustic embrittlement of boiler metal can take place only when the following conditions exist simultaneously: A boiler water which, when concentrated, is embrittling; sufficient stress in the boiler metal; concentration of the boiler water to a high degree; contact of the concentrated boiler water with the stressed metal.

Two general methods for the chemical prevention of embrittlement have been suggested. Inhibitors such as sodium nitrate or tannin may be added to the boiler water. Tannin is effective only at relatively low pressures—below 400 pounds per square inch, but the efficiency of these inhibitors has been well established. Metal embrittlement also may be controlled by preventing high caustic concentration. This may be done by eliminating free caustic and controlling the protective alkalinity in the boiler water by means of various salts, such as tri-sodium phosphate.

The concentration of caustic may be controlled also by the presence of a highly soluble salt which will concentrate with the caustic soda and thus dilute it. Chlorides are salts of this type.

Fortunately, failures due to intercrystalline cracking of metal have apparently been very rare in marine boilers. It has been reported that the United States Navy has never had a case of this sort.

AS PRESSURES RISE—At pressures below 500 pounds per square inch, control of the phosphate balance prevents scale effectively and the efficient operation of deaerating heaters in conjunction with control of boiler water alkalinity prevents corrosion. Embrittlement has not been encountered in marine operation at these pressures and reasonably low alkalinities. But this does not mean that the problems of boiler water conditioning are a closed book. Stationary plant experience with higher operating pressures, supplemented by marine experience of some two and one-half years with the *Examiner* using pressures up to 1200 pounds per square inch, confirms the wisdom of resisting a temptation to standardize and to freeze the development of boiler water treating and testing methods. Progress must be made to meet the new problems of higher pressures, temperatures, and ratings.

As operating pressures rose above 600 pounds per square inch, a new group of siliceous deposits began to appear. The control of the phosphate equilibrium is not effective in preventing deposition of silica and sodium silicate, or sodium-aluminum and sodium-iron silicates. It became necessary to hold silica and alumina in the boiler water to a minimum and to limit, if possible, through boiler design and operation, the rate of heat input to the boiler surfaces. This approach has proved helpful but not always entirely satisfactory.

Corrosion of boiler surfaces by dissolved oxygen carried into the boiler by the feedwater has ceased to be a major problem on marine installations equipped with a properly functioning deaerating heater. However, the boiler water itself contains 88.9 percent of oxygen by weight bonded to hydrogen in the water molecule. Conditions under which this oxygen may be liberated and combined with the boiler metal occur with greater frequency in the higher rating and temperature range of high-pressure boilers. Only a narrow band of optimum protection exists at 590 degrees, Fahrenheit, (1418 pounds per square inch) with attack on boiler steel increasing with a rise in either alkalinity or acidity. With proper boiler water control, acid attack may easily be prevented, but certain operating conditions may give high local concentrations of alkalinity and oxidation of the boiler steel by oxygen from the water molecule. This may occur in areas of steam blanketing or film boiling where the boiler water is highly concentrated, and continued attack causes grooving or channeling with ultimate failure of the tube.

As pressures rose above 1000 pounds per square inch and stationary boiler designs called for higher ratings and higher rates of heat absorption, the limitations of considering boiler water problems only from the standpoint of chemical balance become evident. A new approach is necessary, and it appears to lie in a closer study of what actually happens as the boiler water traverses those surfaces where steam is generated. Here the water must absorb heat from the boiler tubes which receive it from furnace temperatures of 2000 to 2500 degrees, Fahrenheit, and must pass it on fast enough so that the temperature of the external surfaces of the tubes will not exceed 800 to 900 degrees, Fahrenheit.

CONCENTRATION OF SALTS— As steam bubbles form on the heating surfaces, the question arises as to whether the film of boiler water concentrating around the bubble will evaporate to dryness and deposit its salts in solid form on the tube surface.

To resolve the question of deposition of concentration of salts under the steam bubble, it is necessary to know whether the overheating at the tube surface is sufficient to raise the temperature of the boiler water at the interface between steam and water above the boiling point of a solution saturated with respect to any of the salts present. If the temperature of the film at the interface is greater than the boiling point of a saturated solution of one of the salts present, then to establish equilibrium that salt will start to deposit. Consider, for example, the behavior of sodium chloride, potassium chloride, and sodium sulfate in a boiler operating at 1800 pounds per square inch. The boiling points of saturated solutions of these salts (at 1800 pounds per square inch) are 692, 745, and 625 degrees, Fahrenheit, respectively. The overheating which would result in deposition under steam bubbles in an 1800 pounds per square inch boiler (boiler water temperature 621 degrees, Fahrenheit) would be 71, 124, and 4 degrees, Fahrenheit, respectively. In other words, if the overheating was 10 degrees, only sodium sulfate would deposit, while, if it was over 71 degrees, Fahrenheit, both sodium chloride and sodium sulfate would deposit, but potassium chloride would not begin to deposit until the overheating exceeded 124 degrees, Fahrenheit.

The significance of this approach to high-pressure boiler water problems lies in the fact that once sufficient data have been acquired, it will be possible to predetermine whether a boiler water on concentration will finally become saturated with one or all of the salts present and then, by adjustment of the relative concentrations of these salts, to force the solution to behave as desired.

One of the first fruits of this study has been the unexpected discovery that many potassium salts behave much more favorably than the corresponding sodium salts. It has also become evident that proper control of boiler water will permit concentration of other salts simultaneously with caustic, thus inhibiting alkali attack whether it results in embrittlement or becomes a contributory factor in corrosion by bonded oxygen.

It is necessary to emphasize again the fact that the chemistry of boiler water is a constantly developing science in which many able research men are co-operating with boiler designers and operators to give the latter the greatest possible latitude in design and operation for increased economy. Developments in this field may radically affect marine boiler design in the future.

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POLARIZER

Uses Large Sheets To Good Advantage

EXAMINATIONS by polarized light to reveal strains in structures of various kinds can now be more conveniently made in a new instrument embodying Polaroid sheets. The polarizing sheets are mounted separately between glass plates and so arranged that one is stationary over the light box while the other can be moved through eight inches parallel to it. The plates are about 12 inches square, which contrasts with the calcite prisms of less than a square centimeter in cross section that were formerly available.

X-RAY ABSORPTION

Gives New Tool to Chemical Analysis

SHOOTING a beam of X rays through an unknown substance and measuring how much of the radiation is absorbed thereby is a rapid means of chemical analysis recently developed. The method, which can be used with gases, liquids, or solids, hot or cold, is expected to find extensive application.

X-ray absorption as an analytical method is made practical by a photoelectric X-ray intensity meter developed in the General Electric Research Laboratory, where the method was developed. The invisible X rays fall on a fluorescent material, which becomes luminous where they strike. This material, called a phosphor, is painted on the glass envelope of a phototube of the multiplier type.

With such a tube the light from the phosphor falls first on a sensitized surface within the tube and electrons are emitted. These electrons fall on a second surface from which still more electrons, in larger quantities, are discharged. They fall on a third surface and the yield is still further increased. Then even more stages are used. Thus the electrons are multiplied and those from the last stage result in a small electric current which can be amplified still more with other electron tubes, and measured with an appropriate meter. Amounts of light with energy equal to only one ten billionth of a watt can be measured easily and accurately in this way.

The photoelectric meter can measure very weak intensity X rays and also can detect extremely slight variations in their intensity. For example, if the X rays are passed through a pile of 100 sheets of paper, the difference in absorption caused by the addition or removal of a single sheet produces a noticeable effect.

In the analytical method, which has thus far been set up only experimentally, the solid or liquid sample is placed in a glass cell ¾ inch in diameter and 6 inches long. For gases a two foot cell is employed. The current from the phototube is amplified and its intensity read on a meter. Comparisons are made of the absorption of the cell with and without the sample.

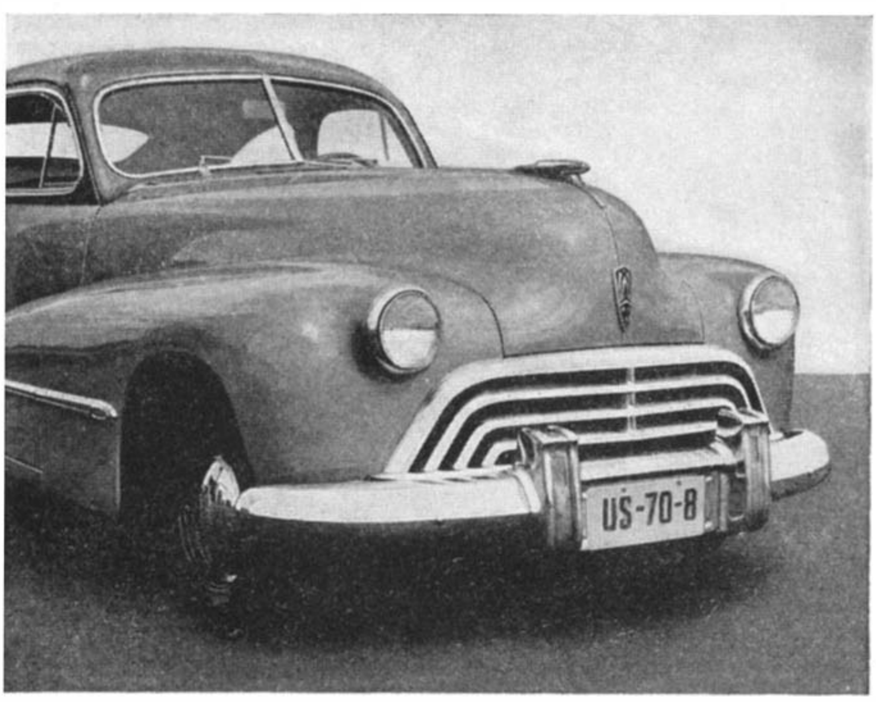
Motor Cars Tomorrow

Rear-Engine Vehicles are Possibilities, but Most of the Radical Changes in Motor Cars are Still in the "Air Brush" Stage. Inroads of Foreign Cars are not Feared, and a New Drive is on to Popularize Small Cars. But the "Big Three" Will Probably Have the Last Word

ALTHOUGH most of the automobiles which are already in production and which will be coming off the assembly lines within the next few months will be only slightly revised editions of 1942 models, Detroit and other automotive centers are seething with rumors of radically different designs. Reason for few changes in the large production models is because the industry is just as anxious to get, and collectively probably more interested in getting, into production than are prospective new car owners. Any basic or radical change would delay getting cars into the hands of the manufacturers' dealers.

At the moment it appears that anything as radical, for example, as moving the engine to the rear of the car will be left to the more fanciful newcomers into the business. However, the possibility of the combination of the reputation of Graham-Paige and the dramatic name of Henry Kaiser might have some hand in a fairly early introduction of a rear-engined car. A version of William B. Stout's "Scarab" is likely in this combination since Mr. Stout has been retained by the Graham-Paige Corporation, as a consulting engineer. He is the country's leading exponent of this design.

Joseph W. Frazer and Mr. Kaiser have announced the formation of the Kaiser-Frazer Corporation, the idea being that the dynamic west-coast dam, bridge, highway, and shipbuilding executive may have an automobile named after him. Mr. Kaiser's steel and light-alloy facilities, marine propulsion, and other engineering interests make his pronouncements about the car of the future something with which to conjure, particularly because of his faith in the unbounded future of the west. He will probably make every effort to establish whatever peacetime industries he can to absorb his steel and light-metal production. His notable record for war production, and his excellent reputation as a doer of big things before the war, augurs well for some interesting news from his direction.



General Motors' Oldsmobile for 1946

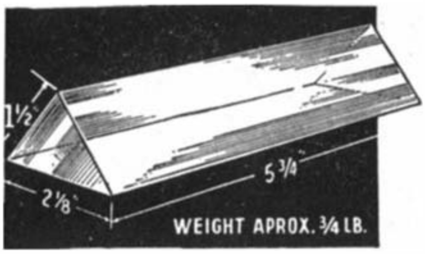
WHAT PUBLIC WANTS—The American motor-car buyer has demonstrated that a large package and good looks are more to be desired than a smaller and more economical vehicle, although the Willys-Overland "de-militarized" Jeep is expected to have a great popularity as a farm and industry utility vehicle. No car has ever had such favorable public acceptance as the Jeep, and numberless stories, told in words and pictures, have made Jeep a household name throughout the world. All of this good will can be counted upon to help merchandise this vehicle.

Apparently Powell Crosley, Jr., thinks there is a good market for small cars in the United States. He recently sold the controlling interest of Crosley Corporation to Aviation Corporation, with the exception of the automobile division. He announced that the post-war Crosley car will be a few inches longer than the pre-war model, and will be powered by a four-cylinder instead of a two-cylinder powerplant. But gasoline consumption and the total weight of the car will be about the same, he estimated. He is gambling against the "large package" boys.

Few Detroiters fear the inroads of British automobiles, which are already in production. Despite reports to the contrary, British and European manufacturers have failed to grasp the economic advantages of mass production to the extent that American manufacturers have

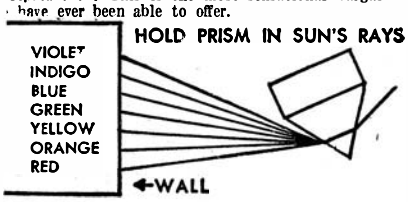
;ENSATIONAL WAR BARGAINS

in LENSES & PRISMS



SILVERED TANK PRISM
-45-45 degree, 5¾" long, 2⅛" wide, finely ɔund and polished. Would normally retail from $24 $30 each.
ɔck #3004-S ....$2.00 each Postpaid
(Illustrated booklet on Prisms included FREE)

FOUR SILVERED TANK PRISMS—
SPECIAL $7.00
ıstpaid . . . This is the most sensational bargain · have ever been able to offer.



TANK PRISMS

In order that the tank driver shall not get shot in the face, 2 of these Silvered Prisms are used to make a Periscope. We have secured a number of these that are very slightly chipped, making possible their sale at a very low price. They are 90-45-45 degree Prisms of huge size 5¾" long, 2⅛" wide, finely ground and polished. Used to build a Periscope . . . excellent also for experiments, class-room demonstrations. Some of our ingenious customers have used these prisms to make camera stereo attachment, range finder, etc. Prism easily converted into desk name plate by affixing gold letters. 100 supplied at only 10c. (Order Stock #3008-S). Normally these Prisms would retail from $24 to $30 each.

SEE THE COLORS OF THE SPECTRUM

It's easy to remove the silvering from a silvered prism to make an interesting experiment. Hold prism in sun's rays as shown in drawing. White incident light which passes through prism is thus broken up into a band of primary colors known as the spectrum—a beautiful sight! By looking through a tank prism at a certain angle, you can see a world of colors everywhere. Truly amazing!

All Items Finely Ground and Polished but Edges Slightly Chipped or Other Slight Imperfections Which We Guarantee Will Not Interfere with Their Use. Come Neatly Packed and Marked.

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To translate millimeter measurements: 25.4 mm. equals one inch.

8 MM. MOVIE PROJECTING LENS SET—Consists of 2 Achromatic Lenses, Diam. 15 mm. and a F.L. when combined of approx. one inch. Each lens has the new magnesium fluoride low reflection coating.
Stock #4011-S ....$1.40 Postpaid

POLAROID (Dyed to reduce light transmission)—Suitable for Experimentation.
Consists 2 discs—2½" Diam. Some imperfections in glass.
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12-POWER COLOR CORRECTED MAGNIFIER SET—Consists of two 15 mm. diam. magnesium fluoride low reflection coated Achromatic Lenses and section of metal tubing for mount.
Stock #1029-S ....$1.50 Postpaid

RIGHT SIDE BINOCULAR BODY . . . New Plastic covering over metal from Navy's 7 x 50 binocular.
Stock #802-S ....$7.50 Each

RETICLE SET . . . Five assorted, finely engraved recticles from U. S. Gunsights. Among others contains a Cross Line Reticle with perfect pin point hole in center. Very useful to astronomical mirror makers for testing. Worth several dollars each.
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ACHROMATIC TELESCOPE OBJECTIVE LENS . . . Diam. 48 mm., F. L. 11 inches. Edged but not cemented.
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MAGNIFIER SET . . . 5 Magnifying Lenses . . . Powers from 1 to 10. Various diam. for many uses. Free Booklet on Home-made magnifiers included.
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ɔontains wide variety of projects and fully covers the ascinating uses of all Lenses in sets listed above . . . ınly $1.00 Postpaid.

RIGHT ANGLE PRISMS

ꞩtock No.	Width	Length	Price
ɜ040-S	23 mm.	33 mm.	$1.00
ɜ041-S	40 mm.	56 mm.	2.00
ɜ042-S	40 mm.	41 mm.	1.00
ɜ043-S	54 mm.	78 mm.	1.00

MISCELLANEOUS ITEMS

Stock No.	Item	Price
3006-S	Porro Abbe Prism. Each	$0.25
3016-S	Pentagon Prism. Each	.75
2024-S	10 Pieces Circular A-1 Plate Glass (Diam. 31 mm.—for making Filter)	.25
3001-S	Lens Surface Prism. Each	2.00
3021-S	Amici Roof Prism (3rd Grade). Each	.25
4009-S	Heat Absorbing Glass 4" x 5". Each	.35
4010-S	Heat Absorbing Glass 2" x 2". Each	.10
2020-S	40 mm. Neg Lens, Cross Lines. Each	.25
3020-S	Right Angle Prism 48 mm. wide (3rd grade). Each	.35
523-S	Six Threaded Metal Reticle Cells	.25
26-S	First Surface Aluminized Mirror, Diam. 1¼". Each	.25
624-S	Neutral Ray Filter, size 4¾" x 2½"	.25
3022-S	Round Wedge, 65 mm. Diam. Each	5.00
3036-S	Roof Prism — 80 degree, face 1⅝" wide. Each	4.00
22-S	Inclinometer—Aircraft type. Each	.25
704-S	Lens Cleansing Tissue, one ream (480 sheets), size 7½" x 11"	1.50
6002-S	Educational Set, 1 blank and 1 finished Porro Prism (3rd grade)	.25
1028-S	8 Power Mounted Magnifier. Each	.35
1030-S	2" Diam. Reducing Lens. Each	.25
1031-S	Perfect 6 Power Magnifier. Diam. 28 mm. Each	.25
2043-S	Standard Crossline Reticle. Diam. 29 mm. Each	.50
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Minimum Order on Above—$1.00

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1 Red and 1 Yellow Filter in following Diam.

Diam.		Price
20 mm.	(seconds)	40c
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45.5 mm.	(seconds)	90c
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(Minimum Order on Above—$1.00)

RAW OPTICAL GLASS . . . An exceptional opportunity to secure a large variety of Optical Pieces both Crown and Flint glass (seconds) in varying stages of processing. Many prism blanks.
Stock #703-S—8 lbs. (minimum weight) $5.00 Postpaid
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PERFECT ACHROMATIC TELESCOPE OBJECTIVE LENS . . . Diam. 1¾ inches, F. L. 20 inches.
Stock #6091-S ....$5.00 Postpaid

CLEANING BRUSH SET . . . For Lenses, Optical instruments, etc. Perfect quality—12 inch Flexible Plastic handle, hollow circular const. Range from stiff to very soft. 4 Brushes to set.
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Stock No.	Dia. in mms.	F.L. in mms.	Comments	Price
6017-S*	12	80	Cemented	50c
6019-S*	15	41	Cemented	60c
6023-S*	25	95	Cemented	75c
6078-S*	33	140	Uncemented	70c
6081-S*	35	55	Uncemented	70c
6082-S*	37	57	Uncemented	70c
6084-S*	41	66	Uncemented	70c
6085-S	45	135	Uncemented	$1.00
6086-S*	49	75	Uncemented	90c
6089-S	56	90	Uncemented	$1.00
6111-S	16	36	Cemented	75c
6116-S*	41	66	Cemented	$1.00

ASTERISKED ITEMS may be requested with new low reflection Magnesium Fluoride coating at 10c extra.

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Complete Set Mounted Components

Rugged, strong, originally constructed for U. S. Tank Corps. Consists of 2 fine Periscope Mirrors mounted in metal and plastic. Perfect condition. Only plywood body frame is required to finish this exceptional Periscope. First surface mirror is well protected by glass windows. Set weighs 2¾ lbs. Overall length of mount 6⅛", width 2⅛". Would normally retail at $40 to $50.
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Two Sets (4 UNITS) ....SPECIAL $5.50 Postpaid

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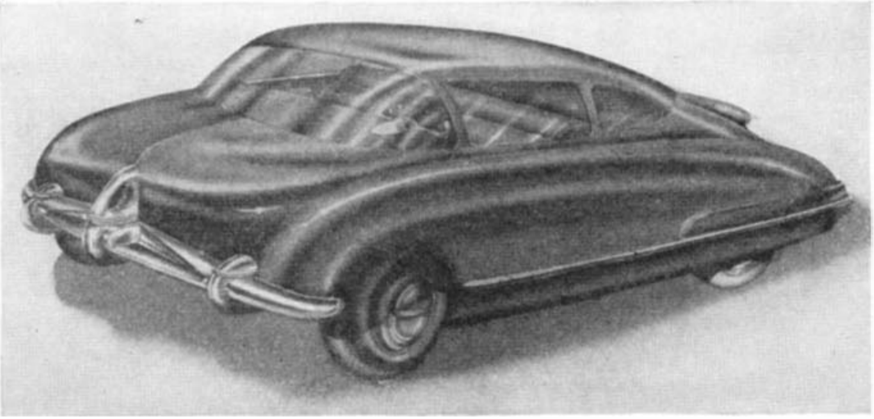
done. The result is that, even in the face of lower hourly wages, these British and European vehicles are more expensive than low priced American automobiles. Several months ago materials for the British motor-car industry were released by that Government, and some of the plants, such as Austin, are in full production. The American market will probably absorb all the British cars that are offered, for a while, in spite of a high price. But as soon as the "big three"— Chevrolet, Ford, and Plymouth—and others in the low and medium priced fields, get into production at pre-war volume, imports of foreign cars are expected to fall off rapidly.



Ray Russell, industrial designer, conceived and built this Quadratic Drive car with rear engine. A hydraulic system eliminates the clutch, transmission, drive shaft, universal joints, differential, rear axle housing, axles, and brakes. The engine drives a multiple hydraulic pump of variable pressure capacity. This pump forces hydraulic fluid through flexible couplings to all four wheels, in each of which is mounted a hydraulic motor. Braking power is applied through regulation of the speed of the hydraulic fluid moving through the motors. The builder of this car (which is not yet in production) claims 12 percent cheaper operation than other cars of similar weight

The next important change in power-plant design apparently will be a combined reciprocating internal combustion engine hooked up with a high speed turbine, the latter to turn the former's exhaust gases into propulsive power. A great deal of experimental work has been done on this type of engine, but little has been divulged about it publicly. Not long ago several Army Ordnance and Navy officers discussed its possibilities, but feared that not enough work has been done to expect that such an engine would get into early production. However, development work is continuing.

HIGHER EFFICIENCY—In general, automotive engineers appear to be satisfied with the present internal combustion engine. However, there are some exceptions and men such as C. F. Kettering, head of General Motors' far-flung research projects, think that only the surface of the problem of more efficient engines has been scratched. "Boss Ket" envisions not only new fuels, but a better understanding of fuels by engine designers, and a better matching of fuel characteristics to the engine of tomorrow.

But automotive engineers everywhere are expecting considerable improvement in motor-vehicle transmissions. The fluid flywheel brought out by Chrysler, and Oldsmobile's "hydra-matic" automatic transmission, are held by a number of men to be only the beginning in improving the power-transmission link between engine and rear axle. At least a dozen organizations are working on this problem, and several engineers have concluded that simpler automatic gear shifting will be justified by popular demand even if the actual efficiency in operation takes a setback.

A wealth of developments in power transmission, ideas which have been borrowed from such industries as the machine tool and industrial power transmission, form an interesting background for vehicle transmission improvements. Although the basic principles of hydraulics have been long known, some of the newer control valves and actuating mechanisms open interesting possibilities to men who are devoting their whole attention to this phase of automotive engineering.

Fords for 1946 come off the production line

RUBBER—Better understanding of synthetic rubbers, and greater experience with the more resilient types, have opened new engineering vistas in car, bus, and truck chassis suspension. Here, as in the case of new fuels and matching new engines to them, is a field where the chemist and engineer must work together closely. Off-the-record opinions about the future of the synthetics as an engineering material are glowing. Few chemists or engineers who have been working with these new materials are willing to be quoted at this stage of developments because of the lack of experience. What has been discovered to date, however, leads many an automotive engineer to envision radically different suspension in the interest of more rider comfort. The fact that large amounts of money are flowing into these researches indicates that management has faith in synthetics.

The top executive of one of the world's most important tire companies predicts tires that will last as long as an automobile, won't puncture, blow out, or even skid on wet pavements. He expects to see the day when a tire can be expected to run 100,000 miles.

Just as the airplane shock strut development borrowed heavily from automotive shock absorber experience and the considerable amount of research it involved, so will vehicle designers borrow from current experience of aircraft engineers who have multiplied the knowledge developed in this field.

METALS—The art of metal working has been making rapid strides while production men have been sky-rocketing output of guns, shells, and the thousands of mechanical devices needed to win a war. Just before the war, the age-old idea of peening surfaces found vigorous proponents, and shot peening of working parts has come into its own. Surface stresses, often increased by grinding and polishing, are relieved by shot blasting. As a result of extensive laboratory work and actual production of parts, a vigorous school of shot peening or shot blasting advocates is showing remarkable improvements in the fight against fatigue of metals. Fortunately for the motor car owner of the future, much of this work has been done in automotive factories. Ford, for example, will offer shot-peened engine valve springs, which will also be rust proofed.

The improvements in other metal-working techniques are almost endless. Better controls of heat in heat-treating operations, better controls of alloying processes in the steel mills, greater knowledge of the nature of the metals as well as of the tools and grinding equipment, more experience in machining and forming aluminum and magnesium, and even the vast experience in manufacture of plastics-impregnated wood and canvas, are being counted upon to have an important part in shaping the future of the motor car.

Most informed engineers do not expect extensive use of aluminum sheets in car bodies, leaving that field of speculation largely to the "air-brush" designers. It is probable, however, that a good deal more aluminum will be used in engine castings than ever before. Continental and other engine builders are developing several models of engines using more cast aluminum than was used in pre-war days. The new Fords will substitute aluminum for steel pistons, both in the six and in the eight, as well as in the new edition of the eight-cylinder truck power-plant.

RESEARCH—Although the huge General Motors Technical Center to be built in the environs of Detroit and the great engineering and research departments of Chrysler and Ford are extremely impressive as facilities for engineering developments in the automotive industry, there is in addition some 150 millions invested in other motor vehicle and parts research and development laboratories and proving grounds in the United States. Suppliers—notably steel mills, non-ferrous, rubber goods, chemical, and petroleum manufacturers—apply a sizable share of their total research effort and expenditures to automotive problems.

As a matter of fact, a large percentage of the actual development of improved automotive devices are attributable to the parts and supply industries which serve the vehicle manufacturers. Often development work is done jointly by the supplier and a prospective customer. A number of projects of this general scheme are getting into high gear.

Atomic Bombs

Power of Devastation Lies in Disruption of the Atom by Methods Not Yet Completely Revealed. However, Research Progress, Reported Before the Entry of the United States into the War, Indicated the Paths Along Which Intensive Work Has Been Done Both Here and Abroad

By A. P. PECK

EDITOR'S NOTE: Admittedly, world security prevents publication of detailed information on the atomic bomb which rocked Japan early in August, and likewise rocked the scientific world and the world of the man on the street to its very foundations. The newspapers have done an adequate job of guessing about the principles of the atomic bomb and about the possibilities of atomic power in the future. The accompanying article, composed mainly of excerpts from issues of Scientific American, gives about all of the specific data available today and points the way to the future.

WHEN the first atomic bomb burst over Japan, it did far more than disintegrate the homes, the industries, and the very bodies of the Japanese within a range far greater than had ever before been reached by any man-made explosion. It proved that man had at last solved, in a limited measure, the means of unleashing the locked-up power of the atom and putting it to work. That such power for good or evil lies in the very atoms which are the basis of all matter has been known for many years. But mere knowing has failed to furnish the key. The road to knowledge has been long and rough. Even now that atomic bombs have proved themselves, there remains much work ahead.

Can the power of atomic energy be put to useful purposes? The answer is that it can but that the means of so doing will probably involve more intensive and extensive research than has already gone into the development of the atomic bomb itself.

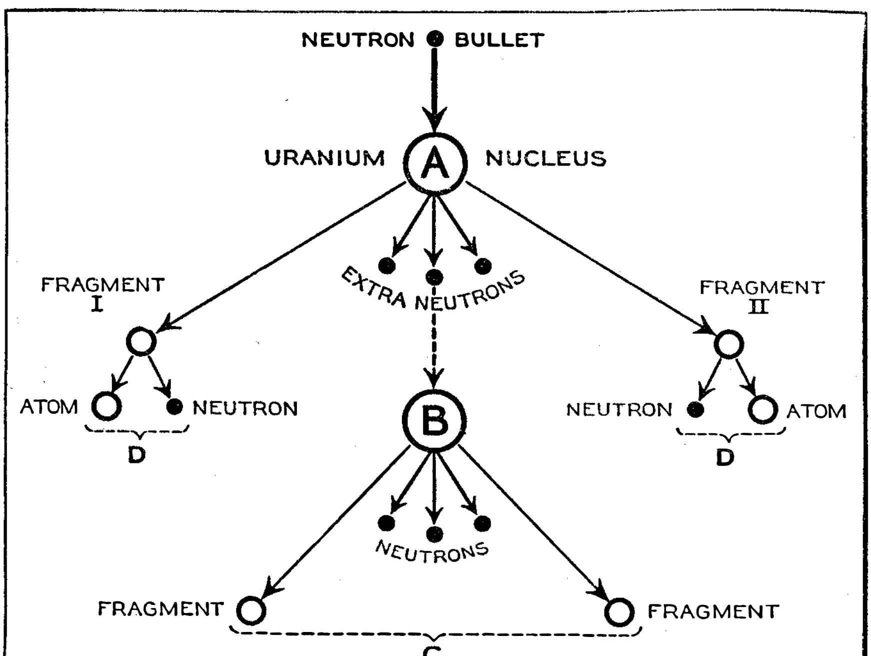
Details of the atomic bomb cannot—and should not—be revealed to the public. However, some insight into the background of atomic power is permissible and can be obtained from back issues of Scientific American. To supply such information on a sound basis, free from the hysteria that understandably characterized the first reports of the atomic bomb in the daily press, the main body of this article is composed of direct quotations from Scientific American. Dates are given so that those interested in seeing the complete articles can easily locate them.

URANIUM SPLIT—The first interpretive article, in an unconnected series that ended when censorship rightly clamped down on atom-splitting articles, appeared in Scientific American for October 1939. In that issue, Jean Harrington, writing under the title "Two Elements for One," had the following to say:

"The Fifth Washington Conference on Theoretical Physics was sitting in solemn conclave when the news broke. Professor Nils Bohr of Princeton and Professor Enrico Fermi of Columbia rose to open the meeting with an account of some research going on in a Berlin laboratory.

"It was January 26, 1939. A few weeks before, at the Kaiser Wilhelm Institute in Berlin, Dr. Otto Hahn, a distinguished German physicist, had obtained an utterly unexpected result from more or less routine experiments. Following the original example of Professor Fermi, Dr. Hahn and his co-worker, F. Strassmann, had for many months been bombarding uranium with neutrons and studying the debris left by this atomic warfare.

"It was news, and big news, to discover barium among the debris—barium, which is only a little more than half as heavy as uranium.



From the article "Don't Worry—It Can't Happen," published in May 1940 issue, Scientific American. Diagram of a theoretical chain reaction for uranium. The neutron bullet at the top splits the uranium nucleus *A* into fragments I and II and, in addition, erupts three extra neutrons. One of the latter may hit another uranium nucleus *B*, and split it into similar fragments and neutrons *C*. Each of the first two fragments may break down into another atom plus a neutron, as shown at *D*, left and right

It meant that the neutron bullets had succeeded not merely in knocking a few chips off the old block, but in blowing the whole atom asunder with a terrific explosion.

"A few insiders had already jumped the gun ahead of the Conference and of the rest who learned of the discovery through the newspapers. In Copenhagen, Dr. O. R. Frisch and Professor Lise Meitner, who had previously worked with Hahn on the same problem, had verified his results ten days earlier. A group of Columbia University physicists, including Fermi, independently thought up and carried out a similar experiment by January 25, the day before the Conference. By the time the meeting wound up its affairs January 28, three more laboratories—at the Carnegie Institution of Washington, Johns Hopkins, and the University of California—joined the chorus of confirmation. In a word, Hahn was right. Uranium, and thorium, too (thorium is also among the heaviest elements), had been split in two by neutron bombardment.

"The phenomenon was quickly dubbed 'nuclear fission,' and in the months ensuing since its discovery, nuclear fission has grabbed the spotlight from the 'heavy electron' sensation of 1937-8. Dozens of the world's top-flight physicists have been busy as bees, roaming the clover of a new field of research.

"In a discovery like this in the realm of pure science, it is always easier to see the theoretical importance than to find a practical application. The fission of uranium has provided a field day for the physicists who like to take atoms apart and find out what makes them tick. It adds a new chapter to their knowledge of the nucleus—the forces that hold it together, the collective behavior of its constituent parts, its reaction 'under fire,' its destiny.

"Our imaginations are immediately seized by the terrific amount of energy liberated when a single uranium nucleus explodes. The two fragments fly apart activated by some 200,000,000 electron volts—a total far greater than that associated with any other atomic phenomenon except cosmic rays.

"The tabloids love to write of blowing up the world with a gram of matter, and it's not such a sensational idea as one might think. Even a tiny mass has an enormous potential of energy if it could but be freed. It is just such a conversion of mass into energy that speeds the fission fragments on their way.

"Of course, 200,000,000 electron volts is an astounding energy compared with the size of the bodies which possess it. But for practical purposes it is absurdly small, amounting only to about three ten thousandths of an erg. In more everyday terms, it would take 25,000 billion fissions per second to produce one horsepower — figures which dwarf even the national budget. The very best a laboratory can do so far is to produce a few hundreds per second.

"If atom smashing could be made more efficient, power production by means of nuclear fission would not be beyond the realms of possibility.

"Research along all these lines is proceeding at breakneck speed. Experiments similar to those with uranium have been performed on thorium with similar results, except that only fast neutrons are effective in splitting the thorium nucleus, while both fast and slow work well on uranium. Other heavy elements, such as gold and tungsten, show some slight tendency to undergo fission.

"It is probable that a sufficiently large mass of uranium would be explosive if its atoms once got well started dividing. As a matter of fact, the scientists are pretty nervous over the dangerous forces they are unleashing, and are hurriedly devising means to control them.

"It may or may not be significant that, since early spring, no accounts of research on nuclear fission have been heard from Germany. It is not unlikely that the German government, spotting a potentially powerful weapon of war, has imposed military secrecy on all recent German investigations. A large concentration of isotope 235, subjected to neutron bombardment, might conceivably blow up all London or Paris."

END OF THE WORLD?—If the energy locked in the atom could be released, why would not that energy release the power in other atoms and start a long chain of reactions that would result in a practically instantaneous end of the world? All atoms hold tremendous locked-up power. Granted that atoms of uranium and thorium are the only ones which thus far can be directly unlocked, why would not the released energy be enough to start other atoms off and disrupt the entire universe within a split second?

Miss Harrington, writing in the May 1940 issue of Scientific American, in an article entitled "Don't Worry—It Can't Happen," showed that the action of the atomic power of uranium can be controlled. Perhaps the title of the article exerted a soothing influence on the Japanese. In any event, it *did* happen, but in a different way than the article title indicated. Here are the important points that Miss Harrington made:

"Just about a year ago, physicists who had been gunning at the metal uranium with neutron bullets, just to see what would happen, suddenly found that they had caused the biggest explosion in atomic history. It wasn't a big explosion in an everyday sense; no Berlin window panes rattled at the blast, and no one heard the noise. But it seemed big and loud enough to other physicists all over the world. They had never before known of an atomic blast of such tremendous energy, and presently they began to worry about it.

"Previous experiments had succeeded only in knocking chips off atomic nuclei, and these operations released only a tiny fraction of the boundless energy locked up in atoms. But, when uranium cracked in two, 200,000,000 volts of energy burst forth in the form of radiation, heat, and speed.

"It was soon apparent that quite a number of strange and wonderful things happened when the uranium nucleus blew up. Besides the two main fragments, a few spare neutrons (two or three per fission) were thrown off from the original nucleus. In addition, the two new atoms were unstable, erupting neutrons and other particles in a whole series or chain of reactions until they finally subsided. The result was a great hodge-podge of new atoms and extra neutrons.

"In the midst of all this research, a chilly sensation began tingling up and down the spines of the experimenters. These extra neutrons that were being erupted—could they not in turn become involuntary bullets, flying from one exploding uranium nucleus into the heart of another, causing another fission which would itself cause still others? Wasn't there a dangerous possibility that the uranium would at last become explosive? That the samples being bombarded in the laboratories at Columbia University, for example, might blow up the whole of New York City? To make matters more ominous, news of fission research from Germany, plentiful in the early part of 1939, mysteriously and abruptly stopped for some months. Had government censorship been placed on what might be a secret of military importance?

"The press and populace, getting wind of these possibly lethal goings-on, raised a hue and cry. Nothing daunted, however, the physicists worked on to find out whether or not they would be blown up, and the rest of us along with them.

"The key to the problem is probably the speed of the neutrons. In the original experiments it was soon found that relatively slow neutron bullets were the most effective in producing fissions. As the chain reaction proceeds and more and more energy is released, the uranium target becomes heated. The extra neutrons are perhaps so speeded up by the heat that they cease to be efficient atom-busters. Thus the reaction poohs out as the temperature rises."

ATOMIC POWER—In July 1940 the article "Is Atomic Energy Nearer?" by Roy C. Copperud of the University of Minnesota, detailed still other research and gave still another lead to the atomic bomb of today and atomic power of tomorrow. The following excerpts from that article are significant:

"Eyes of the scientific world widened the first week in May at the startling news that work of a 28-year-old physicist at the University of Minnesota, Dr. Alfred O. C. Nier, in isolating the explosive uranium isotope, U-235, had been corroborated, marking a significant advance toward shackling atomic energy.

"There were predictions that this discovery made feasible bombs of unheard-of strength, that five or ten pounds of U-235 would propel a vessel around the world for an indefinite time without refueling—in short, that economic foundations of the world were about to crumble.

"The fact of the matter, he insists, is that many a knotty problem remains to be solved before any useful harnessing can take place. Chief among these is extraction of U-235 in vastly greater quantities than is possible now.

"Dr. Nier estimates that one pound of U-235 would generate as much force as the combustion of 2,000,000 pounds of coal, or that its detonating energy would be equivalent to that of 20,000 pounds of high explosives.

"Dr. Nier estimates that, even with any reasonably economical means of extracting U-235 in large quantities, the cost per unit of energy produced would equal that of coal. 'So you see,' he observed, 'it would not mean getting power for nothing.' Despite the extraction cost, the great amount of energy concentrated in a small volume would make it invaluable for airplanes, for example, or any other apparatus where weight of fuel is a consideration.

"The Minnesota scientist considers it hardly likely that the mass spectrometer, the device he used to separate the uranium isotopes, can be adapted to mass production. It is more probable that some chemical means of separation would turn the trick. But as to any such method, researchers are still at sea. Dr. Nier emphasized further that, once extraction is accomplished, the problems of handling and chaining the atomic force safely might occupy scientists for years.

"This is the abbreviated story of what may well prove to be one of the great crests of scientific achievement. True, researchers are cautious about advancing ambitious claims, and Dr. Nier himself believes that remaining obstacles to chaining atomic power will persist far into the misty future. But only ten years ago it was considered impossible to separate the isotopes of any element whatever, and now it is being done commercially with hydrogen."

WHAT IT ALL MEANS—The curtain of censorship falls. Work on the power of the atom becomes too important to spread in the public press. Military supremacy of the world, more important at the moment than anything else, is at stake. Despite the jump that Germany apparently had on the rest of humanity in this matter, the events of early August 1945 showed clearly that the final answer was found in the United States. An atomic bomb spread devastation. Then another. The Japanese learned what "all out" war meant. The power of the atom had been put to man's use, but unfortunately to a destructive use. What man can harness to one purpose, he can control to another. But when?

The atomic bomb poses many questions. It has proved that atomic power can be used. When will atomic fission drive automobiles and airplanes, replace coal and oil for power generation, make water power obsolete? We can only be honest and say that we do not know. The time is closer than it was five years ago, and not only because of elapsed time; concentrated knowledge has bridged a generation in atomic power development. It is probable that someday, perhaps within the lifetime of many present readers, a spoonful of uranium or some similar material will replace a binful of coal or a tank of oil in the cellar; that automobiles will be made with a life-time of fuel sealed in; that power-plants will be independent of fuel as we know it today. But until more details are available—and that time is apparently far distant—we will go along with Mr. Copperud and say: "Many a knotty problem remains to be solved before any useful harnessing can take place."

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FOOD PROCESSING

Successfully Accomplished With High-Frequency Electricity

Food scientists are calling upon the latest findings in the field of electronics to aid in conserving the nutritive value of vegetables during processing for dehydration or freezing preservation.

By using high-frequency electricity for blanching vegetables in place of flowing steam or boiling water, food chemists at the New York State Experiment Station reduced the loss of vitamin C in treated raw cabbage from the 30 to 40 percent occasioned by the usual blanching methods to only 3 percent by electronic blanching.

Commenting on their experiments, the Station workers say: "For their successful preservation by freezing or dehydration, vegetables are briefly exposed to flowing steam or boiling water. This heat treatment inactivates enzymes which may cause deterioration of flavor and destruction of vitamins during storage. However, these heat treatments sometimes damage the texture of the vegetables, making them soft, and the steam or boiling water also leaches out vitamin C and some of the B complex vitamins, thus reducing the nutritive value of the food.

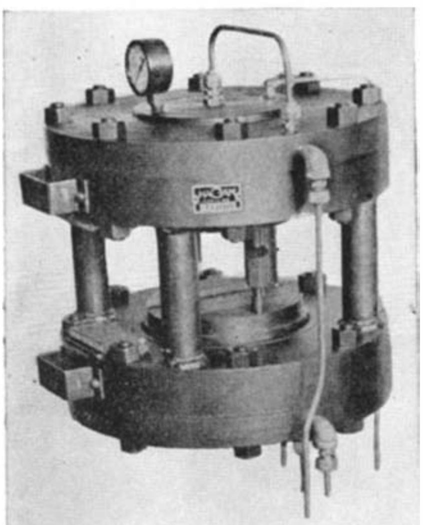
"It occurred to us that electronic heat might be used in place of steam or boiling water, with improvement in the texture of the treated product and reduction in losses of vitamins. It was thought that by using high-frequency electricity, washed fresh vegetables could be placed directly in the container which goes to the consumer, passed through a high-frequency field to inactivate the enzymes, and then directly into the freezer. This would eliminate much handling and possible contamination of the vegetables before they reach the consumer. The results obtained from the electronic heating of cabbage have led to more extensive tests with other vegetables. While our experiments have been on a small laboratory scale, it is possible that rapid advances in electronics during the war may make possible the large-scale use of electronic heating in the commercial processing of fruits and vegetables in the not far distant future."

New Products and Processes

FORCE MEASUREMENT

Instrument Uses Air-Loaded Diaphragm

MEASURING and weighing with air, with such accuracy and sensitivity that the force of a pea from a boy's pea-shooter or the thrust of a giant jet airplane engine can be measured, has been accomplished by a new instrument



Accurately measures force of a pea-shooter or the thrust of a jet engine

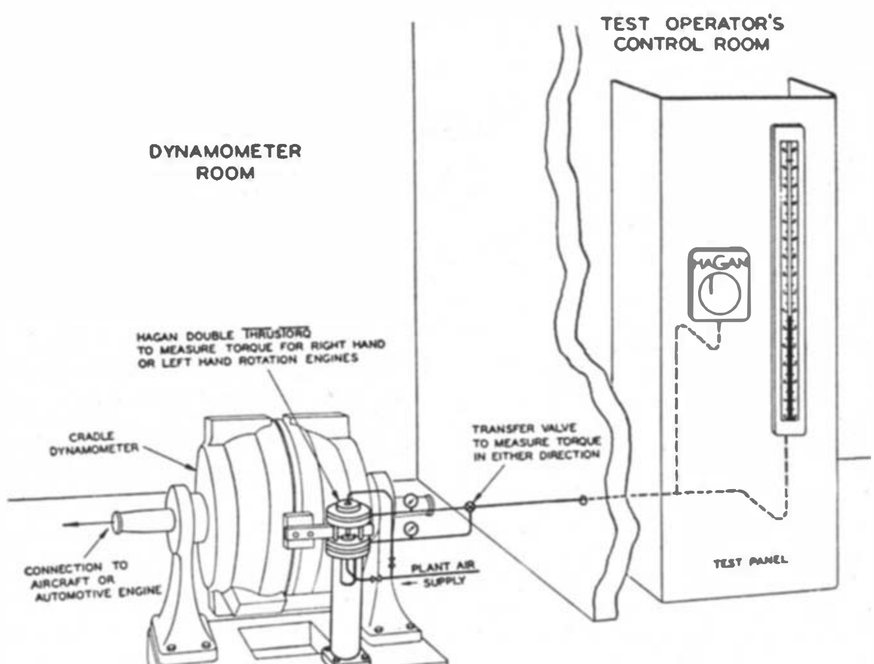
called the Thrustorq. It already is being used in engine testing laboratories and factories to determine and record the thrust and torque of conventional airplane and automobile engines. A jet airplane engine manufacturer is using the instrument to measure the thrust of a new engine.

The heart of the Hagan Corporation's instrument is a flexible diaphragm which forms one face of an airtight chamber. Compressed air is admitted to this chamber through a poppet type pilot valve. The force to be measured is applied to the outside of the diaphragm and is opposed by internal pressure. As the force increases the pilot valve is opened and admits more air to balance the increased force. As the force decreases, air is exhausted until the external force and internal pressure are equal. Thus the air pressure within the chamber provides a direct measure of the externally applied force.

The response of the instrument is practically instantaneous because the diaphragm movement necessary to operate the pilot valve is extremely small.

Because the force is measured by air pressure, the Thrustorq permits remote reading on any number of manometers, pressure gages, or recording devices. Every person connected with a test may have his own recorder in front of him, even in a different room or different building from that in which the test is being made.

Although the Thrustorq's first application in industry was the obvious one, to measure the thrust and torque of engines, its characteristics have suggested many other uses. Because of its compactness and the fact that it requires almost no deflection to provide a reading of force, the unit can be used to analyze many structural stress and strain problems.



A typical force measurement installation, with remote control room

FORMING PAD

Made of Synthetic Rubber For Magnesium Forming

PRODUCTION of magnesium sheet metal parts for industry will be speeded as the result of the development of a new heat-resistant synthetic rubber forming pad announced recently by the United States Rubber Company.

The pad is a solid chunk of synthetic rubber weighing 2800 pounds and measuring 116 inches long, 50 inches wide, and eight inches thick. It is used as the female die in hydraulic presses to form heated magnesium under 5000 tons of pressure. When compressed, the rubber transmits the full pressure of the hydraulic ram against the sheet, flowing into all irregularities and forcing the metal into the desired shape. When the pressure is released the rubber returns to its original form.

Since the beginning of the war the United States Rubber Company has made many rubber forming pads for cold forming aluminum. These pads were not suitable for shaping magnesium, however, because the magnesium tends to be brittle when cold and does not respond to forming without heating. The synthetic rubber pad, the first one of its kind, will withstand the temperatures up to 450 degrees, Fahrenheit, required by the process. In addition to being heat resistant, it is built to stand severe flexing and long wear.

HARDNESS TESTER

Facilitates Testing Without Taking Specimen

AN INSTRUMENT that makes practical the taking of an adequate hardness test right where the material is—in the shop or yard, on the truck or car—anywhere it may be, instead of taking a specimen to a testing machine, announced by Steel City Testing Laboratory, is identified as a Portable Hardness Testing Hammer Type "P".

In many cases it is not necessary to obtain a scientifically accurate test of a material, but it is sufficient to know the hardness in regard to workability. With this self-acting hammer, such tests can be made quickly, employing unskilled labor. Repeated tests can be made without readjusting the hammer.

If material of a certain degree of hardness is to be selected, it is only necessary to see whether the diameter of the impression made corresponds to the desired degree of hardness. If the impression is smaller or larger, the specimen is either too hard or too soft.

The hammer consists of a cylindrical housing and easy moving piston; one end of the housing is closed with a cover and the other end is provided with an open bushing. Between the cover and the piston, a strong spring is located which presses the piston against the bushing. The tension of the spring can be adjusted by turning the cover, to set the hammer to a certain power of stroke. The piston is coupled with a striking bolt, which projects through

A portable instrument for making hardness tests. It does not require the services of a skilled operator and may be taken direct to the location where tests are to be made

the bore of the bushing, guided by an airtight fitting ring in the cylinder, and carrys a steel ball on its end.

Resting the hammer with the ball against the material to be tested and pressing on the operating end, the striking bolt and the piston in the housing move inward and press against the spring between the piston and the cover. At a certain point in this movement, the coupling between the piston and the striking bolt is released, so that the piston, under pressure of the spring, moves quickly against the inner end of the striking bolt and forces the ball against the material to be tested. After the hammer is released, the striking bolt is brought back to its former position by a spring.

PLASTICS PLATES

Can be Permanently Applied To Any Surface

A GUMMED plastics plate that will adhere to and make a permanent bond with any clean surface when moistened with a solvent such as benzine, naphtha, and so on, presents unlimited applications. An identification plate can now be permanently attached to any object with a clean surface without using screws or other usual methods of attaching plates.

Everclear "Everstick" Plastics Plates, made by Pennsylvania Plastics Corporation, are the result of three years of research to develop a cement that could be applied to the back of plastics plates and dried to facilitate easy handling. When the plate is ready to be applied it is reactivated with a common solvent of the type mentioned above and forms a permanent bond with the surface to which it is applied.

The advantages of Everstick Plates include a permanent bond; adherence to any shape or curved surface; more durability than a decal; elimination of drilling, screws, and drill jigs; adhesion that is not affected by weather conditions, unlimited range of color; permanent color; availability with fluorescent and phosphorescent letters.

SOIL TESTER

Operates on Principle of Electrical Conductivity

FOR MANY years it has been known that the electrical conductivity of soil extracts accurately indicates the soluble salt or fertilizer content of the soil. In the past, however, the equipment necessary for such tests has been elaborate and delicate, and not adapted to the needs of the greenhouse.

Now a compact, sturdy, low-cost, easy-to-operate instrument, the Solu-Bridge soil tester, is available, built specifically for soil workers. The soil tester was designed to fill the growing need of soil workers and greenhousemen for a practical instrument to measure the electrical conductivity of soil extracts, particularly greenhouse soils.

The Solu-Bridge soil tester is a self-contained A. C. Wheatstone Bridge, employing a cathode-ray tube to indicate the point of balance, and operating directly from the power line. A temperature compensator is incorporated to eliminate the need for computation.

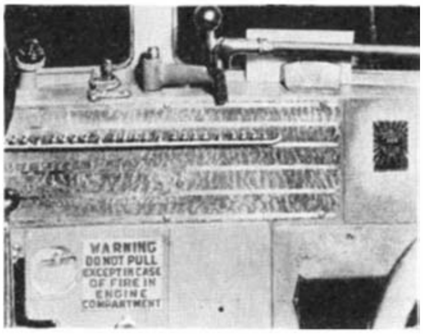
To make a measurement, a sample of air-dry soil is mixed with twice its weight of soft water, shaken for a minute or two, and the coarse particles allowed to settle for a few minutes. The solution is then poured into a clean vessel, its temperature checked with a thermometer, and the temperature compensator is set to that value. The conductivity cell is dipped into the extract and the main dial turned until balance is shown, whereupon the specific conductance is read directly from the scale. No calculations whatever are necessary.

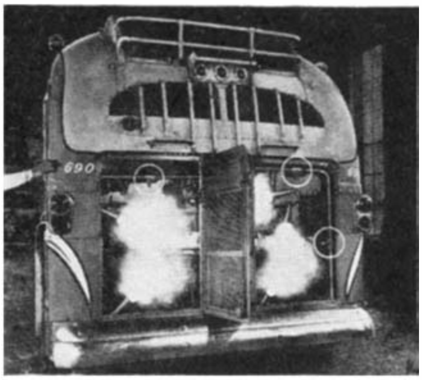
Soil extract conductivity measurements have been used to maintain optimum fertility conditions during the germination and growth of many vegetables and flowers, including tomatoes, roses, radishes, carnations, and so on. It has been found that the growth rate of these and other plants is very sensitive to total fertilizer content, and that budding and blooming time can be controlled through this means.

BUS FIRES

Extinguished by Rapid-Acting System

In a new built-in fire-extinguishing system for the engine compartment of buses, fire detection occupies first place. Specially designed flame detectors, three of which are circled in one of the photos, are spotted at danger points around the engine, and an outbreak of fire near any one of them instantly flashes a warning red light at the dashboard. The operator's quick pull on a fire handle, either near his seat or on the exterior of bus, releases a flood of compressed carbon dioxide gas, which chokes out the fire. The gas is odorless and non-toxic, and causes no damage whatever to the engine.





Dashboard of bus equipped with fire detecting and extinguishing system. Right: Carbon dioxide goes to work

The speed of the Kidde system's operation was demonstrated recently in special tests for the benefit of insurance officials, when gasoline fires which had been permitted to burn for 5 to 20 seconds, thoroughly heating surrounding metal parts, were detected in less than 1 second and extinguished in approximately 1.2 seconds, in spite of an artificially created wind velocity of 25 miles per hour.

PROTECTING PAINT

Is Protected in Turn by Aluminum

Asphalt, widely used as a roof-coating, has high resistance to rain and snow. But asphalt can't stand good weather. The sun plays havoc with asphalt. Hot summer rays cause it to bubble, melt, and run. Besides this, the sun's rays dry up the asphalt saturant contained in roof coatings.

To overcome these draw-backs of an otherwise good roofing material, research men at the A. C. Horn laboratories combined asphalt roof coating with practically pure aluminum. Each particle of asphalt, so to speak, was provided with its own bright metallic reflector to throw back the destructive rays of the sun.

Both the asphalt coating and the integrally contained aluminum are brushed on to the roof at one time, from one can, in one operation for one purpose. Naturally and fortunately, some separation takes place when the law of specific gravity works. The asphalt sinks down to take up its bad-weather job of protection at the bottom of the coating, next to and bonded to the roof, whereas the aluminum stays at the top facing the sun and reflecting its rays.

SAVING FEATHERS

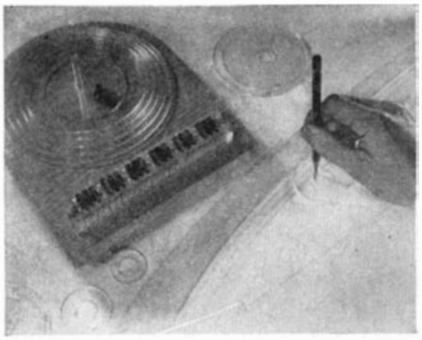
By Means of Chemical Preservative

Millions of pounds of wet-picked chicken and turkey feathers, formerly wasted or used only as fertilizer, can be saved for industrial processing by a simple and inexpensive preservative recently discovered by research scientists in the United States Department of Agriculture. Wet feathers, a by-product of poultry-dressing plants, normally decompose too rapidly to permit their shipment to feather-processing establishments, according to the Du Pont *Agricultural News Letter,* which says the preservative is made by dissolving 15 pounds of common salt and 1 pint of commercial concentrated hydrochloric acid in 30 gallons of water, for each 15 pounds of wet feathers to be preserved. Practical tests included shipment of preserved feathers, while still wet, from Washington, D. C., to Denver and return. The feathers were in excellent condition after a month in shipment and subsequent storage, before being washed and processed.

PARALLEL LINES

Drawn On Curves Quickly With Simple Disks

An ingenious device for speedily drawing a line parallel to a splined line has been devised by Charles A. Jackson. The procedure consists simply of inserting the pencil point in a center hole



Smooth curves drawn rapidly

of a Plexiglas disk and then propelling the transparent plastic disk along the edge of the spline or French curve. A graduated set of disks takes care of ordinary requirements in splining. With the new instrument there is no lost motion and a line parallel to the splined line can be drawn quickly and accurately.

COOLANT

Increases Life of Diamond Wheels

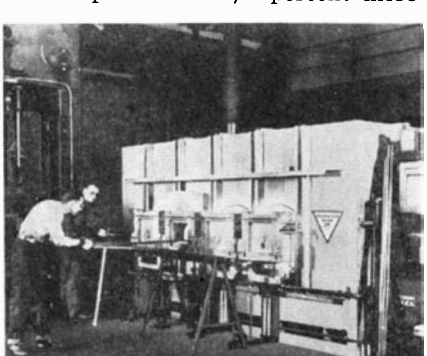
DIAMOND WHEEL coolant that clings tightly to the diamond surface and forms a film which prevents hot chips from imbedding themselves between the diamond teeth, so that wheels can clean without loading or glazing, permits such wheels to cut free and cool. The use of Super-Cut Coolant, compounded by Industrial Abrasives, Inc., is said to substantially improve finish, and, in addition, to add up to 25 percent more life to zurium bonded diamond wheels.

Super-Cut Coolant is reported to contain no harmful ingredients, and to be non-irritant, and non-toxic. It is sold in concentrate form which mixes with 20 parts of plain water, and can be applied by pump, wick, or drip feed in sufficient quantity to keep the diamond surface fully wet.

FORGING FURNACE

Uses Nitrogen Gas For Hard Steel Processing

USING only one half the floor space formerly required by three smaller furnaces, a new type Despatch controlled atmosphere forging furnace recently installed in an aircraft plant is said to produce 33-1/3 percent more heat than the total combined output of the three furnaces previously used. Compact and efficient, this new furnace utilizes a special four-in-row muffle arrangement to keep overall dimensions to less than 12 inches wide and 6 inches deep. Each muffle is 12 inches in diameter and has a working depth of 36 inches. Smooth uniform heat through the entire 36 inches working depth of muffles results from an ingenious system of back-towards-front firing.



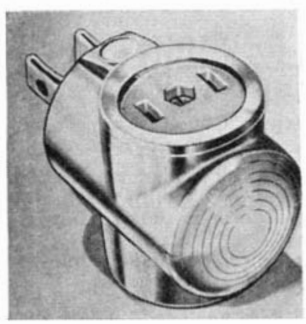
Compact new nitrogen gas furnace does work of three ordinary types

Processing hard steel forgings at 2250 degrees, Fahrenheit, this controlled atmosphere furnace uses nitrogen gas and handles over 2300 pieces per day. Air-operated doors shoot open quickly to allow fast removal of forgings from roomy, convenient-level hearths.

SAFETY PLUG

Has Built-In Light Bulb

ELECTRICALLY lighted, a new wall plug is a combination cord cap, convenience outlet and safety pilot, or nite-light. Encased in an attractive ivory plastics



Illuminated plug is easy to locate

housing, it plugs into any prong type wall electrical outlet.

A tiny bulb inside the housing of the new plug emits a soft glow through the front portion of the unit, providing a pilot light for conveniently locating wall receptacles, regardless of obscure location, without fumbling or hazard. In addition, it affords a night safety light for preventing fumbling and stumbling in darkened rooms, by establishing points around the walls that serve to orient a person. In nurseries, sickrooms, and many other locations, the subdued glow of the light is ample to serve as a night light.

Although the light burns continuously, day and night, as long as it is in the wall receptacle, tests show that it will operate at a cost of less than two cents per year for current. Since the bulb generates but little heat it has an extremely long service life and is reported to last for years without a burn-out.

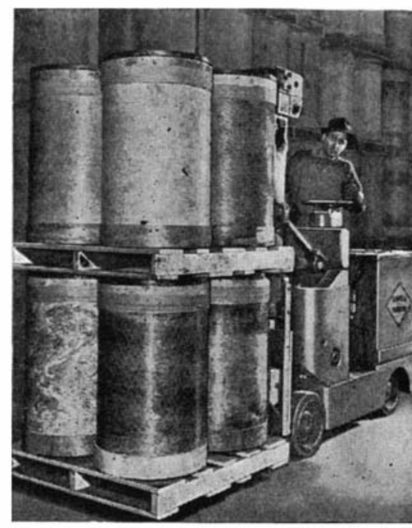
Another feature of the new plug is that it provides two convenient outlets for plugging in other electrical fixtures. In addition, the LumiNite Safety Pilot Plug can be adapted as a cap for the end of the cord to an electrical device. In the rear portion of the housing is located a round thin section which can be easily knocked out by pushing a screw driver through it. The end of the electrical fixture cord can then be inserted through this round hole, knotted inside the plug, and easily connected to metal contacts by means of clinchers provided. Thus a single wall receptacle can accommodate three electrical fixtures in addition to serving as a pilot and safety light.

CHEMICALS HANDLING

Made Safer by Use of Fork Trucks

LARGE carboys of acids and cylindrical packages of chemicals in lump or powder form introduce industrial hazards when they are handled manually. In some plants these hazards have been eliminated and costs have been reduced by the use of electric fork-type lift trucks.

These Elwell-Parker units have enabled manufacturers to make the fullest use of the pallet system for rapid handling and, where necessary, for high tiering in warehouses. Four carboys in wood cases, with a total weight of



Truck handles chemicals safely

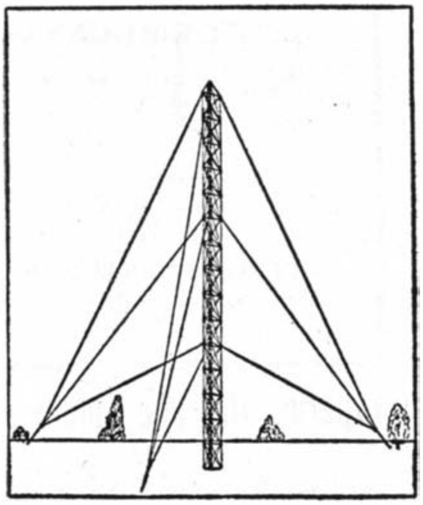
nearly a half ton, are easily handled in one load. To protect the necks of the carboys and afford a support for pallets above floor level, use is made of easily built wood frames. Dry chemicals in fiber, plastics, or wood containers weighing up to one ton or more also are handled by means of pallets and fork-type trucks.

TRIANGULAR TOWER

Can be Erected Easily and Safely

CAPABLE of being erected by three unskilled men in ten hours because of simplicity of construction and small size and weight of individual members, a 90-foot Blizzard King tower offers many advantages for radio or construction use. Average weight of members is only 5.3 pounds; the heaviest is only eight pounds.

Each six foot section of the tower is used as a platform upon which to erect the next section. The members used consist of sleeve connections, tubular corner posts, horizontal steel channel members, and diagonal flats. After any one section is completed and the ladder installed, the three corner posts of the next section are dropped into place. The sleeve connections are slipped over the top of the corner posts and the horizontal channels are bolted in place and followed by the



Easily erected steel tower

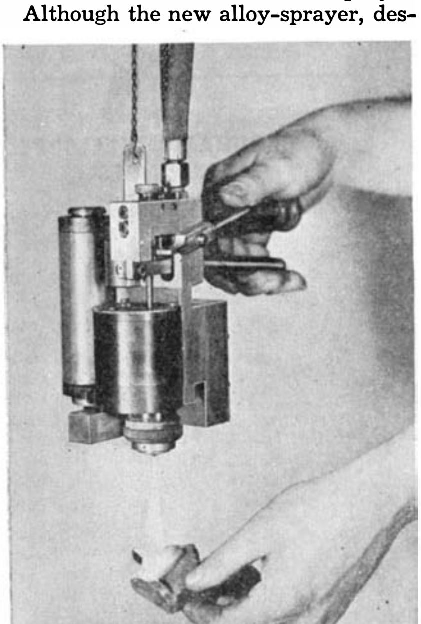
diagonals. The ladder is then installed and the operation repeated. The tower forms a complete safety basket around the ladder. These versatile towers are made by Harco Steel Construction Company.

ALLOY SPRAYER

Controls Flow of Molten Metal

Built especially for precision spraying of low temperature metals and alloys, a new sprayer, which is being used extensively for production spraying of selenium rectifier cells and rectifier disks, for protective coating of wood patterns, and similar spraying, is expected to be particularly useful in laboratory research work due to the closely controlled characteristics of the spray.

Although the new alloy-sprayer, des-



Precision controlled metal sprayer

The Editors Recommend

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **$6.80**

HIGH FREQUENCY INDUCTION HEATING — *By Frank W. Curtis.* Answers many questions concerning induction heating and its utility in industrial processes. Thoroughly practical in scope. **$2.85**

MANUAL OF LABORATORY GLASS-BLOWING — *By R. H. Wright.* A practical book containing latest information on the fundamental operations of glass blowing, both elementary and advanced. 90 pages, illustrated. **$2.60**

TOOL MAKING — *By C. M. Cole.* Instructions for making and using all kinds, from personal tools to arbor presses, lathes, planers, etc., in different metals. **$3.60**

TECHNIQUE OF PLYWOOD — *By Charles B. Norris.* Technical information on all phases of plywood manufacture and use, compiled for engineers, designers, and users of plywood. Important to many phases of wartime housing and manufacturing problems. **$2.50**

OPTICAL WORKSHOP PRINCIPLES — *By Col. Charles Dévé.* War-time translation of a French work on precision shop optics, with heavy emphasis on actual handiwork. Covers glass, abrasives, cements, mechanical theory of working optical surfaces, surfacing, tests, centering, and so on. **$6.10**

HANDBOOK OF CHEMISTRY AND PHYSICS — A classic reference book recently revised and brought up-to-date to keep pace with recent research. Includes material on all branches of chemistry, physics, and allied sciences. Used in laboratories and by engineers throughout the country. Flexible binding. 2571 pages. **$4.10. Foreign $4.50 postpaid**

ATOMIC ARTILLERY — *By John Kelloch Robertson.* Electrons, protons, positrons, photons, neutrons, and cosmic rays, all described for the layman in plain language. Also transmutation of the elements and the manufacture of artificial radioactivity. **$2.35**

PLASTICS — *By J. H. Dubois.* Third edition, again revised and enlarged, with two four-color plates. This is an important book on the whole general subject of plastics, plus much brand new material on synthetic rubber, manufacturing processes, and plastics moldings. **$4.10**

EXPERIMENTAL ELECTRONICS — *By Ralph H. Muller, R. L. Garman, and M. E. Droz.* A solid book of eminently practical information on the characteristics and non-communication applications of electron tubes. The text describes experiments and presents results. For students, radio engineers, communications experts, and the serious general reader. **$4.75**

PRISM AND LENS MAKING — *By F. Twyman.* A wide variety of notes based upon a long lifetime of practical optical shop work. Not a full-step-by-step manual but a valuable working aid to the advanced telescope maker and others in optical work. While the text deals ostensibly with professional quantity production, much of it is basically applicable to single-piece work. **$4.60**

THE MODERN GAS TURBINE — *By R. Tom Sawyer.* Fundamental treatment, yet comprehensive in scope, covering industrial, marine, railroad, and turbo-supercharger applications of the gas turbine. Up-to-the-minute data on jet propulsion are included. **$4.10**

Best Sellers In Science

A PRACTICAL COURSE IN HOROLOGY — *By Harold C. Kelly.* Definite, outright, practical instructions on watch making, repairs, and adjustment. **$2.85**

SLIDE RULE SIMPLIFIED — *By C. O. Harris.* How to use a slide rule without any of the mystification that often surrounds this important tool of the engineer. Excellent illustrations make everything clear. **$3.60** including a slide rule; for book alone. **$2.60**

AN INTRODUCTION TO ELECTRONICS — *By Ralph G. Hudson.* Clear and concise explanation of electronics and its modern applications. Very little mathematics is used. **$3.10**

MACHINERY'S HANDBOOK — *12th Edition.* "Bible of the mechanical industry." 1815 pages of latest standards, data and information required daily in shop and drafting room. **$6.10**

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THE FUNDAMENTALS OF CHEMISTRY — *By Monroe M. Offner.* This text introduces the reader to elements, electrons, acids, alkalis, and so on, and then covers chemistry and its relationship to everyday life. **80 cents.**

ELECTRONIC PHYSICS — *By Hector, Lein, and Sconton.* A simplified text for those who desire to acquire a sound basis for following the advance of applied electronics. **$3.85**

A LABORATORY MANUAL OF PLASTICS AND SYNTHETIC RESINS — *By G. F. D'Alelio.* How to prepare many of the well-known resins and plastics in the laboratory. Understanding of the text requires a knowledge of organic chemistry. **$2.10**

FUNDAMENTALS OF OPTICAL ENGINEERING — *By Donald H. Jacobs.* This new work starts out at the very beginning, is mainly non-mathematical, and is probably the best suited of all existing books as an introduction to optical design. Author is a physicist at Bureau of Standards. **$5.10**

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TRIGONOMETRY FOR HOME STUDY — *By William L. Schaaf, Ph.D.* Extensive and detailed, giving explanations as the text progresses, together with numerous practical applications of trig, such as machine shop problems, surveying, navigation, and so on. **80 cents**

ROCKET RESEARCH — *By Constantin Paul Lent.* Partly historical, plus a chapter on theory, plus descriptions of practical applications and hints to experimenters. Many drawings give specific details of rocket and jet motors. **$5.10**

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ignated "Model FP" by Alloy-Sprayer Company, is primarily designed for spraying vertically downward, suspended on a chain or similar support, it can be swung out to spray almost horizontally. Thus, it can be used for virtually any type of spraying either on a production basis or as a stricly laboratory instrument.

The application of alloy or metal can be made in three stages: fine spray, coarse spray, and pour. Moreover, the degree of fineness and the degree of coarseness of spray in each stage can be varied by means of an adjustable needle valve. Both stages of spray are accomplished with air pressure on, while the pouring is done with air pressure cut off entirely.

Range of operation of the sprayer is 100 to 600 degrees, Fahrenheit. Metal or alloy in almost any form is melted in the pot preparatory to spraying by means of thermostatically controlled electrical elements. Operating air pressures are from 20 to 60 pounds per square inch, depending on the needs of the work.

SHOP MICROSCOPES

Have Built-In Illumination System

DESIGNED to bring precise optical measurement to the machine industry, Polan shop microscopes can take the abuse which cannot be avoided in modern

50-power magnification for shop work

shop practice. These units are small in size and relatively low in cost. The standard reticle permits accurate measurement to 0.001 inch and measurements may be estimated to ±0.0002 inch accuracy. The instrument may be equipped with reticles having special designs for contour inspections or measurement of specific tolerances on tools or parts.

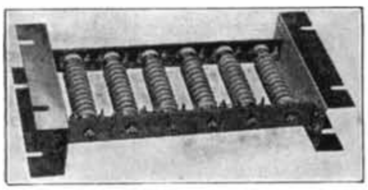
The built-in illumination system, using flashlight bulb and cells, makes the microscope a convenient inspection and measuring instrument. The eyepiece and acromatic objective give an overall magnification of 50 power, adequate for normal inspection of machine parts.

The shop microscope is equipped with separate removable bases, the bottom and sides of which are ground flat. The parallel sides, which are 7/8 inch from the optical center, have ground surfaces which make it possible to use the instrument with gage blocks and measuring wires. The bottom surface has a prismatic groove which optically centers the instrument on round rods or curved surfaces of machines.

BANK-TYPE RESISTOR

Permits Easy Removal Of Burned-Out Element

A BANK-TYPE resistor, supplied with six resistors as standard equipment, can be built with any number of resistors from two to 24 in a bank. The six-bank resistor is made with a frame



Flexibility features this resistor

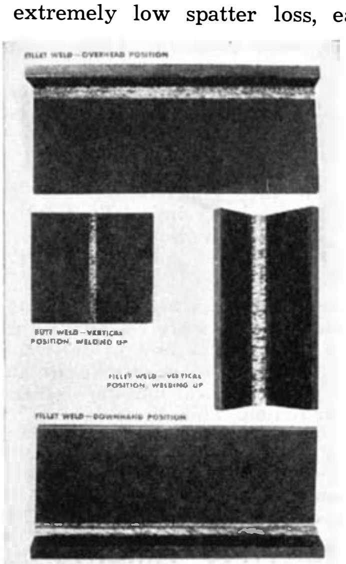
23 inches long and 11⅛ inches wide. The depth is 4½ inches. For banks of more than six resistors, three inches is added to the length of the frame for each additional one.

Cores, elements, straps, and binding posts can be purchased separately, according to the manufacturer, Techtmann Industries, Inc. This means that a burned-out element can be removed by unscrewing two nuts and winding a new element around the core in a matter of minutes.

WELDING ELECTRODE

Has Low Spatter Loss, Easy Slag Removal

A SHIELDED arc electrode, recently developed for general-purpose welding of mild steel, offers a number of advantages over existing electrodes of the same classification. The new electrode, designated as "Fleetweld 47," has extremely low spatter loss, easy

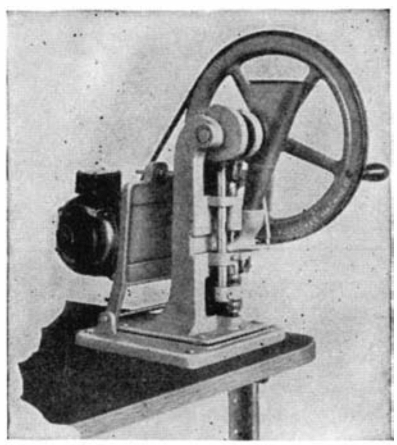


Specimen welds produced with the new general purpose arc-welding electrode slag removal (most welds are practically self-cleaning), excellent re-striking characteristics, and other improved features. It conforms to American Welding Society electrode specifications Class E-6012 and E-6013 and may be used with either alternating current or direct current. The electrode, a product of the Lincoln Electric Company, is said to be especially suited for making high speed horizontal or flat fillet welds over four inches long in which the coating can be dragged on both plates. It has also been used extensively for both vertical and overhead fillets, especially where large single pass fillets are desired.

TABLET MAKER

For Laboratory or Limited Production

A TABLET compressing machine, widely adaptable for research and other laboratory work and for manufacturing industrial specialties where limited production is required, includes an



Up to 100 tablets per minute

efficient feeding device for handling materials difficult to feed and an improved adjustment of the lower plunger which enables the press to make very small tablets.

Applying pressure of 1½ tons, with a maximum die-fill of 7/16 inch, and producing tablets up to ½ inch diameter at rates up to 100 per minute, this press has hundreds of applications in experimental work and for making test pellets; proving industrial specialties such as chemical products, catalysts, and so on, pharmaceuticals, and ceramic mixtures such as Steatite; and for powder metallurgy tests.

WELDING FLUX

Can be Used By Inexperienced Workers

FREE-FLOWING flux for gas welding of aluminum and aluminum alloys, known as "Flo-Well," is now being manufactured by A. K. Mauk. Flo-Well is used to gas-weld wrought, cast, or high tensile aluminum and aluminum alloys, of any size or shape, wherever welding is possible. As a result of improved methods of manufacture, Flo-Well will not solidify or deteriorate. It can be easily applied by inexperienced welders.

Current Bulletin Briefs

Conducted by K. M. CANAVAN

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

INDUSTEX is a monthly service designed to supply industry and business with references to information on subjects covered by leading industrial, trade, and business publications. Summaries of published articles are printed on three-by-five index forms, to be indexed by subject matter. Industex is supplied on a subscription basis and forms are issued monthly on current publications for addition to subscribers' files. Articles appearing in Scientific American are covered in the Industex service. *The Industex Company, 228 North La Salle Street, Chicago 1, Illinois.—Subscription rates on application.*

JEEP PLANNING is a 24-page booklet showing the new universal Jeep performing a wide variety of agricultural and industrial chores. Its four-in-one usage—as a light tractor, a mobile power unit, a light truck, and a passenger conveyance—is fully described. *Willys-Overland Motors, Inc., Toledo 1, Ohio.—Gratis.*

CEMCOAT FILLER AND DUSTPROOFER—THE MODERN WAY TO PROTECT AND DECORATE CEMENT FLOORS is a six-page brochure based on a planned system for the painting of cement floors. Various painting and maintenance problems are discussed. *L. Sonneborn Sons, Inc., Building Products Division, 88 Lexington Avenue, New York 16, New York.—Gratis. Request this on your business letterhead.*

THE FOREST INDUSTRIES BLAZE NEW TRAILS is a 36-page booklet describing the current technological developments of wood as an engineering medium and as the raw material of plastics and chemicals. This booklet, prepared to stimulate further interest in wood research, covers various research projects and developments. *Timber Engineering Company, 1319 18th Street, N. W., Washington 6, D. C.—Gratis.*

BULLETIN NUMBER T-45 is a new and enlarged booklet of tables for computing change gears for hobbing machines for helical gears. Bound in a grease-proof cover for longer service in the shop, the booklet contains approximate feeds and speeds for rough and finish hobbing of gears made of cast iron, bronze, alloy steels, fiber, and rawhide. *Michigan Tool Company, 7171 East McNichols Road, Detroit 12, Michigan.—Gratis.*

THE AMAZING ELECTRON is a 32-page booklet for educators, consumer organizations, farm groups, labor unions, and the general public. Illustrated in cartoon technique, this simply written booklet presents information which brings the basic facts about electronics within the grasp of everyone. *Electronic Corporation of America, 45 West 18th Street, New York 11, New York.—Single copies gratis.*

BULLETIN NUMBER MTM-45 is a four-page illustrated folder outlining the features of an improved medium-duty tapping machine for use in high production, high precision tapping, with either single or multiple spindles. *Detroit Tap and Tool Company, 8432 Butler Street, Detroit 11, Michigan.—Gratis.*

INDUSTRIAL RUBBER PRODUCTS is a 12-page folder containing information and descriptions of rubber, plastics, and synthetic materials which may be helpful in solving unusual fabrication and application problems. *The B. F. Goodrich Company, Akron, Ohio.—Gratis.*

CALGON DATA FOR THE TEXTILE CHEMIST is a 16-page booklet based on the uses of Calgon in washing, scouring, bleaching, and dyeing in the textile industry as well as specific information on applications of the chemical in wool, silk, cotton, rayon, and hosiery processing. *Calgon, Inc., Hagan Building, Pittsburgh 30, Pennsylvania.—Gratis.*

ILG WELFARE CLUB—POLICIES AND PERSONNEL PRACTICES OF THE ILG ELECTRIC VENTILATING COMPANY is a 12-page booklet compiled to answer requests for information on employee policies. Starting with the Ilg Profit-Sharing Plan and Length of Service Bonus in 1907, the booklet lists in chronological order the various personnel practices that have been adopted. *Ilg Electric Ventilating Company, 2850 North Crawford Avenue, Chicago, Illinois.—Gratis.*

SKIN RECOVERY IN SURFACE COMBUSTION FURNACES is a four-page bulletin describing a carbon restoration process by the use of a controlled gas atmosphere which is applicable to both carbon and alloy steels. *Surface Combustion Corporation, Toledo 1, Ohio.—Gratis.*

POLARIZING MICROSCOPE is a four-page bulletin describing a new microscope particularly adapted to the needs of the industrial laboratory, and which is also suitable for polarized light microscopy and as a teaching instrument. Containing Polaroid material in place of the usual calcite polarizing prisms, this microscope is particularly suitable for obtaining the maximum brilliance for interference figure work. Request Bulletin M-136. *American Optical Company, Scientific Instrument Division, Buffalo, New York.—Gratis.*

3-M ADHESIVES IN INDUSTRY is a 12-page booklet outlining adhesive operations in many different industries, methods of application, a listing of the physical properties, and various formulas. An adhesive project sheet for the analysis of any adhesive problem is featured. *Minnesota Mining and Manufacturing Company, St. Paul 6, Minnesota.—Gratis.*

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 the names of available books, 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. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S. All remittances are to be made in U. S. funds. Prices given are subject to change without notice.

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THE MERCHANT MARINE AND WORLD FRONTIERS

By Robert Earle Anderson

AMERICANS will soon be facing the problem of what to do with the world's greatest merchant marine. Sinister and subtle pressure is already being exerted in certain interested quarters to induce us to dissipate or greatly reduce it. Every leader of public opinion would do well to read this book, for the prosperity of every town and city in America is tied to the future of our merchant marine. We must never again let ourselves be hoodwinked into allowing our merchant fleet to deteriorate to the advantage of other vitally interested nations. (205 pages, 6 by 9 inches, illustrated.)—$3.10 postpaid.—*W.D.A.*

PRACTICAL MARINE ELECTRICITY

By Samuel N. LeCount and H. S. Dusenbery

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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"

WHICH optical shop methods are best—professional or amateur? Neither. In each the needs are different. The professional makes many of a given thing, the amateur usually one. Such considerations as this call for adaptability of point of view. At least two professionals have related to your scribe with chuckles how they had employed amateurs and soon heard them saying, "The methods in this shop are wrong—'A.T.M.' says . . ." Thanks for sticking up for "A.T.M." but the mind should always be kept free and limber. Amateurs do single jobs.

One of the functions of this department is to dig stuff out of professional confines and offer it to amateurs. Few professionals these days find that this harms them. Most are more farsighted and are not like one of the old school near whom Porter worked in Washington during World War I. To a request of Porter's he replied, yes, he'd be willing to show some of his pet methods but "German spies, you know, are everywhere these days. Might overhear."

In the following two-part article, Patrick A. Driscoll, formerly of Rochester, now of Poplar Hill Road, Lima, N. Y., describes one method of making telescope mirrors, using a hand-lever spindle similar in principle to those shown in "A.T.M.," page 163, at *C*, and in "A.T.M.A.," page 151. Driscoll is an experimental lens maker in the Eastman Kodak Company Hawk-Eye Works and is the amateur who, in an article on making objective lenses, published in this department March last, described himself as "an amateur professional amateur"—he started as an amateur. His article:

THE barrel-head merry-go-round of grinding and polishing by hand, coupled with the amateur's almost universal use of the equal diameter grinder and mirror, leaves much to be desired. Grinding and polishing by hand often is laborious to the point of monotony; but, given the proper simple machinery and a fair amount of help, the basement optician can evolve a perfect optical surface and have fun in doing it, reducing grinding and polishing to a minimum. The following notes describe standard optical practice and can be relied upon to give good results.

Building the grinding and polishing machine shown in Figure 1 will call for an assortment of angle iron and so on, and a raid on the local junk yard. We shall also need a ¼-horsepower motor or, as a last desperate substitute resort, the family washing machine. The grinding machine will give excellent results both in working performance and the surfaces produced. It will handle a mirror up to 8" in diameter, using V-belting on the spindle drive. The stroke will be from side to side, not back and forth, and will be manually applied with the lever shown. Spindle speed for grinding will be about 200 r.p.m., and for polishing about 36 r.p.m.

Long experimentation proves that, when grinding by hand on a machine, a concave surface should be ground face down, grinder on bottom, mirror on top. The grinder should be 5/4 the diameter of the mirror. A convex surface should be ground face up, with the grinder on top, and the grinder should be 4/5 the diameter of the other disk.

In polishing, the mirror should be on top, and the polisher should be 6/5 the diameter of the mirror, but with a convex surface the polisher should be on top and 5/6 the diameter of the other disk. For makers of reflectors or refractors these rules may be considered practical. Discussion of their philosophy would require too much space to prove what is accepted as correct by expert technicians because it works.

We shall assume that we are grinding a 6" concave mirror and, in order to simplify division of diameters, all measurements will be given in millimeters, a smaller unit than inches. Since one inch is 25.4 mm, a 6" blank is 152 mm in diameter. Therefore, by the rule just cited, a glass grinder of 190 mm diameter is needed. For the mirror we purchase a rounded disk 24 x 152 mm.

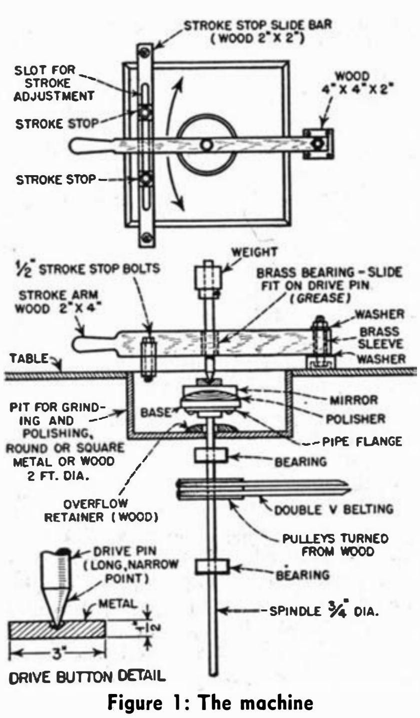

Figure 1: The machine

The emeries will be numbers 180, 500, and 1200. On the machine these three sizes will give excellent results, and an elaborate sequence of grain sizes is unnecessary. If desired, 90 emery may be used to hog out the curve, but grinding to gage should be done in 180. Emeries 90, 180, and 500 may be had from The American Abrasive Co., Westfield, Massachusetts, and 1200 from the Bausch and Lomb Optical Co., Rochester, New York. (Carborundum also is good for roughing but as a finishing agent in precision work it leaves something to be desired. The amateur's troubles with scratches is traceable more often to Carbo than to carelessness, since its granules are not so consistent in size as emeries.) Since it will be used in a pit (Figure 1) this permits recovery and re-use during the rough grinding stage (180) but the 500 and 1200 are too likely to become contaminated, and should not be recovered.

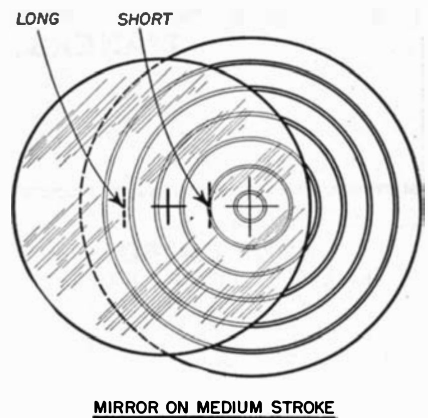

Figure 2: Stroke positions

The mirror blank requires a driving button (Figure 1) which will be attached to the glass with pitch and remain there throughout the grinding and polishing operations. To fasten it to the blank we melt the pitch slowly, heat the blank and button, dip the button into the pitch and quickly place it on the blank, centering it before it becomes cold. In the same manner we pitch the tool on the spindle pipe flange shown in Figure 1, centering it by rotating the spindle and shifting it until the tool runs concentric.

Since the grinder and the mirror blank have flat surfaces it will be necessary to start the curve by hand grinding for about 15 minutes. We shall use a sweeping round-and-round stroke, keeping the center of the blank over the edge of the grinder. When the edge of the grinder shows a ground ring extending in about 1" smaller than the mirror diameter we are ready to machine grind.

We replace the mirror on the grinder, engage the drive pin in the hole in the drive button and, with the mirror held offside on the grinder—say 2" off center—start the spindle.

Emery is kept in a jar or can and fed on the grinder with a 1" stiffbristle brush. The emery should be well submerged in water, as the cutting effect of emery is at its best in a thin solution. A 1-quart jar half full of 180 emery is recommended, also that water be added until the emery is saturated and the jar full.

As the curve starts to form on the grinder and blank, both disks will rotate more smoothly, and so we commence swinging the stroke arm of the machine from side to side. From this point on, the stroke will determine the ground figure we wish to evolve.

Figure 2 shows stroke positions. These are calculated on a basis of the grinder diameter, as divided into four equal points. If the stroke overhang brings the center of the mirror to the respective indicated points on the grinder, as we move outward, we obtain the short, medium, and long stroke. With the mirror on top a stroke that is excessively long will shorten the radius. A short stroke will have a reverse effect. A long stroke will grind the center more than the edge, and a short stroke will grind the edge more than the center.

The drive arm should be swept slowly right and left. Tests for curvature should be frequent, and the stroke shortened or lengthened as these tests indicate.

A rule that must be remembered is: never use so long a stroke that the edge of the mirror crosses the center of the grinder, and never a stroke so short that it holds the mirror inside the diameter of the grinder.

On a short stroke the mirror must overhang the edge of the grinder, if only ¼", in order that the grinder will be used all over its surface at each stroke.

Emery is applied by a stroke of the brush at each stroke of the drive arm. It will be ejected by the grinder into the pit and in this rough-grinding stage it can be reclaimed and used again so long as the ejected portion still contains unused particles.

The grinder and mirror will rotate in the same direction. It is fallacious that the disks must rotate in opposite directions, as many even advanced workers insist. Direction of rotation has nothing to do with the production of a truly spherical surface, which is accomplished by the stroke and rotation of the spindle causing the grinder and work never exactly to duplicate the conditions of any one stroke.

As a check on the curvature I recommend the glass gage ("A.T.M.", page 344). Even for the worker who owns a spherometer the glass gage can be of value. The spherometer can, of course, be used to check the gage and mirror for sagitta, but the gage will also show the overall variation of the mirror along its arc when used as a check on radius and sphericity. The glass should be as thin as can be found and the gage must be very carefully executed. A slight variation in the scribing apparatus will have a bad effect on the arc that carries the glass cutter. Pivot bearing and scribing bar should be very rigid and the cutter must be held very tightly to assure a perfectly even cut on the glass. Make a gage about 14" long, if for a 6" mirror, and cut out the portion having the most even curve. Grind the edges lightly together in 500 emery. A minute's work will bring them to a tight fit.

The mirror, having been rough ground in 180 emery, must be brought to a tight fit on the gage before smoothing in 500 is undertaken.

We do not intend to grind by wets, as this method leaves the amount of glass removed in each size of emery to guesswork. By grinding exactly to

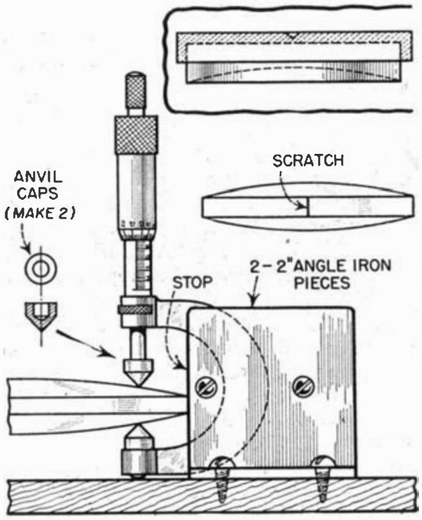

Figure 3: Micrometer in fixed stand. Insert: Chuck substitute for drive button on Figure 1

curvature in each emery, and miking the glass each time, we shall be very sure of eliminating the pits from each previous size. This should lay to rest, once and for all, the great disappointment of finding No. 180 pits holding over on the surface after it is polished.

The micrometer shown in Figure 3, with pointed tips over the anvils, will give accurate measurements of glass removal. The mirror must be marked on its edge with a permanent notch scratched in and filled with black paint, and this shall be the miking point.

After grinding with 180, the edge of the mirror is beveled. Hold a scrap of glass against the edge of the disk and, with the spindle running, apply a little 500 emery until the bevel is about 2 mm wide. This will eliminate future scratches due to edge particles breaking free. Retain this bevel throughout smooth (500) and fine (1200) grinding, and polishing. Keep the edge of the tool beveled also.

DRISCOLL'S article will be concluded next month. Observant readers will have discovered one important difference between the hand-lever spindles in "A.T.M." and "A.T.M.A." and Driscoll's. In the former the pressure on the work is regulated by the hand. In the latter the weight on the head of the free-floating pin regulates it uniformly.

The philosophy of dragging and dragged disks, which Driscoll found too lengthly to discuss here, is discussed at length in Dévé's "Optical Workshop Principles."

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