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Metallizing Builds a Bearing Area . . . See page 193

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INDUSTRIAL DRAMA: Unforeseen — and highly satisfactory — have been some of the results gained by spraying molten metal on shafts which run in bearings. For details see article starting on page 201.

Scientific American

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of May, 1897)

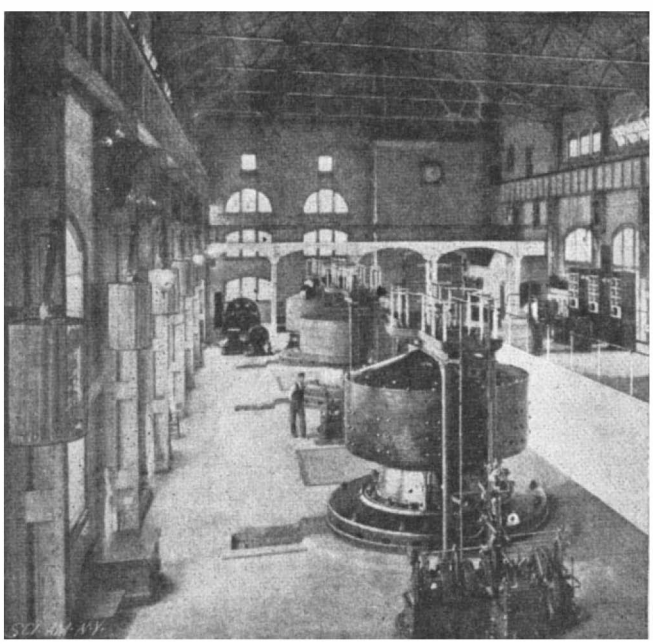
HIGH-SPEED TELEGRAPHY — "By making use of the alternating current and special designs of receiver and transmitter, two well-known American specialists, Lieutenant G. O. Squier and Prof. A. C. Crehore, have succeeded in sending messages over a wire at the rate of twelve hundred words a minute, and they confidently assert that between three thousand and six thousand words a minute may be dispatched by the same system between points that are a thousand miles apart."

JAP LABOR PROBLEMS — "Like causes are producing like results in Japan, and the remarkable industrial development of the country is bringing in its train those very same industrial troubles which have harassed or are still perplexing the older civilizations of the West. If recent labor troubles are an indication, it looks as though the apparent prosperity of Japan was not as healthy as it might be, and that it was based on the poverty and misery of the wage earners."

ALUMINUM COATING — "A new departure in the field of sheet metals has just been undertaken by a St. Louis, Mo., firm. This firm has sent us samples of steel sheets coated with aluminum, which, it is claimed, are superior to and more durable than galvanized iron, tin plate or planished iron for many purposes for which those materials are now generally used. . . Moreover, they can, when desired, be polished to a luster equal to burnished silver or nickel."

SAFETY GOGGLES — "Injury to the eyes by dust, sparks, flying splinters, and stones is by no means rare, and only imperfectly prevented by the ordinary spectacles. . . Dr. Thomalla, of one of the Berlin accident wards, has devised a spectacle made of Schering's gelatoid, an elastic, transparent material, which can be hardened in amyl acetate. If really broken by flying pieces, the mass does not splinter."

ELECTRICAL HEATING — "The Niagara Falls Power Company's big power station offers one of the most interesting studies on the subject of electrical heating to be found in the United States, if not in the world. . . The heaters in the offices are on a secondary 100 volt circuit, and this circuit is fed through converters which reduce the voltage from 2,000 to 100. In the office portion of the power house there is about 175 horse power in heaters of the American pattern, but they are seldom all on at the same time. Of course, it depends entirely upon the weather conditions as to the amount of heat required to make the rooms comfortable. . . In the dynamo room there are fifteen heaters, three circuits of five each, and each circuit takes up about 200 horse power. However, it has never yet been found necessary to use all three circuits, two of them being found sufficient in the coldest weather. By consulting the illustration in connection with this article the heaters will be seen on the left on the walls of the dynamo room, about 15 feet above the floor."



Electric heaters (at left) in Niagara generating station

RAILROAD TROUBLES — "By the dropping of the brake bar of a freight car of the new Third Rail branch of the N. Y., N. H. & H. R. R., the switchboard at the Berlin, Connecticut, power houses was burned out, causing a loss of one thousand dollars, delaying probably for a week the opening of the Third Rail route between New Britain and Hartford."

SUBMARINE — "On Monday, May 17, there was launched at the Crescent Shipyard, Elizabethport, N. J., an extremely interesting specimen of marine architecture, known as the Holland submarine boat. It embodies the results of some twenty years of experimental work on the part of the designer, who firmly believes that the submarine torpedo boat will prove to be the most deadly weapon of future naval warfare."

PAPER MACHINE — "At Rumford Falls, Me., the largest paper machine in the world is now in the course of construction by the Rumford Falls Paper Company. It will produce paper 150 inches in width, which is said to be 15 inches wider than any American machine and 2 inches wider than any other machine in the world . . . at the rate of 500 feet per minute, or, in a complete day's run of 24 hours, will turn out about 9,000,000 square feet, equivalent to 35 tons."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of May, 1847)

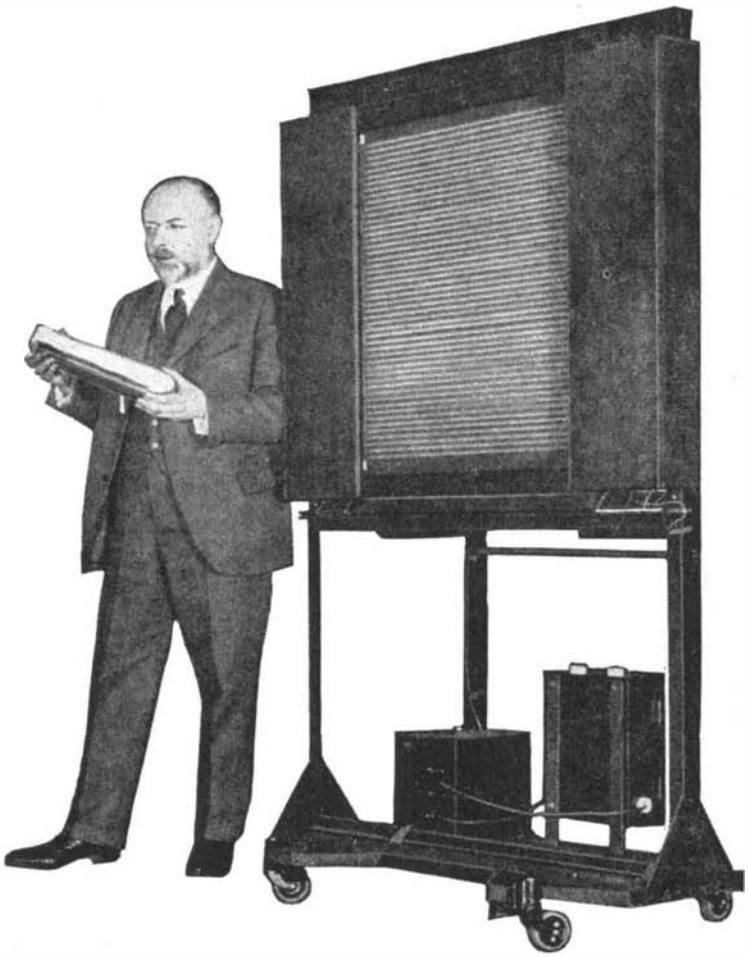
POWER — "The steam engine itself, improved as it is, and wonderful as have been the results produced by it, is capable of further improvements. Its bulk and weight may be further diminished, both in the form and construction of the boiler as well as the engine itself, and thus in effect, its power may be increased; or it may be reserved to us to discover the means of producing, and rendering subservient to our purposes, some other power which shall surpass steam, or, perhaps, to substitute for it that all-powerful agent, electricity, which Jacobi has already attempted to apply to navigation."

BALLOON TIRES — "A number of cabs with newly invented wheels have just been put on the pave in London. Their novelty consists in the entire absence of springs. A hollow tube of India rubber about a foot in diameter, inflated with air, encircles each wheel in the manner of a tire, affording the greatest possible amount of cab comfort to the passenger."

ZINC CASTINGS — "Some of the French artisans have adopted the plan of casting statues and groups of figures, in zinc instead of bronze. By this means the cost of such models is very much reduced, while an equally good representation is produced."

TELEGRAPH WIRE — "The Directors of the New York and Buffalo Telegraphic Company, at their recent meeting in Utica, resolved to use in their operations an iron wire known as No. 10, weighing about 250 pounds to the mile."

Long-distance Television is twenty years old



At the 1927 demonstration, Dr. Herbert E. Ives explained the television system developed in Bell Telephone Laboratories.

April 7 is a notable day in communication history, for on that day in 1927 was the first demonstration of television over long distances. Large-scale images were flashed from Washington, D. C., by wire and from Whippany, N. J., by radio to a public demonstration in New York City. "It was," said a newspaper, "as if a photograph had suddenly come to life and begun to smile, talk, nod its head and look this way and that."

That was the first of many public demonstrations, each to mark an advance in the television art. In 1929 came color television, and in 1930 a two-way system between the headquarters buildings of A. T. & T. and Bell Laboratories. When the first coaxial cable was installed in 1937, television signals for 240-line pictures were transmitted between Philadelphia and New York and three years later 441-line signals were transmitted. By May, 1941, successful experiments had been made on an 800-mile circuit.

End of the war brought a heightened tempo of development. Early in 1946 began the regular experimental use of coaxial cable for television between New York and Washington, and a few months later a microwave system for television transmission was demonstrated in California.

Transmission facilities will keep pace as a great art advances to wide public usefulness.

BELL TELEPHONE LABORATORIES

EXPLORING AND INVENTING, DEVISING AND PERFECTING, FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE

Previews of the Industrial Horizon

By A. P. Peck

PUBLISHING COSTS VERSUS INCOME

REGARDLESS of what some labor unions and "economists" may say about the necessity of maintaining low sales costs in the face of skyrocketing production costs, there comes a time when cold facts call for painful decisions. One such decision has just been made. With the July, 1947 issue, the price of Scientific American will be increased to 50 cents a copy, five dollars a year.

We looked at every angle, considered every possibility. But certain things could not be changed. In round numbers, our printing costs have increased 80 percent, paper is up 50 percent, and engraving has risen 40 percent, based on 1940 costs. Add similar increases in all other phases of business operation and it becomes obvious that something had to be done.

One thing we refused to do: We would not sacrifice the editorial quality of Scientific American in order to cut costs. This must be maintained. So, since we cannot continue to absorb all of the cost increases and still stay in business, we reluctantly decided that the price of the magazine must be increased. We are sure that our readers will be in sympathy with this move, will understand that it was done only as a last resort, will bear with us until a downward readjustment can be made.

See also important announcement on page 234.

MAN'S HUMANITY TO MAN

APPLICATION of the Golden Rule in industry and elsewhere, naïve though some may think it to be, is part and parcel of progress. More modern word for the Rule is "humanities," a subject that is becoming an ever more important facet of our complicated civilization.

Warning that the world must develop increased respect for the humanities, Dr. Frank D. Fackenthal, acting president of Columbia University, gives this expanded and clarifying definition: "The field of study is the natures of men, their psychologies, their explosiveness in this or that situation, their resistance to this or that movement even though it be for their advancement, their attraction to this or that idea though it may ultimately enslave them and destroy their freedom, their instinct for immediate individual welfare as against the long-term public good."

This indeed is a study worthy of as much attention, as much effort, as any research in the physical sciences. Through it the physical sciences and all their potential possibilities can advance rapidly; without it, man and his industries will surely wither on the vine.

GAS TURBINES ADVANCE

INTRIGUING as are the simple mechanical features of the gas turbine, technicians in the field are still loath to become too glowing in its praise. Thus, Alan Howard, General Electric engineer, recently said: "While the gas turbine seems very promising, it is, nevertheless, still in the development stage."

Occasion for the statement was the announcement that tests are about to begin on a 4800-horsepower turbine unit—19 feet long and weighing between 2½ to 4 pounds per horsepower—that will burn Bunker "C" oil, with simultaneous work being directed toward burning powdered coal. Also on the General Electric horizon is a 5000-kilowatt machine for electric power stations, scheduled for tests within the next 12 months.

Further reports indicate that the powdered-coal-burning gas-turbine locomotive (Scientific American, August 1946) will be on the rails before 1947 becomes a mere memory.

UNMINED COAL

SUCCESSFUL burning of coal underground, without the necessity of first mining it (Scientific American, December 1946), opens a number of fields for investigation. Not the least of these is the use of the resulting gases in gas-turbine units, especially in areas where cooling water is scarce. Other possibilities stemming from this method of using unmined coal include manufacture of synthetic fuel from the gases, using the gases directly as fuel for industrial furnaces, and economical powering of high-temperature steam generating plants.

An average of 35 to 50 percent of the available coal is left underground in present mining processes; it is reported that several more abandoned mines will be "fired" to further the experimental work on burning coal underground.

STRAWS IN THE WIND

MINIATURE vacuum tubes, already in use in hearing aids and pocket radio receivers, will aid aircraft radio as well; within the next few years it is predicted that a large transport plane will carry as many as 600 electron tubes which would weigh 225 pounds in present sizes but only 37 pounds in the miniature form. . . Soviet industry, eagerly gobbling up thousands of patent specifications to glean benefit from Yankee ingenuity, may point toward unseen riches lying at American industry's doorstep. . . The Gulf Coast, rich in petroleum, natural gas, salt, sulfur, lime, and so on, is making a strong bid for chemical industry's expansion southward; Monsanto, Du Pont, Shell, Dow, and others have already spent millions for plants in that area; more will follow. . . A number of manufacturers of equipment requiring small motors, stymied by far-distant delivery dates promised by established manufacturers of power units, are making the motors themselves, effectively breaking deadlocks which were preventing sorely needed products from reaching the market. . . A bill (H. R. 2520) has been introduced in the House of Representatives which, if passed, will increase the patent-application filing and patent issue fees from the present $30 to $50 each, with similar increases all along the line.

FIRELESS HEAT for the HOME

By HARLAND MANCHESTER

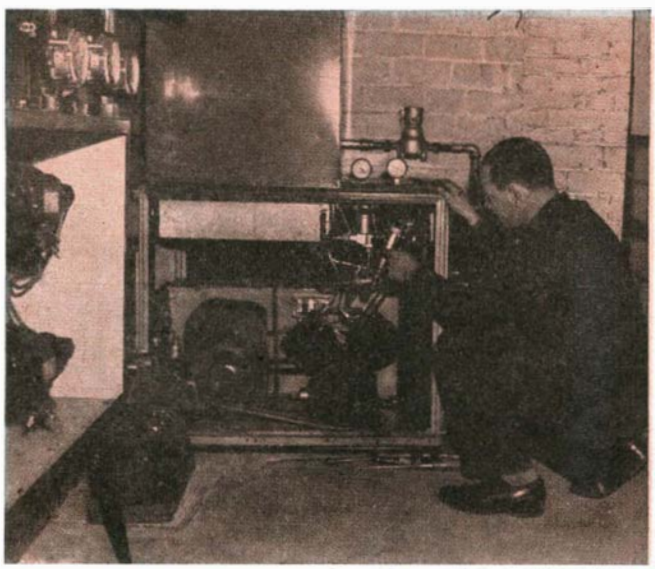
Heat Pumps, Electrically Operated "Refrigerators in Reverse," Can Provide Year-'Round Constant Temperatures — Heating in Winter and Cooling in Summer. One Automatic Unit Does the Entire Job. Cost, Convenience Considered, Compares Favorably with Established Fuel Burning Systems

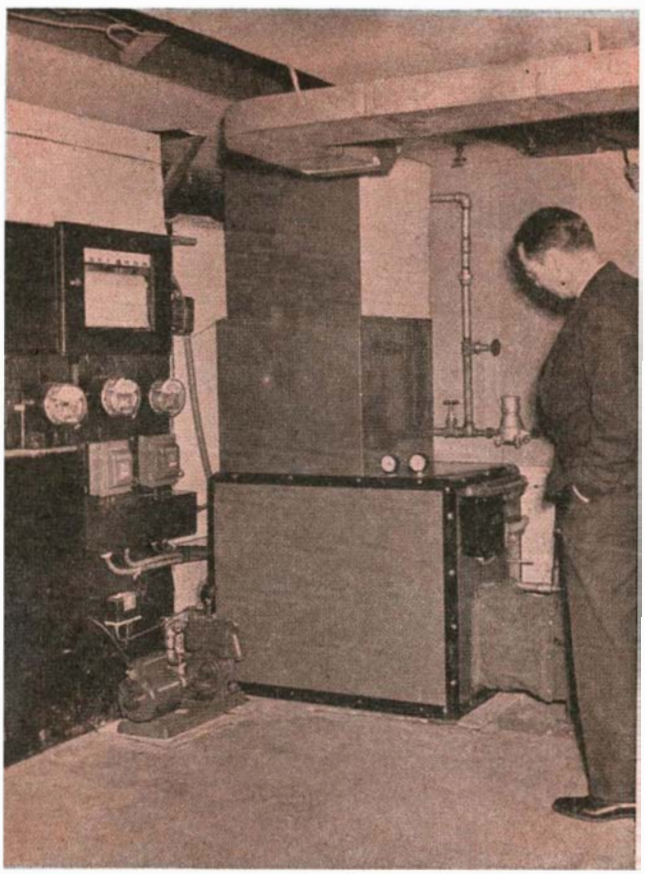
DURING the winter just past, a few houses in central Indiana were heated by a revolutionary device which involves no dust, soot, stoking, fuel, furnace, flue, or fire. When summer comes, the device automatically shifts over to cooling. You set the thermostat once and forget about it.

This is the "heat pump," an ingenious idea which has been knocking around for 95 years and has at last been put to practical work by a few inventive Hoosiers. In principle, the heat pump is an electrical refrigerator running backward. Your kitchen refrigerator cools the food by pumping the heat out of the box and throwing it away. Put your hand in back of it and you can feel the hot air coming out. If the cycle were reversed, the refrigerant gas would collect heat from the outside air and pump it into the food compartment. That is what the heat pump does. Even in the dead of winter, there is heat in the outside air, in the ground, and in the water in wells and streams. The Indiana house-warmers collect this heat and use it to produce hot air which is circulated through registers.

A few dozen of these systems have been in use for several years, but they were too expensive to operate in any but mild climates. Now two rival Indiana firms, one at Indianapolis and the other at Muncie, are pioneering in the manufacture of new types of heat pumps which are equally suitable for Florida or Minnesota.

The Indianapolis heat pump, the Terra Temp, originated in the restless mind of a 35-year-old cellar inventor named Robert C. Webber, a North Carolina native who for many years worked for the local power and light company. Mr. Webber has long been a deep-freeze enthusiast, and builds his own freezers. He has four of them. One day four years ago he ran one of his boxes down to 95 below zero to see what would happen. He put his hand on the outlet pipe and almost burned it. That set him to thinking on a new tack. Here was a lot of heat being thrown away. So he ran the outlets from his freezers through a boiler, with the result that his family had more hot water than they could possibly use. He was still wasting heat, and wondered what to do with it. His seven-room house was warmed





Interior and exterior views of a Marvair heat pump installed in a building of Pennsylvania Power Company

• LOOKING AHEAD •

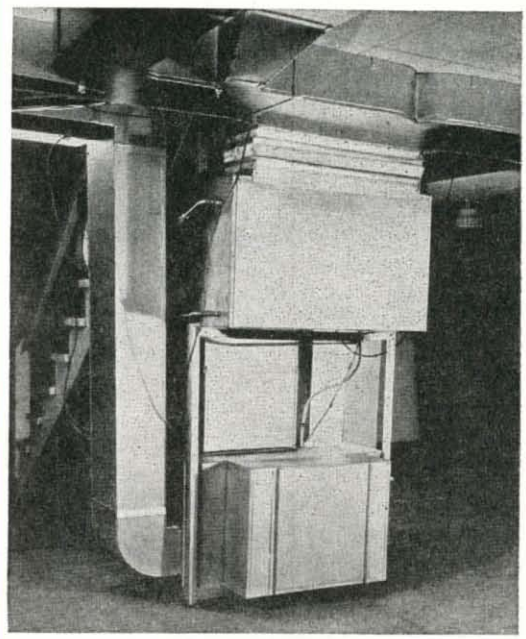
New homes without chimneys . . . Competition of electrical heating with coal, gas, and oil . . . First wide-spread use of heat pumps in areas where current cost is low . . . Increasing desire for comfort-cooling systems in homes . . . Expanding markets for utility companies.

by hot air from a coal furnace. He decided to use the surplus heat from his freezers to save coal, so he piped some of the hot water from his boiler through a coil beneath one of the floor registers, and installed a small fan to drive air past the hot coil.

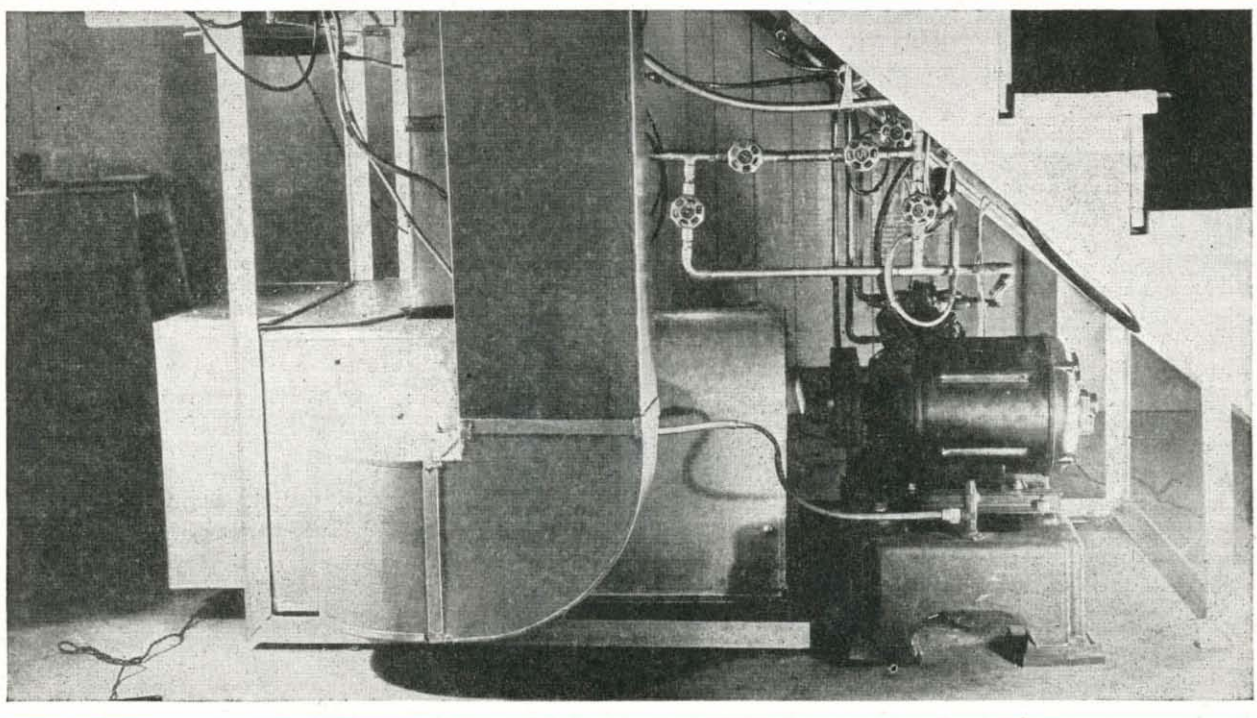
The results were so encouraging that Mr. Webber decided to build a full-size heat pump to warm the whole house. That meant a great deal of figuring, shopping for scarce materials wherever he could find them, and working evenings and week-ends for the better part of three years.

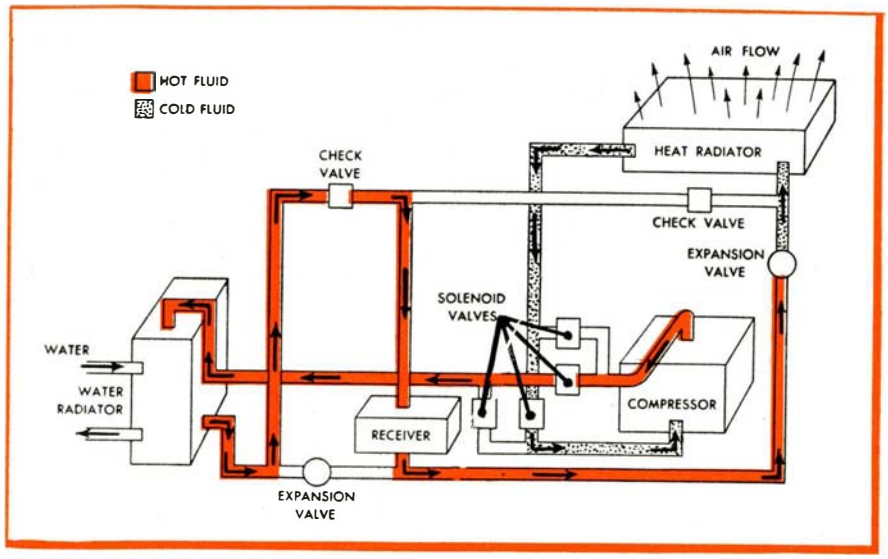
HEAT FROM THE GROUND—Lord Kelvin discovered the heat pump in 1852, and in recent years a number of window-type air-conditioning units have been installed which can be reversed in cool weather to extract heat from the outside air. This is expensive heating; the colder the day, the more thinly the heat is dispersed in the air and the more power it takes to collect it. But Webber hit upon a new idea: Why not pump heat from the ground below the frost line, where the temperature doesn't vary more than 20 degrees or so throughout the year? So he dug a ditch in his back yard and buried 400 feet of ¾-inch copper tubing. Freon gas circulates through this tubing and picks up the ground heat. When it reaches the heat pump in his cellar, the gas is compressed to a liquid which then goes to a condenser. Here it gives off its heat, and the now expanded gas goes back through the ground coil to pick up another load. Air is driven by a fan through the hot coil in the cellar (the condenser) and sent through ordinary ducts to registers in the rooms, while ducts near the floor bring back cool air for reheating.

Webber has been heating his house this way for three winters, and everyone is happy. Last winter he gleefully sold his coal furnace. Parts and materials for his heat pump cost him $524. For the first winter, from October 1 through May, the cost of electricity to run the pump (at two cents a kilowatt-hour) was $124. This is about $16 more than he used to pay for coal, and he also points out that a new



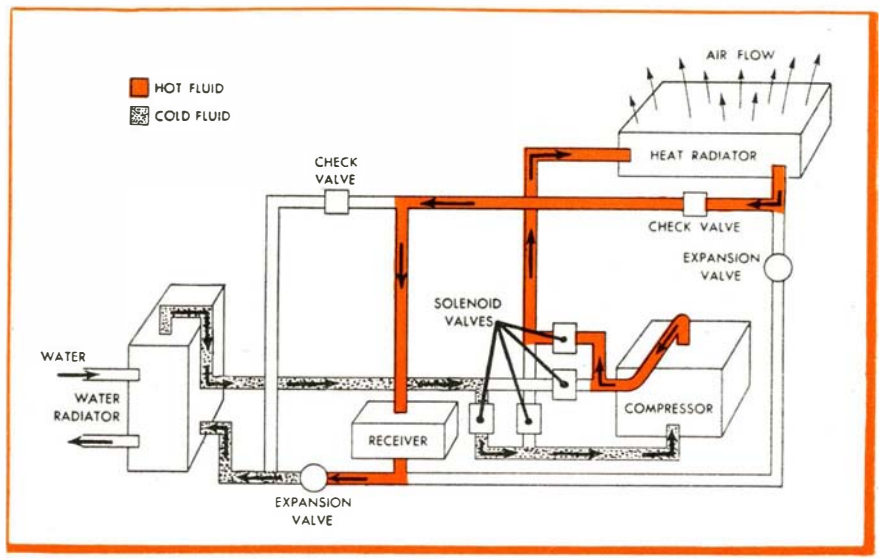
Right: Side view of a Terra Temp heat pump in the cellar of Webber's home, showing part of the duct system for distributing worm or cooled air os required by outside temperatures. Below: Front view of the same unit, showing main motor at the right. The entire installation is placed out of the way under the cellar stairs





tinuous loop of pipe running from the bottom of the well to the heat pump in the cellar, 15 gallons of water constantly circulate. This water picks up the heat in the well water (which draws it from the surrounding ground), carries it to the cellar, and uses it to heat freon gas in a coil through which it passes. The gas is compressed to a liquid, which makes it much hotter, then

Simplified diagrams of the heating and cooling cycles of the Marvair heat-pump system. Water from the deep well, not shown, circulates through the water radiator at the left in each diagram. Left: Cooling cycle when room temperature is above thermostat setting. Below: The cycle when thermostat calls for heat



house-insulation job favors his heat pump. But he says it's a cheap price to pay for not having to shovel coal and haul ashes. And his cellar looks as clean as a surgeon's glove.

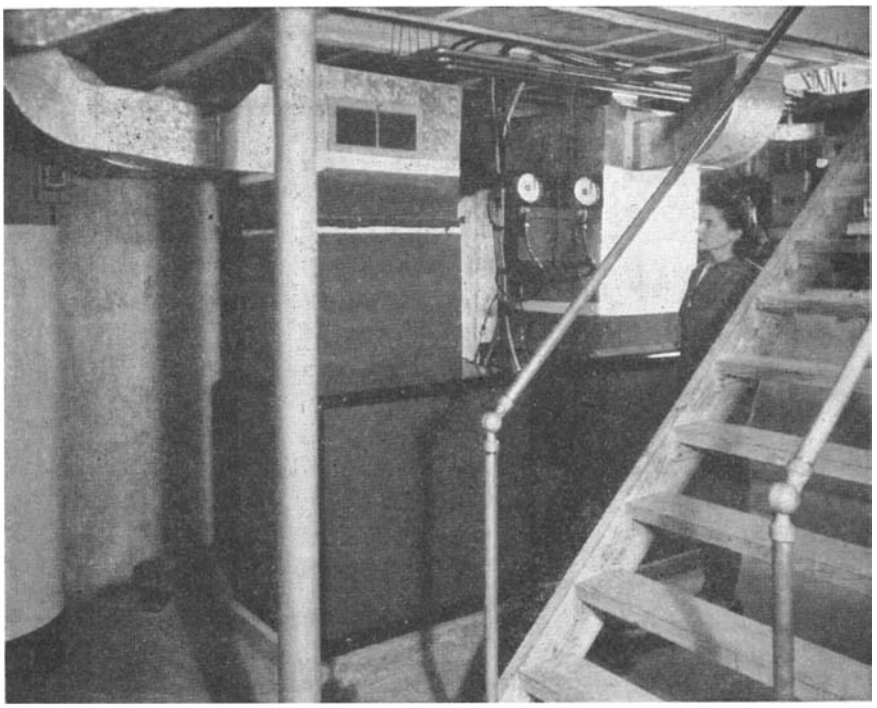
PLUS AIR COOLING—At no added cost, he has an air-conditioning plant for the blistering Indiana heat waves—a luxury enjoyed in very few homes. When the temperature goes above a certain point, the machine reverses itself, pumping heat from the house and dispersing it in the relatively cool ground. The cooling job, he reports, uses somewhat less juice than does winter heating.

Mr. Webber built his heat pump for his own use with no definite plan for exploiting it commercially, but he soon found that the world was beating a path to his door. Now the Terra Temp Company of Indianapolis has been organized to take over his patents and manufacture the novel heating plant on a mass-production basis. Further research is under way and more efficient models have been built. One resembles a large streamlined refrigerator which, in a cellarless house, would look attractive in the kitchen or a utility room. The Armour Research Foundation of the Illinois Institute of Technology has constructed a laboratory model and is securing data for the guidance of the manufacturers and of building contractors in various climates. Norman Kevers, one of Terra Temp's founders, estimates that the heating system, completely installed, should sell for less than $1000.

This is one man's heat pump. There are others. Some 60 miles from Mr. Webber's doorstep, in a veterans' housing development in the University Heights section of Muncie, stands a spic-and-span new four-room bungalow with no chimney. When William A. Spurgeon and his bride moved in last October, they set the thermostat at 72 and left the rest to the Marvair heat pump in the cellar. If the house cools down to 71, the pump goes on, and 30 seconds later hot air comes through the registers. If the thermometer goes above 73, the device reverses itself and blows in cool air until the temperature drops to the correct level. When June comes, with hot days and chilly nights, the Spurgeons will still do nothing about it. Come heat or cold, the robot in the cellar will accurately provide the desired indoor temperature. Other installations are being made.

220-FOOT WELL — The Marvair heat pump is the product of Muncie Gear Works, Inc., an old, experienced firm which also manufactures coal stokers and outboard motors. Instead of taking heat from the ground, Marvair pumps it from well water. Back of the Spurgeon house is a 220-foot well. Through a con- it expends its heat on a stream of air which is driven by a fan through conduits into the rooms. Cold air is returned through other conduits for reheating. Thus the heat units in the well water are collected and moved to the living-room by means of three intermeshing cycles of water, gas, and air, and the whole thing is driven by electric power from the utility line.

The reader may protest that it is prohibitively expensive in cold climates to heat a house by electricity. It is, if you are using ordinary electrical resistance heaters. The secret of the heat pump is its superior efficiency. Theoretically, it will convert the electric power equivalent of one resistance-heat unit into six or seven heat units in your house. So far, in actual practice, the yield is between three and four, but engineering projects now under way may bring even better results. It is the first method ever devised which shows practical promise of obtaining household heat from



Marvair heat pump in the Spurgeon home in Muncie, Indiana

the cleanest, safest, and least bothersome source—electricity.

Aside from heating in winter and cooling in summer, this device can heat water far more cheaply than the electrical water heaters now in use. A large utility company, aware that resistance heating cannot meet the competition of gas-fired water-heaters, has sent specifications to manufacturers for a heat pump for this purpose. As Mr. Webber proved in his cellar, refrigerators and deep-freeze boxes can be coupled with a heat pump. It would be easy to add a bathroom tap for ice-water. Today we buy one expensive device to throw away unwanted heat and another one to get rid of unwanted cold. The heat pump can be made to swap the two, with an important saving in equipment and power. It will perform all household heating and cooling jobs except cooking.

PRODUCTION PLANS—Both of the Indiana firms have ambitious production plans. They don't expect 30,000,000 American householders to junk their furnaces overnight and put in heat pumps, but as more of the effortless indoor heating and cooling systems are seen throughout the country, they are confident that the demand will keep them busy. While Terra Temp is in the process of getting under way, the Muncie firm has converted an entire plant to producing its Marvair pump, and has 3500 firm orders to be filled before July. Muncie originally planned to build 10,000 units this year, but has had to cut this estimate in half because of material shortages.

Heat pumps of various types are being installed in all climates. In mild Los Angeles, a number of pumps are in use which extract heat from the outside air, and the Drayer-Hanson firm of that city plans to build 5000 this year, suitable for use in the Southern belt of the United States. Three Marvair heat pumps using deep wells are being installed in houses in Binghamton, New York, and there are orders from other cold-winter places like Montreal and Milwaukee.

Utility companies throughout the country are showing a lively interest in the heat pump. Its use even in a small percentage of homes would add tremendously to their market for power.

Many firms have installed it in their office buildings, among them the Ohio Power Company, which uses it for heating and cooling buildings in Portsmouth and Coshocton, Ohio. However, its first big boom will probably be in the TVA area, where power sells for as low as four mills per kilowatt-hour. C. B. Osborne of the Chattanooga Electric Power Board heats and cools his house with a Marvair unit, and several others, of both the ground and water type, are being installed in other Chattanooga houses. An individual well 200 feet deep is expensive business. Existing shallow wells or cisterns are not suitable because there is not enough adjacent ground area to supply the needed amount of heat. S. R. Finley, general superintendent of the Board, suggests that the cost of deep wells can be eliminated by tapping the water of the Tennessee River to bring the new heating and cooling system to all of downtown Chattanooga. Both the first cost and the cost of operation are at present somewhat higher than oil and coal heating systems, but compared with the cost of separate heating and air-conditioning plants, it's a bargain. As Marvin Smith, Marvair executive, puts it: "You buy air conditioning and get your heating system thrown in free." And it doesn't take water from the ground, which disposes of one air conditioning problem in parts of the country where the water table is dangerously low.

OPERATING COSTS — The heat pump's further progress will depend largely upon the cost of electric power and the cost of household fuels in various parts of the country. One expert estimates that with electricity at one cent per kilowatt-hour and coal at $10 a ton, the heat pump can match the cost of conventional winter heating, to say nothing of the advantage of summer comfort. At present there are few places where power can be bought at that price, but with wide adoption it is probable that power companies would put a separate meter on the pump and establish a special rate. They make this arrangement now for household electric water heaters, which operate during the morning hours when the power load is light. By adding an insulated hot-water storage tank, the heat pump might also help to smooth out the power demand.

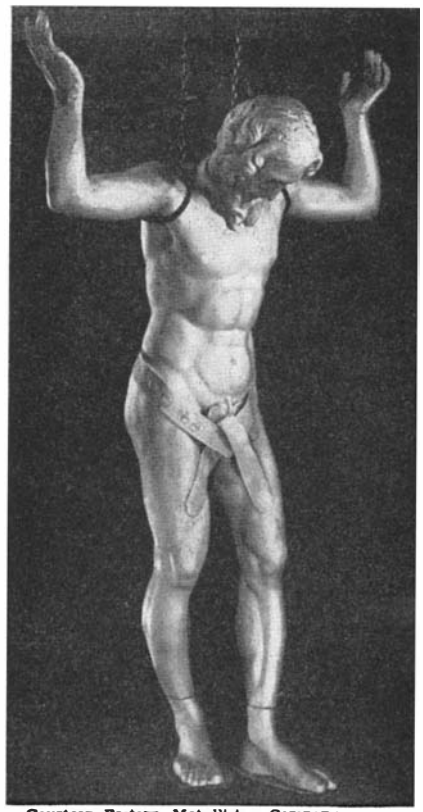
The Muncie firm plans to sell its Marvair unit for about $1700, all installed and ready to set the thermostat for whatever year-'round indoor temperature you wish. This includes the cost of the well, which in actual jobs has varied from $300 to $800. If this type of heat pump wins out, a rotary core driver can dig wells much more cheaply. And if Mr. Webber's ground-coil system gets the breaks, digging costs will be still less. On the other side of the ledger, houses will not need chimneys, expensive items which now run up a construction bill $300 to $500.

All this adds up to the conclusion that the new heating system has its foot firmly in the door. In the early '20's, only the well-to-do owned mechanical refrigerators. Old-fashioned ice-boxes were much cheaper, but convenience won out, and the iceman cometh no more. Liberation from the coal shovel, from dust, smoke, and summer heat would be a priceless boon. Don't expect delivery next week, but we may be headed for something like a domestic millenium.

Metallizing TAKES OVER

Struggling to Rise from the Status of a Stunt Process to That of a Respected Tool of Industry, Sprayed Metal, With Its Unusual Metallurgical Structure, Offers Solution to Difficult Production Problems

By EDWIN LAIRD CADY



Courtesy Eastern Metallizing Company

The thorough restoration of this dry-rotted antique wooden statue is an excellent example of metallizing wood

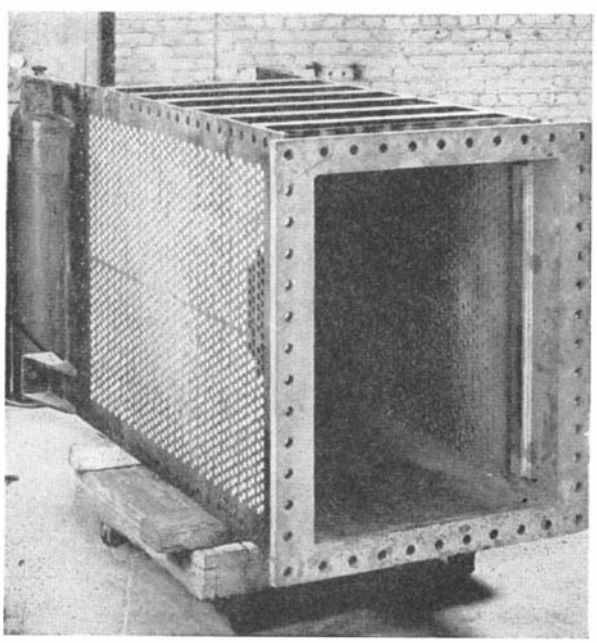
SOME 30 years ago one of the developers of metallizing sprayed molten metal on the head of a kitchen match. The match did not ignite. He was to make this demonstration again and again. He was to be sorry he ever had done it the first time. It was just a stunt. And metallizing (molten metal spraying) has spent its entire growth-period fighting off with one hand the attempts to use it as a futile stunt process, and working with the other to build its place as a solid technique of industry.

Much of the demand to do sunts has come from the fact that metallizing is so completely unrelated to any other industrial process. Briefly, this process consists of feeding a metal wire or rod into an aceytlene flame, picking up the molten metal in a compressed air blast, and blowing it onto the object which is to be coated.

This might sound a lot like paint spraying. But sprayed paint is much like brushed paint. And sprayed metal is like nothing else made of metal.

Seen through a microscope, sprayed metal does not resemble the granular structure of cast metal or the somewhat fibrous structure of wrought alloys. On the contrary, the sprayed metal looks like millions of tiny apple pies squashed down upon each other. Many a metallurgist looking at it for the first time has said "there ain't no such metal. There can't be." Many another has said "it disobeys all of the laws of metallurgy. It cannot be any good."

The practical production man who finds a machine or process going wrong is apt to say "I've got to get the bugs out of it." For debugging he turns to an odd process—the odder the better. Metallizing, with its reputation for odd stunts and odd metallurgical structures, is highly inviting to him. And in plenty of cases it works.



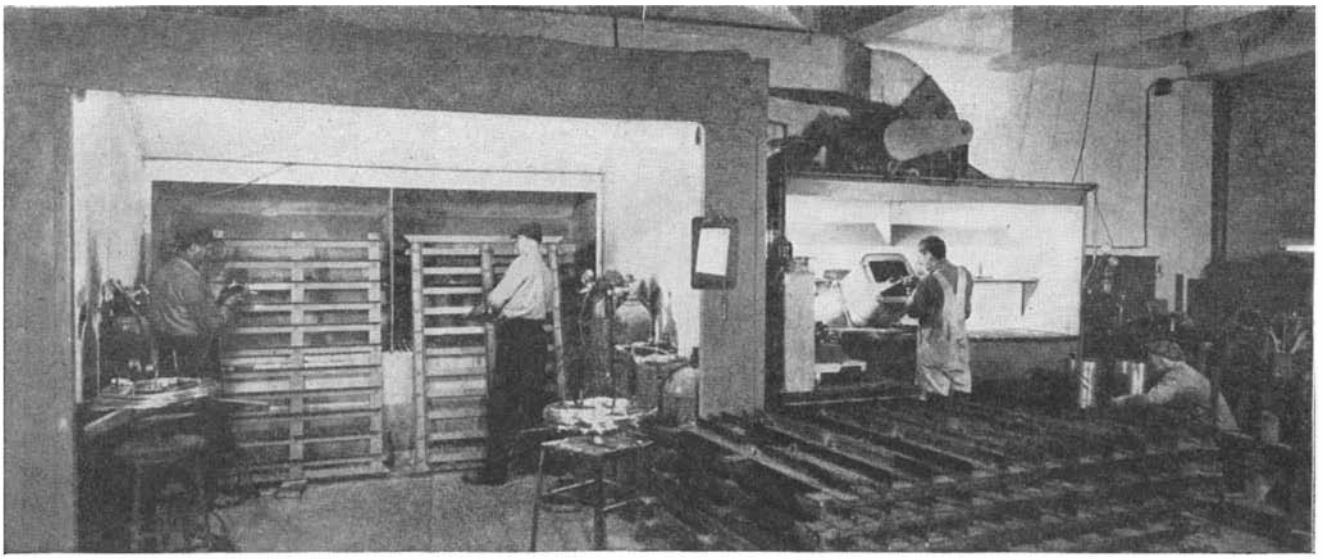
Courtesy Metallizing Company of America

Metallizing insures longer and more efficient operation of this heat exchanger structure

HEAT RESISTING—One example is that of heat exchanger tubes. These often are made of copper because their function is to conduct heat, and copper is second only to silver in its heat-conducting ability. But they frequently have to take the waste heat out of exhaust gases at temperatures as high as 2000 degrees, Fahrenheit. At temperatures quite a bit lower than this, copper is likely to disintegrate rapidly enough so the costs of tube replacements are high.

To solve this one, metallizing had to work out a process. An alloy of aluminum and copper is much slower to disintegrate. Metallizing could put a thick coating of aluminum on the copper but could not cause the two metals to fuse together into an alloy. The aluminum therefore was sprayed onto the tubes; then the tubes were placed in a furnace and held at a temperature of about 1600 degrees, Fahrenheit, for one hour. This caused the forming of an alloyed coating which will protect the copper tubes at temperatures up to 2100 degrees, Fahrenheit.

And so, in taking the bugs out of copper heat-exchanger tubing, met-



Courtesy Eastern Metallizing Company

Metallizing is an economical method of applying a corrosion-resistant coat to frozen food equipment

• LOOKING AHEAD •

New techniques to lower both initial and maintenance costs of bearings and shafts . . . More effective, less expensive protective metal coatings for objects of any size . . . Low pressure dies, molds, and related items fabricated swiftly, simply, and at a new low cost.

allizing worked out a solid process and found a consistent market for itself. This application no longer is a stunt, but is an accepted technique of industry. And metallizing likes to develop these steady "bread and butter" markets.

Prolonging the lives of pots used for carburizing of steel products is another example. For a great many years the steel treater had two choices. He could use common cast iron pots which were low in first cost, but which failed rapidly under the furnace heat on their exteriors and the weights of metals and pressures of gases against their interiors. Or he could use costly alloy pots such as those made of Nichrome.

There were many attempts to fill in between these extremes—to make carburizing pots of middle endurances at middle prices. Pots were made of special cast irons, cast steels, molybdenum bearing alloys, and given surface carbon treatments.

All of these worked for some applications, but metallizing was able to go much further. Common cast iron pots, or any of the special steel and alloy ones, can be metallized with aluminum, Nichrome, stainless steels, or almost any alloy which is known to impart heat-endurance properties. Pots of the same materials which had failed after only eight hours of service lasted more than 100 hours after being inexpensively metallized.

ON SHAFTS—Metallizing of shaft surfaces which are to operate in journal bearings (plain hole bearings or plain sleeve bearings) is having little-understood effects which may completely change some machine design practices.

The shaft surface usually is much more costly to renew or replace than is the sleeve surface in such a bearing. Therefore, the bearings have commonly been so designed that the sleeves or the plain holes would wear first and would leave the shafts comparatively unworn. But when the shaft surfaces finally showed bad amounts of wear, the shafts had to be replaced or their surfaces renewed.

Many shafts were so large or of such complex contours that replacing them was costly. Metallizing was tried, largely as a "last hope" process, for renewing these. It was tried in increasing numbers of instances when the war made replacement parts impossible to obtain.

The metallizing often gave results which were astounding. Nobody as yet fully understands them, although their explanations may lie in certain theories of bearings.

When a bearing is operating improperly because of wear or overload, several things happen in complex combinations. First, any lubricant which exists in the pores of the bearing metals is drawn out and begins to function. Second, the shaft and sleeve alternately seize each other and then let go, thus setting up vibrations; overloaded bearings make noises, which range from squeals to groans. Third, the bearing temperature is raised by the increased friction. Fourth, as the temperature increases, the metals expand, reducing the clearance within which the lubricant can operate. They seize more and more completely, and finally either seize altogether and "freeze," or else fracture or melt one of the bearing members.

Sprayed molten metal helps to meet all these enemies of the bearing. Its "pie upon pie" metallurgical structure is an excellent reservoir for small supplies of lubricant, and can help the lubricant to keep the trouble from becoming serious. This same structure is one of the best dampeners of vibrations and can reduce the "bound and rebound" effects which would otherwise cause the bearing to seize more rapidly. As the temperatures builds up and the shaft and journal expand, the tiny voids which exist within the sprayed metal become areas into which the expansion can go, rather than all of the expansion being imposed between the bearing surfaces.

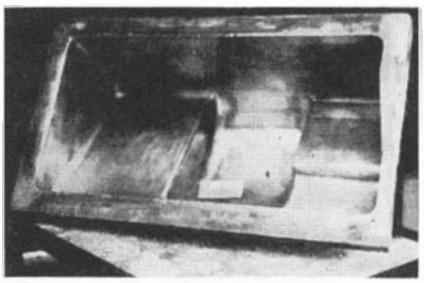
The results of this have been proved again and again in the operations of machines. Many a shaft, "temporarily repaired" by metallizing, has lasted much longer than it did when brand new. And scientific measurement has confirmed these experiences.

BEARINGS TESTED—A recognized scientific method for determining bearing qualities is to mount a shaft in a standard bearing sleeve which is so split that its halves can be forced toward each other. The shaft is revolved at a standard speed, and a standardized lubricant is fed in measured standard amounts to the bearing. The bearing halves are then forced toward each other with stand-

ard time increments of pressure. The result is that under completely standard conditions the bearing is subjected to gradually increasing pressure. At some point the pressure will become great enough so the bearing will seize or otherwise fail. Since the rate of pressure increase is known, the time-period for which the bearing endures this test becomes a direct measure of the bearing endurance.

A low-carbon steel shaft had its surface finished for bearing purposes in the usual way. A second shaft was metallized with the same low-carbon steel, then was machined to bearing surface smoothness in such fashion that the bearing areas of the two shafts would be alike in diameters. Both shafts were submitted to this test, the testing being done in an independent and unbiased scientific laboratory. The plain carbon shaft endured eight hours, the metallized shaft 20 hours.

With results like these in his



Courtesy Eastern Metallizing Company
Low-pressure die made by metallizing

hands, many a machine designer is changing his ideas about journal bearings. Shafts are being metallized on original production lines, are entrusted with much heavier bearing pressures and higher speeds in their machines, and are re-metallized as a standard maintenance operation if they wear. Some shafts are metallized with very hard materials such as Stellite; others with ordinary carbon steel, or with corrosion resistant alloys if the bearing area is subjected to corrosive materials in service.

CANNOT BE HAMMERED — Not solved by metallizing, as yet, are the problems of anti-friction bearing seats. A sprayed metal coating is tenacious; it can be almost impossible to remove without also removing some of the base metal. But it is too brittle to resist direct hammering or peening action. Gear teeth, for example, should be metallized only if they operate at extremely slow speeds and in the presence of abrasive materials which wear them rapidly.

The making of dies, molds, and pans of intricate contours is a rapidly advancing field for metallizing. The master models or patterns for precision investment casting can benefit from this technique.

In one instance, a contoured mold which did not have to endure extreme pressure or abrasion was wanted. The estimated cost of machining it from the solid was $3000. Metal spraying made it for $400.

The production sequence for this was: 1. Make a wooden pattern of the mold. 2. Surround this with a steel frame, the frame being a weldment. 3. Spray consecutive layers of zinc to the mold and the frame, following the contours of the wood, until the zinc was one-half inch thick. 4. Remove the wood pattern, leaving the frame as a protection and stiffener for the mold.

Metal-sprayed zinc has unusual ability to protect metal surfaces, a coating of it .003 inch thick being said to have more than four times the salt spray test endurance of a normal .0025 inch thick electro-deposited coating. And the metal-sprayed coating can be built up to any desired thickness whereas the electro-deposited (galvanized) coating is limited. Racks for frozen foods and other foods handling equipment are now metal-sprayed as a standard protective procedure. Whole rooms in packing houses have been sprayed with tons of protecting metals.

In one field after another, metallizing is finding ways to solve problems. In so doing it has become a settled, even a sedate industry. But it never is likely to become too sedate. There is never a day during which some metallizing sales engineer is not asked to show how he can spray molten metal onto the head of a match. However, when metallizing calls at the factory door, it still is likely to be taken by the hand and led to the odd problem—the problem that "has bugs in it."

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ASCENT BY ROCKET

Envisioned From Passenger's Viewpoint

MANY A man has wondered what it would feel like to go 100 miles straight up in a rocket. Dozens have volunteered to find out. Nobody as yet has made a successful flight. The business of getting back to the ground would be too hazardous; the chances of making it too slight. But scientists have sent up instruments, also a movie camera, and have put together the story from the film and the records.

The passenger would climb a ladder, enter a chamber high in the nose of the rocket. The door would be closed tightly and securely fastened. The cabin would have to be pressurized.

He would strap himself into a padded seat, probably make a wise crack or so about padded cells. All around him would be windows, before him a bank of instruments.

For about three seconds he would see the glow of a bright orange flame as the preliminary jet let go. Then the rocket would begin to move.

The take-off would be slow, no more rapid than the movement of a heavily loaded truck leaving its loading platform. But all around would be a roar like a million blow torches all going at once.

Then he would be pressed down heavily in his seat. The rocket would be picking up speed, accelerating. The human body can stand a peak acceleration of five Gs (five times gravity). The rocket would not reach that. But in 50 seconds it would reach three or four Gs, and only a man in good condition could take it.

In 65 seconds all of the fuel would be gone but the rocket still would be going. In three minutes he would be at the top. The visible ground area would have been widening and flattening below him. He might be able to see objects 900 miles away. The rocket would be rolling and tumbling by now. When his windows were aimed at the sky he might see only dense blackness and he might see the stars at the brightest any man ever has seen them. The rocket-borne camera has seen only blackness, but balloon ascent theory says that the sky would be the clearest of night skies.

The rocket would start back down. He would not know when this happened unless his instruments told him. It still would be rolling very slowly. The tail surfaces would then take hold and the nose go down. He would tighten the straps which kept him from diving out of his seat. All the objects that had looked smaller and smaller as he went up, now would look larger and larger.

At a safe height an automatic device would work. It might eject him from the rocket, and it might eject his entire cabin. Scientists have not determined just how to work that.

One parachute would open, catch the air, explode from the force. A second would open, be torn to ribbons. The third or fourth might hold.

Then he would be on the ground. And he would promptly get a ghost writer and write a book.—*Edwin Laird Cady.*

OXYGEN by the TON

Capable of Turning Out Unprecedented Volumes of Oxygen Daily, Projected Plants Will Make Available to All Industry Vast Quantities of That Gas, of Adequate Purity, at a Fraction of Present Cost

By D. H. KILLEFFER
Chemical Engineer

• LOOKING AHEAD •

Greatly increased efficiency of many oxidation processes to result from the reduction or elimination of diluting gases . . . Processes heretofore considered impractical, due to expense or difficulty in obtaining proper heating, to be brought into the pay-off bracket . . . Oxygen finding more and more applications throughout all industry, with oxygen taps becoming nearly as prevalent as water and compressed-air sources.

OXYGEN, most plentiful of all the chemical elements, has come out of World War II ready to bulge into new and larger places in our industrial economy. A revolution threatens, and not a minor one. Although nearly half of our world and all that is in it (actually 46.46 percent) is oxygen, we are only now becoming seriously discontented with production of this extremely useful gas. One example of the need for accelerated oxygen production is seen in a projected plant that will convert natural gas into motor fuel and Diesel oil. This plant alone will consume oxygen faster than our present total production. Futhermore, this plant will probably be the first of a series of such plants. All this is much more than a simple expansion of demand; it is a magnification, and it makes oxygen appear to be a quite new and revolutionary thing, certainly worth looking into.

This oxygen renascence grows out of forces that have operated over a long period. They have been focussed by developments of the recent war period, and given new and vigorous life. The basic facts are quite simple. The air over each five square feet of the earth's surface contains something over a ton of oxygen, but this is so thoroughly mixed with nitrogen and other gases that it is expensive to separate. The second important fact is that vast numbers of chemical reactions involving oxygen can be better carried out by using oxygen without the serious dilution of the four volumes of nitrogen which normally accompany it. The most important reason that nothing has been done about this in the past is that most such reactions really go on quite well with ordinary air—so well that the possible gain by using oxygen instead has never seemed particularly attractive. But the tremendous demands for production to supply the machinery of war, and the serious depletion of some of our high-grade natural resources to meet them, forced attention to every possible means of raising output. This came at a time when it was quite impossible to get more output by the usual simple expedient of building more plants. Something had to be done to get more out of existing equipment. That meant, among other things, to avoid diluting the oxygen, which is vital, with inactive nitrogen, which simply takes up space. In those words the idea sounds very simple, and indeed it is, but scarcely that simple. First, you must get your oxygen.

GETTING THE OXYGEN — That problem has heretofore assumed very much the aspect of the old question of the prior arrival of the hen or the egg. Cheap oxygen would undoubtedly promote demand, and large scale demand would certainly lead to materially lower prices. War stringencies forced the decision, and both appear to be arriving together. Heretofore, the purchasers of oxygen have been well pleased with a price of 55 cents per hundred cubic feet, which is equivalent to about $125 per ton. That is for 99.5 percent or better oxygen. But most tremendous scale industrial uses can be quite well satisfied with a somewhat lower purity gas if it can be had at a lower price.

Obviously, the advantage to be had from oxygen comes from enriching the air used in most processes, and in only a few is there any particular necessity to go to the maximum possible purity. Thus the concentration of oxygen can be established for each enterprise at the point providing the greatest overall economy, considering cost of concentrating and advantage gained. New and improved methods of recovering 95 to 97 percent oxygen from air can be operated at a cost of $2.75 per ton of the gas in a plant with an output of 1000 tons per day and up to $5.21 per ton if the plant is designed for only 120 tons per day. Such figures are entirely new to the art. Plants of these magnitudes are still new to American industry, and costs as low as those mentioned are quite out of line with past experience. Large forces are involved in such an expansion and large results can be expected from it.

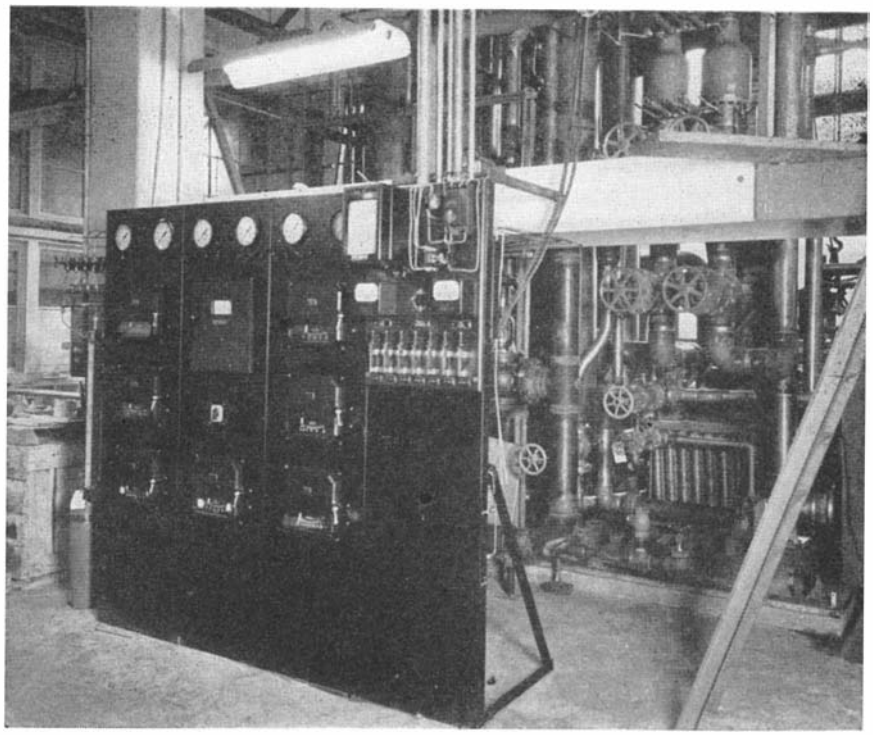
In Scientific American for September, 1946, page 101, some of the implications of enlarged oxygen supplies for the mechanical industries were examined. These were found to be developments and growth of traditional uses, enlargements principally of present demands. While the present mechanical uses may change in some respects, their relative magnitudes are unlikely to be completely upset. The steel industry consumes about 40 percent of present oxygen output in its operations, particularly scarfing (29.5 percent). Another 25 percent goes for steel fabricating, and industrial maintenance uses about 8 percent more. The remainder is divided into many small uses. The sum total is some 40 to 50 thousand tons per month.

Contrast to that the consumption planned for the *single* chemical plant already mentioned of some 2000 tons of 95 to 97 percent oxygen per day, 60,000 tons per month.

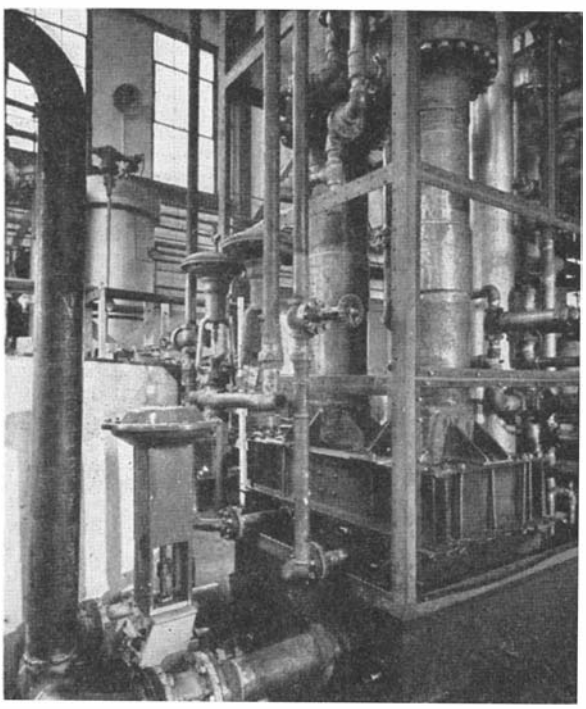
LIQUID FUEL FROM GAS—Conversion of natural gas, which is still abundant in this country, is looked

upon as the most practical way to meet the diminution of our oil reserves under the continued drain of our use of liquid fuels. The several possible reactions available to perform this transformation of gas to liquid fuels are based on an initial conversion of the hydrocarbon of the natural gas (largely methane) to carbon monoxide and hydrogen by reaction with oxygen; subjecting the mixed gases to further reaction gives heavier hydrocarbons together with more or less minor amounts of oxygen-bearing compounds that have value in other ways than as fuel.

For efficient operation of the initial reaction, as well as the subsequent conversion of its products, the mixture of active gases should be as free as possible from dilution by nitrogen. These reactions are to be employed on a huge scale first in the Texas natural gas field to produce some 5800 barrels of gasoline and 1200 barrels of Diesel fuel daily. In addition, substantial but reasonably controllable quantities of chemical compounds containing oxygen will be available as by-products from the same operation. Estimates place the total output of alcohols, aldehydes, ketones, and organic acids from this single plant in the neighborhood of 160 million pounds per year without affecting fuel production.



Photographs courtesy M. W. Kellogg Company



The control panel of an existing low-pressure oxygen plant capable of producing a volume equivalent to 21 tons per day (above). The reversing exchanger tubes of a high-pressure oxygen plant with a similar rate of production (left)

INCREASES OUTPUT — As has already been noted, oxygen is preferable to air in chemical processes because it avoids diluting the reacting mixture with nitrogen, thus increasing the output of given equipment, or allowing its size to be reduced for the same output. A second significant advantage of oxygen is that many reactions can proceed when oxygen is used that become sluggish or stall entirely with air. Reporting on the subject of "tonnage oxygen," Downs and Rushton suggest six fields of chemical application that will be affected by the use of cheap oxygen in huge quantities. In *Chemical Engineering Progress,* they list these immediate possibilities:

"Oxygen, or oxygen-enriched air, undoubtedly will be employed on a very large scale for improving processes or products, or in the manufacture of new products in the process industries. Potential examples are:

"1. For the production of gas from coal by continuous complete gasification for use as city gas of current or increased thermal content.

"2. For the production of gas with a composition suitable for synthesizing hydrocarbons, oxygenated products, and ammonia from coal and natural gas.

"3. For the oxidation of ammonia (to oxides of nitrogen and ultimately nitric acid) and sulfur dioxide (to trioxide and ultimately sulfuric acid), and for partial oxidation of organic compounds to derivatives.

"4. For roasting and burning sulfide ores, pyrites, and other sulfur-containing compounds.

"5. For smelting iron ores and for refining iron in Bessemer converters and open hearths.

"6. For combustion of fuels where unusually high temperatures are advantageous, as in calcining, and perhaps even for the direct combination of nitrogen and oxygen.

"It is possible that cheap oxygen may even revive the Deacon process (recovering chlorine from hydrochloric acid by air oxidation) and that hydrogen peroxide may be found more economical to make from hydrogen and oxygen than by other indirect methods."

HIGHER HEATING VALUE—Clearly, the complete gasification of coal is simplified and made practical if the partial combustion of the coke to carbon monoxide, a reaction es-

sential to supply heat for the simultaneous water-gas reaction, can be carried out without diluting the product gas unnecessarily with nitrogen introduced with air. Replacing air by oxygen, or even enriching the air used, in this operation greatly improves the reaction taking place and renders it more effectively controlled. At the same time it obviates, or substantially reduces the percentage of, diluting nitrogen in the product gas and thus correspondingly raises its heating value.

The gas mixtures used in synthesis of liquid fuels and derivatives of hydrocarbons consist principally of carbon monoxide and hydrogen with possibly some hydrocarbon if natural gas has been the raw material. These mixtures require the simultaneous operation of the water-gas reaction between steam and carbon or hydrocarbon, and some direct oxidation to supply the heat needed to keep the water-gas reaction going. The situation is much the same as for complete gasification of coal except that here the efficiency of the subsequent synthetic reactions depends closely on the concentrations of the constituents of the gas mixture and the absence from it of any diluent. If ammonia is to be made, the mixed gas to be prepared as raw material consists of three volumes of hydrogen and one volume of nitrogen, obtained from water gas and producer gas by conversion of the carbon monoxide content to carbon dioxide which can be washed out. Here again the close control of the basic reactions, possible through use of oxygen alone or as enrichment of air, adds significantly to the overall efficiency of the operation.

IN ACIDS—Oxidation of ammonia for the production of nitric acid is made considerably more efficient if the product of oxidation is not diluted with nitrogen. This is advantageous in raising the capacity of the equipment by an amount corresponding to the nitrogen omitted, and it further improves the efficiency of absorption of the nitrogen oxides and the capacity of the absorber.

Sulfuric acid production also benefits substantially by the same concentrating process. When air is used in the ordinary manner, the maximum concentration of sulfur dioxide possible in the raw gas is 14 percent to leave 7 percent oxygen in the mixture to convert sulfur dioxide to trioxide, which combines with water to form sulfuric acid. Although this is a theoretically possible mixture, practice is to use about half that concentration of sulfur dioxide (7.5 percent). This percentage is arrived at as most practical because the mixture in any case contains 79 percent inert nitrogen. Any enrichment of the air supply by introducing oxygen gives a tremendous increase in output of both sulfur burners and sulfuric acid plants, whether contact or chamber plants.

This does not consider the possibility opened by oxygen enrichment of burning lower grade pyrites than is feasible with air. Not only pyrites, but numerous other sulfur-bearing ores support combustion in practicable furnaces only when of a relatively high grade. For this reason, many large ore bodies are not practical to smelt by the usual processes, but require additional heat to be supplied by a supplementary fuel fire to maintain their combustion. Thus, the availability of oxygen for enrichment of smelting air would lower the cost of treating low-grade sulfide ores (including many now uneconomical to smelt) and would at the same time raise the value of the sulfur dioxide by-product of the smelting process.

METALS PRODUCTION—Enhanced output and efficiency of iron- and steel-producing equipment would naturally follow enrichment of their air supplies with oxygen. Here again the benefit would be achieved by raising temperatures through removal of diluent nitrogen, by increasing the speed of reaction between more concentrated reactants, by reducing the quantity of exit gases and hence their heat-carrying capacity, and, by this means, raising the temperature and reaction rate in the active zone. Not only is output increased in this way, but a number of alloys such as 50 to 60 percent ferrochrome can be made in blast furnaces that now require electric furnaces.

High temperature operations of various kinds are improved by the possibility of raising flame temperatures with oxygen or enriched air. Such differences are significant where radiation of heat is involved since the rate of transfer under such conditions varies as the difference between the fourth powers of the temperatures.

Quite obviously, a vast new field of chemical operation as well as metallurgical processing is opened by the new era of "tonnage oxygen" that is now at hand. The difference in degree between past and future is reasonably equivalent to a difference in kind. Certainly the contrast is clear between the average output of two to three thousand tons of 99.5 percent oxygen *per year* of each of 222 present plants and prospective capacities of 120 to 1000 tons *per day* of 95 to 97 percent oxygen. So too is the difference between $75 to $125 per ton of 99.5 percent gas and the prospective $2.75 to $5.21 per ton for 95 to 97 percent product. Fulfillment of present plans will mark the beginning of new and efficient chemical production of many kinds.

SLIME PREVENTIVE

Developed For Industry, Found Beneficial to Fish

DURING extensive testing of pyridyl mercuric acetate for controlling the slime that plagues paper makers, the discovery was made that the small concentrations (about 1 in 7,000,000) of the fungicide that escaped into a stream actually promoted the health of the fish in its waters.

Slime in paper mills originates from the growth of bacteria and fungi, and these are made much less vigorous by the addition of the pyridyl mercury compound. In the same way, the health of the fish seems to be promoted by the suppression of the growth of microorganisms in their watery homes. Following the first observation of this effect, tests were made to confirm it under more closely controlled conditions, with the result that a fraction of a part of the fungicide per million of water is suggested for protecting young fish in hatcheries.

STORED VEGETABLES

Kept from Sprouting by Application of Hormone

IMPORTANT cause of spoilage of vegetables in storage is their sprouting under the moist conditions necessary for proper keeping, even though the temperature is kept quite low in the storage space. This tendency of root vegetables, and tubers particularly, can be controlled to a considerable degree by the use of plant hormone substances which suppress sprouting. Latest successful tests show that an easily applied methyl ester of alpha-naphthyl-acetic acid is effective in preventing sprouting spoilage of potatoes, carrots, and turnips. This compound is closely related to the alpha-naphthyl-acetic acid which prevents premature dropping of apples and other fruits from the trees.

All photographs courtesy Standard Oil Co. (N. J.)

Testing the pool unit of the oil pool analyzer

PREDICTIONS by Electronics

Reducing Years To Minutes, an Electronic Analyzer Permits Engineers To Review Over and Over the Productive Life of an Oil Pool, Testing Various Operating Techniques. Data so Obtained — Unfailing Predictions of How a Pool Will React to Any Given Circumstances — Enable Production Men to Extract the Greatest Amount of Oil Most Efficiently

By JOHN MARKUS
Associate Editor, *Electronics*

LIQUID black gold—oil deep in the bowels of the earth—is as inviting a treasure to man as the yellow metal itself. But perserverance in searching and drilling alone cannot insure anywhere near maximum recovery of the precious oil from between the particles of sand in underground pools. So science comes to the rescue with its electronic instruments for exploring oil sites, for guiding drills, and finally for determining the best way to get the most oil out in the shortest time.

Engineers know that if you take the oil out of a given pool too fast, the pressure drops and no more oil comes up. So they compute, by means of involved mathematical equations, the rate of oil withdrawal that will best maintain an oil pool's pressure. But there have been two handicaps to this procedure; a staff of expert mathematicians had to labor for long periods of time to solve the complex equations, and some problems were so involved that even the best mathematicians could do no more than approximate the answers.

• LOOKING AHEAD •

Extension of principle to complex industrial heat-flow problems . . . Means of determining where and how to place heating ducts in buildings for highest efficiency . . . Engineers, physicists, and geologists relieved of involved mathematical chores.

Today oil men have a robot mathematician, an electronic device called the oil-pool analyzer, which, in mere minutes, can work problems that calculators normally might take months to solve. Researchers had found that heat flows through a solid body much as electricity flows through a network of condensers and resistors, and that oil and water, under pressure in sand deep underground, behaves similarly. The flow of electricity can therefore be translated mathematically to represent the flow of either heat or liquids; this constitutes the principle of the oil-pool analyzer developed by Dr. W. A. Bruce in the laboratories of The Carter Oil Company.

Accuracy of the analyzer has been proved by feeding into it early data on oil fields which had been worked for some time. The predicted behaviors agreed exactly with what had happened in actual practice. Thus, the analyzer can look ahead 10 or 20 years, to tell at what rate oil may be withdrawn—or water or gas may be injected—so that enough pressure will be left to produce a high ultimate yield.

The analyzer's chief use is in guiding production engineers as they plot the rates of withdrawal of oil in new fields. It also will be of value to universities where new generations of oil scientists are being trained, to state regulatory commissions interested in conservation, and to industries having complex heat-flow problems.

An oil pool in miniature is the technician's device for representing a real oil field in the laboratory. Round tabs on a board indicate producing oil wells. The wells of this oil-pool unit are really electrodes connected in groups at the back of the board to simulate actual groups of wells draining an area of an oil pool. Some are producing wells, while others are injection wells through which vast quantities of water may be pumped back into the

earth to restore partially the pressure lost by oil withdrawal. A glycerine-water solution, in which the electrodes stand, conducts electricity just as the sand far below ground conducts water and oil. The solution also resists the flow of electricity as the sand resists the flow of fluids.

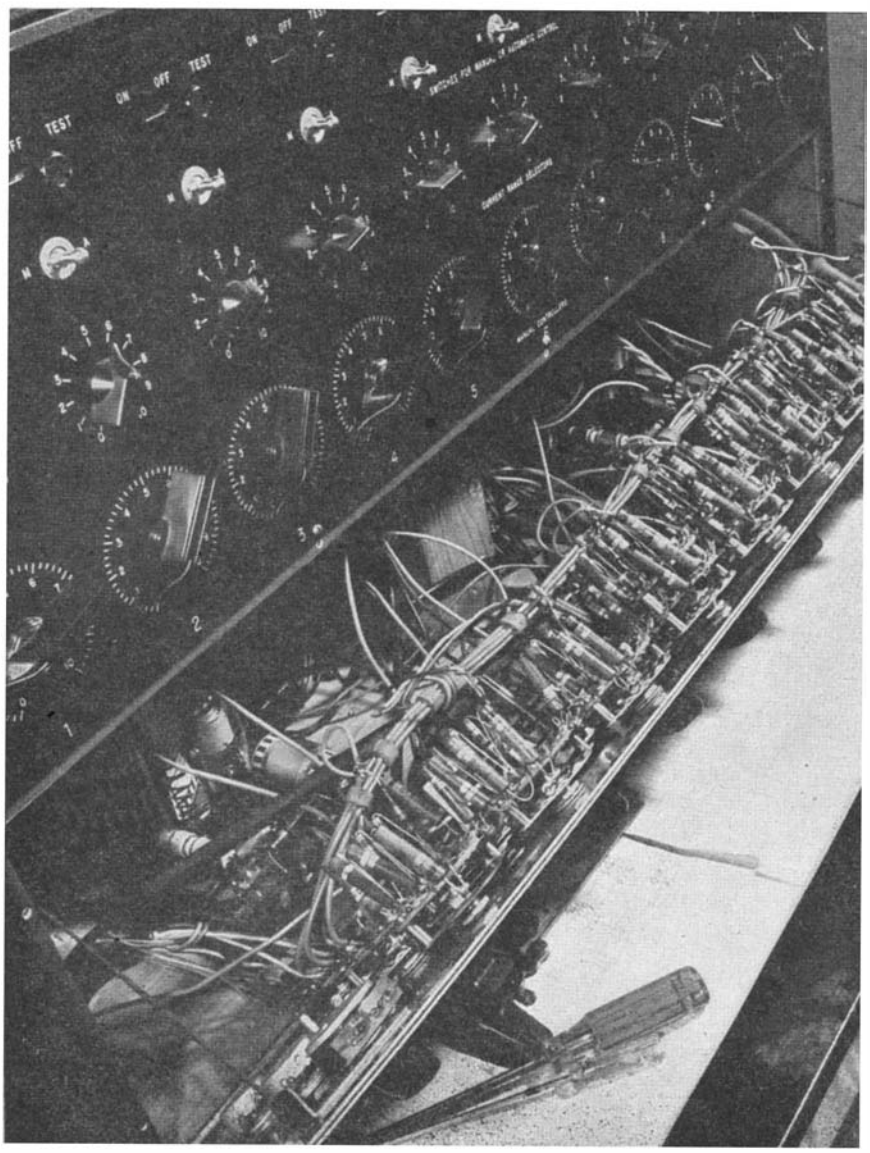
ANALYZER FED FACTS—Into the oil-pool analyzer go such facts about a field as the number of wells, production rates, pressure history of the field from the start, amount of fluids withdrawn, and an estimate of the amount of water or gas that may be injected. With this information to work on, the analyzer will forecast reservoir pressures far into the future, or tell the rate of oil withdrawal or the rate of water or gas injection that will make it possible to maintain a working pressure.

There is a remarkable parallel between the way an electrical condenser can store an electrical charge and the way sand can store oil. The analyzer uses a bank of condensers to represent the capacity of the sand to store fluids. But stored oil is of no value unless it will flow to the wells. The analyzer takes flow into account by a set of electrical resistors. These units resist the flow of electricity just as sand impedes the flow of oil. A number of resistor-condenser units can be connected together to represent a large and complex liquid-filled porous medium, with the currents discussed in terms of barrels per day and the voltages in terms of pounds pressure per square inch.

Another big faetor in the problem is time. The faster oil is withdrawn —and with it gas and frequently water—the faster the pressure will drop. In the timer cabinet, the analyzer squeezes months into seconds. It is set so that 2½ seconds equal one month of the field's history and prediction. Thus the machine works out a ten-year analysis of the pool in 300 seconds. The analyzer can look ahead to tell what the pressure will be for each month for an assumed production rate.

With all the basic facts introduced, the analyzer can proceed with its problem. The machine's heart and brains are its electronic tubes that control withdrawal of current from the condensers (representing oil or water withdrawn from the pool), and control current fed into the condensers (representing water injection wells). Similar allowances can be made for gas withdrawal and injection.

Other electronic tubes measure voltage on the condensers (underground pressure of oil and water) and amperes of current flowing (rate of flow of water and oil). These split-second computations, which tell how much fluid is flowing how fast, are the key to the analyzer's answer.



A section of the panel of the oil pool analyzer has been pulled forward to show some of the controls that can be set to simulate conditions of an oil reservoir

FINDINGS CHARTED—The machine translates its findings electronically into lines on a chart that will go back to the geologists and engineers as a guide for future operation of the field.

When the pool contains a single-phase liquid and does not develop a gas phase during the time under consideration, the entire problem can be set up in the analyzer, and studies made of the relationship between production and pressure or injection of water and pressure.

When the reservoir either has a gas cap originally, or develops a gas cap phase later, it is necessary to determine the original volume of the oil zone and consider the behavior of gas in the reservoir. This problem is treated by the successive approximation technique, in which the pressure-water influx relationship as shown by the analyzer is compared with material balance calculations, which in turn permits an adjustment of the pressure-water influx curve.

SUCCESS IN ARKANSAS—The real proof of an analyzer's validity lies in its ability to follow a complicated pressure-production relationship with values for the condensers and resistors compatible with known geological data. A particularly satisfactory result was obtained in the Midway pool in Arkansas, where predictions were based on a relatively short history. The pool was discovered in January 1942, and predictions made in April 1943 indicated almost perfectly the effect caused by water injection. After a year of operation, however, the production and injection conditions were changed

With all the necessary information applied to the analyzer's control panel, the machine will simulate, on a miniature time base, the changes that would occur in an underground reservoir, represented by the circular tray at extreme left

so much that it was necessary to make a new prediction assuming the changed conditions; this was also followed perfectly through late 1944 and early 1945.

The solution of a problem encountered at the Midway pool in Arkansas illustrates the scope of the analyzer in dealing with complex problems. The Midway pool by April 1943 had 40 wells producing 175 barrels per day each. With this production, the pressure was falling at the rate of 0.5 pound per square inch per day. Two questions arose: (1) How much cutback in production would be necessary to arrest the pressure decline, and (2) how much water injection would be necessary in the event it was attempted to maintain pressure by water injection on the flanks of the pool?

The problem was analyzed, and it was found that reduction below 150 barrels per day would only temporarily arrest the pressure decline if no water injection were used. It was further found that if the production rate of 175 barrels per day were maintained, about 5000 barrels per day of water injection would be needed to hold the pressure constant. Measured pressures today show how well the analysis anticipated the behavior of the pool as it was operated with water injection.

Thus is electronics squeezing years into minutes, running life cycles of wells over and over again, and noting how much oil comes out each time, so that the one best operating technique for a particular well or field can be followed in practice.

In other industries, similar electronic analyzers can likewise speed up time, permitting engineers to peer far into the future. These electronic brains will answer such questions as how many dollars worth of fuel is saved in a home in ten years by installing storm windows, or how much fuel is saved in an average year by dropping the thermostat setting at night in a building. The more complicated the problem, the greater are the possibilities for real savings by finding electronically the best operating conditions.

MAGNETIC SOUND FILM

Used in Making Home Talking Movies

APPLYING a magnetic coating to movie firm, for simultaneous recording of sounds during taking of home movies, is now a practical possibility. The magnetic track, only 0.0005 inch thick and 1/20 inch wide, is put between the sprocket holes and one edge of the film during manufacture, and is unaffected by developing solutions. The magnetic head used both for recording and playback is spring-pressed against the film while it rides on a flywheel stabilizer. This head is easily mounted on conventional projectors, and can be connected to an ordinary audio amplifier and loudspeaker. With this technique, developed by the Armour Research Foundation, all sounds from 50 to 5000 cycles are satisfactorily handled on 16-mm film; for 8-mm film that moves at half the speed of 16-mm film, the upper frequency limit is about 2500 cycles, which is still adequate for clear and natural voice, but not as good for music.

RADAR ON AIRLINERS

Will Detect Bad Weather And Aid in Navigation

MODERN commercial radar equipment is being installed in eight Boeing Stratocruiser luxury airliners now under construction for American Overseas Airlines. Storm areas and regions of dangerous icing will be revealed by a radar antenna in the nose, pointing forward, and shorelines will be mapped from many miles out to sea by a 60-inch diameter antenna in the belly, pointing downward.

PHONES IN TAXIS

Reduce Rates and Improve Cab Service

NEARLY 8000 taxicabs in the United States, comprising over 200 different fleets, have already received authorization to use two-way radiotelephone equipment, and applications for thousands of additional units are rapidly being processed by the Federal Communications Commission. Largest grant went to a fleet of 1600 cabs operating in San Francisco and Los Angeles. Many users are reporting that the radio equipment pays for itself in less than a year in cutting down idle cruising time in the larger cities and in providing better, cheaper service in smaller communities doing a telephone rather than pickup business. Customers no longer have to pay meter charges on the run from the taxi terminal to their homes, as the radio dispatcher is generally able to find an idle cab within a few blocks of the customer; and the resulting lower charges have greatly stimulated business.

HARDENABILITY

A Revolutionary Basis for Steel Specifications

By FRED P. PETERS
Editor-in-Chief, *Materials & Methods*

THIS IS the story of a mere technical trend that is becoming a revolution—of a concept of steel metallurgy whose commercial exploitation by industry as a whole is completely changing the basis on which the giant steel industry does business with the rest of American industry.

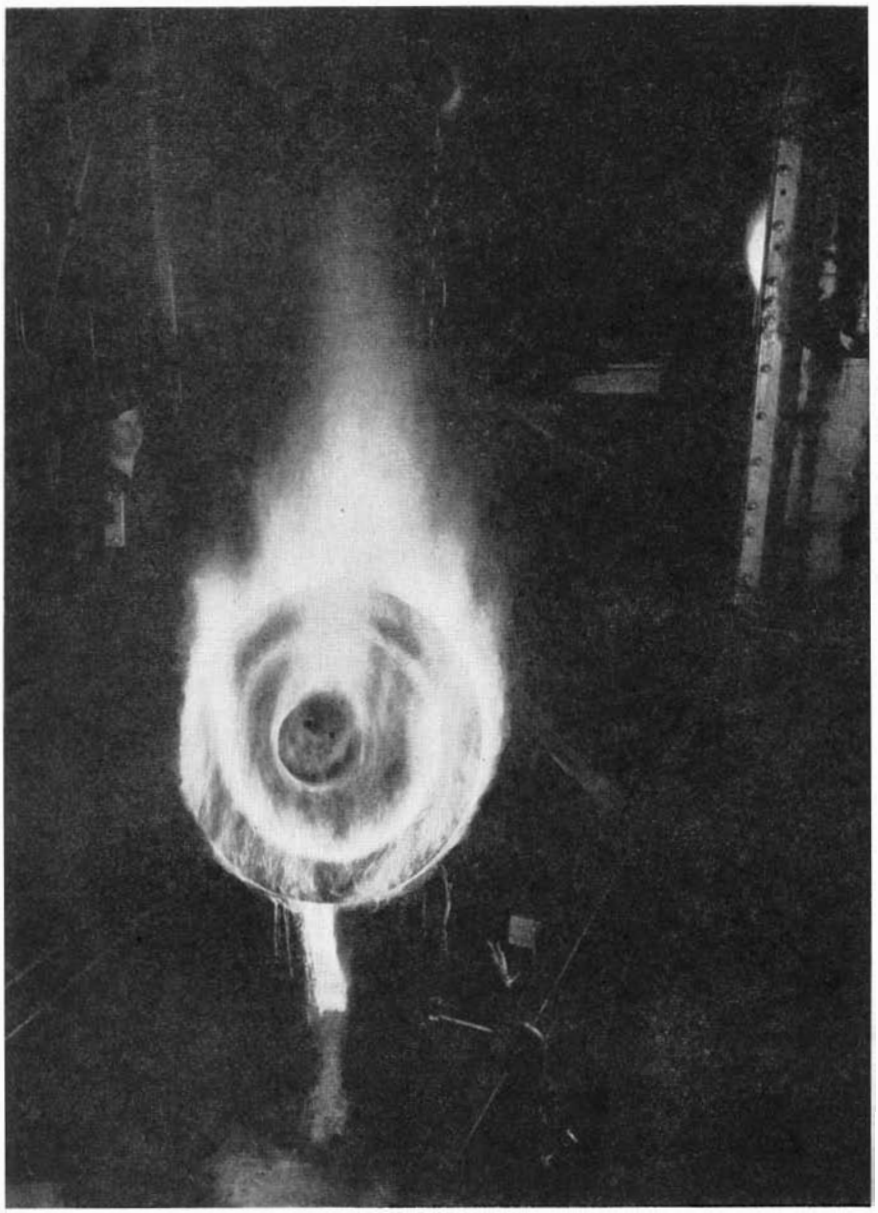
The concept is the "hardenability" of steel or, more significantly, the different hardenabilities of different steels. The revolution is the growing practice of selecting and specifying steels on the basis of their hardenabilities, replacing the time-honored procedure of ordering steels to a specified standard composition. It is of great importance commercially, because it is saving mass-production industries like the automobile manufacturers thousands of dollars annually on heat treating, inspection, and other production costs, while permitting the steel industry also to save much money previously spent in "adjusting" steel compositions during manufacture, so that the traditional "chemical analysis" specifications of the customer could be matched.

As a commercial situation, hardenability has evolved its own somewhat hieroglyphic terminology, including "H" steels, end-quench tests, Jominy bars, hardenability "bands," and so on. These are not nearly so formidable as they sound and should not be allowed to remain a barrier to the understanding and use of hardenability specifications by the people who can benefit most from them.

For approximately half a century, chemical analysis has been the chief basis by which steels were graded, bought, and sold. A steel user would decide that he required a medium-carbon, non-alloy steel for his product, and would then proceed to order so many tons of that standard steel whose composition seemed closest to giving him the properties he desired. For example, he might have decided that this was S.A.E. 1040 and when his steel was delivered, it

Courtesy Joseph T. Ryerson and Son, Inc.

Quenching a Jominy hardenability test sample. The quenching fixture is located close to the furnace (extreme right) to keep heat losses as low as possible while the specimens are being transferred from the furnace to the quench bath during the course of the test



Courtesy American Rolling Mill Company

In parts which must undergo heat treatment, such as this steel wheel shown receiving a full oil quench, hardenability is a factor of considerable importance

• LOOKING AHEAD •

Money, time, and temper saved by assuring that material has correct properties for the job . . . Adjusting composition during manufacture . . . Inspections and re-heat treatments by the fabricator greatly reduced . . . Steel performance rather than precise composition finding ever-increasing favor.

would indeed be found to contain between 0.37 and 0.44 percent carbon, 0.60 and 0.90 percent manganese, and so on, as set forth in the S.A.E. specification under which he ordered it.

AIDED MASS-PRODUCTION—The use of these standard specifications was a boon to industry, since it permitted the steel industry to mass-produce, at consequently lower cost to their customers, a relatively small number of standard steels. These steels, thus standardized, covered most of the requirements of the steel-using industries, which in turn were sure not only of receiving without undue delay whatever amounts they needed of them, but also that they would be reproducible from lot to lot or order to order. The steel mills employed thousands of chemists simply to make check analyses of heats of steel both during and at the completion of manufacture, and many of their customers also made chemical analyses of the steel on delivery, to be sure the steel fell within the specification.

The number of steels coming under the standard steel specification system steadily increased, particularly in conjunction with the spectacular expansion of the automotive and aircraft manufacturing industries. At the same time, these fields were coming to place ever greater dependence on *alloy* steels, for alloy steels as a group possess greater *hardenability* than carbon steels. (Hardenability should not be confused with hardness; hardenability in the sense in which metallurgists and the steel industry use it means not *how hard* a steel will become on heat treatment, but rather *how deeply* the full hardening effect will penetrate large-size pieces and parts under normal heat treatment.) Steels of high hardenability were required for heavily stressed engine and transmission parts because such parts were large in section, and needed their maximum heat-treated properties throughout the section—not just near the surface; alloy steels, being higher in hardenability, gave this extra depth of hardening in oil-quenching treatments, without resorting to the drastic practice of water-quenching, which in large parts may cause cracking and distortion.

Since this characteristic of extra hardenability was one of the chief factors in the selection and application of constructional steels for engine and machinery parts, it was natural that metallurgists should begin to make intensive studies of hardenability, and especially as it is related to (1) the chemical compositions of steel, the traditional basis for their specification, and (2) other properties, such as tensile strength, ductility, and so on. They found that (a) hardenability is very closely related to the exact, accurately determined composition (including elements present in "trace" amounts), (b) it is, however, considerably affected also by such non-chemical factors as grain size of the steel as seen under the microscope, method of deoxidation during manufacture, and so on, (c) it is only loosely related to the composition ranges provided in the standard steel specifications, and (d) changes in hardenability generally run parallel to changes in other mechanical properties for a given type of steel.

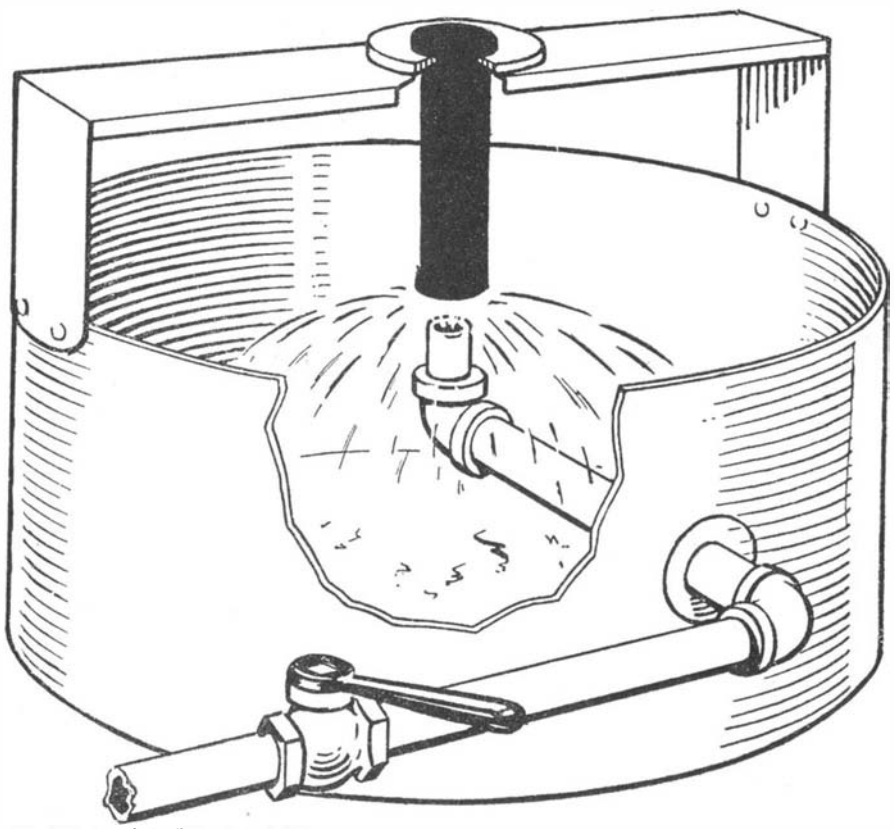
METHOD INADEQUATE—On this basis, therefore, it was becoming clear that the most important factor in the selection of machinery steels was only inadequately reflected in the chemical composition method by which they were traditionally specified. Out in the auto and tractor and aircraft engine plants, these inadequacies of the traditional system were bing felt in very practical and

painful ways. Of several lots of the same steel that successfully fell within the composition range of the covering specification, some lots would have much higher hardenability than others; and the hardenability of a few batches might even be so far out of line as to make them unsuitable for processing in the automatic, production-line heat treating set-ups increasingly used. Steel users therefore began to demand narrower composition ranges in the specs or asked for special grades to meet their own hardenability requirements, and the steel makers' costs began to rise in proportion.

Then almost simultaneously several people perceived that the error lay in the basis for the standard specifications, and that if the steel maker were given plenty of latitude with respect to composition so long as he delivered steel within a narrow specified *hardenability* range, practically everybody would be happy. Thus were born the so-called "H" steel specifications of the American Iron and Steel Institute and the Society of Automotive Engineers; specifications which are the official culmination to date of the trend toward use of hardenability as the prime factor in choosing constructional steels.

At present the "H" steel specifications cover a relatively small group of steels. For each of these, a broader chemical composition range than the conventional specification is provided and a hardenability range or "hardenability band" becomes the specifying factor. These bands enable the user to specify minimum and maximum limits of hardenability for a given type of steel, so that he may have better control of hardness variations from lot to lot, and a minimum or an elimination of re-heat-treatments in production. In ordering his steel, the user simply orders, for example, so many tons of 8620H, instead of just 8620 and specifies the hardenability requirements it must meet. When he receives it, the steel will be uniformly within the hardenability range or band for 8620H but may be inside or just outside the composition range of the standard 8620 chemical composition specification.

Testing hardenability of steel has thus become virtually as important as determining its chemical analysis has been to both steel makers and steel users for the past several decades. Indeed, the hardenability test has already taken its place beside the hardness tester (Rockwell, Brinell, and so on) and the metallurgical microscope as the most important means of evaluating steels for production, acceptance checking, or research. Thousands of hardenability tests are now made in this country every month, and there is accumulating a vast body of data on the hardenability of individual steels which will without question be used in extending the "H" type of specification to many other steels in addition to the few now covered by them.



Courtesy Joseph T. Ryerson and Son, Inc.

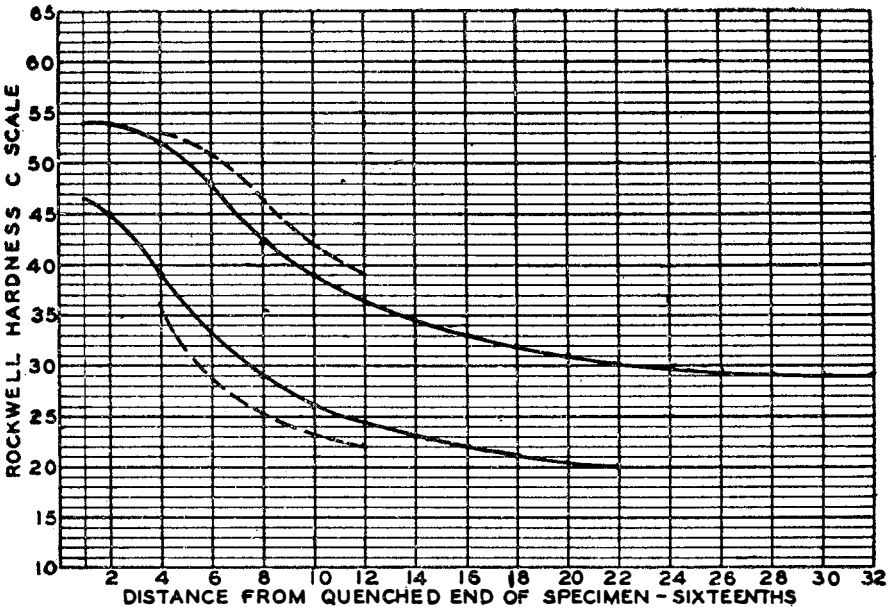
Schematic diagram of the quenching fixture used in conducting a Jominy test

HOW STEEL IS TESTED — These tests are all made by a standard procedure, called the "end-quench" test, developed a few years ago by two General Motors metallurgists, Jominy and Boegehold. The test consists of water-quenching one end of a properly heated standard flanged one-inch diameter bar of the steel in question (often called a Jominy bar) and measuring how far from the quenched end the steel is fully hardened. In addition to providing a means of checking or comparing the depth-hardening characteristics of different lots of steel, the Jominy test gives much other useful information about the heat-treated properties of an individual steel—the maximum hardness that it could probably achieve under the most favorable hardening conditions, the mechanical properties it will develop under those same conditions, and so on. At the present time, it is easily the best all around test for evaluating steels on a probable performance basis available to industry.

From all over the country and from steel users in several industries have come reports of better quality, fewer rejects, and lower operating costs because of attention to the hardenability of the steel used, and especially through the use of the new 'H' steel specifications. One large producer of agricultural equipment, for example, states:

"Before going to the 'H' steels, we accumulated considerable data on the alloy steels which were being supplied to us on a chemistry specification. We were able to work up hardenability bands to cover all the steels that had been supplied to us over a period of time. We were then able to sell our engineering department on the proposition of changing our specifications to permit the wider chemistry that would, in turn, enable us to secure narrower ranges of hardenability and better production control. We have continued making hardenability tests on each heat of steel, and we can say that every heat of steel that we have purchased on the 'H' specification has come within the specified band. We are definitely obtaining a closer range of hardenability by the use of the 'H' steels."

EXAMINATION NEEDED—The use of hardenability bands rather than straight chemical composition limits



Courtesy American Iron and Steel Institute

Hardenability band for an H steel (solid line) shows a narrower range than does the band of its counter-part (dotted line), specified by chemical composition

will impose upon the consumer of steel the necessity for examining each steel part made in his shop, determining the hardnesses of critical areas of those parts, and comparing them with the hardnesses shown on the end-quench test curve for the same steel. In spite of the seeming complexity of this job, it is one that can be done without elaborate equipment, and which will pay substantial dividends to the men or companies who adopt the idea and carry it out faithfully.

On his part, the steel maker, by obtaining wider leeway in the specified percentages of carbon, manganese, nickel, and chromium, can deliver a steel more closely controlled as to its really important physical properties than he could under the chemical composition method of specifying. The reason for this apparent anomaly is the fact that he can balance his composition, as a result of test analyses run while the steel is still molten and before it is poured, to bring the steel within the desired hardenability range. He could not do this if he had to be sure to stay within a narrow composition range.

Within a relatively short period, as a result of joint committee activity of the American Iron and Steel Institute and the Society of Automotive Engineers, other important alloy steels will become the subject of "H" specifications, and eventually the hardenability bands will be formally and officially agreed upon and standardized. This will complete the first major step in transferring the selection and specification of metals and their alloys from the venerable chemical composition base to the more significant basis of performance characteristics. Metallurgists with an eye on the future say other materials and other properties are sure to follow along this progressive path.

CARBIDE GUIDE-REST

Lasts Eight Times as Long as Cast Iron Piece

CEMENTED carbides, well established in use for cutting tools and wire-drawing dies, are rapidly invading the field of hard, wear-resistant parts and machine components.

For example, a New England machine-tool builder recently reported rapid wear on the cast iron guide-rest in a circular die roll threader, caused by the rotation of hard steel blanks during the roll threading operation. Wear was so severe that the guide-rest had to be reground to the required flatness after each lot of 9000 pieces.

In an effort to eliminate excessive regrinding and setup time, the guide-rest was tipped with Carboloy cemented carbide. Production between regrinds rose to an average of 74,000 pieces. Moreover, each regrind of the guide-rest required the removal of only 0.001 inch of carbide.

The problem of marring of the guide-rest surface by scored threads was eliminated, the carbide guide-rest surface being so hard that scored surfaces of threads were not reproduced on it.

SPRING MATERIAL

Is Resistant To "Set" and Corrosion

DEVELOPED for use in mainsprings of watches, a new alloy is a cobalt-base product, containing 40 percent cobalt, 20 chromium, 15.5 nickel, 15 iron, 7 molybdenum, 2 manganese, 0.15 carbon, and 0.03 berryllium. Tests have shown watch springs made of this alloy, called Elgiloy, to have several times the life of ordinary carbon steel mainsprings, not only because of greater strength and resistance to "set," but also because of its exceptional corrosion resistance. They are for all practical purposes unattacked by even corrosive atmospheres—atmospheres that "eat up" a carbon steel spring in a matter of months.

The new alloy is surprisingly easy to fabricate, either hot or cold, and does not require quench-and-temper heat treatment as does carbon steel. The Elgin National Watch Company, who developed the material, have used it in mainsprings for nearly a year without a single failure. Studies are currently underway on other applications for the material in various high-temperature uses such as in jet engine parts.

ELECTROSTATIC PAINTING

Proves Economical On Large Scale

ELECTROSTATIC spraying, widely used during the war for rapid application of paint finishes on small parts, is now increasingly used for larger units. Typical of the latest of these large-scale systems is the mechanized installation for electrostatically spraying steel wall panels, about 93 inches high and 24 inches wide, with attractive finishing coats at the Martin-Parry Corporation.

The success achieved is represented by Martin-Parry's comparative figures. With ordinary spraying, 60 gallons of paint was required to coat about 500 panels. After adopting the electrostatic spraying method, the same quantity of paint would suffice for 944 panels. An overall saving of more than one third was reported in the quantities of mixed paint used. Labor costs have gone down, too. Whereas 21 men were needed to operate the previous system, the present force consists of only eight men, turning out 25 percent more production. Floor space needed for the present system is one third less than that previously required.

WHERE DO Plastics GO FROM HERE?

Present Suppliers of Coal-Derived Chemicals Cannot Keep Pace With the Combined Requirements of the Rapidly Expanding Plastics Industry and With Other Equally Fast-Growing Non-Plastics Markets. As A Result of This Fact, Are the Present Ambitious Plans for Plastics in the Coming Year Doomed to Only Partial Fulfillment?

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

IS THERE a ceiling on plastics expansion? As far as end products are concerned, there was the feeling, until the very recent past, that everything and anything could be made of plastics. Fortunately, this "Plastics World" idea is gradually being abandoned as the industry gains more and more experience in just what can and cannot be done with these materials. Some applications have been discarded entirely because they represent uses in which plastics can, at best, be only substitutes. But just as fast as these poor applications have been weeded out, they have been replaced—more than replaced, in fact—by new outlets in which plastics meet the operating conditions better than do other materials. In many instances, plastics have created applications for themselves, applications which were unthought of before the arrival of plastics with their unique characteristics.

A somewhat similar misconception has existed—and still exists—regarding the basic materials from which plastics are produced. It has been assumed that since the chemicals on which plastics production depends are derived from such abundant materials as air, water, and coal, the supply is virtually unlimited. A common impression is that the chemist dumps coal into a hopper and, by some miraculous transmutation, extracts plastics at the other end of the machine. The fact that these natural materials can not be used directly for the processing of plastics is entirely overlooked. Actually, only a small fraction of the coal mined is of use for plastics production and the dollar value of the chemicals derived is only a fraction of the total cost of the coal. It is obvious, then, that because of these economic factors, the derivation of coal chemicals for use in producing plastics materials must be secondary to other uses of coal. Thus we have the strange situation of the great plastics industry depending on the by-products of other industries for its essential supplies.

Today it is the steel industry that provides most of the basic chemicals for plastics materials. The greatest sources are the coal tars and light oils that are by-products of the coking process; and the steel plants are, of course, the major producers and users of coke, although a small amount comes from artificial gas producers. These tars and light oils can be refined to obtain such coal chemicals as benzol, phenol, cresylic acid, and naphthalene. Simple dependence on the steel industry would be bad enough, but there are other complicating factors; plastics processors, for example, are not the only bidders for the available supply of chemical-laden tars and oils.

The ceiling on plastics production depends, then, on the following factors: 1. The total amount of coal chemicals available from present sources. 2. The relative proportion of these materials that plastics can expect to obtain in a competitive market. 3. The development of new sources for the necessary base chemicals.

In an expanding economy that sees an increasing demand for plastics products, it is reasonable to assume that there will be a concomitant increase in the demand for steel. This would be fortunate, for the expansion of steel production would increase the supply of coal chemicals. The situation is beclouded, however, by the fact that the chemical supply does not increase in direct ratio to steel production. An accompanying chart shows the relationship between steel ingot production on the one hand, and coal tar and benzol (one of the chief chemical derivatives of light oil) on the other. While steel production was increased during the war by 50 percent over its pre-war high, coal tar production went up less than 30 percent.

WHY TAR IS SHORT—Authorities offer a number of explanations for this situation. Among the reasons is the faster-than-normal operation of coke ovens due to heavy demands

Year	Steel Ingot	Coal Tar From Coke	Benzol[1]
	tons	gal.	gal.
1937	57,000,000	603,000,000	
1944	89,000,000	772,000,000	178,000,000
1945	80,000,000	696,000,000	156,000,000
1946	66,000,000	600,000,000	135,000,000

[1]Not including motor grade

Steel production compared with coal tar and benzol outputs

for steel, for fast operations reduces the amount of coal chemicals obtained. Then, too, coke ovens are worn out from excessive operation which, in turn, has decreased the yield of coal chemicals. Use of poorer quality coal for coking also results in a lowering of the average number of gallons of coal chemicals obtained per ton of coal. (The average for good coal is eight gallons with the quantity ranging from six to 12 gallons, depending upon the volatile matter of coal.) Perhaps the greatest single factor contributing to the lower ratio for coal derivatives is the use of bee-hive coke ovens for a portion of the coke needed when demand for steel is above normal requirements. No chemicals are recovered from these ovens.

Many of these factors were, of course, the products of war-time emergency measures. It can be anticipated, for example, that the ratio of coal tar produced per ton of coke may increase slightly when new ovens come in and slower coking is again practiced. That increase, however, may be offset by new processes using oxygen in blast furnaces, which will decrease the total amount of coke required for steel production.

The second possibility for raising the ceiling of plastics production would be the purchase of a greater proportion of the total coal chemical supply for plastics processing. This may develop into a monumental economic struggle, because many other industries have an equally urgent need for coal chemicals. Even considerations of national defense and international politics enter the picture.

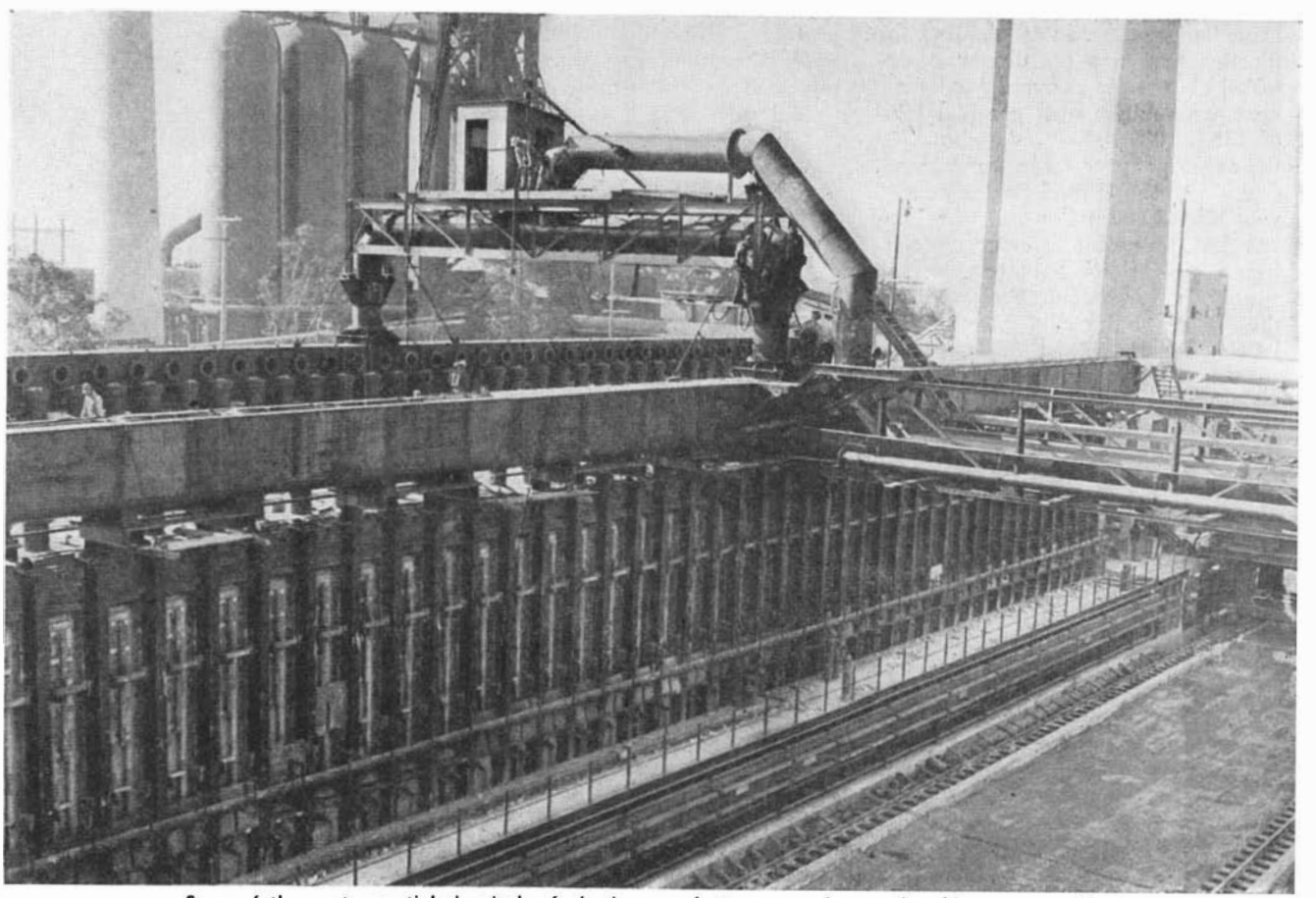
While it isn't feasible in this limited space to discuss all the chemicals derived from coking, the general situation should be clear from a consideration of the competition for one major chemical—benzol.

BENZOL WIDELY NEEDED—Benzol has many important uses within the plastics industry, being a necessary ingredient of polystyrene and of phenol.

Polystyrene is an increasingly popular plastics which has expanded phenomenally from a production of 750,000 pounds in 1939 to 60,000,000 pounds in 1946, and is expected to reach 200,000,000 pounds annually by 1948—a production that would account for 35,000,000 gallons of benzol. Because of its low price and its low specific gravity, it is popular for such applications as interior refrigerator parts, household equipment, toys, containers, and so on. Formulations can be built that have special characteristics such as high heat resistance, high-frequency dielectric qualities, and great flexibility. It has possibilities for impregnating, bonding, and laminating, for coatings of all types, and for adhesives and extrusions. As a foamed or fibrous substance, it has been suggested as an insulation material.

Phenol is perhaps the most familiar of all the plastics—the established material for housings of business and adding machines, many telephone sets, radio set housings, and innumerable other articles in common use. Phenolics always have accounted for a large percentage of plastics business and, though recently other materials have attained a slightly greater volume, the demand for phenol is still expanding. Part of this is due to a trend toward heavier and larger molded pieces, coupled with doubled or tripled processing speed attributable to the greater use of electronic preheating and plunger molding. Thus, phenolic production rose from 65,000,000 pounds in 1939 to 140,000,000 pounds in 1946, with a predicted level of 170,000,000 pounds in the current year—a production requiring 20,000,000 gallons of benzol.

NON-PLASTICS COMPETE—Competing with polystyrene and phenol for the limited benzol supply are such non-plastics markets as syn-



Some of the most essential chemicals of plastics manufacture come from such coking ovens as these

thetic rubber, dyes, medicinals, rubber, camphor, detergents, insecticides (D.D.T.), and other products.

The synthetic-rubber industry grew to spectacular size during the war to supply the requirements of a nation and military machine cut off from its supply of natural rubber. With the re-opening of trade with the East Indies and Southeast Asia, it was natural that production of synthetics should decline sharply. Still, in 1946, more than 600,000 tons of GR-S rubber were manufactured in this country. Two factors militate against a much greater decline: First, the improved quality and decreased price of the synthetic product have given it a good competitive position with regard to natural rubber. Second, and most important, the synthetic rubber industry is an important element in the defense program. With China, Indo-China, and India in ferment, and with international tension still high throughout the world, it is unlikely that the United States will allow too large a segment of this essential industry to fall into disuse. If production is maintained at a level of 500,000 tons, the benzol requirement will be 43,750,000 gallons.

It is estimated that the dye industry can use 20,000,000 gallons of benzol if it is available. Another 20,000,000 gallons would find a ready market in detergents, D.D.T., and miscellaneous products. Adding the plastics and non-plastics uses detailed above, the demand for benzol next year might well reach a total of 138,750,000 gallons. As shown in the accompanying table, benzol production in the United States in 1946 was 135,000,000 gallons. It is apparent that the nation is fast approaching a precarious balance between supply and demand. Expansion of the using industries beyond the levels anticipated in the near future would be impossible without an increase in the supply of benzol.

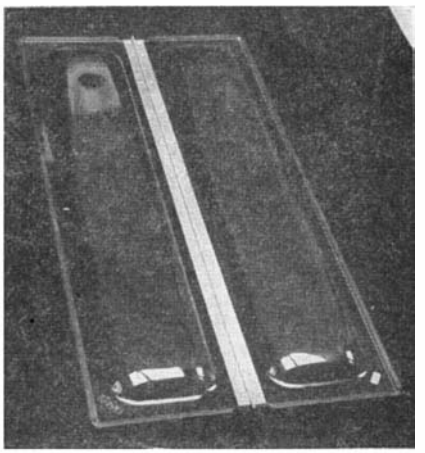
It is believed that a considerable quantity of benzol could be obtained at a price slightly above the prevailing level by scrubbing coal gas more thoroughly and further refining the better grades of motor benzol for recovery of chemical grade benzol.

BENZOL AND TOLUENE—Petroleum offers another possible source, since benzol can be obtained at the same time as toluene in the petroleum cracking process. Toluene was obtained from petroleum in great quantities during the war, but it was not seen fit to take out the benzol at that time. So far, there has been no great enthusiasm shown by the oil companies for the development of benzol production, but it is believed that experimental work has been carried on to a point where production could be undertaken within a reasonably short time if the oil companies were assured of a permanent future market at a price higher than that now prevailing.

Little is known about the development of the natural gas process for obtaining benzol or phenol, but it might not be too bad a gamble to wager that, when coal-processed benzol falls too far short of filling demand, natural gas may become the provider. A limiting factor is the possible future exhaustion of natural-gas supplies.

There is always the possibility that plastics materials producers will find other source materials to use in place of, or to supplement, benzol. Finally, work on extenders may develop to a point where much less phenol is required. Most companies have been furnishing extended phenol compounds over the past few months to conserve their phenol supply, and it is possible that this practice will continue indefinitely with the extended resins selling at a lower price.

Although the plastics industry is by no means doomed to a stunted growth by the lack of raw materials, it is about to venture into new and uncharted territory. The next year or two will be the critical period, while the industry approaches the limits of existing supplies and potential new suppliers of basic materials wait to see the extent of demand and the stabilized price level.



Two plastics lids hinged together

10 pounds of groceries, even when this weight was placed at the very center of the lid—the weakest section. The second advantage of acrylic was that it fogged only slightly around the edges when formed into the domed shape desired. Then, too, the acrylic has the dimensional stability necessary for this application and is easily cleaned.

ACRYLIC LIDS

Provide Strong Tops For Merchandise Cabinets

A WHOLE NEW field of possible plastics applications is opened up by the transparent acrylic lids that are now being used on the Biltwel frozen food cabinets made by Fraser and Johnston Manufacturing Company.

The purpose behind the development of these lids was better merchandising. The freezer company wanted some type of covering that would invite the shopper to reach into the cabinets for frozen peas, strawberries, corn, and so forth. Acrylic material was finally selected in preference to glass for a number of reasons.

In the first place, acrylic lids, drawn from 3/16 inch Lucite by K-Plastix, are strong enough to support a shopping bag filled with over

DISPLAY BOTTLE

Made of Acrylic, Is Light-Weight, Resists Breakage

TYPICAL of the wider use that is beginning to be made of plastics in large-scale displays is a Royal Crown Cola display shaped like a bottle. The bottle is fabricated by

Large . . . but light and strong

Arnold Plastic Company of one-quarter inch acrylic, and is processed on the inside with decals to simulate a label. The cap is also of acrylic, opaque material in this instance.

Diesel Power Comes of Age

By N. C. DEZENDORF
Director of Sales and Service, Electro-Motive Division of General Motors Corporation

Now That Many of the Factors Which Formerly Militated Against Its Wider Application Have Been Overcome by New Refinements, the Diesel Engine Appears to be Ready to Realize its Fullest Potentialities

• LOOKING AHEAD •

The railroads' complete abandonment of steam for Diesel power just over the horizon . . . Diesels used in many fields from which their former size and weight per horsepower have long barred them . . . Diesel-powered passenger automobiles more than an engineer's day-dream . . . Competitive balance restored to transportation.

THE DIESEL engine today is on the threshold of achieving many of the objectives its enthusiasts have been claiming for it during the past 40 years. This is the opinion of Charles F. Kettering, head of General Motors Research, who has been intimately associated with Diesel engine development since 1928. Events of the near past and in the making bear out this prophesy.

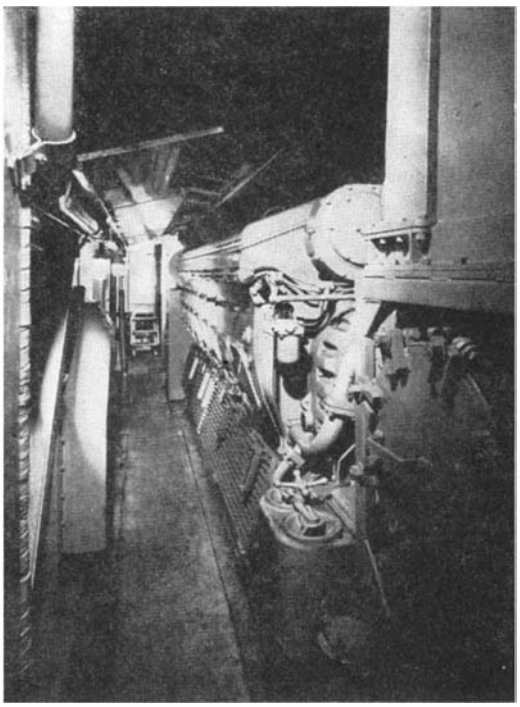
Probably no source of power, except the atom, has been given greater publicity than the Diesel engine. It is a household by-word denoting the last word in internal-combustion machines. People for years have awaited the arrival of Diesel powered automobiles while condemning the seeming slowness of manufacturers in making this development available to them. School boys who now are grandfathers were taught that the efficiency of the Diesel engine far out-distanced that of the simple steam engine by as much as 5 to 1, and even surpassed the steam turbine by from 10 percent to 50 percent depending on the type of application. Little wonder that the public gave the Diesel so much attention.

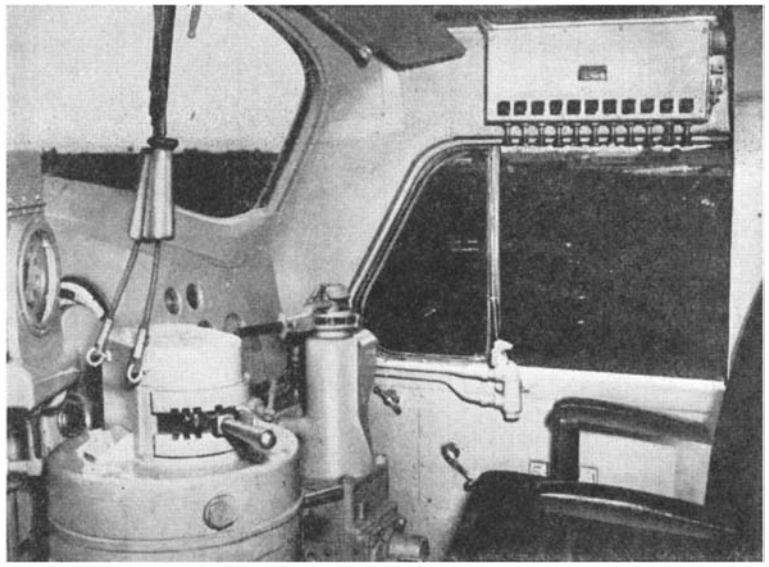
The first commercially successful American Diesel engine was built in St. Louis in 1898. It was a 60-horsepower, two-cylinder affair weighing about 300 pounds per horsepower. Dr. Rudolph Diesel had patented his engine in 1892 but did not construct a successful model until 1897. The enterprising St. Louis builder did not let any grass grow on his enthusiasm for this new source of power before he decided to do something about it. Within a few years literally hundreds of engine builders in America and Europe were applying for licenses, and were building various types of Diesel engines for specific power uses.

But with all of this publicity and the enthusiasm of so many builders, the Diesel engine was able to achieve only limited application. Two barriers prevented the widespread use of this efficient power plant—weight and cost. These barriers presented a challenge to engineers and engine manufacturers for many years, a challenge which has only recently been met. Until the last 15 years, the predominant uses of the Diesel engine were in stationary power plants—such as pumping stations, electric power generation, and mill operation—and for marine purposes. These applications were characterized by slow engine speeds and constant loads. Given these conditions, many Diesel engines had established noteworthy records of economy and reliability. The barrier of weight, and with it, size in higher horsepower ranges, prevented its application to most mobile uses. Engines of 200 pounds per horsepower were

All illustrations courtesy General Motors Corporation

Diesel locomotives are now in the mass-production stage





Engineer's cab of a Diesel locomotive (above) is clean and comfortable. Engine room with 1500 horsepower Diesel engine (left)

common in these applications. A 600-horsepower Diesel engine would weigh about 60 tons.

SOUGHT IMPROVEMENTS — In 1928, Mr. Kettering set out to do something about the improvement of the Diesel engine. Development work by the General Motors Research Division under his direction resulted finally in the production of a two-cycle engine with many new features. The first two engines of this design, each rated at 600 horsepower, were placed on exhibition at the Chicago World's Fair in 1933. The importance of this development can best be illustrated by the fact that the weight of this new Diesel was reduced over 80 percent and size over 75 percent from contemporary engines of comparable horsepower. In addition, the new engine possessed characteristics which adapted it to varying loads and engine speeds. In other words, it was made to order for mobile applications, with weight characteristics of less than 20 pounds per horsepower.

There still remains the barrier of cost. The Diesel engine, even the two-cycle, 20 pounds per horsepower engine, is an expensive engine to build. We are accustomed to hearing gasoline engines referred to as "high-compression" engines and it is true that the compression ratio of gasoline engines has been gradually increased in the interest of greater economy and better performance. Yet a high-compression gasoline engine has a ratio of only 6 to 1 in comparison with 16 to 1 for the average Diesel. In other words, the Diesel engine must be built to withstand more than three times the cylinder pressure of the gasoline engine. This means larger bearings, heavier crankshafts, stronger metals, and more accurate machining to finer tolerances. Fuel injectors are more costly than carburetors. Hence, modern Diesel engines may cost several times the amount of gasoline engines of comparable horsepower. This limits the application of them to uses where fuel and maintenance economies can offset higher first costs. In general, Diesel engines of modern design are finding their best mobile applications in heavy-duty trucks, tractors, buses, boats, and railroad locomotives. Today, the Diesel engine is rapidly becoming the heavy-duty work horse of America.

ON HIGHWAYS — Unfortunately, the statistics available concerning the number of Diesel-powered vehicles in operation are meager. However, the growth of Diesel-powered trucks, tractors, and buses has accelerated during recent years. In 1938, only one truck in every 10,000 was Diesel powered. By 1941, it had increased to one in every 1000. Today there are two to every 1000 and the proportion will increase as full-scale production is reached. It is a safe prediction that the majority of heavy duty, long-distance trucks will be Diesel-powered as quickly as they are made available by the manufacturers.

Tractor statistics are almost nonexistent. A survey made by the United States Public Roads Administration in 1941 showed 3200 Diesel powered tractors in operation out of a total of 121,000. In recent years, nearly all of the tractors used in heavy construction and road building have been Diesel powered.

There are some 80,000 buses licensed in the United States and the number has remained fairly constant since 1938. During that time the proportion of them powered by Diesel engines has grown from ¼ of 1 percent in 1938 to 2 percent in 1941 to 10 percent in 1946. A large proportion of street buses in metropolitan cities and the long distance inter-city buses are Diesel powered today and the trend will continue.

AFLOAT — Use of Diesel engines in the marine field expanded so rapidly during World War II that by the end of hostilities the United States Navy had more Diesel horsepower in operation than steam. Most of this Diesel horsepower was in the smaller, more agile boats such as tow boats, landing craft, submarines, sub-chasers, destroyer escorts, and destroyers. It is a little-known fact that the advent of the General Motors Diesel engine in 1933 freed the submarines of the United States Navy of dependence upon a Diesel engine made under German patents, and that this new engine was so much smaller and lighter than the European engines that it immediately doubled the range of the American submarine. Because so much more space and weight could be devoted to fuel, we actually had submarines in World War II that could go from Seattle to Tokyo and return without refueling.

Development of the so-called high-speed Diesel, operating at speeds up to 2000 revolutions per minute in the smaller landing craft and up to 800 revolutions per minute in the engines for the larger boats such as submarines, LST's, and destroyers, hastened the marine application.

The Navy experience has resulted

in a distinct trend toward Dieselization not only of smaller commercial craft but also of larger boats. Freighters of 5000 tons are being repowered with groups of Diesel engines driving generators which supply electric current to motors that operate the propellers. There is a strong trend toward Diesel engines for river towing and pushing craft because of their greater speed and economy.

ON THE RAILS — The most spectacular results from the application of Diesel power have occurred in the railroad industry. The growing fleets of Diesel-powered passenger trains such as the Zephyrs, the Twentieth Century Limiteds, the Super Chiefs, the Cities of Los Angeles, San Francisco, and Portland, the Rockets, the Capitol and National Limiteds, the 400's, and more than 150 other trains in daily service throughout the country have operated at capacity while establishing enviable records of clean, on-time performance, unequalled in railroad history.

In the transcontinental field, the Diesel-powered Santa Fe and Union Pacific premier trains were the first to reduce schedules from 56 hours to 39¾ hours. These trains have operated continuously since 1938 with hardly a vacant seat. The Great Northern has just Dieselized its daily Empire Builder between Chicago and Seattle, and in the East, the B and O offered the first all-Diesel trains from Chicago to Washington and New York in 1936. Since then, the 20th Century Limited has been powered by Diesels which have rolled up more than one million miles in the past 19 months of operation. In the South, the Seaboard, the Atlantic Coast Line, the Florida East Coast, the Southern, and the L and N have all swung to Diesels for passenger train operation.

As spectacular as some of these applications of Diesel power to railroad service have been, even greater results are to be expected in the near future. During 1947 it is planned that every principal through passenger train between Chicago and the Pacific Coast will be Dieselized with further reduction in scheduled time and with much more frequent service. In the East, both the New York Central and the Pennsylvania have announced the order of sufficient Diesel equipment to Dieselize all of their first-class through passenger trains between New York and Chicago and St. Louis. Many of these trains will be Diesel-powered during 1947. In the Southwest, the Missouri Pacific is expanding its Diesel fleet and will improve schedules of both passenger and symbol freight trains. The M.K.T. and the Texas and Pacific also will receive new mainline Diesel power. The Cotton Belt and the Kansas City Southern intend to amplify their Diesel equipment and improve their services.

STEAM ELIMINATED — But the most dramatic development—and the one fraught with the most significant and far-reaching possibilities—concerns plans for 100 percent Dieselization. During the past year the Electro-Motive Division has been invited to co-operate with ten important railroads in the preparation of studies to Dieselize all or important sections of their lines. Some of these studies are so well advanced and have been so well received by railroad managements that the eventual carrying out of them is already assured.

While the benefits of Diesel power to the traffic man and shipper are already apparent, the eventual complete Dieselization of important railroads will bring a few more surprises. The economies possible from the complete elimination of steam facilities are so great that railroads, which have found it difficult, if not impossible, to stay solvent whenever traffic falls off over a protracted period of time, will be able to withstand much more severe traffic fluctuations and still remain healthy. In favorable years, sufficient earnings will be available to undertake badly needed improvements to plant and equipment, and thus improve services in the interest of shippers and the travelling public. No medium of transportation can maintain its position successfully against new forms of competition if it lacks the earning power to modernize its equipment and promote its services to the maximum. The shift in traffic which occurred from the railroads to trucks and buses was caused as much by neglect on the part of the railroads in matching the services offered by these new forms of transportation as by the subsidies in highway construction which are usually blamed for it.

The rapid expansion of airplane usage occurred at a time when the railroads were confronted with financial problems of the first magnitude. Many were in bankruptcy or receivership. They were therefore prevented from matching many of the improvements in service—aside from speed alone—which attracted both travellers and shippers. As a result, much traffic was diverted to airlines, in addition to that which would have been attracted naturally by the faster speed at higher cost.

The Diesel passenger, freight, and switching locomotives have proved themselves to be the most effective tools ever offered railroad managements for modernizing their services and for restoring the competitive balance against other forms of transportation in favor of the railroads. The rapid increase in the use of this power has resulted from the demonstration of its ability both to improve services and to reduce operating costs. These demonstrations up to now have been limited to direct operating economies while maintaining all of the expensive steam facilities.

No tool—no matter how efficient or how superior to other tools—will by itself bring about great changes or improvements in methods. Man is a creature of habit. It takes a long time to make him fully alive to the potentialities of a new tool. A steam man is slow to become a Diesel man.

The Diesel engine in its present state of development is still a new tool as applied to mobile services. How effectively management extends itself to utilize to the maximum the full potentialities of this engine will determine how rapidly the heavy-duty transportation facilities of this country are modernized and placed in a position to compete successfully with other forms of transport.

NYLON STAPLE

Can Increase Strength Of Many Fabrics

Socks that almost eliminate darning, infants' soft sweaters that can be sterilized by boiling, and upholstery with amazing wearing qualities are in prospect as a result of limited commercial production of nylon staple fiber scheduled for mid-1947. The fiber to date has been produced only experimentally. Other prospective uses are for seersuckers, sheer lawns, bedsheets, and rugs with crush-resistant pile that withstands constant foot traffic.

The new textile fiber, made of nylon in short and fuzzy lengths, for use alone or blended with other staple fibers, is expected to have a fundamental influence on the textile industry because of its unique properties. Nylon's strength is about five times that of untreated wool, its abrasion resistance about three times as great. Its stability in washing, combined with wool's resilience and resistance to wrinkling, make the

two fibers natural complements. Because nylon is non-irritating to the skin, wool-type garments of the spun fiber will be especially welcomed by people who are allergic to wool.

Blended with cotton, spun nylon contributes not only longer wear, but quicker recovery from wrinkling, faster drying, and a softer, fuller hand.

The synthetic fiber's resistance to moths and mildew are other qualities that broaden its practicality in many of the uses forecast for fashions and home furnishings.

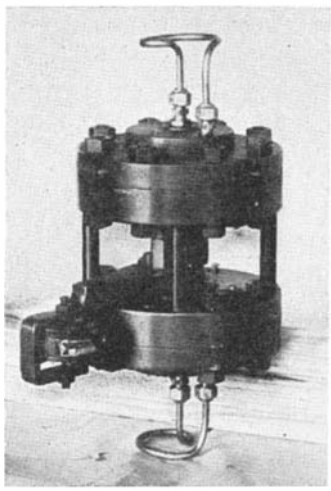
TORQUE TESTS

Aid In Bettering Motor Car Performance

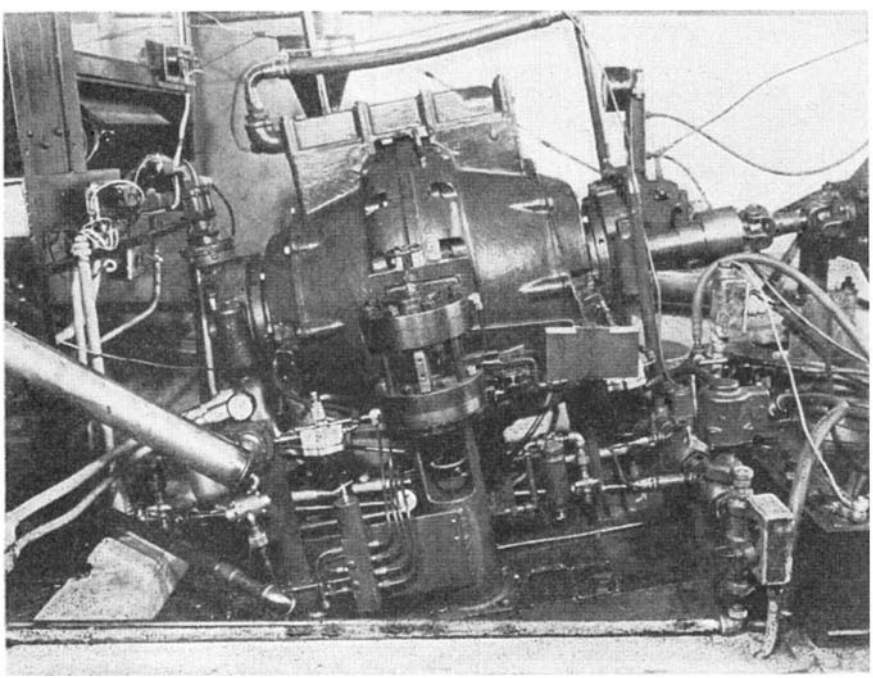
AUTOMOBILE manufacturers, anxious to improve the performance and lengthen the life of their products, are leaning more and more toward torque testing as a means of obtaining data on engines, axles. and so on. The Buick Division of the General Motors Corporation, for example, is running engines through exhaustive tests, using dynamometers and the Hagan Corporation's Thrustorq units to measure force and horsepower.

In developing this procedure, it was felt desirable to test engines at approximately the same angle at which they will operate in the finished automobile. As a result, the present dynamometer installation is tilted 10 degrees from the horizontal. This permits operation of the engine at angles up to 20 degrees without a serious angular deflection in the universal joint which transmits engine power to the dynamometer. If desired, the dynamometer could be mounted at any angle from horizontal to vertical.

Buick is using the Thrustorq for both endurance and power runs. Standard practice involves running the engine for 100 hours and then taking it off the stand. It is then completely disassembled and checked for wear. After the check-up it is again placed back on the stand and run to failure at continuous speeds well above those expected to be developed even in abnormally high-speed operation of the finished automobile. The Thrustorq, which measures force as the product of an accurately-measured air pressure acting on a precision diaphragm, has several advantages—it has no knife edges to wear, causing inaccuracy; it can be mounted in any position and at any angle, and readings from the tests can be made at any desirable remote point. Also, it can be hooked up with any reasonable number of force or torque indicators.



The highly-sensitive double Thrustorq is operated by means of compressed air



An engine dynamometer equipped with torque tester. It is inclined so engines may be tested at the same angle at which they would operate in completed cars

Two other major tests are now being planned at the Buick Division, each to be equipped with Thrustorq units. One will be in connection with a Gleason axle-testing machine. In this test, two axles will be hooked together, force being applied in opposite directions. The force applied by the Gleason machine will be measured by the Thrustorq. This test will be carried to failure of the axle. A 60 square inch Thrustorq capable of measuring torque from 200 to 185,000 pound-inches will be used.

The second major test installation will be a new chassis dynamometer testing machine. In using this machine, the car is anchored so that it cannot move; the wheels, however, turn at road speed, the resulting torque being absorbed by the dynamometer and measured on the Thrustorq.

By these various new tests, say Buick engineers, we hope to develop better carburetion, better engine design, better valves, better axles and, in general, better performance.

ELECTRONIC SPECTROGRAPH

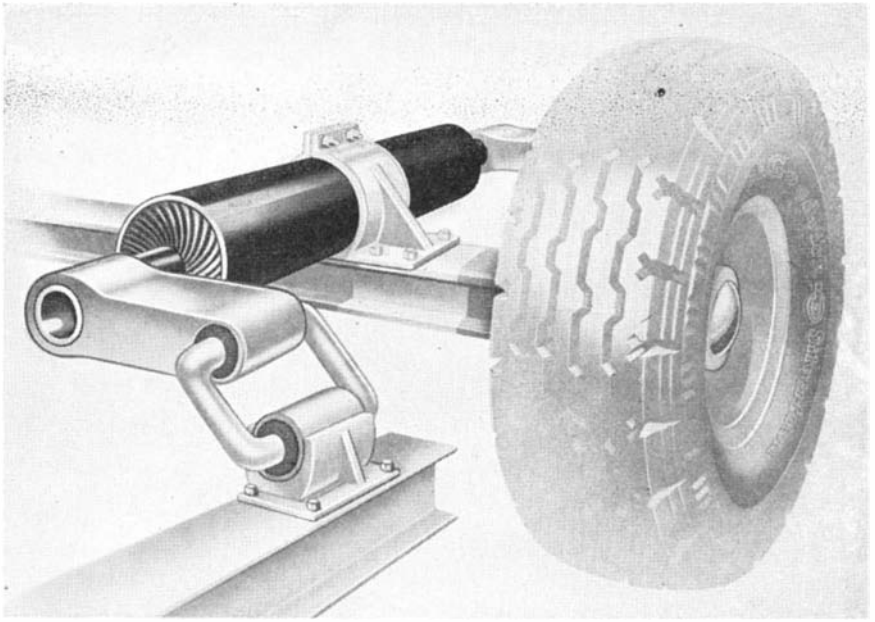
Facilitates Study of Rapid Chemical Changes

DEVELOPMENT of a cathode-ray spectrograph, which makes a continuous analysis of rapidly changing colors and permits detailed study of the chemical changes these colors reflect, was revealed recently at a meeting of the American Institute of Electrical Engineers.

The electronic instrument is expected to be valuable in jet engine and rocket research, chemical and industrial plants, radar, and television, as well as in basic scientific research.

The instrument combines a spectrograph, which breaks a ray of light into a band of color for chemical analysis, and a cathode-ray tube, which converts the color-band into a single wave-like line on a colored screen, with the pattern of the line indicating the nature of the original compound giving off the light.

It is expected to prove useful in studying optimum combustion conditions for jet engineers, particularly when it is desired to use the instrument in the small amount of space available in airborne missiles. Since the spectrograms or color bands have already been converted into electrical form by the instrument, they may be transmitted over a wire or by radio to a cathode-ray



A rubber sleeve, acting in shear between torsion bar and encasing cylinder, as shown in the simplified sketch, offers auto comfort superior to that of steel springs

screen miles away and there projected as a picture.

The instrument should find wide application in the many chemical and industrial process controls where a continuous indication is required of the state of the product being tested. For example, a reaction may be carried to the correct point, as shown by the spectrogram, and then automatically stopped. This can be done whenever the pattern on the screen reaches a predetermined shape. The indicator may, in these cases, be located in the control room of the plant, while the analyzer is in a remote location.

RUBBER SPRINGS

On Motor Vehicles Will Result in Smoother Rides

RIDING comfort of passengers in automobiles and buses can be improved with rubber springs and better suspension designs, it was demonstrated at a recent meeting of the Metropolitan Section, Society of Automotive Engineers.

Advantages of rubber over steel springs is the softer ride it gives, said A. S. Krotz, of the B. F. Goodrich Company, and R. W. Brown, of the Firestone Tire and Rubber Company. Rubber offers that "riding-on-air" feeling because it absorbs a great deal more energy than do steel springs so that the rubber suspension, not the passenger, takes the jolt of a bump on the road.

Resiliency of rubber makes this possible. It deforms under loads and then returns to its original form. Being incompressible, no amount of flexing will change its form.

Another reason why rubber looms as a leading spring material for tomorrow's passenger cars is the fact that it not only acts as the spring, but also anchors moving parts. Weight and cost of bearings and linkage—required for steel springs—are eliminated.

WOOD DECAY

Can Be Controlled, Forest Pathologist Says

POSSIBLY as much as 10 percent of the wood from all trees cut in our forests annually is used to replace wood that has decayed in service. Much of this loss can be prevented, according to studies made by Dr. Ray R. Hirt, forest pathologist of The New York State College of Forestry, Syracuse University.

Because of the shortage of well-seasoned lumber, much that is poorly seasoned is now on the market and is being used in the construction of houses and other buildings. Serious decay may result because of the high moisture content of this lumber, says Dr. Hirt.

He states that wood rot results in damage amounting to millions of dollars annually, and that this is a double economic loss because all the lumber that can possibly be cut will be needed for new construction in the next ten years to meet housing demands.

Tremendous progress was made during the war in the development of fungicides for treatment of wood, rope, and fabrics used in military equipment. By forcing these fungicides under pressure into wood, lumber may be protected for many years against decay. Pressure-treated wood is not yet available in quantity on the market. Although painting with wood preservatives is less effective than pressure treatment, nevertheless, it gives worthwhile protection if done thoroughly. Moreover, brushing preservatives on wood can be done when the timbers are being placed in service.

Not all wood preservatives can be successfully covered with paint. Among the newer preservatives for wood that can be painted over are those using copper and zinc naphthenate and chlorinated phenols as a base.

The proper use of wood preservatives in modern construction should be regular procedure among builders and contractors, says Dr. Hirt.

ETHYL ALCOHOL

From Oil Proves Purer Than Brewer's Product

BASIC ingredient for hangovers, ethyl alcohol, now being made for industrial use from petroleum gases, is shown by chemical tests to have fewer impurities than the beverage alcohol made by fermentation. The synthetic alcohol, made from waste petroleum ethylene gas, was proved by ultra-violet absorption, an extremely sensitive test, to have negligible proportions of impurities.

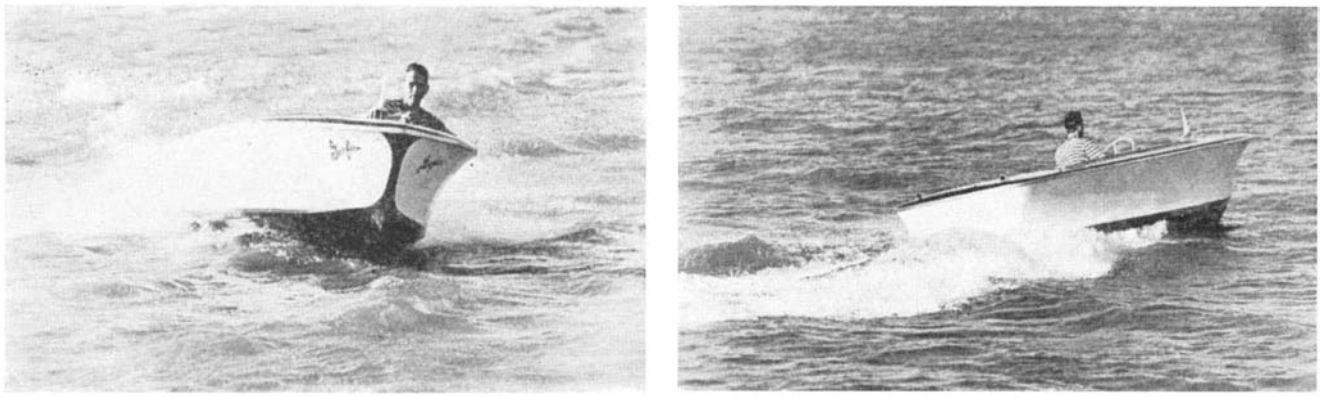
In the same report, by the Standard Oil Company of New Jersey, announcing this development, it was predicted that other sources of alcohol would be tapped in the future to meet the tremendous demand for this chemical. Within the next few years it is expected that alcohol will be made from waste liquors of paper mills, sawdust, and by the Fischer-Tropsch process.

COLOR DYNAMICS

Can Create Greater Comfort In Railway Cars

EMERGING from the realm of experimentation into that of practical engineering, the use of color dynamics is today taking its place beside reclining chairs, broad vision windows, and rubber air springs to increase the comfort of the modern railroad passenger car. Light shades of yellow, green, and blue will predominate in modern passenger car designs, but to avoid monotony different tones of these colors will be used.

The ceilings will be lightest, with slightly darker tones for the walls. Light ceilings seem to recede from the eye, giving the impression of spaciousness, which is augmented by the darker walls, designers say, but the contrast is not enough to require any appreciable adjustments of the eyes when viewed for a longer



Made in one seamless piece, the seaworthy utility craft demonstrates its maneuverability at full speed

period of time; sharply contrasting colors produce eye fatigue.

To complete the eye-level ensemble in the car, gold-tone murals or gold-tone mirrors will be placed on the walls at each end of the car, blending with any of the basic car colors. Dropping below the eye-level, stronger colors will be used because they help to set off furnishings, and being below the eye-level will not be gazed upon constantly.

Seats will be in tones of cedar or red, floors in blues, greens, or reds matching or contrasting to the predominant color scheme used in the cars, and aisles will be in mahogany bordered with cream inlays.

Through the use of color psychology it is possible to make these cars, designed by the Pullman-Standard Car Manufacturing Company, seem larger, brighter, and more restful, the designer claims, and once the passenger has selected his seat and his eyes travel to the walls and ceiling, the colors bring the comfort and cheerfulness of sunshine into the car, aiding full relaxation.

FIBERGLAS BOAT

Is Light, Inexpensive, And Easily Maintained

FOR BOATING enthusiasts of moderate income, an inboard-motor utility craft is made of a combination of Fiberglas and plastics, cured in one seamless piece. The boat is driven by a specially designed 26-horsepower marine engine light enough to be lifted with one hand. Water tests show that it is capable of speeds in excess of a mile per hour per horsepower, and is handleable and seaworthy at maximum speeds.

With a length of 16½ feet and a beam of 5½ feet, the boat will carry six adults. It weighs less than 600 pounds as compared with 1800 pounds for wooden craft of similar size, and is portable on the simplest automobile trailer. Its seamless construction, absence of pressure joints, and the fact that the color is embedded in the glass-plastics material make painting or caulking permanently unnecessary.

Spring or fall overhauls are completely eliminated. The hull is impervious to worms, the bugaboo of wood bottoms in warm waters. There is no storage problem, for drying will not cause shrinkage or resulting leaks.

Designed by Gar Wood, Jr., of the Wood Marine Engineering Company, the boat will be available in several color combinations.

DECIMAL DIMENSIONING

Finds Growing Favor In Aeronautical Industry

AFFORDING major benefits of the metric system without simultaneously creating wholesale disruptive conversion headaches, decimal dimensioning is being used increasingly by the American aeronautical industry.

A survey by the Aeronautical Drafting Committee of the Society of Automotive Engineers, made among airlines operators and manufacturers of planes, powerplants, propellers, and accessories, discloses that 80 percent now employs decimal dimensioning or contemplates its early adoption. Users explain that the practice of expressing limited measurements in decimals rather than fractions of inches contributes to speed and to accuracy both in design and in manufacture. Decimals are carried to two, three, or more places to satisfy varying tolerance requirements.

The survey reveals that 76 percent of the aeronautical industry has considered the use of decimal dimensioning, that 63 percent uses it already, and that 37 percent is using it for some purposes. In the propeller branch of the industry, 80 percent of manufacturers uses the decimal dimensioning system exclusively.

The practice is characterized as making the dimensioning of drawings much easier and more rapid, and as being especially helpful in eliminating the time-consuming, error-producing operations of converting decimals to fractions and back to decimals again. Furthermore, tolerances may be indicated merely by extending digits after the decimal point.

RESONATING NUCLEI

Reveal Their Chemical Composition In a Magnetic Field

THE FEASIBILITY of using the frequency and magnetic reaction of atom nuclei in quantitative and qualitative analysis is being probed by Dr. Felix Bloch at Stanford University. Based on the principle that the atom nucleus of every element has a characteristic, precise frequency to which it resonates under the influence of radio-frequency current in a given magnetic field, the experiments consist of enclosing the test materials in tiny glass vials and placing them in the field of a powerful electro-magnet. Then the radio-frequency current is induced into the nuclei, making them spin very much like a gyroscope. A sensitive receiving set determines, when the nuclei are spinning at a rate of approximately 42,500,000 revolutions per second at right angles to the field, the frequency given off by the nuclei. And it is this frequency at which the nuclei resonate which gives the key to the composition.

At present, Dr. Bloch explained, his experiments have centered on testing hydrogen nuclei, which, although light, have a high nuclear magnetism. These tests have proved effective and signals strong enough to be recorded have been secured when the protons existed either in solution or in paraffin.

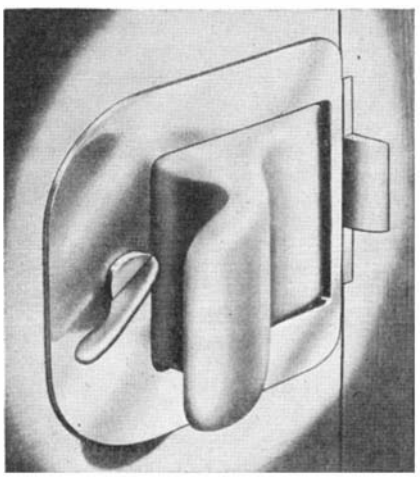
Cautious in predicting the practical applications of this method of analysis, Dr. Bloch states that "the system at this stage isn't foolproof and 100 percent accurate as yet, as it must be in order to be of practical, scientific value in qualitative and quantitative analysis."

New Products and Processes

PUSH-PULL LATCH

Fits Standard Doors, Is Easily Opened

REPRESENTING a departure from conventional design, a door latch which is simply pushed to open doors swinging outward, or pulled to open doors swinging inward, offers new convenience and safety. In case of emergency pressure from the elbow, knee, or body will open the latch; because the working parts of the latch are precision-



Door-latch installation is simple

formed, only light pressure is required. Manufactured by Parlyn, Ltd., it is easily installed in standard-size doors. The unit is fitted into a saw-cut 2½ by 2¼ inches, and is then made secure by turning two bolts which expand the latch in the cut. Slight inaccuracies in the cut will not affect operation. Latches are available in a wide variety of finishes, and in three styles: without lock, with trip lock, and with cylinder lock.

MIDGET DRY BATTERY

Provides Light-Weight Source of High Potential

DESIGNED as the high-voltage source for a compact, portable, and completely self-contained radioactivity meter, miniature 300-volt dry batteries weigh only one pound apiece. With dimensions of 2-11/16 by 2-11/32 by 3-15/16 inches, these high-potential, low-drain batteries, known as Eveready Number 493, have a life expectancy of as high as 350 hours, and are the product of the National Carbon Company.

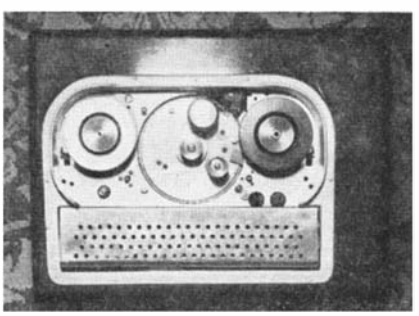
In addition to supplying the high-potential for portable radioactivity meters, known as Geiger counters, these batteries will find application in a variety of other fields. In commercial and press photography, for example, a set of six of these batteries will provide sufficient energy for as many as 2500 flashes in multiple flash tubes of the gas discharge type. They should prove valuable also in photo multiplier tubes for the measurement of small quantities of light. Other possible applications include a voltage source for small, lightweight insulation testers, excitation voltage supply in portable television pick-up devices, bias supply in high-gain direct current amplifiers, or in any circuit requiring a high potential where drains are measured in microamperes.

WIRE DICTATING MACHINE

Has High-Speed Rewind To Facilitate Corrections

SPECIFICALLY designed and built as a dictating machine for general business use, a magnetic-wire recorder, complete in one unit, combines both re-

Receptacle into which magazine fits



To load, a magazine containing spools of wire is set in place on top of unit

corder and play-back. The voice of the speaker is recorded on a strand of stainless steel wire moving between two spools. The same wire passing through the magnetic field with the control switched to the "listen" position reproduces the voice with all the clarity of the original. The spool of wire may be stored away and reproduced years later with no impairment of reproduction, or it may be reused by simply recording over the original message.

One of the features of this machine, called Sound-On-Wire, is forward and rewind speeds of 20 feet per second, ten times faster than the recording speed. This added speed facilitates the whole dictating operation by cutting down the time spent in going back in the message to make "erasures." When a correction is desired, the wire is reeled back at this accelerated speed and the operator simply re-dictates. No intermediate step is required, as the wire is automatically cleared when it passes through a demagnetizer coil before reaching the recording head.

The magazine holding the wire is self-contained and can be transferred from one machine to another for play-back or recording. The controls are so simplified that no instructions are required to operate it.

With the use of a small earphone about the size of a modern hearing-aid ear piece, the transcribing operator can adjust the volume so that the reproduced sound cannot be heard by others in the room. A convenient pedal-type control enables the operator to start and stop playback by applying light foot pressure.

In addition to general office service, Sound-On-Wire, a product of the Standard Business Machine Company, is adapted to many special uses such as recording radio programs, business meetings, and telephone conversations.

CORRUGATED PLASTICS

Add Beauty and Strength To Structural Applications

INDUSTRIAL and architectural designers in decorative and structural fields will find new applications for transparent

Dictating with the wire recorder

The transcribing operator can use the comfortable, light-weight earphone

acrylic plastics in corrugated sheets. In this form, Plexiglas combines the decorative advantages of a transparent corrugated material with the safety, flexibility, and ease of handling found in the usual flat acrylic plastics. A thin sheet of the plastics is made rigid by corrugating and can therefore be used where a much thicker sheet of the flat material would tend to sag or bend. In trains and buses, for example, baggage racks made of .080 inch thick plastics are able to withstand the impact of 25 pound lead weights and to support these weights without visible deflection. Also, corrugation reduces the area exposed to surface abrasion and effectively diffuses any scratches which do occur.

For lighting shields, free standing screens, inner partitions in home or office, diffusing windows and display fixtures, corruguated Plexiglas is described as not only displaying superior structural advantages, but adding a lustrous modern note of beauty as well.

FATIGUE TESTER

Needs No Attention
During Operation

FILLING the demand for a bench-type fatigue testing machine with the "constant-force" loading feature, a new machine affords flexure fatigue tests on sheet stock of any material—metal, plastics, wood—and requires no attention during the test. The unique design eliminates the need for any electronic equipment, complex linkage, or special device to maintain a constant force while the specimen is under test.

This testing device uses a revolving eccentric mass as a means of loading the specimen, avoiding cams or eccentric connecting rods which require readjustment during the test as the stiffness of the specimen changes. With this constant force machine, the load automatically remains constant regardless of the changes in the amount of deflection of the specimen. A predetermined load is alternately applied to the specimen, and the resulting deflection is incidental.

The value of dynamic testing with this machine developed by The Baldwin Locomotive Works, as compared with any static test, is obvious. The specimen undergoes the same stresses the material would sustain in actual use and the point of failure is accurately determined. Because of its comparatively small size, 15 by 12 by 32 inches, the fatigue testing machine can be placed in a cabinet during a test so that temperature and humidity can be controlled. The machine weighs 115 pounds, has an alternating force capacity of 20 pounds and a speed of 1800 cycles per minute.

MELAMINE TABLEWARE

Resists Breakage
In Roughest Service

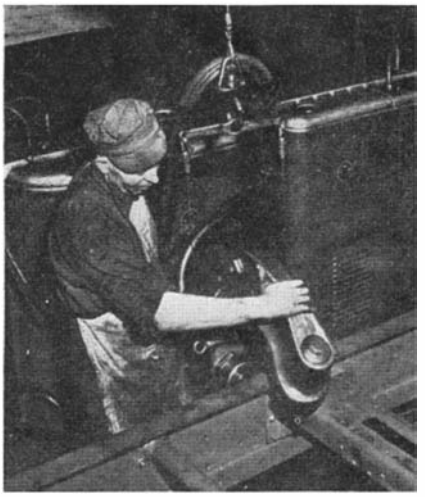
HEAVY-DUTY plastics tableware has been designed especially for use by restaurants, institutions, cafeterias, hospitals, and hotels, with ease of handling and conservation of space in mind. All pieces stack; plates and cups are suspended on molded-in flanges, and do not rest directly on one another. Consequently, there are no unsightly rings and sanitary air drying is made possible. Constructed of the American Cyanamid Company's Melmac plastics, the tableware withstands boiling and can be cleaned in automatic dishwashing machines. Because of the shock-resistant characteristics of the melamine plastics, dishes resist breakage, even when submitted to the most severe restaurant or cafeteria service. The plastics is odorless, tasteless, and highly resistant to attack by fruit juices or other foods.

All units are supplied in a range of standard colors—blue, cream, green, light tan, red, and yellow.

SILENT RIVETER

Hydraulically Operated,
Flattens Rivets with Single Blow

USED PRIMARILY in manufacturing plants where work can be brought up close to the machine, a silent riveter



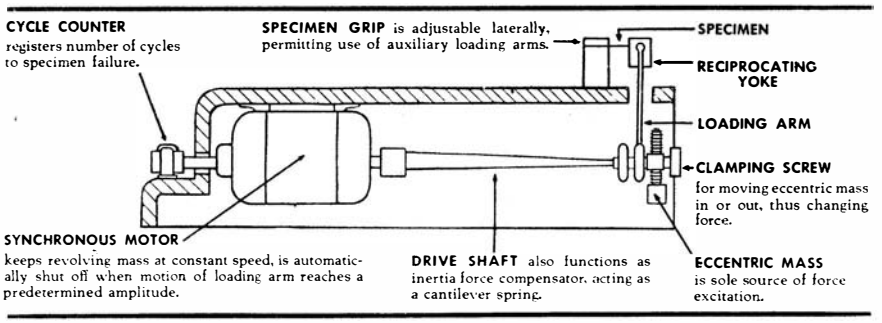
Noiseless riveter in operation

looks like a huge C-clamp, and slips over the parts to be joined, holding the head of the rivet in place while the other end is flattened with the tremendous pressure of a single stroke. Hydraulic pressure of several thousand pounds per square inch is transmitted from the generating equipment to the riveter by means of an oil-resistant wire-reinforced synthetic rubber hose manufactured by the United States Rubber Company.

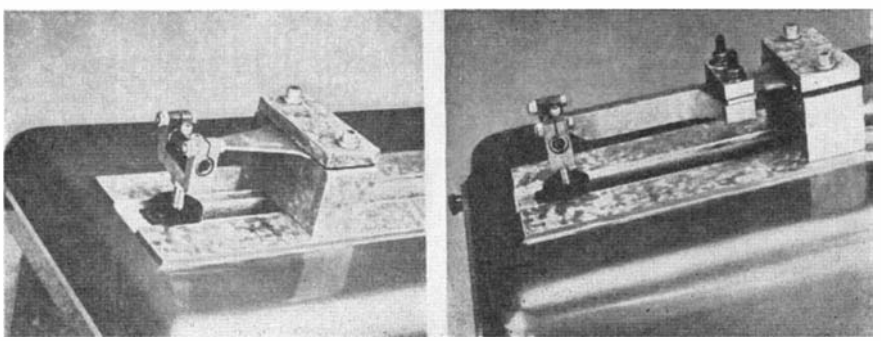
AUTO REFINISHING

Takes Only Five Hours
On Production Basis

MAKING it possible for the automobile owner to have his car repainted in any one of 3700 original factory finishes in less than five hours, a high-speed, low-cost auto refinishing process uses a low bake enamel which was developed by the Sewall Paint and Varnish Division



Simplified diagramatic drawing of the fatigue tester



Testing to the point of fatigue failure, the machine will impose a bending moment of 60 inch-pounds on the tapered specimen (left). The five-inch auxiliary loading arm (at the right) affords a maximum bending moment of 100 inch-pounds

of the American-Marietta Company. The paint has special oxidizing characteristics which permit the finish to dry completely within 45 minutes. Temperatures in the bake oven range from 165 to 180 degrees, Fahrenheit, causing a curing action in the enamel; as soon as the car is removed from the oven and cooled, it is ready for service.

Refinishing can be done on an assembly line basis, each of eight operations requiring at least 20 feet of floor space. After the metal work is repaired and sanded, the car is washed and cleaned of all dirt and grease, windows and chrome are masked, and the car

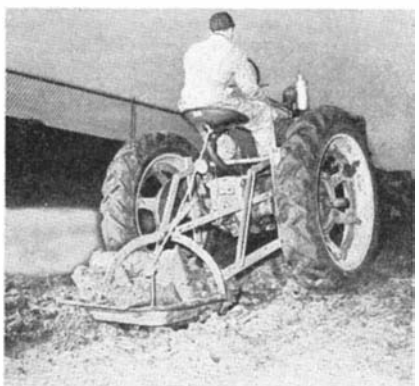
is primed with a coat of special lacquer.

The car is then ready for water sanding, making use of fine abrasive paper. After the car has been carefully inspected to be sure that all masking tape is securely in place and that all imperfections have been filled and sanded, the entire surface is carefully blown off by high-pressure air to remove all traces of dust and moisture. It is then ready for the paint booth where two operators with high pressure spray guns, working at opposite sides of the car, apply the desired color. Ventilation in the booth is supplied by two blowers, each equipped with filters to keep the booth absolutely dust-free. Doors from the spray booth open directly into the ovens where the car is baked.

TRACTOR SCOOP

Easily Attached, Operates Hydraulically

ATTACHABLE to most hydraulic-lift tractors, an earth-moving scoop that can be mounted in less than five minutes is simple to operate, easy to maneuver in tight places, and sturdily



Takes less than five minutes to attach

built for hard use. In less than 15 seconds it will scoop up a load of ten cubic feet of dirt. Under reasonably favorable conditions it is possible to excavate a basement 20 feet by 30 feet by 6 feet deep in less than a day with this scoop.

Digging ponds and ditches, repairing washouts, landscaping, leveling, and similar tasks can be done with equal ease.

This hydro-scoop, manufactured by the Stockland Road Machinery Company, mounts on the rear of the tractor, rather than being pulled behind it. The scoop is raised or lowered by the tractor's hydraulic lift unit, and can be tripped or dumped with an easy, one-hand movement, while the tractor is moving.

STABILIZER AND LUBRICANT

Can Also Serve for Waterproofing

DIBASIC lead salt of stearic acid, a soft, pure white, unctuous powder with all the apparent lubricity of normal lead stearate, is insoluble in water and in most of the common organic solvents. It reacts with warm turpentine forming a waxy compound with an approximate 5 percent solubility therein. This compound is in turn soluble in mineral spirits which suggests its use as a protective coating for unpainted metal, in the waterproofing of fabrics, and so on. It is soluble in some plasticizers. Its basic lead content, its low refractive index, and its solubility in these plasticizers make it an excellent plasticizer for some types of clear vinyl plastics.

When so used, the dibasic salt has two-way utility, being an excellent heat and light stabilizer. It has some degree of solubility in tricresylphosphate and several other plasticizers. Moreover it is very soluble in mixtures of either tricresylphosphate or dioctylphthalate and some of the aromatic petroleum type plasticizers. It produces clear amber films when the aromatic petroleum type plasticizer is used to the extent of 50 percent or more, or comprises the total plasticizer content. Called DS 207, it is also an effective lubricant—an excellent replacement for the lubricants commonly employed with vinyl compounds to improve flow characteristics for molding, extruding, and related processes.

DS 207 makes superior leaded greases when mixed with lubricating oils. The greases are excellent protectives against corrosion, due to the basic characteristics of the dibasic lead stearate. DS 207 greases are uniform in composition which insures positive protection against wear of the machine parts to which they are applied.

The compound, produced by the National Lead Company, has possibilities as a constituent of cutting oils. Other potential uses suggested by its compo-

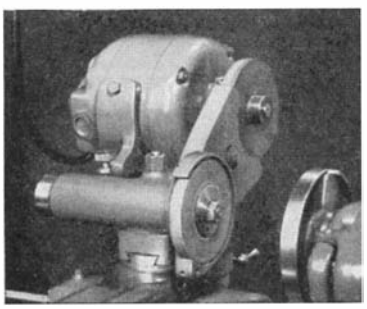
sition are as a drier in some types of paint, and as an additive to improve the brushing characteristics of oil paints.

GRINDING ATTACHMENT

Can Be Adapted To Most Machine Tools

FOR USE on lathes and other machine tools, an electric grinding attachment is designed primarily for precision external grinding, and is equipped with a four by one-half inch grinding wheel which is driven by a constant speed continuous duty one-quarter horsepower motor. This permits taking heavier sustained cuts than would be practical with a universal type motor of the same rated horsepower. Available with frame sizes to fit various sizes of lathes, this grinding attachment can easily be adapted to milling machines, shapers, planers, and so on.

The grinding wheel spindle runs on pre-lubricated sealed precision ball bearings which require no adjustment



Wheels available for various materials

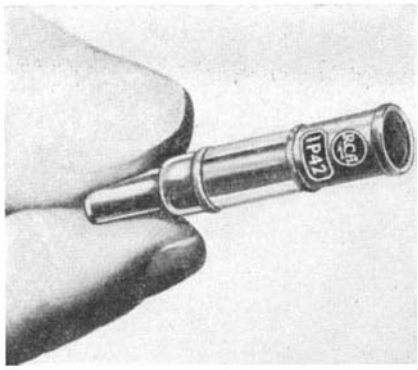
or additional lubrication. Effectively protected from abrasive grinding wheel dust, the bearings will retain their precision indefinitely. Tension adjustment is provided for the V-belt which connects the motor with the grinding wheel spindle, and both the grinding wheel and the V-belt are enclosed in a single guard.

Spring stops for grinding straight and spiral fluted reamers and cutters, diamond dressers for truing the grinding wheel, and holding fixtures for the dressers can be furnished for use with this grinding attachment, a product of South Bend Lathe Works. Wheels are available in several grades for grinding various materials, including tungsten carbide, tool steel, machine steel, cast iron, brass or bronze, aluminum, Bakelite, hard rubber, and soft rubber. Special cup wheels are supplied for reamer and cutter grinding.

CAPSULE-SIZE PHOTOTUBE

Permits More Compact Photoelectric Devices

SMALLEST ever offered commercially, a new phototube about the size of a .22-caliber long rifle cartridge, has a maximum diameter of only 1/4 inch and an overall length just under 1-13/32 inch and is activated by light entering through a tiny window at its larger end. Comparing favorably with larger phototubes in sensitivity, the tiny new tube, produced by the Radio Corporation of America, is expected to find many applications in business and industry, particularly in devices and machines where the size of former phototubes has been a problem.



Activated by light through end window

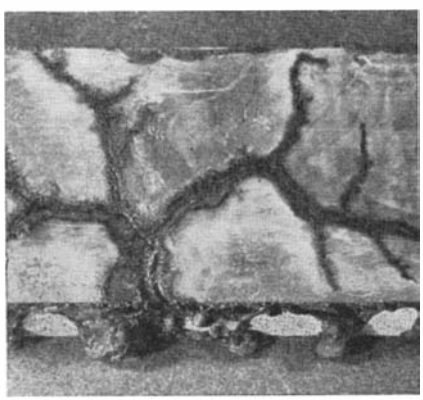
In multiple-circuit control devices, the new tube makes possible either smaller devices or more circuits in the same space. In animated signs, for example, where each phototube is individually wired to a light in the corresponding position on the signboard, many more of the 1P42 tubes, as the new tube is called, may be used in a given area. When light, projected through slides or film, falls on and activates the more closely spaced tubes, sharper and clearer pictures can be reproduced on the lighted signboard.

NON-ARCING GLUE

Eliminates Burns In Dielectric Curing

PHENOLIC glue, especially formulated to be non-conductive in a high-frequency field, will not arc when a squeeze-out of the resin forms contact with an electrode in a radio-frequency dielectric heating installation, nor when the electrodes are brought into contact with the glue line, thus eliminating one of the chief disadvantages of dielectric glue curing.

Known as Cascophen RF-228, this product of the Casein Company of America allows the use of maximum power, speeding the curing process. It is supplied in liquid form with a separate powder catalyst. The set film pH is substantially neutral and forms a durable, waterproof, fungusproof, and boilproof bond. The liquid resin is stable in storage for 10 to 12 months at 70 degrees, Fahrenheit, in tightly closed containers. The resin is an alcohol-water solution, and is not harmed by freezing. The catalyst is stable in storage, but should be kept in an airtight container, away from heat.



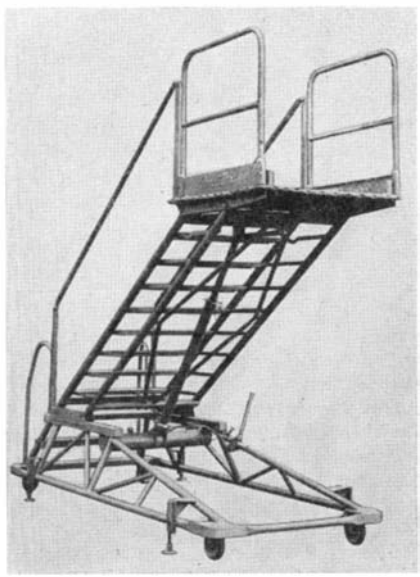
Dielectric glue avoids such burns

ADJUSTABLE PLATFORMS

Replace Scaffolds In Many Operations

HYDRAULICALLY operated adjustable work stands, originally designed for the elimination of costly, cumbersome scaffolding and special workstands for war-time aircraft maintenance, are now available for general industrial use. A 16-square-foot work platform, with a maximum static load capacity of 1500 pounds, is hydraulically elevated or lowered to any working level from 3 to 24 feet, according to the individual model. The units feature the exclusive and patented use of automatic and self-adjusting steps which maintain their position parallel to the ground regardless of the working angle of this stand produced by Airquipment Company.

Scaffolding strips, stand extensions, and hoist attachments further enhance the general utility features of the stands, called Aerostands, and all models are equipped with guard rails and skidproof surfaces on platforms



Maximum load is 1500 pounds

and steps. Frames are constructed of welded tubular steel mounted on swivel casters with caster locks. Truck locks are provided to hold stands stationary when in service. Tow bars, scaffold strips, stand extensions, and hoist attachments are optional equipment.

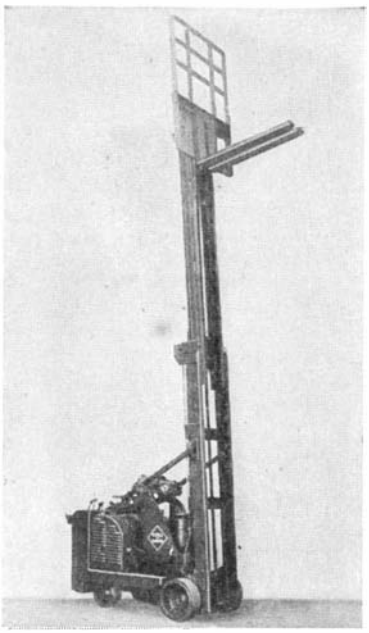
FORK TRUCK

Will Lift 3000 Pounds To a Height of 18 Feet

HAVING an elevating reach of 18 feet above floor level, a novel fork-type industrial power truck has new features of design and construction which make it especially useful for high-tiering materials and merchandise. It is unusually compact, with increased speed and flexibility for maneuvering, and lifting and lowering loads. The

truck picks up loads on its bare fork or on pallets in the same manner as with standard models. Its capacity is rated at 4000 pounds for lifting to a height of 11 feet, and 3000 pounds to 18 feet. It is electrically driven, with three separate motors; one for traveling, one for operating the elevating mechanism, and the third for tilting the upright columns. Tilting limit is 15 degrees backward and five degrees forward from vertical.

Lifting speed with capacity load is 13 feet per minute, lowering speed 20 feet per minute; truck's traveling speed five miles an hour.



Speedy, compact, and maneuverable

Body of the Elwell-Parker truck, independent of the uprights and fork, is only seven feet eight inches long. Overall width is three feet two inches, enabling it to maneuver in narrow aisles.

One pair of columns, 11 feet above the floor level forms a primary frame the bottom of which is pivoted at the forward base of the truck body. A second pair of columns, virtually the same length as the primary, forms the telescoping frame. The secondary frame operates on ball-bearing rollers in alloy steel tracks which form part of the primary frame. The secondary frame is not actuated below heights of 11 feet, in fact, its presence is not apparent until the fork is lifted beyond that height.

FIREPROOF SHEETING

Conserves Fuel, Is Easily Installed

SHEET-STEEL fire-arresting insulation, only .006 inch thick, has been proved to withstand temperatures up to 1000 degrees, Fahrenheit. Easily installed in any building, the sheet insulation is also completely resistant to vermin and termites. Because it reflects 95 percent of all radiated heat, installation of this material, known as Ferro-Therm, cuts fuel costs as much as 30 percent and, during summer, reduces inside temperatures as much as 10 degrees. This fireproofing, produced by the American Flange and Manufacturing Company, is available in sheets 24 by 32 inches; a carpenter can install an average of 800 square feet per day.

NON-WOVEN FABRICS

Of Rayon Staple Are Strong and Easily Colored

A DEVELOPMENT in the use of viscose rayon staple is making possible the manufacture of several different types of non-woven fabrics. Among the industrial forms are ribbons, tapes, filters, lens wiping tissue, bindings and interlinings, insulation covering, tags and special wrappers, containers, and bags. In the household they are found as wall coverings, curtains, drapes, napkins and table cloths, towels, and wiping cloths.

Non-woven fabrics are essentially multiple webs of rayon or other fibers in which the fibers are bonded together by various means. Prominent among the methods of accomplishing the bond is by blending potentially adhesive fibers, such as Vinyon or plasticized cellulose acetate, with non-adhesive fibers, like cotton, wool, or rayon in the formation of the web, and subsequently activating the adhesive fiber by means of heat and pressure to lock the fibers in place and strengthen the fabric. By varying the relative fiber content, weight of web, and bonding conditions, many interesting, novel, and desirable changes in hand and

Editorial purpose of Scientific American is to provide its readers with thought-provoking feature articles and shorter items on all phases of industrial technology. In every case the material is drawn directly from industry itself. The Editor will be glad to refer interested readers to original sources and, when available, to additional literature, giving further details of a more specialized nature.

texture may be obtained "to order."

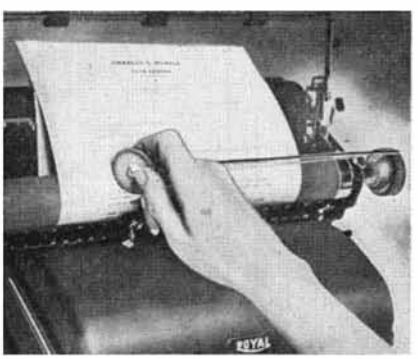
The use of rayon staple in non-woven fabrics is considered essential for many of the applications being developed for this material, as well as some of those in which it is replacing woven fabric and fine texture specialty papers. The ease with which rayon non-woven fabrics may be dyed or printed, and the brilliance with which rayon takes color make the use of rayon especially attractive.

Examples of these materials may be found in the products of Chicopee Manufacturing Company, Minnesota Mining and Manufacturing Company, Visking Corporation, and others, who co-operated with the Industrial Division of American Viscose Corporation's Textile Research Department in developing the use of rayon staple in non-woven fabrics. While relatively a new product with these companies, numerous uses in varied fields have already been established.

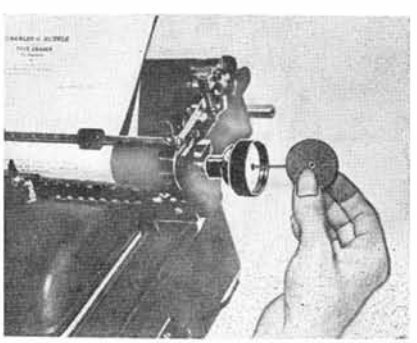
TYPEWRITER ERASER

Returns Automatically To Knob After Using

FITTING snuggly into a recess in a special platen knob on a typewriter, a circular eraser is always at the typist's fingertips. Known as Type-Eraser, it is



Typewriter eraser in use



Fits into recess in platen knob

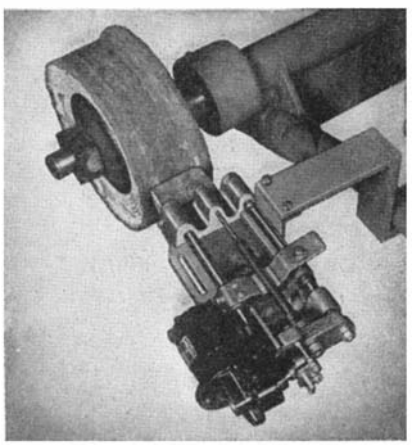
attached by a nylon cord to a spring reel in the knob, and returns automatically to its recess when released after using. It is manufactured by Charles G. Hurrle to fit most standard models of typewriters.

COMPOUND APPLICATOR

Electrically Driven, Fits Any Buffer

A BUFFING compound applicator that has an intermittent feed control operating at the rate of 14 strokes per minute, affords a feed ranging from .0015 to .015 inch per stroke. The applicator, manufactured by the George L. Nankervis Company, can be mounted on any automatic machine (either right- or left-hand) and can be adapted to everything from simple to complex multiple-stage buffing operations. It is driven by a totally enclosed geared head motor, and 110, 220, or 440 volt motors are available.

The quick-action compound applicator clamp, with adjustable features to compensate for variable thicknesses,



Light weight permits adaptation

and standard carrier will accommodate any length stick of compound up to four inches. Special carriers for wider cakes are available.

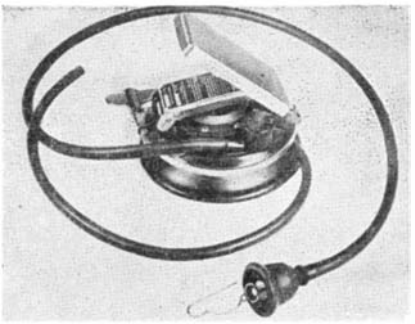
Total weight of the applicator is only 20 pounds; this light weight permits adaptation to floating heads without disturbing balance.

POCKET FILTER PLANT

Guarantees Safe Drinking Water

CONSTRUCTION crews, sportsmen, travelers, and other small groups traveling away from approved public water supplies can be assured safe drinking water by a new small, portable filter plant. The device which gives this protection from water-borne disease such as typhoid and dysentery—germs of which are often present even in water sources that look clean—is a pocket-size water filtering unit called Mini-Filter.

Originally developed during the war for the Armed Services, the filter plant, produced by Wallace and Tiernan, includes a hand pump and filter, together with a purifying kit of Aqua-Tabs, all in a small unit weighing less than five pounds. The principle of operation is the same as that used by municipal filter plants, and it eliminates the need for taking chances on water quality or boiling drinking water to be safe.



Entire unit weighs under five pounds

MOLYBDENUM TUBING

Is Commercially Available In Many Sizes

AVAILABLE immediately on a production basis, seamless molybdenum tubing is now being made in sizes ranging from .040 to .500 inch outside diameter and in lengths up to nine inches. Other diameters may be had on special order.

Moly tubing, offered by the Callite Tungsten Corporation, can readily be machined, is easily worked and shaped within reasonable tolerances, and can be welded to iron, nickel, and similar materials. It is not affected by hydrofluoric acid, potassium or sodium hydroxide, and only slightly by nitrogen.

LOW-COST MICROSCOPES

Designed For Use By Students and Amateurs

CREATED specifically for schools and hobbyists, a line of low-cost microscopes is produced in two styles: the achromatic model with a power range of from 75x to 400x, and the student model with a power range of from 65x to 200x. Both models, products of Testa

Two models are available

Manufacturing Company, are available for immediate delivery. Accessories include a number of interchangeable objectives and eye pieces, dark-field illumination, and polarizing attachment.

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.)

A NEW INDUSTRIAL CATALOG SERVICE FOR SOUTH AMERICA is an eight-page booklet describing a new catalog service which will keep information on the products of American manufacturers accessible, at all times, in the offices of potential customers in ten South American countries. Classifications will include: extractive industries, such as mining, oil, and lumber; manufacturing industries, both mechanical and process; service industries, such as power and transportation; and engineering firms, designers, and consultants. *Sweet's Catalog Service, 119 West 40th Street, New York 18, New York.—Gratis.*

ENTOMOLOGY is a 12-page 1947 catalog of supply services for secondary school teachers, students, and collectors. It describes equipment for collecting, mounting, and displaying insect specimens. Books and manuals on entomology, from beginners' guides to publications on special phases of the subject, are briefly reviewed. Request Catalog No. 479. *Ward's Natural Science Establishment, Box 24, Beechwood Station, Rochester 9, New York.—Gratis.*

THE GLASS LINING is a periodical published as a service to the dairy, food, beverage, and chemical process industries. In each issue it covers various phases of the application of glass to industrial processes, with emphasis on chemical and physical durability, structural advantages, and sanitary aspects of glass-lined tanks and other glass equipment. *The Pfaudler Company, Rochester 4, New York.—Request this periodical on your business letterhead.*

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ber of weights and measures tables are supplemented by such information as figuring quantities of brick, estimating cement and concrete requirements, uses and grades of plywood, setting tile, weight of building materials per cubic foot, proportions for concrete, and the like. *A. C. Horn Company, 43-37 Tenth Street, Long Island City 1, New York.—Request this booklet on your business letterhead.*

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The Editors Recommend

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The Editor

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By Osborn, Brace, Johnson, Cable, and Eagan

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Edited by Earl T. Engle

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A Symposium compiled by H. Bennett

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embraced within the broad term "chemical specialties." It also describes methods of mixing ingredients and packaging the various products. On the business side, it brings together information from a variety of sources that should be useful to anyone engaged in a business of this kind. An appendix gives sources of many of the materials specified in the formulary section. Undoubtedly the book will be valuable to many people in the field of chemical specialties. (826 pages, 5½ by 8½ inches, illustrated.)—$12.70 postpaid.—*D.H.K.*

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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"

AVERAGING once a year someone asks this department why telescope mirrors have to be so thick, and now comes an inquirer who reasons that if mirrors were thinner they would have just that much less weight to support and therefore wouldn't sag any more than thicker ones, also would adapt themselves to temperature changes more quickly.

This sent us to a remembered file of papers containing an article in the *Journal of the Royal Astronomical Society of Canada,* July-August 1935, in which Harold C. King, Calgary, Alberta, similarly contested the statement in "A.T.M.," page 75, that mirror disks should have thicknesses not less than one eighth of their diameters, one sixth still better, and which was never rebutted. "Some dicta," he stated, "are proved to be wrong by their supposed explanations. If there is anything illogical in the explanation there is probably something wrong with the whole proposition. Consider, for example, the dictum that the mirror of a reflecting telescope must be made of glass which has a thickness of at least one eighth of its diameter, and is said to be better still if it is as thick as one sixth of its diameter. . . The reason given for this thickness, in the book 'Amateur Telescope Making,' is that if the mirror is made of glass having a less thickness in proportion to diameter than one eighth, it will not keep its figure. That is, it will warp, the reason for the warping being that 'it will bend of its own weight.' Even supposing it to be true that thin mirrors are found to warp," he then continued, "the explanation that this is caused by its own weight is illogical on the face of it. It should be obvious that if the mirror is thin there is therefore less weight to warp it."

And so he made a thin mirror, ½" by 9½", or a ratio of 1:19, and it gave excellent star images and suffered not the slightest change in figure—which does not, however, prove anything.

If the premise on which the above-described argument is based is sound logic, then we may continue on past the 1:19 ratio. If it is good for 1:19 why isn't it good for 1:29 or 1:39? Or 1:99? Why stop even there? Why not toss out the glass altogether and let the aluminum coating stand up alone? In this series of stages has any new principle entered in at any point? We see none.

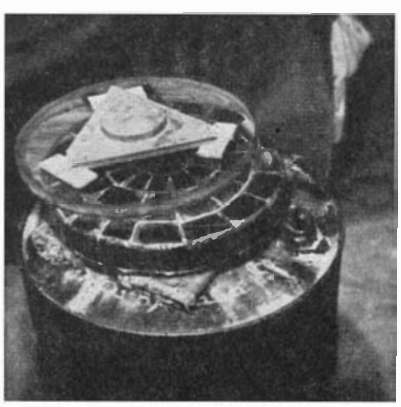


Figure 1: Grinding thin mirror

This, therefore, is disproof by *reductio ad absurdum,* but just why does the thick mirror stand up and the thin one, weighing proportionately less, fall down? For answer, we need only look at an engineering treatise, in the section on strength of materials. Consider the mirror in two extreme positions—first, flat on its back, then on edge. Taking the first case, a cross-section of the mirror has its analog in a common floor beam having uniform loading, in this case the weight of the mirror disk itself. Various factors enter in and the analysis could be made complicated but there is no need of it. No need, either, to cite a flock of formulas. In Trautwine's "Engineer's Pocketbook" is the simple statement of principle that the strengths of beams having similar cross-sections are inversely proportional to their spans and directly proportional to their breadths *and to the squares of their depths.*

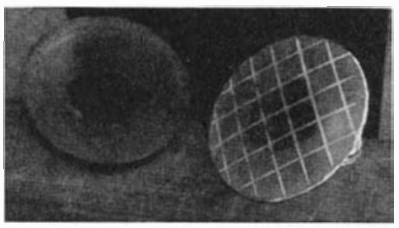


Figure 2: Channeled tool

Now take the alternative case of the mirror when tipped up on edge. It is now a column and here the general relation involved is a proportion between the square of the height and the square of the width. Again the square.

This, then, is the plain answer—in principle, for circumstances sometimes will modify it in specific cases.

How, then, did the Calgary critic's 1:19 mirror get by? Probably because the 1:6 or even the 1:8 ratio contains a very large, healthy factor of safety and, many think, wisely so, just as is the case in most engineering structures wherever such is possible. And his 1:19 luckily lay within it—in this particular instance. It might always, or even often. Maybe three out of four, or even nine out of ten, mirrors would get by with a ratio of, say, 1:12. Maybe thereafter the tides would set in strongly against luck. These figures are based on no definite experimental data and are simply guesses.

The 1:19 that got by was probably pretty close to the edge of the cliff. It is fun to live dangerously. Therefore, try 'em as thin as you like—at your risk. But glass is cheaper than sweat and tears.

Commenting on the above comments, which were shown to him, R. W. Porter mentioned an experiment described in *Comtes rendus,* Vol. 186 (1928) page 311, by Professor André Couder of the Paris Observatory, a co-author of that excellent work "Lunettes et Télescopes," ("Refractors and Reflectors"), by Danjon et Couder, published 1935. "He took a Pyrex dish," Porter writes, "which was 7½" in diameter and about 2" high, with walls only ½" thick, and parabolized the bottom of the dish. He then took it from a warm room out into the cold night and inserted it in his Newtonian telescope, and could see no change in definition with temperature change of 36° F. This," Porter adds, "would be a good stunt for the amateurs to try out. A bar, if supported at its ends, sags twice as much as if the ends were clamped to some rigid body and that condition obtains in the experiment just described." Maybe because of this last this was not an extreme kind of experiment.

The 200" mirror has a thickness of 24", hence its ratio is approximately 1:8. Even then, it has an elaborate flotation system. Yet, from the single point of view of rapid temperature equalization, the 200" has a thickness-diameter ratio of 1:40! Its face is only 5" thick and no part of the honeycomb rib structure that supports that face (and is cast integral with it) is farther than 2½" from the surrounding air. This is a true triumph.

AFTER the above was prepared, the following cognate discussion of a mirror of thin ratio, 1:13.8, came from C. S. Walton, 5975 W. 44th Ave., Wheatridge, Colorado, (one of the former Roof Prism Gang of wartime ATMs; he, with neighbor Anton Bohm, made 500 prisms of two-second roof-angle tolerance).

"In June, 1941," he says, "Anton Bohm and the writer got the idea of trying to make a large mirror of glass much thinner than is usually prescribed. We got a piece of 1¼" plate glass, cut out a 17¼" disk with a biscuit cutter and completed a mirror which is at last mounted. In the intervening years after final figuring numerous Foucault, zonal, and Ronchi tests were made and no change from the original figure was detected. Now mounted, the mirror has good definition and no noticeable astigmatism."

Walton continues: "Mr. R. E. Glover, supplied some mathematical data and remarks on thin-mirror practicability. 'If this disk,' he stated, 'were supported in a horizontal plane by a rim under the outer edge, its own weight of 23.3 pounds would deflect the center of the disk 0.000,025,3" downward. It is estimated that, if the disk were pressed against the polishing lap with a force of 20 pounds, transmitted to it through a handle 4" in diameter such as was used (Figure 1), the deflection would

be 0.000,023,4", based on the assumption that the pressures were applied uniformly by handle and lap. Both of these deflexions are large enough to have an effect on the corrections, since they equal about one fifth of the modification necessary to parabolize the mirror. They are small enough so that, with care in the design of the mirror support and, before that, of the polishing handle, they should permit a disk of these dimensions to be used successfully.'

"The handle we therefore devised," Walton continues, "adhered to the mirror at six points located on the 70 percent zone—that is, at two pitched on points on each of the three pieces shown in Figure 1. The mirror was worked face down and the illustration shows it on its lap atop an oil drum.

"Tony Bohm and I were after quick results so he did the roughing out with his sandblasting equipment [Runs a gravestone works.—*Adv.*—*Ed.*] and then an old coarse-grit Carbo wheel used on its side by hand, with plenty of Carbo grains, brought it to rough curvature in a hurry.

"We made a concrete tool having approximate curvature and stuck glass facets on it with pitch. It turned out to be a fast cutter and did not seize easily in the fine-grinding stage. Clifford Crowe chauffered the mirror around on the lap for about 23 hours and I took a dozen spells of about three minutes each at figuring, mostly with a small polisher, as the big mirror did not respond to overhang strokes for parabolization.

"The mirror is mounted in a hexagonal, ¼" plywood tube, on a 27-point flotation system very closely following Hindle's chapter in 'A.T.M.' It is rather critical on focus, being *f*/5, and images deteriorate rapidly toward the edge of the field, but the drive holds objects in the center and thus this deterioration is of little inconvenience. We are inclined to think the wooden tube is better than other kinds we have used, from the point of view of image steadiness.

"For any such telescope I strongly recommend designing the tube saddle so that the tube, or else the whole upper end of the tube, will rotate, a method that pays out richly in comfort of observing at the eyepiece, which may thus at all times be used in a horizontal position."

WALTON mentioned the fact that his tool, built of a mosaic of plate glass pieces stuck to a background, did not easily seize to the mirror. This is an example of the "broken" type of tool described by Ferson in the chapter on "Prisms, Flats, Mirrors," in printings of "A.T.M.A." issued since June 1944. Figure 2 shows a tool facetted by sandblasting after a couple of stages of coarse grinding. This, Walton writes, is the tool he used in making a Schmidt. He points out that this tool, and the mirror also, shows considerable transparency because fine grinding could be carried on as far as desired without fear of seizing, thanks to the breaks.

While the broken type of tool is not

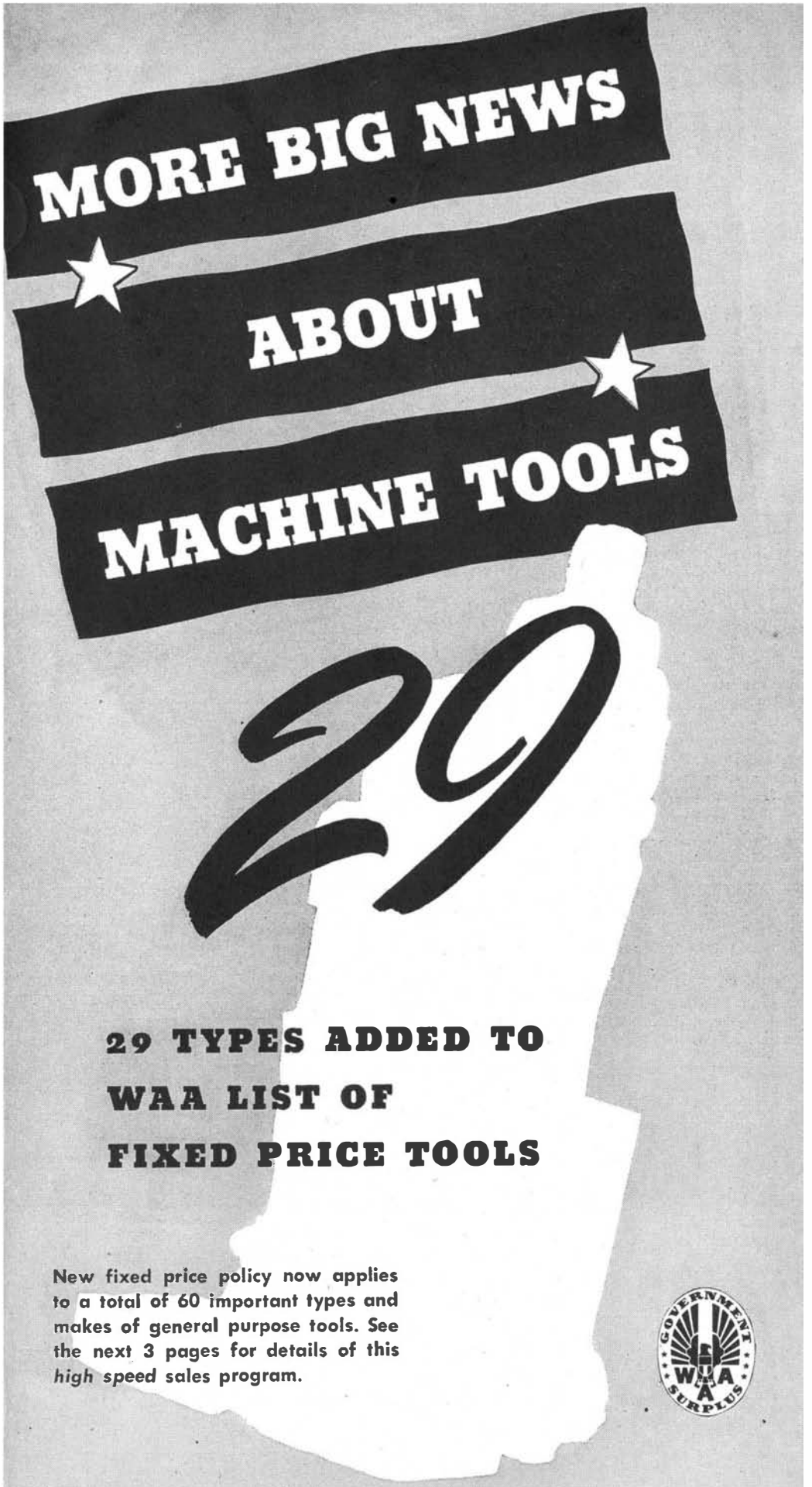
new—professionals often use it—Ferson, in making many scores of blocks of prisms cemented in blocks (thus, essentially flats) during the war, greatly developed its working philosophy. In "A.T.M.A." he points out its superiorities, in a clear train of reasoning with which experience checked fully. Turned edge had resulted from grinding with too much water; necessary, however, to avoid seizing. If now the wets could be dried up really to refusal of the work to move further, he found there would be no turned edge. And if the tool were channeled, the wets could be thus dried up—safely without risk of sticking. As a by-product, the fine grit cut faster and pits were less troublesome—the whole story is too long to develop here in closer detail.

Your scribe has subsequently used a tool much like the broken one described by Walton—glass facets pitched to an iron disk. It worked fully as described by Ferson but scratched badly—until the edges of all the facets were chamfered, and thereafter it scratched not at all. Another tool was given integral facets by grinding them in with the edge of a thick piece of copper against a straightedge clamped on, using Carbo. Time, ten minutes a channel (say, 1/16" deep) and it paid fine dividends: not a seizure in a shipload. You could lift the mirror off without any effort at all, at any time.

EXUENT pencil mark test was the verdict reached in these columns last January, on evidence that this otherwise useful test, described in "A.T.M.," page 288 (draw pencil marks across the fine-ground tool and mirror and rub the two together dry), sometimes leaves scratches or gouges, possibly by molecular, glass-to-glass cohesion and grabbing and probably not, as several have suggested, by grit in the pencil since the disks are first rubbed clean with the hand. Such piteous pleas in extenuation of this Jekyl-and-Hyde accused were received that the sentence is suspended. But a warning—"The above-described test may cause scratches"—will be inserted in "A.T.M.," page 289, line 2, and the suspect watched further.

Fred B. Ferson, Ferson Optical Co., Biloxi, Miss., advises us how the pencil test is made in his plant without rubbing dry disks together. "We merely lift off the mirror and draw two lines across its face. Without bothering to wash it we brush on a little more emery and grind half a minute or so. On any zones not in contact the marks will show through the back of the glass if clear and, if not, wetting it will make it so. Incidentally," Ferson adds, "emery does not stick mirrors; that fault lies largely with Carbo."

FOR WORKING 16" mirrors, now becoming the mode, a modified Draper machine is suggested, sub-diameter tool on top. An article describing the basics of stroke length, stroke offset, stroke de-centering, and the respective effects on the curve, is in preparation. For the machine, see Strong's famous book, Figure 10.



Floor Grinders—With Wheels over 6" Diameter and Driving Motors Other Than 110 Volt.

Boring Machine—Horizontal, Precision, Bridge Type, Single and Double End.

Chucking Machine—Bullard Mul-au-Matic Vertical, Multiple Spindle Type.

Chucking Machine—Six Spindle Automatic, Horizontal.

Drilling Machines—Deep Hole, Pratt and Whitney.

Drilling and Tapping Machine—Multiple Spindle Automatic.

Drilling Machine—Multiple Spindle, Fixed Center-Drills, Natco.

Gear Tooth Grinder—For Spur Gears, External and Internal (Formed Wheel Type Machine).

Gear Tooth Lapper—External and/or Internal Gear Tooth Lapping Machine.

Gear Tooth Shaver—Rack or Rotary Type, External or Internal Gear Shaver.

Contour Cutter Grinder.

Grinders, Cam and Crank Pin.

Grinders, Miscellaneous—Spline and Radius Grinders.

Lapping Machines—Flat, Norton Hydrolap.

Lathes, Production—Between Centers Automatic, Horizontal Single Spindle.

Slot Milling Machine.

Milling Machine—Spline.

Milling Machine—Bed Type, Vertical.

Planer—Craven Bros.

Screw Machine—Multiple Spindle Bar Type Automatic.

Vertical Shapers and Slotters.

Speed Lathes—All Types and Sizes.

The following types of tools were originally repriced on October 1st. They are listed again because additional makes and models have been put on the new fixed price schedule.

Gear Hobber—Horizontal.

Gear Hobber—Vertical, Muir.

Gear Tooth Grinder—Generating Type, For Spur and Helical Gears.

Milling Machine—Bed Type, Horizontal Spindle, Plain or Rise and Fall, Simplex or Duplex.

Milling Machine—Vertical, Knee Type Except Bench Models.

Tapping Machine—Vertical, Single or Multiple Spindle.

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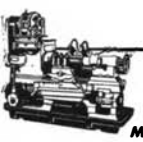
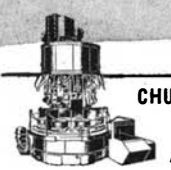


LATHES, PRODUCTION—BETWEEN CENTERS AUTOMATIC, HORIZONTAL SINGLE SPINDLE

Manufacturer: **JONES AND LAMSON MACHINE CO., SPRINGFIELD, VT.**

MODEL	SIZE AND CAPACITY	SALES PRICE
8" Fay Automatic	8" swing x 21" center to center	$ 796.00
8" Fay Automatic	8" swing x 33" center to center	843.00
8" Fay Automatic	8" swing x 45" center to center	889.00
12" Fay Automatic	12" swing x 21" center to center	$1195.00
12" Fay Automatic	12" swing x 33" center to center	1261.00
12" Fay Automatic	12" swing x 45" center to center	1330.00
12" Fay Automatic	12" swing x 63" center to center	1465.00
12" Fay Automatic	12" swing x 81" center to center	1636.00
16" Fay Automatic	16" swing x 21" center to center	$2079.00
16" Fay Automatic	16" swing x 33" center to center	2148.00
16" Fay Automatic	16" swing x 51" center to center	2284.00
20" Fay Automatic	20" swing x 25" center to center	$1569.00
20" Fay Automatic	20" swing x 37" center to center	1638.00
24" Fay Automatic	24" swing x 69" center to center	2717.00
Manufacturer: **LODGE AND SHIPLEY MACHINE TOOL COMPANY, CINCINNATI, OHIO**		
No. 1 "Duomatic"	16" swing over bed, 10" over slides, 39" centers	$1078.00
No. 3A "Duomatic"	20" swing over bed, 10" over slides, 15" centers	1772.00
No. 3A "Duomatic"	20" swing over bed, 10" over slides, 27" centers	1826.00
No. 3A "Duomatic"	20" swing over bed, 10" over slides, 39" centers	1879.00
No. 3A "Duomatic"	20" swing over bed, 10" over slides, 51" centers	1932.00
No. 3A "Duomatic"	20" swing over bed, 10" over slides, 63" centers	1986.00
No. 3A "Duomatic"	20" swing over bed, 10" over slides, 75" centers	2039.00
Manufacturer: **SENECA FALLS MACHINE COMPANY, SENECA FALLS, N. Y.**		
IMP Lo-Swing	4-1/2" swing over front and rear carriage, 8" centers	$ 746.00
IMP Lo-Swing	4-1/2" swing over front and rear carriage, 12" centers	769.00
LR Lo-Swing	5-1/2" swing over front and rear carriage, 10" centers	768.00
LR Lo-Swing	5-1/2" swing over front and rear carriage, 16" centers	815.00
LR Lo-Swing	5-1/2" swing over front and rear carriage, 22" centers	$ 854.00
LR Lo-Swing	5-1/2" swing over front and rear carriage, 34" centers	965.00
LR Lo-Swing	5-1/2" swing over front and rear carriage, 46" centers	1021.00
R-14 Lo-Swing	11-1/2" swing over front and rear carriage, 34" centers	2627.00
Manufacturer: **SUNDSTRAND MACHINE TOOL COMPANY, ROCKFORD, ILL.**		
8 Automatic Lathe	8" swing x 15" center to center	$ 715.00
8 Automatic Lathe	8" swing x 21" center to center	757.00
8 Automatic Lathe	8" swing x 28" center to center	816.00
10 Automatic Lathe	10" swing x 16" center to center	$ 976.00
10 Automatic Lathe	10" swing x 22" center to center	1020.00
10 Automatic Lathe	10" swing x 34" center to center	1128.00
10 Automatic Lathe	10" swing x 46" center to center	1242.00
12 Automatic Lathe	12" swing x 22" center to center	$1126.00
12 Automatic Lathe	12" swing x 34" center to center	1233.00
12 Automatic Lathe	12" swing x 46" center to center	1349.00
15 Automatic Lathe	15" swing x 22" center to center	$1102.00



CHUCKING MACHINE—AUTOMATIC, VERTICAL, MULTIPLE SPINDLE TYPE

Manufacturer: **BULLARD COMPANY, BRIDGEPORT, CONN.**

MODEL	SIZE AND CAPACITY	SALES PRIC
D "Mult-au-Matic"	34" swing 4 spindle	$19393.0
D "Mult-au-Matic"	8" swing 6 spindle	6136.0
D "Mult-au-Matic"	12" swing 6 spindle	6506.0
F "Mult-au-Matic"	7" swing 12 spindle	6380.0

SCREW MACHINE—SINGLE AND MULTIPLE SPINDLE BAR TYPE AUTOMATIC

Manufacturer: **CONE AUTOMATIC MACHINE COMPANY, WINDSOR, VT**

MODEL	SIZE AND CAPACITY	SALES PRIC
SK Automatic Screw Machine	1-1/2" diameter bar capacity, 6 spindle	$3066.00
SN Automatic Screw Machine	2" diameter bar capacity, 6 spindle	3307.00
SD Automatic Screw Machine	2-1/4" diameter bar capacity, 6 spindle	3446.00
SE Automatic Screw Machine	2-5/8" diameter bar capacity, 6 spindle	3932.00
SF Automatic Screw Machine	3-1/2" diameter bar capacity, 6 spindle	4432.00
WW Automatic Screw Machine	1-1/2" diameter bar capacity, 8 spindle	$3065.00
XX Automatic Screw Machine	1-7/8" diameter bar capacity, 8 spindle	3132.00
DD Automatic Screw Machine	1-1/2" diameter bar capacity, 8 spindle	2360.00
VB Automatic Screw Machine	1-5/8" diameter bar capacity, 8 spindle	3132.00
MM Automatic Screw Machine	1-7/8" diameter bar capacity, 8 spindle	2529.00
Manufacturer: **GREENLEE BROTHERS AND COMPANY, ROCKFORD, ILL.**		
1" Automatic Screw Machine	1" diameter bar capacity, 6 spindle	$2216.00
1-5/8" Automatic Screw Machine	1-5/8" diameter bar capacity, 6 spindle	2636.00
2" Automatic Screw Machine	2" diameter bar capacity, 6 spindle	3269.00
Manufacturer: **THE NATIONAL ACME COMPANY, CLEVELAND, OHIO**		
3/8" R-6 Automatic Screw Machine	3/8" diameter bar capacity, 6 spindle	$2105.00
9/16" RA-6 Automatic Screw Machine	9/16" diameter bar capacity, 6 spindle	1602.00
1" RA-6 Automatic Screw Machine	1" diameter bar capacity, 6 spindle	3036.00
1-1/4" RA-6 Automatic Screw Machine	1-1/4" diameter bar capacity, 6 spindle	3465.00
1-5/8" RA-6 Automatic Screw Machine	1-5/8" diameter bar capacity, 6 spindle	$4118.00
1-5/8" RB-6 Automatic Screw Machine	1-5/8" diameter bar capacity, 6 spindle	4118.00
2" RA-6 Automatic Screw Machine	2" diameter bar capacity, 6 spindle	4350.00
2" RB-6 Automatic Screw Machine	2" diameter bar capacity, 6 spindle	4350.00
2" RAS-6 Automatic Screw Machine	2" diameter bar capacity, 6 spindle	$4350.00
2-5/8" RA-6 Automatic Screw Machine	2-5/8" diameter bar capacity, 6 spindle	4969.00
2-5/8" RB-6 Automatic Screw Machine	2-5/8" diameter bar capacity, 6 spindle	4969.00
3-1/2" RA-6 Automatic Screw Machine	3-1/2" diameter bar capacity, 6 spindle	5781.00
Manufacturer: **NEW BRITAIN-GRIDLEY MACHINE COMPANY, NEW BRITAIN, CONN.**		
60 Automatic Screw Machine	5/8" diameter bar capacity, 6 spindle	$1778.00
204 Automatic Screw Machine	5/8" diameter bar capacity, 6 spindle	1059.00
60 Automatic Screw Machine	1" diameter bar capacity, 6 spindle	2741.00
61 Automatic Screw Machine	1-3/8" diameter bar capacity, 6 spindle	$2299.00
61 Automatic Screw Machine	1-5/8" diameter bar capacity, 6 spindle	3373.00
61 Automatic Screw Machine	2" diameter bar capacity, 6 spindle	3560.00
61 Automatic Screw Machine	2-1/4" diameter bar capacity, 6 spindle	3662.00

CHUCKING MACHINE—SIX SPINDLE AUTOMATIC, HORIZONTAL

Manufacturer: NEW BRITAIN-GRIDLEY MACHINE COMPANY, NEW BRITAIN, CONN.

MODEL	SIZE AND CAPACITY	SALES PRICE
652 Automatic, Work Rotating Chucker	2" swing	$2682.00
654 Automatic, Work Rotating Chucker	3-1/2" swing	2885.00
65 Automatic, Work Rotating Chucker	5-3/4" swing	5058.00
665 Automatic, Work Rotating Chucker	6-1/2" swing	5139.00
675 Automatic, Work Rotating Chucker	7-1/2" swing	$5313.00
16 Automatic, Work Rotating Chucker	9" swing	4863.00
16 Automatic, Work Rotating Chucker	10-1/4" swing	5458.00
656 Automatic, Work Rotating Chucker	5-3/4" swing	5058.00
Manufacturer: THE BAIRD MACHINE COMPANY, BRIDGEPORT, CONN.		
76H Automatic, Work Rotating Chucker	7" swing	$3880.00

FORGING MACHINERY AND HAMMERS—IMPACT STAMPING TYPE

Manufacturer: CHAMBERSBURG ENGINEERING COMPANY, CHAMBERSBURG, PA.

MODEL	SIZE AND CAPACITY	SALES PRICE
Elpic Ceco Stamp	30" R to L, 24" F to B, 36" stroke	$1343.00
Elpace Ceco Stamp	48" R to L, 36" F to B, 42" stroke	2074.00
Elplain Ceco Stamp	48" R to L, 48" F to B, 42" stroke	2455.00
Elpoint Ceco Stamp	66" R to L, 36" F to B, 48" stroke	2471.00
Elplank Ceco Stamp	66" R to L, 48" F to B, 48" stroke	$3684.00
Elplanet Ceco Stamp	66" R to L, 60" F to B, 48" stroke	3896.00
Elpale Ceco Stamp	96" R to L, 48" F to B, 48" stroke	3922.00
Elpublic Ceco Stamp	96" R to L, 60" F to B, 48" stroke	4642.00

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- one low price everywhere — any regional office, dealer or site sale.
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MILLING MACHINE—BED TYPE, HORIZONTAL SPINDLE PLAIN OR RISE AND FALL, SIMPLEX OR DUPLEX

Manufacturer: BROWN AND SHARPE MFG. CO., PROVIDENCE, R. I.

MODEL	SIZE AND CAPACITY	SALES PRICE
000 Plain (Simplex)	6" table travel x 8" width	$ 394.00
10 Plain, Electrically Controlled (Simplex)	12" table travel x 10" width	789.00
12 Plain, Electrically Controlled (Simplex)	18" table travel x 12" width	969.00
12 Plain, Electrically Controlled (Simplex)	24" table travel x 12" width	1009.00
Manufacturer: CINCINNATI MILLING AND GRINDING MACHINES, INC., CINCINNATI, O.		
34-36 Plain, Hydromatic	36" table travel x 16" table width	$1550.00
35-48 Plain, Hydromatic	48" table travel x 20" table width	1918.00
56-90 Plain, Hydromatic	90" table travel x 24" table width	2807.00
4-36 Duplex, Hydromatic	36" table travel x 16" table width	2471.00
Manufacturer: KEARNEY AND TRECKER CORPORATION, MILWAUKEE, WIS.		
1218 Automatic, Simplex	18" table travel x 12" table width	$1206.00
1842 Automatic, Simplex	42" table travel x 18" table width	1623.00
1854 Automatic, Simplex	54" table travel x 18" table width	1662.00
Manufacturer: KENT-OWENS MACHINE COMPANY, TOLEDO, OHIO		
1-8 Plain, Hydraulic, Single Spindle	8" table travel x 9" width	$ 454.00
2-20-DS Plain, Hydraulic, Double Spindle	20" table travel x 12" width	1433.00

DRILLING MACHINE—MULTIPLE SPINDLE WITH CENTRAL DRIVING UNIT

Manufacturer: NATIONAL AUTOMATIC TOOL CO., INC., RICHMOND, IND.

These prices apply only to exact model listed and cover types with nonadjustable fixed center drill spindle or spindles which are all driven by a separate motor mounted directly above spindle gear box and moving vertically with the gear box.

MODEL AND DESCRIPTION	SALES PRICE
Mod. B-2A Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	$1417.00
Mod. B-3A Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	1780.00
Mod. B-4A Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	2196.00
Mod. B-5A Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	4052.00
Mod. 2-AL Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	$1417.00
Mod. 3-AL Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	1780.00
Mod. 4-AL Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	2196.00
Mod. 5-AL Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	4052.00
Mod. 2-AH Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	$1417.00
Mod. 3-AH Natco Vert. Multi-Spindle Fixed Centers Drill With Separate Spindle Driving Motor	1780.00

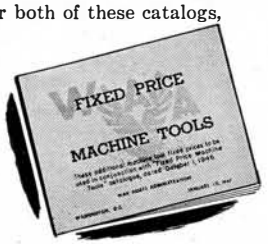
The above prices do not apply to general purpose adjustable Multi-Spindle Natco drilling machines equipped with slip spindle plates or with standard adjustable spindles.

ALL TOOLS SUBJECT TO PRIOR SALE

Get this new catalog list

If you can use any of the 29 additional types of production tools on which fixed prices have been established, send today for WAA's new (January 15) Fixed Price Machine Tool Catalog giving all sizes and new fixed prices.

PLUS—Catalog of sizes, models and prices of 31 types of production tools previously (October 15) placed on the fixed price list. For copies of one or both of these catalogs, simply write, phone or wire the nearest WAA office listed on the 4th page of this advertisement.



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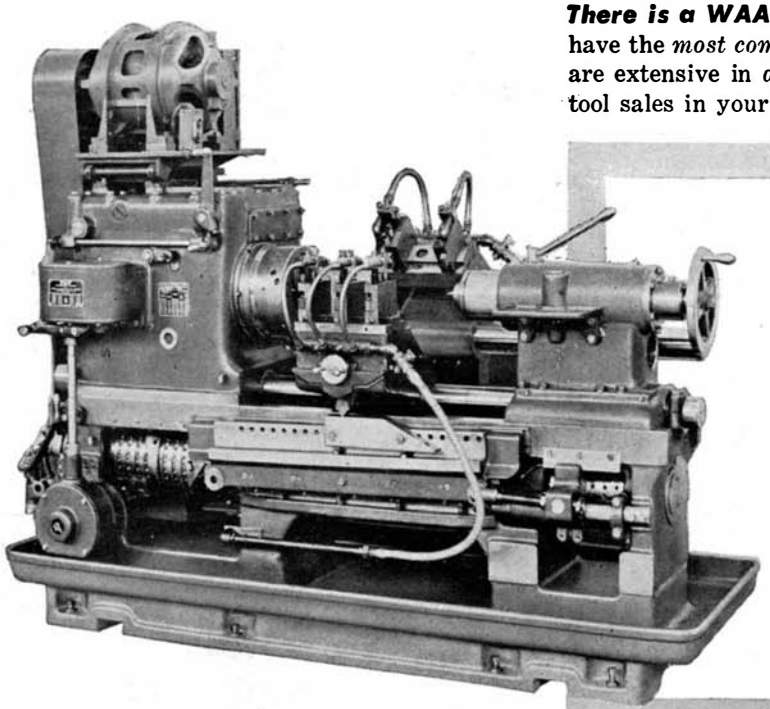
There is a WAA office near you — Offices listed below with a star have the *most complete* inventories of surplus machine tools—but stocks are extensive in *all* offices. Watch your newspaper for special machine tool sales in your area.



HOW NEW PRICE POLICY WORKS

New prices take into consideration the estimated cost of engineering and rebuilding the tools. For example:

Here is how WAA's new price has been set on a 20 inch Fay Automatic Production Lathe, 37" center to center, a Jones and Lamson machine. WAA code No. 3416-61-62-57.

Price (New)	**$7,059.00**
Previous WAA Sales Price (based on depreciation primarily)	**3,529.00**
Average Market Value	**2,130.00**
New WAA Fixed Sales Price	**1,638.00**
Available for Rebuilding	**$ 492.00**

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OFFICE OF GENERAL DISPOSAL

WAR ASSETS ADMINISTRATION

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