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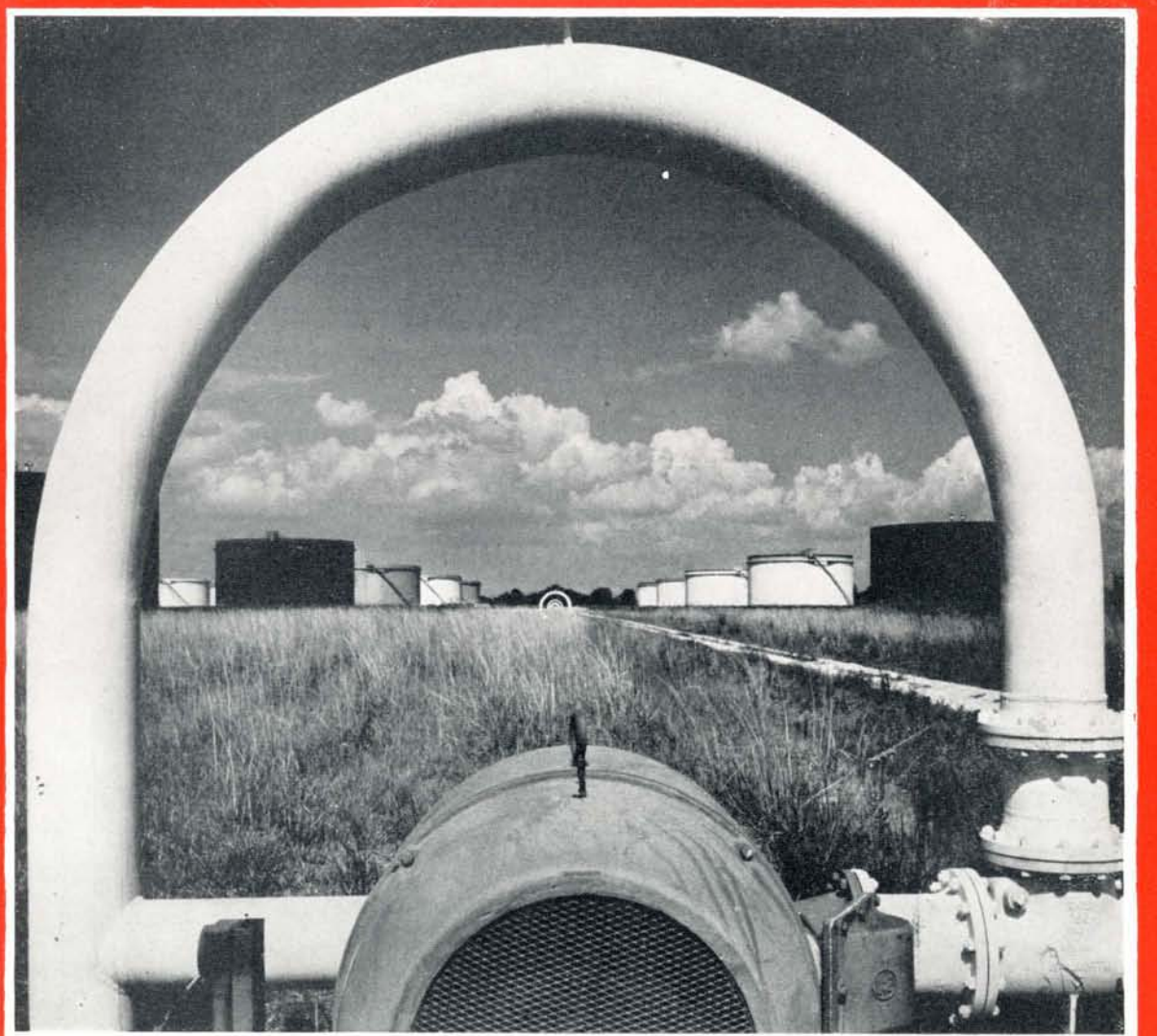
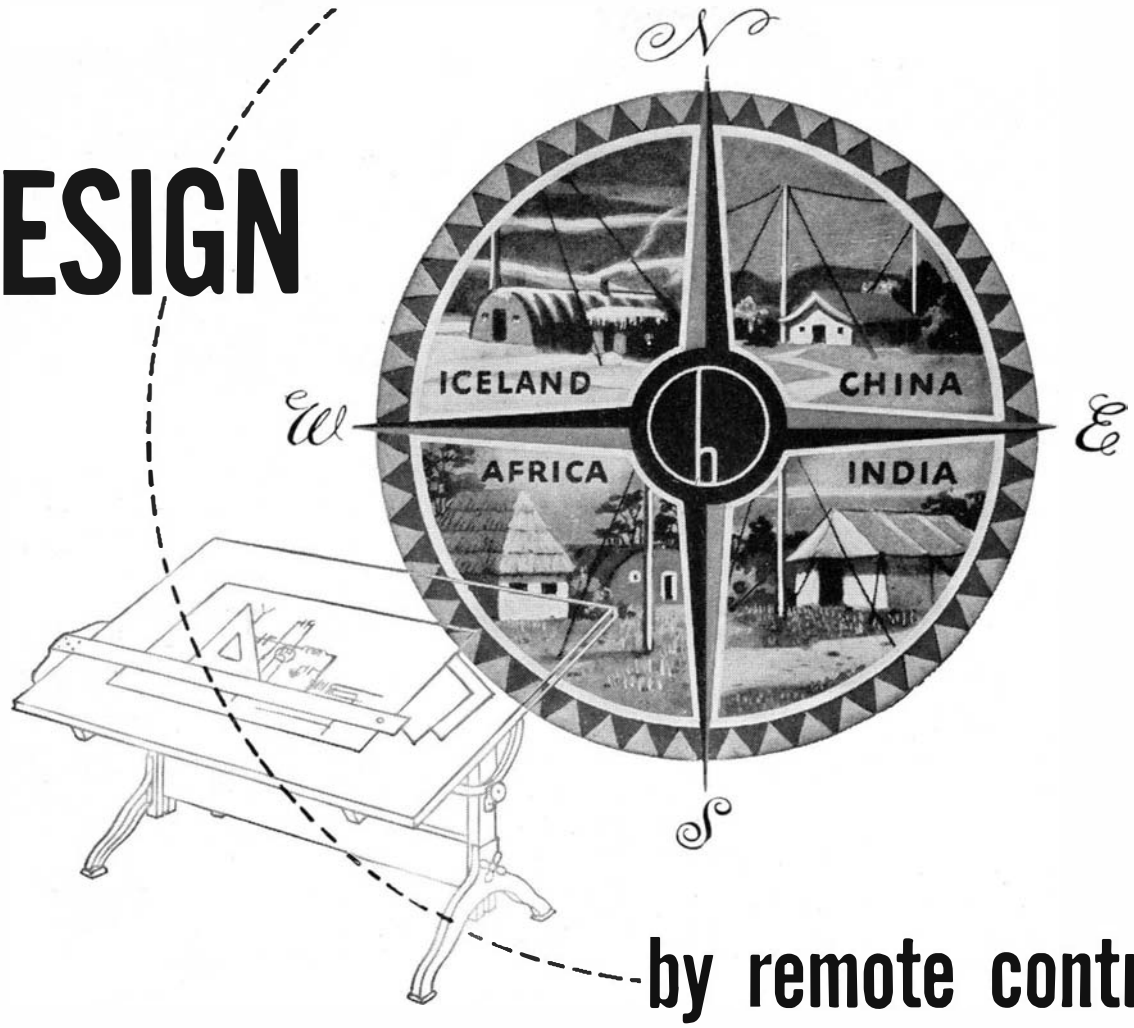


Storing Industry's Life-Blood . . . See page 257

The Story of THE PETROLEUM INDUSTRY

Anniversary Issue
No. 11

DESIGN



by remote control

The design of radio equipment that will come from Hallicrafters is already shaping up—determined largely by thousands of hams who, from their remote control locations all over the world, are sending advice and suggestions on new radio ideas to Hallicrafters engineering department.

Thousands and thousands of Hallicrafters pieces of high frequency radio equipment are in use in the armed services. In a high percentage of cases this equipment is used by operators with practical amateur experience. From these qualified experts Hallicrafters has received hundreds of letters telling how Hallicrafters-built equipment stands up under the most vicious battle conditions. Hallicrafters receives regularly many valuable suggestions from hams in the field and at home. From this rich deposit of "design by remote control" will emerge Hallicrafters new line—built to meet ham requirements, designed for the world's most exacting users—the radio amateurs.

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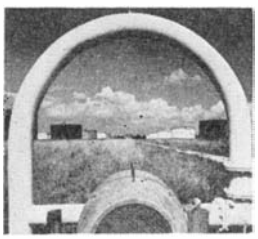

Our Cover: Tank "farms" located near oil refineries are studded with metal storage tanks containing from 55,000 to 140,000 barrels each. In foreground of our cover is a pump and by-pass, the "heart" which controls the flow of oil to and from the tanks. Courtesy Standard Oil Company (New Jersey)

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Previews of the Industrial Horizon

By A. P. Peck

OIL RUSH

WAR's heavy drain on known underground petroleum reserves and the probability that civilian consumption of all types of petroleum products will increase in the near and more distant future, demand that something be done about it. And several things are being done that brighten the oil horizon considerably.

Up in the Pacific Northwest there is a new oil rush on. At the time of writing, no oil has yet been found in the area around Portland, Oregon, but a number of dry wells have been drilled and abandoned, others are down several thousand feet, and new drilling is being started almost every day. Cause of all the excitement in this area, where wild-catting has been going on sporadically for almost a quarter of a century, is two fold. Surface formations in this section of Oregon are identical with those in the highly productive fields of California, and geophysical prospecting has given definite indication that the underground formations are of the type in which oil may be found.

Still farther north, in the Canadian province of Alberta, oil exploration is going on apace. Twenty miles from Turner Valley, Canada's most productive oil field, geologists are confident that a dome-shaped formation has been located that will soon be producing crude; out on the Alberta plains a well was drilled last year that produced 1000 barrels a day and is now being held back to 100 barrels. Since then, other producing wells have been drilled, and still more are going down.

This is a brief view of part of the exploratory work that is going on in an effort to increase the proved oil reserves of the world. But there is another part of the picture that may someday become as important to the oil industry as the familiar drilled wells. This involves the extraction of petroleum from shale and sand. This type of work has been carried out on a small scale in many parts of the world but has the drawback that costs are too high. Now Socony-Vacuum has announced a new method of processing oil shale which, while still expensive, could make available 90 billion barrels of petroleum or in excess of four times the present probable proved crude oil reserves.

Now, back to Canada again, and to northern Alberta. Here, in and around Fort McMurray, is what has been reported as one of the world's largest oil reserves. The oil is at or near the surface, but it is mixed with sand; extracting the oil, again as in the case of shale, is expensive. However, four companies are actively at work in this region and have developed fairly economical methods of separating the oil from the sand. But then they are faced with the problems and expense of transportation. At present there is only a single-track railroad to the oil-sands area and freight rates are high. Someday a pipe-line to the "outside" may open up this rich resource.

Eventually the oil resources of this world are going to dwindle and disappear, but the work that the oil industry is doing today seems to be pushing that day farther into the future instead of bringing it closer.

MAGNESIUM POSSIBILITIES

LIGHTER than aluminum and, like that metal, available in almost unlimited quantities, magnesium may be considered as a war baby that has cut all its teeth and is now lustily chewing its way into many phases of industry. Thus far the surface has only been scratched, and the wheelbarrows and other gadgets that have been featured in the daily press are mere straws in the wind. Wherever lightness and rigidity are required, there magnesium holds promise. Production problems have been solved; the metal can be adequately protected from corrosion; methods of welding have been perfected; casting procedures no longer present difficulties—all in all, magnesium is not only ready to go, but it is going places rapidly.

In the textile industry magnesium is replacing steel and wood for such parts of machinery as have to be handled in the mill or sent by freight; thus labor and transportation costs are reduced. Used in fabricating movable roller conveyors, magnesium makes the unit so light that one man can move it from place to place instead of calling for additional help or using a plant truck. These are only two concrete examples; the future will disclose many more possibilities as thinking machine designers delve into available facts about magnesium and really put the metal to work.

PUDDING PROOF

NO ONE department of an airline can anticipate all the various problems which may arise in connection with the operation of an airplane. With this truism in mind, American Airlines has invited nearly all of its 10,000 employees to aid in the selection of a new utility type of plane. The plane to be used will be selected from several specifications after the employee survey is completed.

Here is an approach to an industrial problem that parallels familiar consumer polls. It could well be extended to machine tools, plant layout, materials handling, and even materials selection.

SMOKELESS CITIES

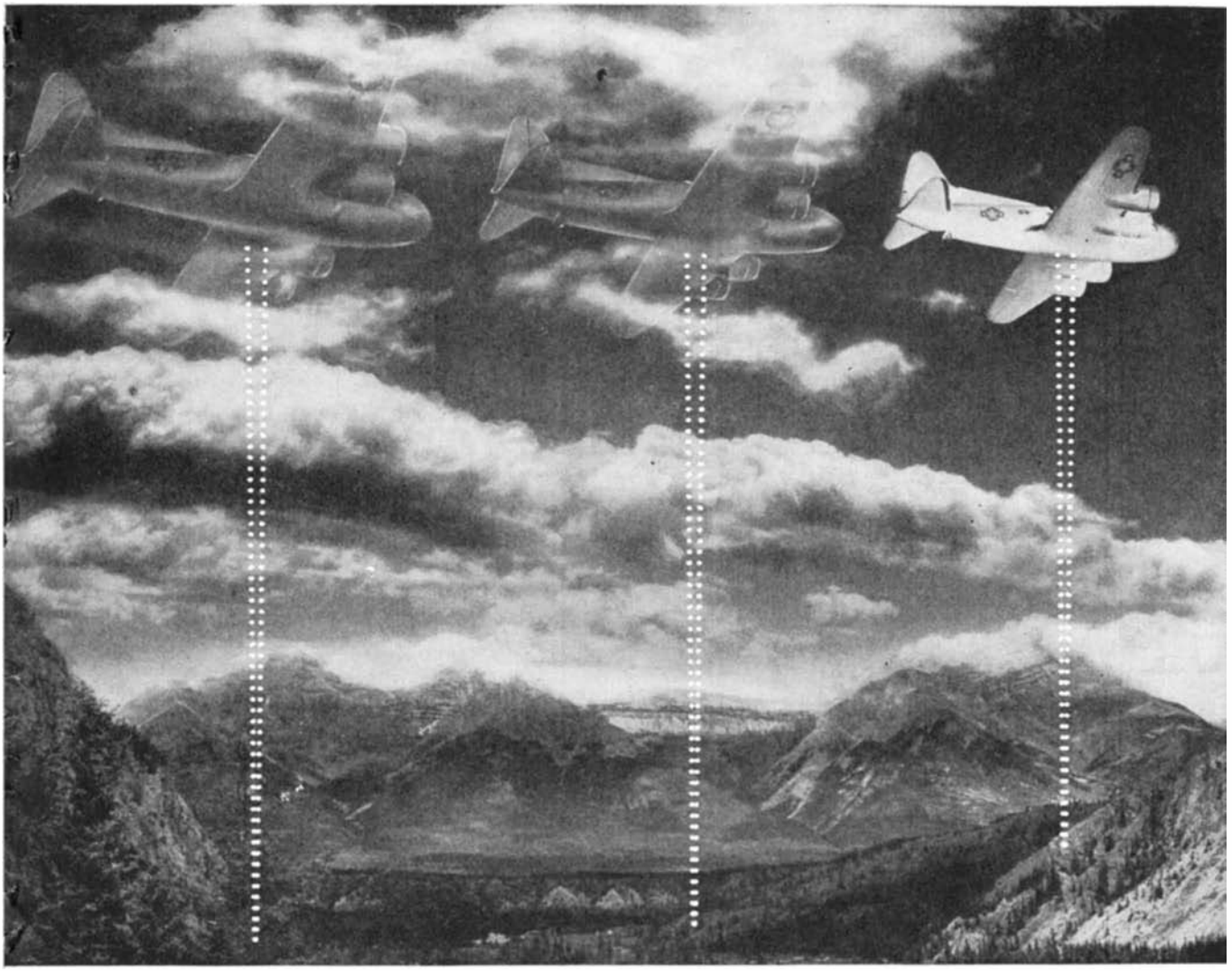
JUST BEFORE the war, St. Louis succeeded, by passing laws that were drastically enforced, in virtually eliminating industrial and residential smoke from its atmosphere. Other cities were ready to follow suit when the war emergency pushed the problem into the background. Now the question of city smoke comes up again.

In the meantime, smoke precipitators have been improved, smokeless stoves burning bituminous coal have been developed, and furnace attachments have been perfected which eliminate smoke. Another approach to the problem is group heating of buildings, where highly efficient fuel-burning equipment is in charge of an experienced fireman.

City smoke is wasteful, not only from the fuel standpoint but because it increases laundry and painting bills and probably has serious health implications. It can, and should, be eliminated.

FOR FUTURE REFERENCE

BY USING aluminum as a coating for steel and as a deoxidizing agent in the manufacture of steel, it is foreseen that the steel industry will become one of the principle customers of the aluminum industry. . . The Department of Agriculture estimates that farmers in the United States may buy 200,000 tractors a year for the next three years. . . Despite cancellations, machine-tool manufacturers report huge backlogs of orders, especially in high-production machines; apparently few industries are willing to wait for release of government owned equipment, both because of the time element and the risk of obtaining tools that are on their last legs. . . In a recent housing survey, only 3 percent of the people questioned said that they were considering purchase of prefabricated houses . . . Fallen trees, left in the woods from one logging season to the next, may be saved from insect destruction by DDT.



The RCA Radio Altimeter assures that the last mountains have been passed before letting down to the airport in the valley below.

Measuring "every bump on the landscape" —at 20,000 Feet!

A radio altimeter—that indicates the exact height above land or sea—is another RCA contribution to aviation.

Old-style altimeters gave only the approximate height above sea level—did not warn of unexpected "off-course" mountains.

To perfect a better altimeter was one of science's most baffling problems. So RCA developed an instrument so accurate it "measures every bump on the landscape" from the highest possible altitudes... so sensitive it can measure the height of a house at 500 feet!

This altimeter—actually a form of radar—directs radio waves from the airplane to earth and back again . . . tells the pilot exactly how far he is from the ground... warns of dangerously close clearance . . . "sees" through heaviest fog or snow.

All the radio altimeters used in Army, Navy and British aircraft were designed and first produced by RCA. This same pioneering research goes into *every* RCA product. So when you buy an RCA Victor radio, Victrola, television receiver, even a radio tube replacement, you enjoy a unique pride of ownership. For you know it is one of the finest instruments of its kind that science has yet achieved.

Radio Corporation of America, Radio City, New York 20. *Listen to The RCA Show, Sunday, 4:30 P. M., E. T., over NBC.*

The RCA radio altimeter will be a major contribution to the safety of post-war commercial flying. The section at the left sends the radio waves to earth and back again while the "box" at the right—timing these waves to the millionth of a second—tells the navigator the plane's exact height in feet.

RCA **RADIO CORPORATION of AMERICA**

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of November, 1895)

CARBORUNDUM—"Among the new industries resulting from the economical production of electrical current at Niagara Falls is that of Carborundum. . . To produce Carborundum at the lowest possible cost, and thereby permit of its general adoption as an abrasive for all classes of work, has of course been a subject of vast importance to the Carborundum Company, and after having investigated the possibilities of Niagara Falls as a manufacturing point, they determined to locate a plant in that city that they might have the benefits of cheap power from the Power Company and have also the advantage of railway facilities there offered."

PUNKAH PULLERS — "There are over 120 patents for punkah pullers, and yet none have come into general use in India. . . . So long as the coolie is cheaper than the cost of working a machine puller, there is no chance of their ever coming into general uses."

ELECTRIC LOCOMOTIVES — "The first of the lot of four electric locomotives to be built by the General Electric Company for the Baltimore & Ohio tunnel at Baltimore is in active service. The second one is being shipped in parts. The contract requires the engine to haul 15 loaded passenger cars and a locomotive at 35 miles an hour and 30 loaded freight cars and locomotive at 15 miles an hour through the tunnel up an 0.8 percent grade."

NATURAL GAS — "Since 1886 natural gas has been a commercial product in Kansas, where it has been found in numerous localities, although the total supply thus far ob-

tained has not been great. Quite recently, however, oil and gas were discovered in the southeastern part of the State, and several companies obtained leases and began prospecting, the Palmer Oil and Gas Company, of Ohio, operating in the neighborhood of Iola, Kansas. In a well recently drilled near that place, the pressure of the flow of gas was so great that drilling operations had to be suspended, and, after getting the well under control, the managers arranged to drill a second well by operating the engine and drilling plant with the high pressure gas obtained from the first well."

TRANSSIBERIAN — "A work of prime importance is now being accomplished in Asia, silently and without parade—the construction of the Transsiberian Railway. When finished, this line will exceed in length any of those that exist upon the globe. In fact, its length, from Tcheliabinsk, its initial point, to Vladivostok, its terminus, will be 4,536 miles, while the length of the Transcanadian, which is alone worthy of being compared with it, reaches, between Montreal and Vancouver, but 2,760 miles."

FIREPROOF — "The ideal fireproof building should fulfill three conditions: 1. It should be proof against attack from without. 2. The skeleton frame, consisting of steel columns and horizontal girders, should be inclosed in some thoroughly fireproof material. 3. It should be able to localize a fire, and confine it to the particular floor upon which it originates."

RATIONS — "The federal government has been experimenting at its various military posts with condensed army rations. . . . The theory of condensed rations is, not that they shall serve the army as permanent food, but rather as provision to be taken along in an emergency. The condensed rations have less weight and bulk than the regular rations, but the prime desideratum was that the food should be serviceable in emergency cases, for expeditions of about four days' duration."

INDIAN SILK — "Though the Indian trade in silk has fallen off since the days when the Portuguese found the silk-laden ships of the merchants of Cambay the greatest prize they could win, or the industry constituted the chief source of revenue to the old 'Honorable Company,' yet still it forms in the raw a very appreciable item in the commerce of India."

GLASS HOUSES — "The day may yet arrive when people will live in glass houses. A patent has been secured for glass bricks of a peculiar pattern. The material of which they are composed being a first rate non-conductor, these bricks will keep the cold out of a dwelling built of them, while admitting the light. It is claimed they will exclude noise, being hollow. Furthermore, the inmates of a glass house need not be afraid of being under too close observation by neighbors, inasmuch that it is not requisite that the bricks shall be transparent. They may be of opaque ground glass or of any color that may be suitable for decorative effect."

SAFETY — "A safety appliance for electric wires consists of a bracket at the top of the pole which supports the line, the bracket having at its extremity a pear-shaped loop, the inner portion of which has a sharp edge. . . When the line breaks it drops upon the sharp edge of the loop, which cuts the insulation, if there be any, and forms an electric contact with the bracket, and the bracket being connected by a wire with the ground, the fallen wire is immediately grounded and the portion lying outside of the loop or within reach is thus rendered harmless."

WATERWHEEL — "A waterwheel of remarkable construction has been introduced in the North Star mine, Grass Valley, Cal. It is eighteen feet in diameter, weighs 10,500 pounds and develops 250 horse power, running under 750 feet head, at 110 revolutions, and is directly connected to the shaft of a duplex compressor, compound tandem type, of same capacity. . . From a cast-iron hub radiate twenty-four steel spokes, which are connected to a rim made up of angle iron properly shaped, having a slat for the buckets, which are bolted to the periphery, the strain being taken by four heavy steel truss rods."

LIQUID AIR — "An interesting illustration of the rapidity with which purely scientific discoveries frequently become the starting point of new industries is furnished by the case of liquid air. It is no long time since liquid air was produced for the first time in quantities great enough to admit of its application for purposes of research; yet steps are already being taken to treat liquid air as an article of commerce and to turn it out upon a large scale."

WOOD "CANS" — "Wood pulp fruit cans are among the latest applications of wood fiber to a useful purpose. One method of manufacture consists in taking the soft pulp direct from the wire netting and moulding it into cylindrical form, about the length of a dozen cans, and keeping it as hollow tubes until ready for cutting and heading."

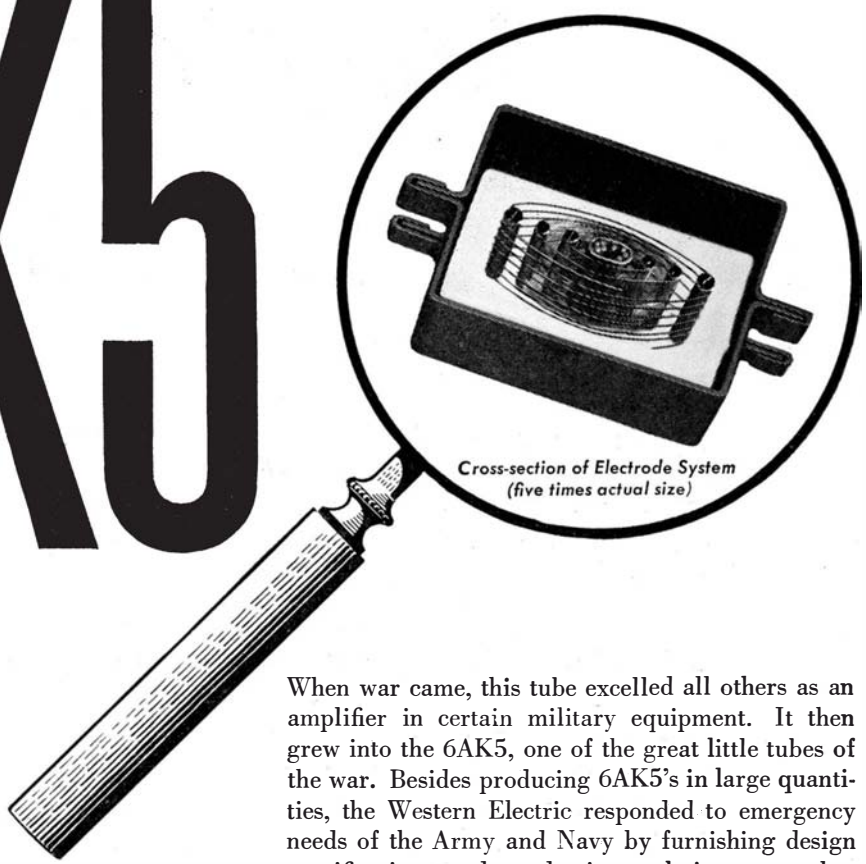
• • •

TINY GIANT WITH A HISTORY

Long before the war, the men who design your Bell Telephone System were looking for an electron tube with frequency capabilities never before attained. With it, they could transmit wide bands of telephone messages — several hundred of them — simultaneously through coaxial cable—economically, and over long distances.

They developed a tube which set a new standard in broad-band, high-frequency amplification. So minute that its electrode system had to be inspected under a magnifying glass, the tube could amplify either the voices of 480 people talking at the same time, or the patterns of television. Long-distance, broad-band transmission became a commercial reality.

6AK5



Cross-section of Electrode System (five times actual size)

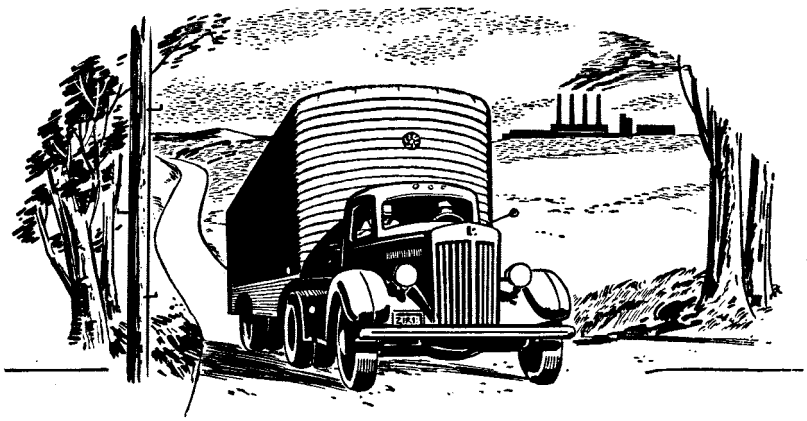
When war came, this tube excelled all others as an amplifier in certain military equipment. It then grew into the 6AK5, one of the great little tubes of the war. Besides producing 6AK5's in large quantities, the Western Electric responded to emergency needs of the Army and Navy by furnishing design specifications and production techniques to other manufacturers, of whom at least five reached quantity production. On every battlefront it helped our ships and planes to bring in radio signals.

Developing electron tubes of revolutionary design has been the steady job of Bell Laboratories scientists ever since they devised the first practical telephone amplifier over thirty years ago. Now tubes like the 6AK5 will help speed the living pictures of television, as well as hundreds of telephone conversations simultaneously over the coaxial and radio highways of the Bell Telephone System.

BELL TELEPHONE LABORATORIES

Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service.

BETTER GASOLINE IS HERE!



You can utilize today's gasoline quality to pay extra dividends in power and economy

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BETTER GASOLINE is no longer a hope — it's a reality. Gasoline companies are now supplying gasoline with improved base stock and higher octane ratings.

This high-quality fuel will be of great value to truck operators, who are faced with the changing conditions of the postwar world—heavier competition in the truck field, demand for better service, and the need for lower ton-mile operating costs. *Higher octane gasoline, used to full advantage, can help provide the extra power, performance and economy needed to solve these problems.*

In ordering new equipment, you'll want to specify compression ratios to utilize better gasoline. Many engines now in service can also be brought up to date—can be modified to utilize improved antiknock value.

By keeping pace with gasoline improvements you will be taking a long step toward more economical operation per ton mile.

More power from every gallon of gasoline and from every cubic inch of engine displacement through

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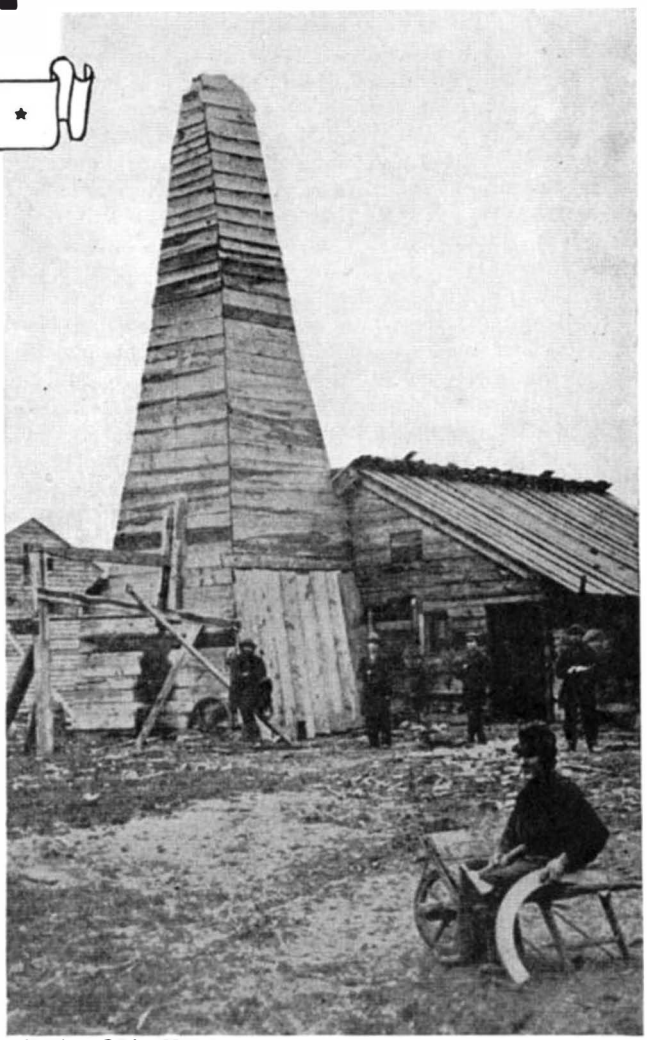
Scientific American
NOVEMBER • 1945

* 100th Anniversary Year *

Life-Blood Of The World

Petroleum Was Known and Used in Limited Ways for Thousands of Years Before It Was First Deliberately Sought After on a Commercial Scale. Then Came "Drake's Folly" and the Dawn of the Petroleum Age. The Development of Production, Transportation, and Processing of Crude Oil Presents a Vivid Background Against Which to Evaluate Achievements of the Petroleum Industry

By **RUSSELL HOGIN**
American Petroleum Institute



Courtesy Drake Museum

The famous Drake oil well rig as it appeared about 1864. In the foreground, sitting on wheelbarrow, is "Uncle Billy" Smith, who did the actual drilling

REAL beginnings of the petroleum industry of the world date back only to the middle of the 19th Century, when Drake drilled the first well ever sunk in deliberate search of a supply of "black gold." Yet, as long as history has been recorded, and even before, mankind has been making use of petroleum in one or another of the many natural forms in which it is found. The chariots of ancient Egypt's pharoahs were greased with a lubricant provided by nature and the bodies of these mighty monarchs were preserved in pitch obtained from the same sources. Herodotus relates that the walls of Babylon were cemented by a mortar of pitch; the curious round boats that have plied the waters of the Euphrates from the time of Nebuchadnezzar to the present day are made water-tight with pitch; the Bible states that Noah's Ark was made of gopher wood, pitched "within and without with pitch."

The Zoroastrians of ancient Persia built their temples around natural gas vents in what is now the Baku oil field and thus obtained the "eternal fire" which they worshipped. The more practical Chinese were using natural gas carried through bamboo pipelines to heat and light their houses 2000 years ago, and Pliny tells us that oil from Sicily was burned in the temple of Jupiter. There are many other references to the use of petroleum in ancient times and there is, in addition, a large body of evidence of its use not set down in written history.

One of the strangest of the latter is that oil pits were dug in eastern North America at least hundreds of years before the first white man set foot on this continent. These ancient workings in the oil regions of Pennsylvania, Kentucky, and Ohio have been examined carefully by a number of early historians who fairly well agree that these pits are hundreds of years old and that they were used to collect oil. These workings had long since been abandoned when they were first noticed by early-day explorers. Large trees were growing out of some of them, testifying to their age.

Nobody knows who the ancient people were who dug these pits, nor the use to which they put the oil. The pits do not resemble the work of Indians, who were not given to the digging of wells. These ancient oil pits were carefully prepared, frequently lined with timbers that had been hewn with stone axes, and in some cases were dug to a considerable depth. The evidence is strong that the eastern petroleum fields were producing oil hundreds of years ago and on a more extensive scale than they were when the white man first penetrated these regions.

The first Europeans to visit the New World found the Indians collecting and using petroleum. Spanish explorers visiting Peru in 1527 named La Brea after the asphalt deposits there. Juan Rodriguez Cabrillo, a Portuguese navigator in the employ of the Spanish, toured the coast of California in 1542-3 and found the Indians at what is now Carpenteria, California, waterproofing their dugout canoes from a pitch deposit there. Cabrillo took advantage of the deposit to repair his

ships, as did many navigators in those distant days of uncharted seas and fragile wooden ships. At approximately the same time a group of the survivors of the De Soto expedition, attempting to make their way from the mouth of the Mississippi back to Mexico, were blown ashore near Sabine Pass, Texas, and repaired their boats at a nearby pitch deposit.

The first written reference to the use of petroleum on this continent in its more familiar liquid form was made in 1627 by a French missionary, Joseph de la Roche D'Allion. This lay brother followed the Indian trails to a famous oil spring near what is now Cuba, New York, which was under the control of a branch of the Iroquois tribe whom the French called the "Neutral" Indians. Warfare was forbidden in the area around the spring over which these Indians held sway, and access to the oil was open to all.

De la Roche recorded his experiences in a letter dated July 18, 1627, in which he said that "these Indians collect a good kind of oil called Antonotons, which is translated to mean 'oh how much there is of it.'" Other French missionaries later visited the spring, and by 1670 it was marked on a map of the French colonies.

For two centuries thereafter, the story of petroleum follows an unvarying pattern. As the early traders and explorers followed the Indian trails across the Alleghenies, the Great Smokies, and up into Texas from Mexico, they found the Indians collecting seepage oil and using it as a medicine for themselves and as a cure for ailments of horses. The early travelers and settlers followed their example.

The Indians had an unusual custom of "peace trails" and "war trails." Situated on the peace trails were common necessities such as salt deposits, oil springs, and the like. A party of Indians traveling the peace trail could traverse hostile areas to obtain these necessities without danger of attack. The early white men noted this and acted accordingly. The trail down Oil Creek in Venango County, Pennsylvania, was one of these peace trails. Petroleum flowed as scum over the surface of this creek, which later was the scene of the first oil well and the first oil boom. The seepage area in Nacogdoches County, Texas, was known to travelers

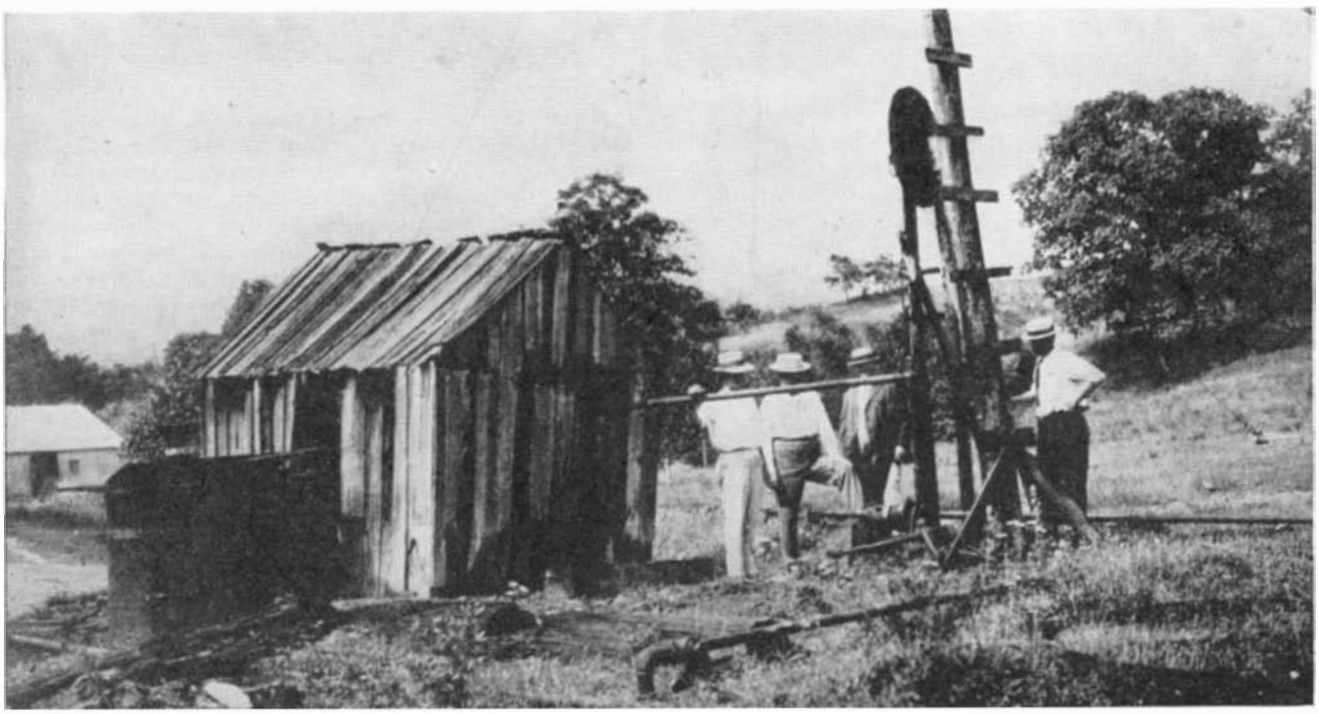
"Kicking down" a well in the early days of the oil industry was only a slight improvement on the method used in China for many centuries to sink water wells

up the Spanish Trail as early as 1790. They collected the oil to use as a lubricant for the axles of their wagons and carts, in addition to the common use as a supposed cure-all for man and beast.

William Byrd III noted two oil springs southwest of Richmond, Virginia, in 1705, although their exact location is now unknown and in 1753 George Washington and General Andrew Lewis received a patent on a section of land near Charleston, West Virginia, that contained a "burning spring." All of these and doubtless many other oil seeps were known and visited by the early settlers.

DESPISED PETROLEUM — The world's first oil well was drilled in 1859, but the method by which it was drilled was developed west of the Alleghenies in 1806. Salt was a highly prized commodity in the newly settled western country and the Ruffner brothers started a salt works in 1806 at what is now Charleston, West Virginia. Their procedure was to drill a well to salt water, which then would flow to the surface in artesian fashion; the salt was obtained from the brine by evaporation.

The Ruffners' method was to dig a shaft down to

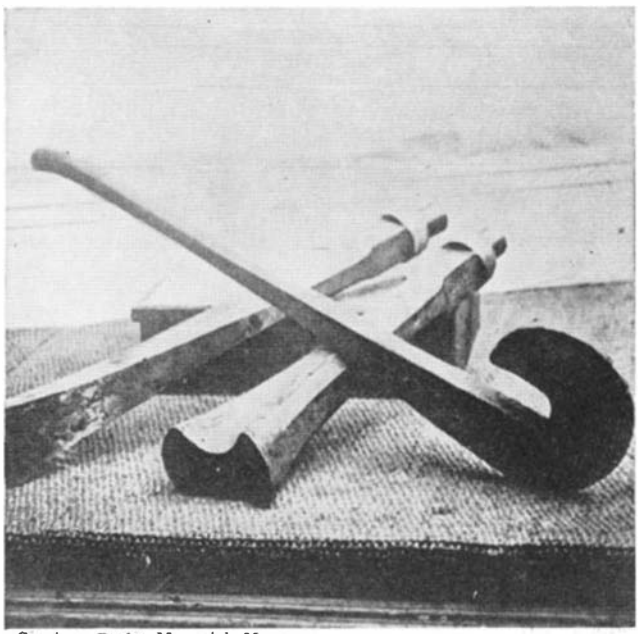


From Scientific American

Oil well in Ohio, drilled in 1864, which has continued to produce for over three quarters of a century

bedrock and to fix a "conductor" made of a hollow sycamore log in the shaft. They then drilled through the log down to a depth of 58 feet, where they struck a strong flow of salt water. The Ruffners encountered only a small amount of oil in their well, but did get a flow of natural gas which they used for fuel for evaporating the water from the salt. Many of the later salt-well drillers were not so lucky. They got large quantities of petroleum, for which they had no use whatsoever.

It is of interest to note the Ruffners' drilling method, not only because it was widely used in the early oil fields, but because the Chinese had invented it 2000 years before. The chief feature of the method was the spring pole, a green tree trunk some 40 feet in length with one end firmly imbedded in the ground or attached to the butt of a tree. The pole passed over a forked post, with the lighter, or spring, end of the pole extending over the drilling site. The drilling tools were attached



Courtesy Drake Memorial Museum

Tools used in drilling the Drake oil well in 1859

to the spring pole. These consisted mainly of a heavy length of iron, slightly sharpened on the end, and chained to the spring pole. A couple of men would throw their weight on the spring end of the pole, thus dashing the iron bit against the bottom of the hole. There were a number of variations of this primitive method in later wells, but the spring-pole rig remained in use for a long time.

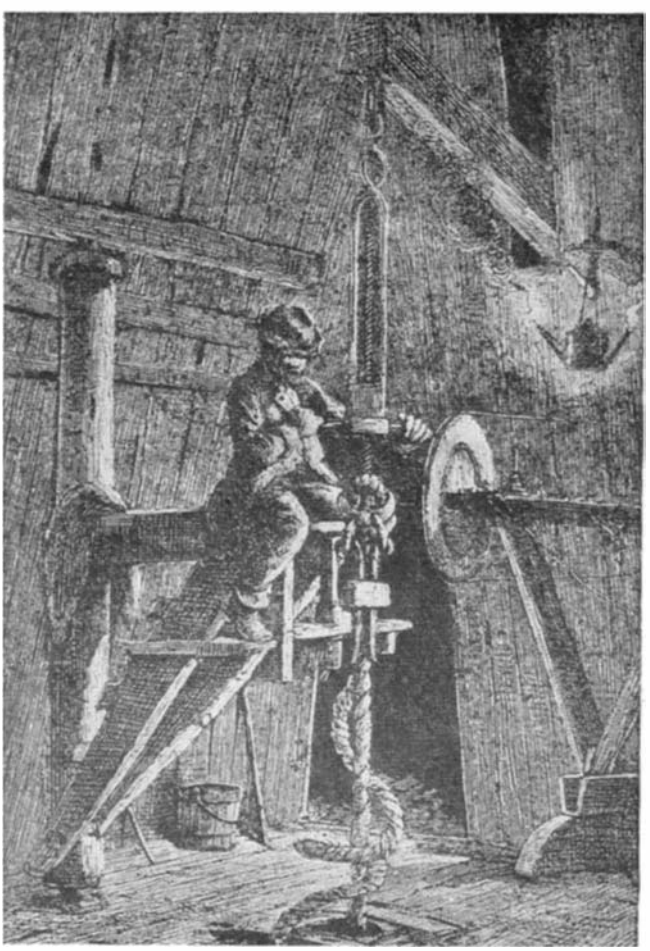
For almost half a century after the Ruffners drilled their first well, petroleum was a despised and thrice-cursed intruder to the salt-well drillers of the Ohio Valley region. Nobody wanted it. The small amount used as medicine and as a lubricant was readily obtainable otherwise and the remainder was not only a drug on the market, but a discouraging deterrent to the profitable business of obtaining salt. Oil ran out onto the ground from salt wells, floated down rivers and streams, caught fire, and served mankind only as a topic of conversation in the pioneer countryside.

True, as early as 1819, men were suggesting simple refining methods to remove the unpleasant odor from burning crude oil, thus making it available as an illuminant, but nothing was done about it at the time. The best explanation for this apparent lack of foresight seems to be that the world simply was not yet ready for oil and men's imaginations had not envisioned its possibilities. We do know that when oil was found in quantity in 1829 in Cumberland County, Kentucky, as a result of the usual salt-well curse, it was allowed to flow for months down the Cumberland River, reaching as far as Gallatin, Tennessee, 100 miles away. The oil later caught fire, and the "burning Cumberland" was noted and commented upon all over the burgeoning United States.

The times cried for a new source of light. In common use were tallow candles, sperm oil lamps, pine knot torches, and open fires—essentially unchanged since the dawn of history. The world wanted something better and in various countries men were seeking it. James Young of Scotland distilled "paraffine oil" from shale and coal in 1848; Abraham Gessner, a Canadian, started the manufacture of illuminating oil from coal at about the same time. Gessner called his product "kerosine," but "coal oil" was the popular name for it for years to come. Tiny refineries sprang up throughout the United States and a brisk industry was aborning when Colonel Edwin L. Drake drilled the world's first oil well on the banks of Oil Creek, near Titusville, Pennsylvania, on August 27, 1859, and the Petroleum Age began.

DEVELOPMENT STARTS — Many men had a part in that first oil well. It was the result of a chain of actions. The time was ripe for beginning the development of this great natural resource and men and events moved in sequence to bring it about.

George H. Bissell, New York lawyer and New Haven businessman, started it. The story goes that, in 1854, he visited Dartmouth College, his alma mater, and called upon Professor Crosby of the chemistry department. The professor showed Bissell a small bottle of crude



Well drilling in the early days of the oil industry

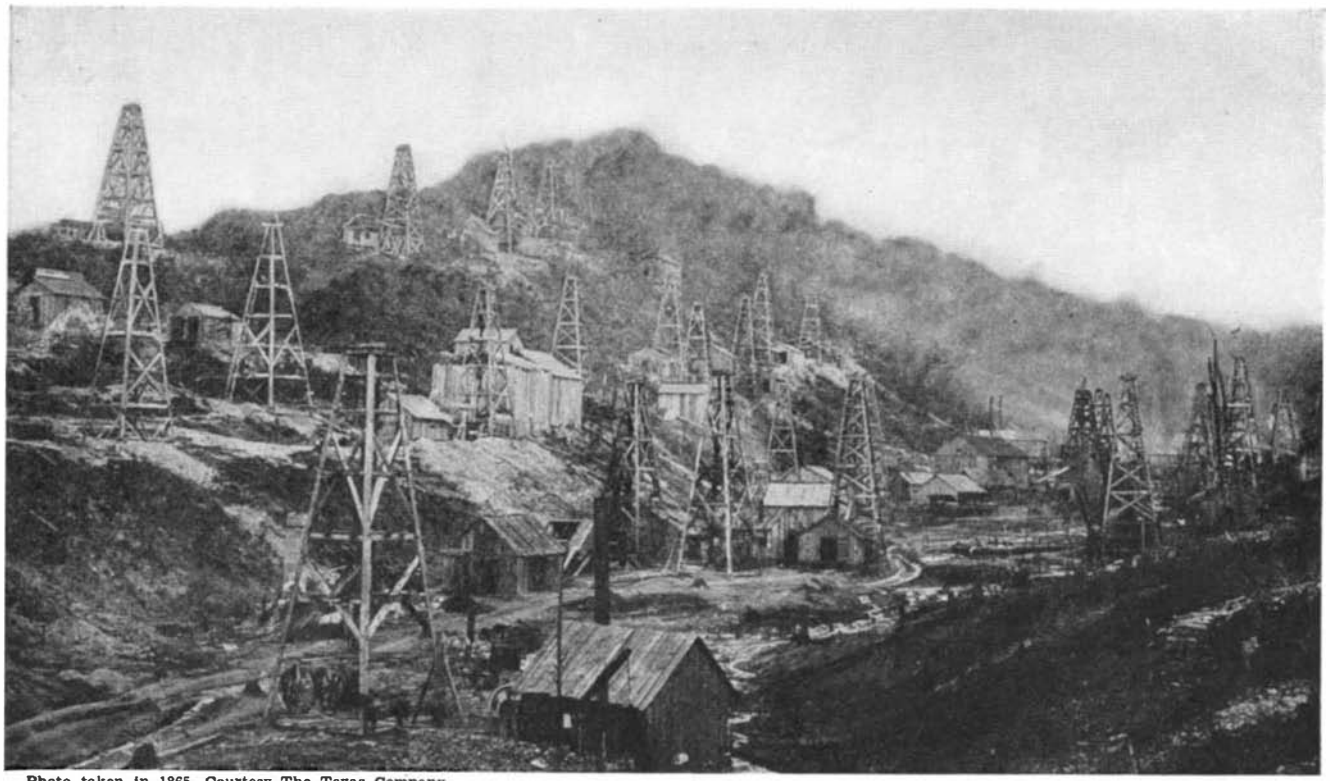


Photo taken in 1865. Courtesy The Texas Company

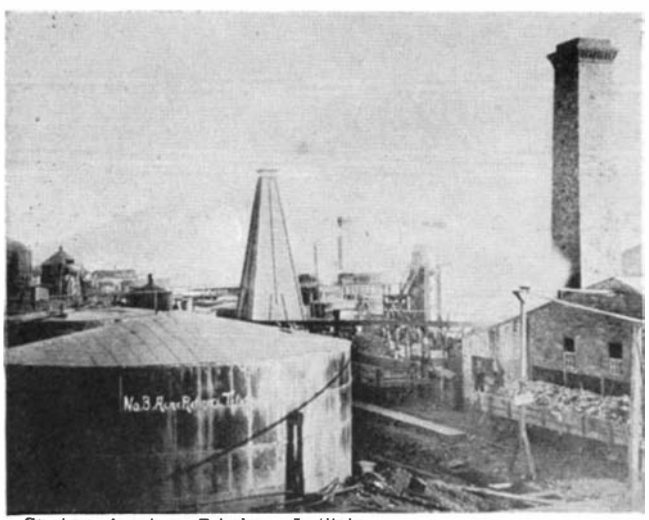
Within a few years after the Drake well was brought in, oil derricks dotted the Pennsylvania and Ohio country sides

oil sent by his nephew, Francis B. Brewer, who had collected it from an oil spring on his father's land near Titusville, Pennsylvania.

Bissell was impressed. Here was Opportunity with a capital O and he determined to take advantage of it. Persuading his former law partner, Jonathan G. Eveleth, to join him, Bissell leased, in November of 1854, 105 acres of land from Brewer for 99 years without royalty. The price was $5000; $500 down and the rest on notes from Bissell.

The opening move of this first oil operation was to have the land trenched to collect the surface seepage oil. When three barrels had been collected, they were sent to Benjamin Silliman, Jr., professor of chemistry at Yale University.

The report of this chemist is a monument to scientific analysis. He analyzed the many components of the crude oil and set the pattern for refining that has endured to this day. He concluded with the statement that many valuable products could be obtained from petroleum. That did it. While it took Bissell five years to get an oil well—and many more years for refining to emerge from its swaddling clothes—nevertheless the basic facts about this great mineral resource were resolved.



Courtesy American Petroleum Institute

One of the early Pennsylvania oil refineries

ORGANIZING FOR OIL — Backed by the Silliman report, Bissell and Eveleth obtained limited backing from a banker, James M. Townsend, and others and that same year, 1854, the Pennsylvania Rock Oil Company was formed. The company later was reorganized as the Seneca Oil Company and it was this latter concern that drilled the Drake well.

There was Bissell, then, with oil land, with capital, and with a report that indicated a profitable use for the product. The problem was how to get it out of the ground in commercial quantities. Samuel M. Kier, a salt-well owner of Pittsburgh, provided the answer.

Kier, associated with his father, had put down two 400-foot salt wells on the Allegheny River near Pittsburgh. True to form, they produced some oil. The resourceful Kier, having no ready market for his oil, put it through a crude refining process, and put it up in half-pint bottles labeled "Kier's Petroleum or Rock Oil, Celebrated for its Wonderful Curative Powers. A Natural Remedy. Produced from a Well in Allegheny County, Pennsylvania, 400 Feet Below the Earth's Surface." Alongside the lettering were drawings of the derricks used in boring and pumping the brine wells.

Bissell saw one of these bottles in a New York drug store window in 1857 and decided immediately to drill for oil in the same manner in which salt wells were drilled. Colonel Edwin L. Drake, a 40-year-old railroad conductor, was hired by the company to go to Titusville and arrange to drill a well.

Colonel Drake, whose title was purely complimentary although it stuck to him for life, reached Titusville in May, 1858, and proceeded to encounter every kind of trouble possible to a new venture. He was beset by lack of finances, lack of faith, and lack of knowledge. His as-

sociates failed to meet their financial commitments and Drake was forced to strain his own limited credit to the utmost. The countryside, almost to a man, scoffed at the idea of drilling for oil. "Drake's Folly" became a topic of conversation as far away as Pittsburgh.

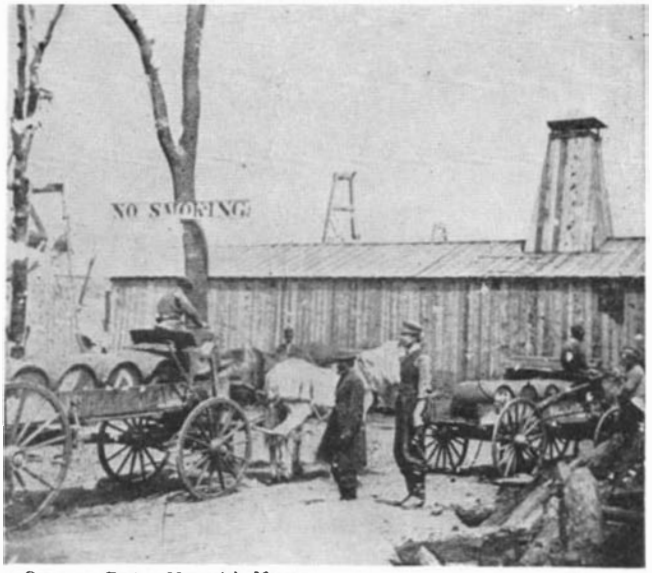
Drake was a patient, steadfast man, however. He visited the salt wells at Tarentum and studied drilling methods and talked to salt-well drillers. Finally, he found the experienced driller he needed for his experiment. That man was "Uncle Billy" Smith, who was assisted by his two sons. The well was rigged up in June, 1859, close by the oil spring from which Drake had been collecting seepage oil.

Then Drake made his big contribution to oil drilling. He had an iron pipe driven from the surface down 39 feet to solid rock. The drill stem was inserted in the pipe and the world's first oil well was on its way. On a sultry Saturday afternoon, August 27, 1859, Uncle Billy found oil bubbling in the pipe within a few feet of the surface. Bottom of the hole was at 69½ feet.

Uncle Billy jumped on a mule and hurried to Titusville to spread the good word. That oil brought $20 a barrel. Less than three years later, oil was down to 10 cents a barrel, so rapidly had the Oil Creek region between Titusville and Oil City been drilled after Colonel Drake pioneered the way.

For a good half dozen years or more, the Oil Creek area was a milling maelstrom of brawling rivermen and teamsters among closely packed oil wells. Vice flourished openly. Conflagrations were of almost daily occurrence. Mud—deep mud—was everywhere. It was a wild and roaring time as a great industry went through its birth pains.

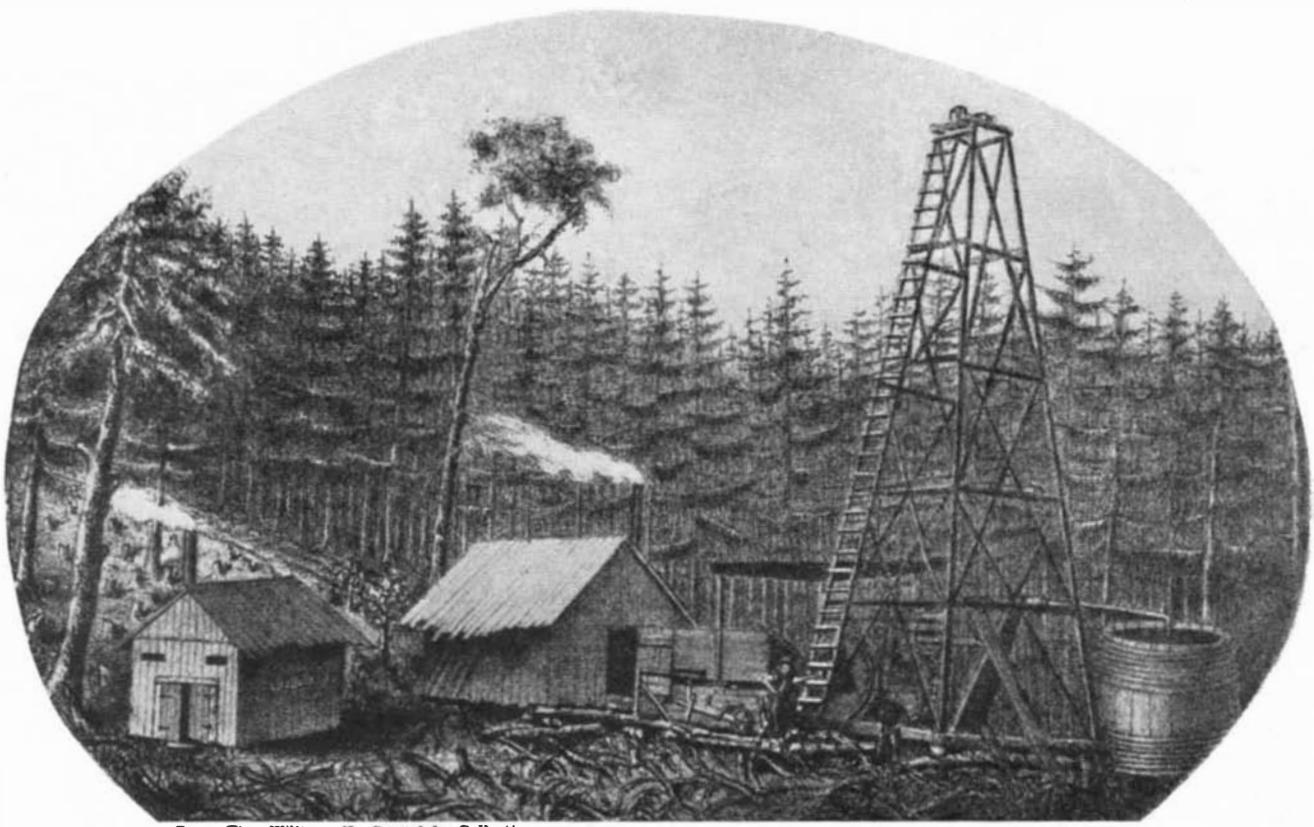
Refineries sprang up at Oil City, Pittsburgh, Philadelphia, Cleveland, and New York. (The first one was built at Titusville in 1860 by William Barnsdall and William H. Abbott.) These small "teakettle" refineries had one principal product, kerosine. Gasoline, produced naturally and as a by-product of kerosine refining, was known as "volatile spirits" or naphtha and was the curse of the industry. It was a dangerous nuisance that sometimes contaminated kerosine, causing lamps and lanterns to explode. Hence the gasoline at refineries was shot into the air as gas, dumped into lakes and streams, burned—or gotten rid of by whatever other expedient the exasperated refiner could find.



Courtesy Drake Memorial Museum

In the 1860s, before the advent of pipe lines, oil was transported in drums by slow horse-drawn wagons

OIL TRANSPORTATION — Earliest method of transporting crude oil from wells to refineries was in barrels carried on lumbering horse-drawn wagons. Dirt roads and mud limited severely the quantity of oil that could be carried and the speed with which it could be moved. However, from the middle 60's on, the industry made good progress in solving the important problem of trans-



From The William H. Coverdale Collection

One of 50 oil wells drilled in 1860 on Gaspe Peninsula, Canada. Production was small and they were abandoned

Courtesy American Petroleum Institute

Delivering kerosine in the old horse and buggy days

Fuel oil is delivered to homes today by tank trucks

portation. The first successful "long-distance" pipeline was constructed in 1865 by Samuel Van Syckel. It was a two-inch line, five miles long, in the Oil Creek region. In 1874, J. J. Vandergrift and George W. Foreman built the first trunk line—60 miles of four-inch pipe from the Oil Creek area to Pittsburgh and four years later work was begun on a line across the Alleghenies to the Atlantic seaboard.

The railroad tank car made its first appearance in 1865, to be followed three years later by the prototype of the present horizontal, cylindrical tank. Tank ships made almost equally rapid strides. The first transoceanic shipment of oil was one of five barrels from Philadelphia to London in 1861. By 1869, the *Charles* was fitted with 59 separate iron tanks with a total capacity of 714 tons and she plied regularly between the United States and Europe. In 1872, Palmer and Company of England built the first tank steamer, the *Vaterland,* for the Red Star Steamship Company of Antwerp and by 1885 more than 1000 vessels were transporting American oil across the waters. The "Lamps of China" were far from being the only ones that burned American oil.

Drilling and production of oil spread rapidly during these years. Oil was found in California in 1866, largely as the result of a report on California oil by Professor Silliman, similar to his 1854 report on Pennsylvania crude. In the east, production spread into West Virginia, Ohio, and Kentucky and later into Illinois, Indiana, Kansas, and Oklahoma. Dry holes were not very expensive in those days of shallow wells; any surface indication of oil—or nothing more convincing than a hunch—was enough to set off a drilling campaign.

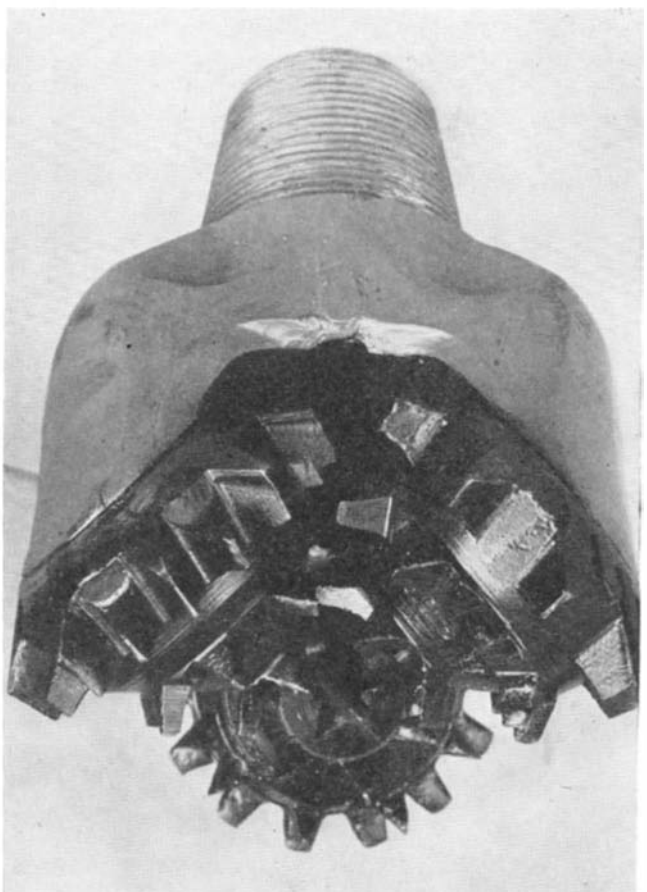
The present-day highly developed science of petroleum geology was practically non-existent, particularly insofar as the average producer was concerned. Men of learning were developing, debating, and expanding the anticlinical nature of petroleum deposits, but knowledge of their findings was confined to the few. All the crude necessary to meet the demands of the kerosine trade and the lubricants market was being produced, so the urge for more intensive exploration was wanting.

GASOLINE ENGINE — Meantime, there was developing in Europe the invention of the gasoline engine, which was radically to alter the entire nature of the petroleum industry and transform the life of the world.

Many men had made satisfactory models of engines based upon the principle of a piston driven by an explosive charge before Nicholas Otto and Eugen Langen brought out the father of the modern gasoline engine in 1877. It remained for Otto to realize, however, the importance of compression in the internal combustion engine. His engine worked and his factory near Cologne was kept busy turning out these new stationary engines.

It did not take long for others to put wheels on the Otto engine. Steam carriages had been made for a hundred years and the application of the gasoline engine to the "horseless carriage" came rapidly. Carl Benz patented his machine in 1886, and Gottlieb Daimler's appeared almost simultaneously. Americans were not far behind. Charles Duryea, Elwood Haynes, and Henry Ford all made cars in 1892. Four years later, these three cars and one made by Benz in Germany were the only four automobiles in the United States. Yet, in 1900, more than 4000 cars were built in this country and in 1910, 368,000 cars and trucks were turned out.

The impact upon the oil industry of the resulting demand for hitherto-despised gasoline was terrific. Men



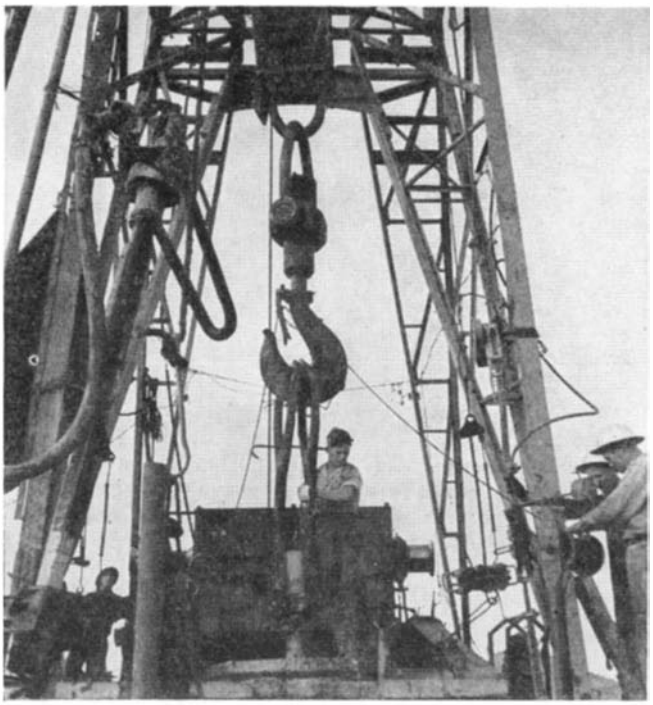
Courtesy Hughes Tool Company

Today wells are bored miles deep by tri-cone roller-bearing rock bits which cut their way by a rotary motion. Many of these bits are two feet in diameter

hunted long and hard for new oil fields and found them. The national production of 30 million barrels in 1852 had risen to 63 million in 1900 and by 1910 had reached 209 million barrels.

Even this greatly increased production of crude oil failed to meet the growing demands for gasoline available from the simple distillation methods then in vogue. "Straight run" gasoline, as it was called, is produced by heating crude oil and condensing the resulting vapors. More gasoline was needed than this method could produce.

The gasoline supply situation was tight when, in 1911, Dr. W. M. Burton patented the "cracking" process and



Courtesy Standard Oil Company (N. J.)

Gigantic hooks, taller than a man and weighing several tons, are used in modern drilling operations

the first cracking plant was built at Whiting, Indiana. This method, in effect, subjects crude to both heat and pressure so that larger molecules in the crude oil—unsuitable for motor operation—are broken up into smaller molecules that work efficiently in a gasoline engine.

SCIENTIFIC METHODS — As the demand for crude oil rapidly increased, producers sought the help of science in determining where to drill. Easily-found fields were becoming far less common. Drilling costs, as deeper holes became necessary, went up. So, slowly at first but in ever-increasing numbers, the petroleum geologist became a man of prime importance in the industry. He mapped areas of petroleum promise, looking for evidences of the folding and faulting of rock structures that form oil traps. He studied rocks for porosity. He brought the physicist, the paleontologist, and the engineer onto his team so that the search for oil became a painstaking and precise, if not an exact, science. With his help, more than 400,000 wells are producing oil in the United States today.

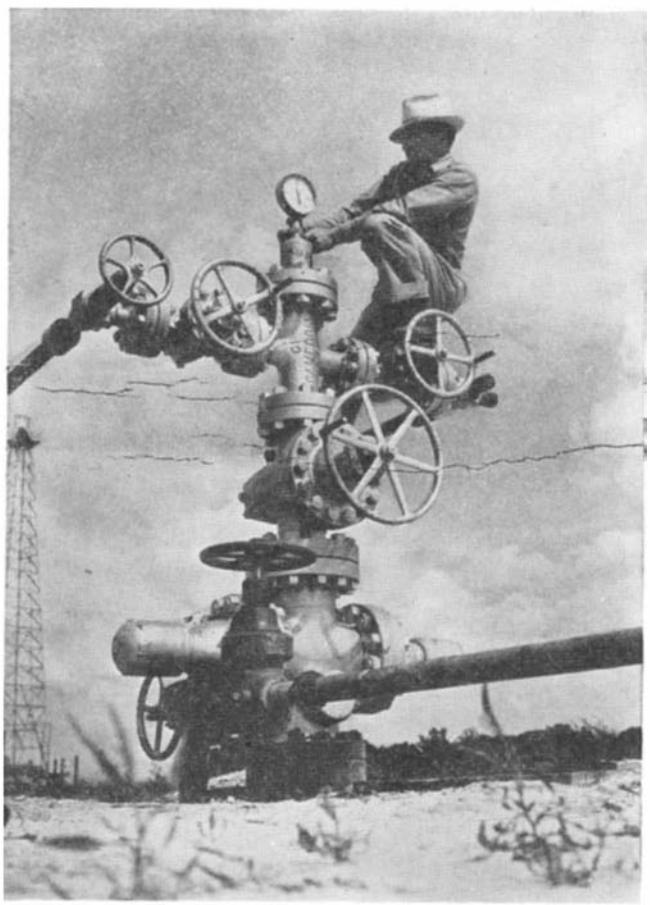
The years from 1910 to the outbreak of the recent war were ones of steady progress for the petroleum industry. Scientific exploration replaced the hit-or-miss methods that had gone before. The seismograph and the magnetometer came into general use and the search continued for an exploratory device that would disclose the definite presence of oil instead of merely locating formations that might or might not contain it. That device still remains to be found, however, and only the drill actually discovers oil.

Great progress was made in drilling methods. While the rotary drill has, to a considerable extent displaced the older percussion or cable-tool method, both remain in use. Rotary equipment has grown heavier through the years and has been vastly improved in many respects. It is the rotary drill that makes possible the deeper wells of today. The world's deepest drilling in Texas, is more than three miles down—16,555 feet, at last reports—and the world's deepest production is from a Louisiana well, at 13,520 feet.

For many years one of the bugbears of drilling was the crooked hole. As the bit went down it frequently was deflected by hard rock formations and the resulting "bottom hole" might be as much as 1000 feet to one side of its surface opening. Science changed that during the '20s by a number of devices, including underground photography, that enables the driller to determine exactly where his well is going and to correct deviations. In addition, by use of a weighted bit, directional drilling is now possible, enabling wells drilled on land to tap oil formations under the ocean, lakes, or rivers. These are only a few of the thousands of inventions that have made possible precision drilling thousands of feet into the earth's surface.

Equally great progress has been made in the production of oil. In the older fields, from 20 to 30 percent of the crude in a given formation was recovered. Today, 70 to 80 percent is brought to the surface. Again, every branch of science has been used to achieve this result.

Conservation practices now in vogue, under state



Courtesy American Petroleum Institute

Devices known as "Christmas Trees" eliminate the spectacular, wasteful "gushers" in oil fields today

laws, are of great importance in making this increased recovery possible. These practices prohibit the indiscriminate drilling of wells, dissipation of gas pressures, and wasteful production. They are designed to provide the largest possible total recovery of oil from underground formations rather than immediate flush production.

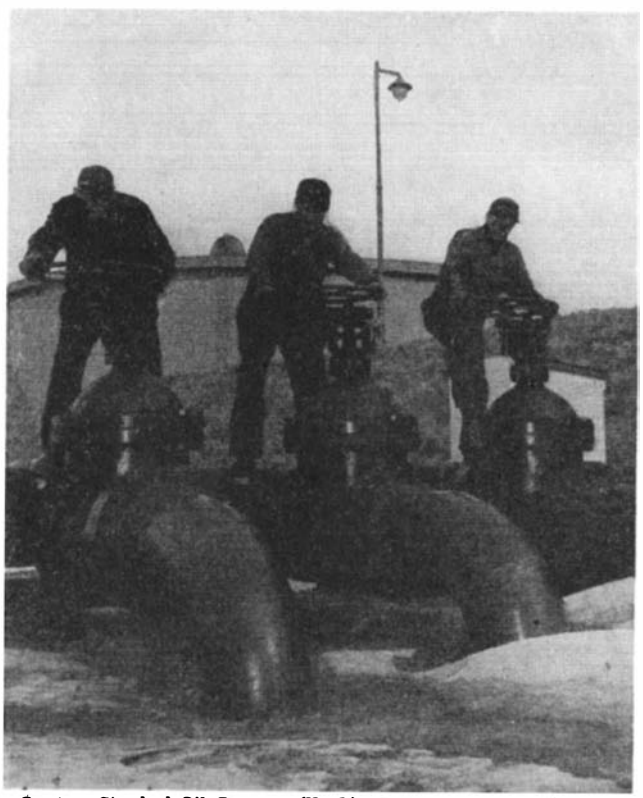
Another outstanding contribution to oil production was the perfection of the "Christmas tree" connection, so named because of its many arms and branches. The "Christmas tree" has ended, almost entirely, the wild well that was for many years a feature of the oil field landscape. The "gusher" is a thing of the past. When a well comes in nowadays, regardless of size, pipe connections already are in place to keep it under constant control.

ENGINES AND FUELS — The spectacular advances made in refining, both of motor fuels and lubricants, are well known. Improvements in gasoline engine designs consist largely of increasing the compression ratio; that is, increasing pressure in the cylinders in which combustion takes place. This gives more power from the same size engine with a smaller consumption of fuel. As motor designers and petroleum refiners learned that the motor must be geared to the fuel, and vice versa, for efficient performance, they "teamed up" in their research activities. Steady improvements in the cracking process made possible gasolines to fit any motor design. Engine lubricants were improved by additives that increased their adhesiveness to metal and controlled their viscosity. The general trend just before the outbreak of World War II was more and more away from ordinary gasoline and lubricants and toward synthetic or "built up" products that render better performance.

At the same time, the number of products obtained from petroleum, other than gasoline and lubricants, increased enormously. A modern refinery makes some 2000 products, from which thousands more are made by other processors. For more than a decade, every household and every industry has depended directly, in one way or another, upon petroleum products in some of its myriad forms.

From Scientific American

The picturesque days of the "gusher" gone wild are a memory of the past, due to modern control methods



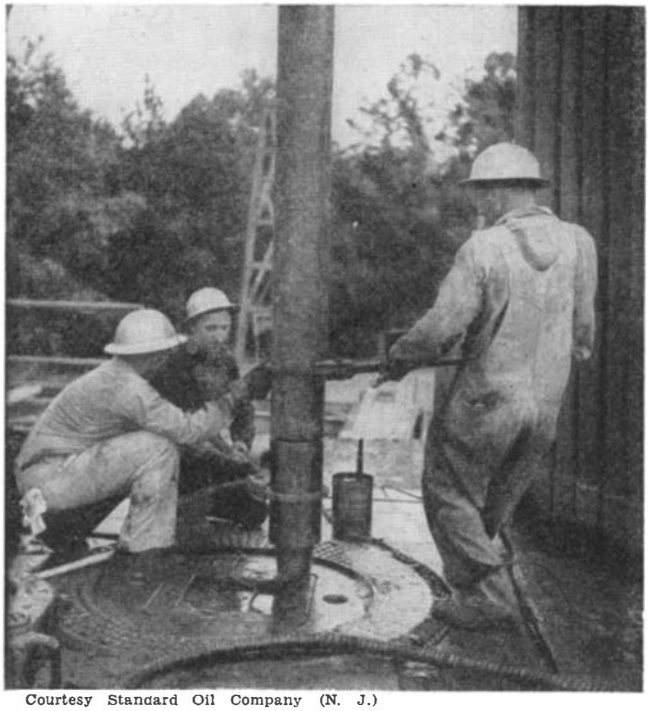
Courtesy Standard Oil Company (N. J.)

Opening huge control valves that regulate flow of oil from tankships into storage tanks seen in rear

While the oil pipeline had its genesis in the 1860's, tremendous pipeline development took place in the 20's and 30's. Today, a network of approximately 150,000 miles of main trunk pipelines stretches throughout the country, and thousands of miles of gathering lines extend through all the nation's oil fields. By 1941, a marketing system had been built up that employed some 750,000 persons and had more than 300,000 retail outlets in every section of the country.

Thus, at the outbreak of the greatest war in history, the petroleum industry was a strong one, with the men, the materials, and the "know how" to produce many and varied products. No one had any inkling, however, of the industrial miracles the petroleum industry would be called upon to perform in the recent war.

The first was aviation gasoline. Only two refineries in the United States made 100-octane gasoline before the war, and the 35,000 barrels a day which they turned out was ample for all civilian and military demands. The armed services suddenly demanded 100-octane fuel in vast quantities. Processes with which researchers had been experimenting in their laboratories were rushed to full-scale production. Every refinery in the country was assigned some part in the great task and development went on at a feverish pace. One-hundred octane, the supposed perfect gasoline from an anti-knock standpoint, has been topped so frequently that the motor fuel which powers a B-29 Superfortress, for instance, can hardly be called gasoline in the usual sense. Triptane (2, 2, 3-trimethyl butane), the newest laboratory wonder fuel, gives four times as much power as 100-octane gasoline and has been developed so rapid-



Courtesy Standard Oil Company (N. J.)

Working on an oil drill collar. Threaded ends of pipe lengths must be carefully joined to insure the successful operation of the well-drilling equipment

ly that motor designers have not been able to perfect an engine to use it. It is employed now to blend with lower grades of aviation gasoline to improve their quality.

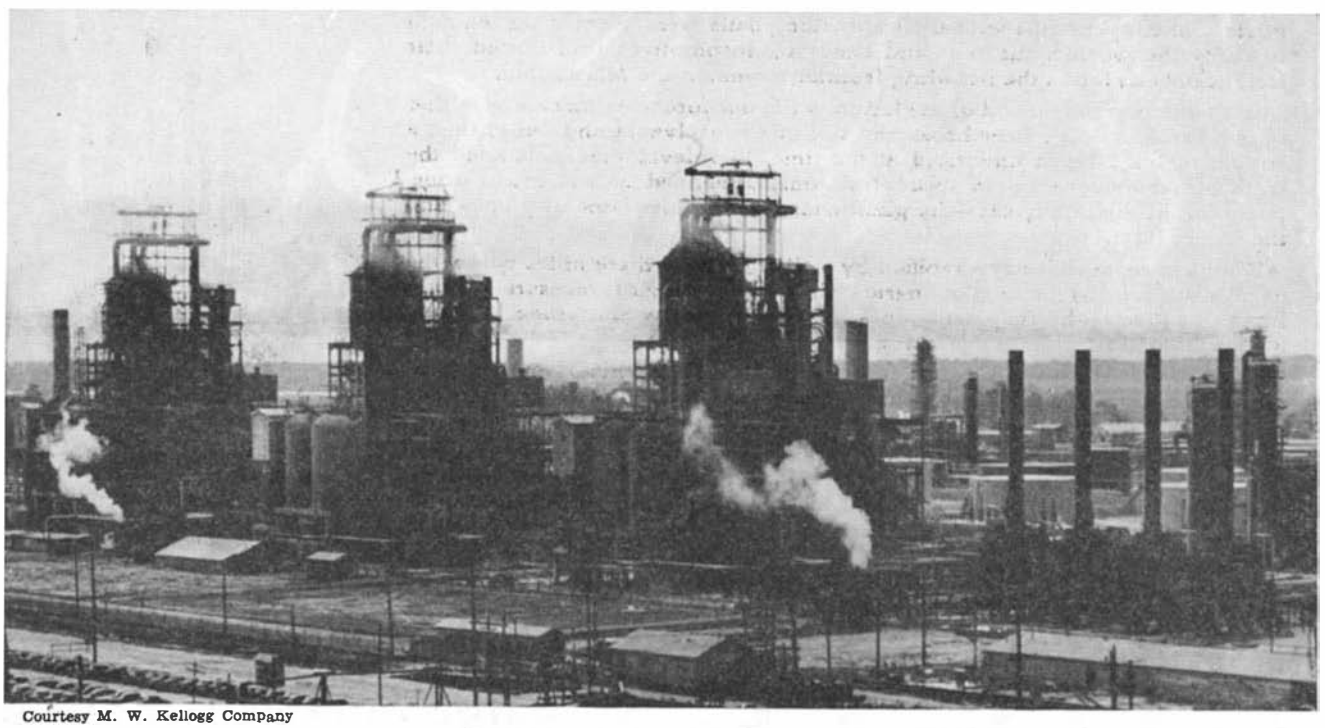
American refineries at the close of the war were making more than 500,000 barrels of aviation gasoline a day, 85 percent of the world's production.

War suddenly called for lubricants that would work equally well in Greenland or on an equatorial island. A plane standing on the North African desert, for instance, might take off from an airport where the temperature stood at 140 degrees, Fahrenheit. In a few minutes it would be in the stratosphere where the temperature stood at 60 below. No lubricant had ever been designed, for quantity production, that would perform under those conditions. It was vital to the war, so this nation's petroleum scientists produced it—as they did many another "impossibility."

The list of war-time petroleum industry accomplishments is long: synthetic rubber; rust preventives; DDT, the wonder insecticide; vast quantities of fuel oil for our mighty Navy; asphalt for temporary landing fields; and a hundred others. A case in point is that of Diesel fuel. Just prior to the war there was approximately 10 million Diesel horsepower in operation in the United States; by the end of 1944 it totaled 80 million horsepower and the needed fuel was available.

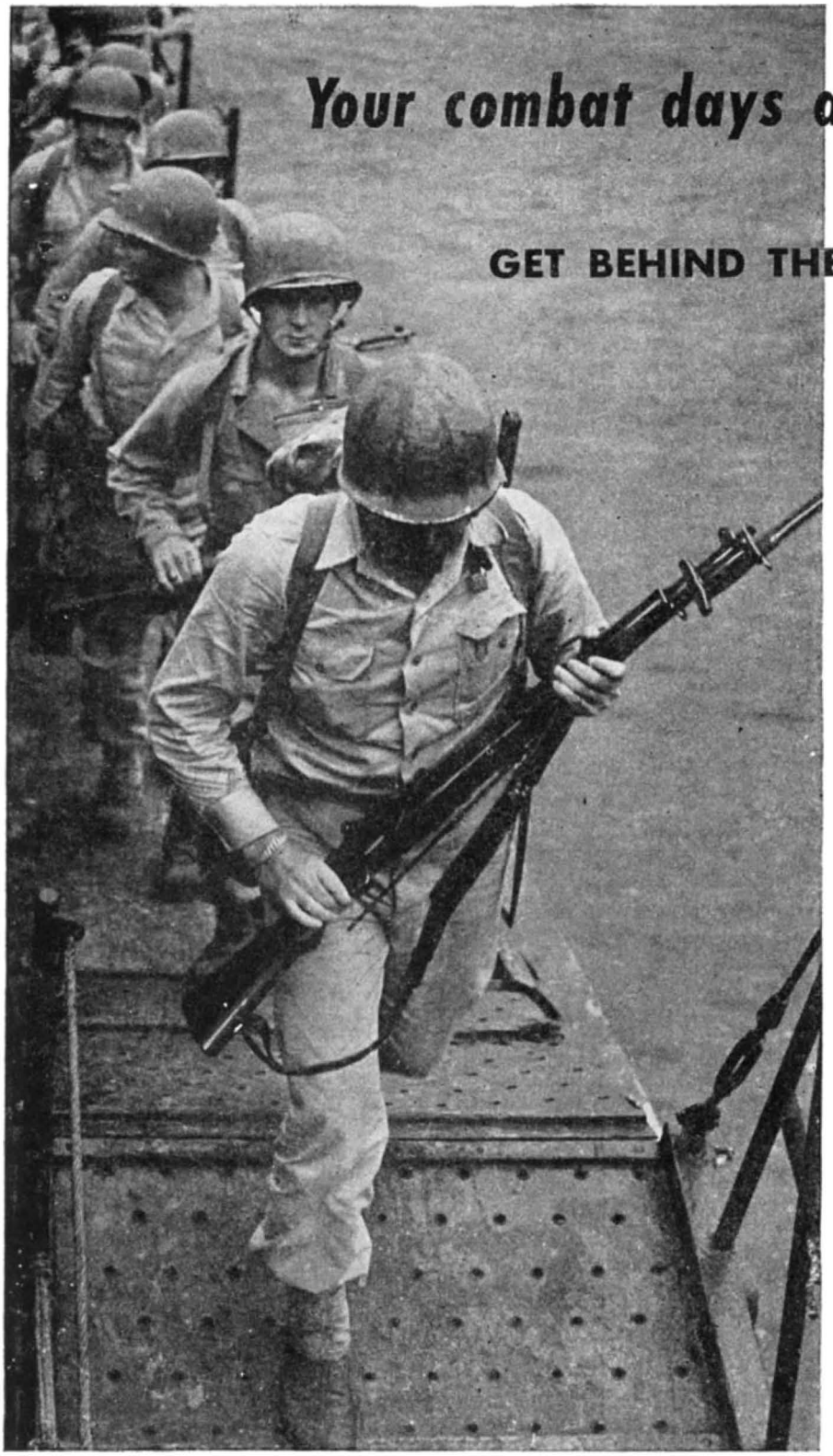
The American petroleum industry "oiled" World War II as it did World War I. In 1918, the military forces of the Allies consumed about 39,000 barrels of gasoline per day. In World War II, the daily military gasoline demand reached 800,000 barrels, and gasoline is only one of many products which modern war requires of the petroleum industry. This tremendous demand, with the United States supplying 69 percent of all petroleum products, has had, of course, its repercussions upon all phases of the industry. Production reached an all-time record of 1,678,000,000 barrels of crude in 1944. This was achieved in spite of manpower and material shortages of serious proportions.

HYDROCARBON CHEMISTRY — Today the petroleum industry looks ahead to a new and vaster usefulness, based upon hydrocarbon chemistry. Science has solved the secret of the hydrocarbon molecule, and a great new vista of synthesis has opened up. The fuels and lubricants of today are synthetics, chemically arranged for the best possible use of the tremendous energy locked in petroleum and natural gas. In addition to these, there are hundreds of new chemical products in the making, based upon synthesis of the hydrocarbon molecule. The industry is convinced it is standing on the threshold of great achievement—a tribute to its leaders who never have hesitated to spend millions of dollars, year in and year out, for scientific research.



Courtesy M. W. Kellogg Company

Partial view of one of world's largest oil refineries. It covers 640 acres. The three giant catalytic cracking units are of skyscraper height. Besides other products, this refinery produces over 70,000 barrels of gasoline daily



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Precision Quenching

By Control of the Pressure, Temperature, and Turbulence of Quenching Mediums, Engineers Have Made it Possible to Predict, With High Accuracy, the Exact Amount that Metals Will be Distorted by Heat Treatment. Through Use of these Methods, Machining Time Can be Reduced

WHEN makers of metals shaving machines announced that they could predict within a few ten thousandths of an inch the amounts and directions in which metal parts would warp and change dimensions when being heat treated, they added one more bit of evidence to the belief that precision quenching will bring a brand new era to the metals fabricating arts.

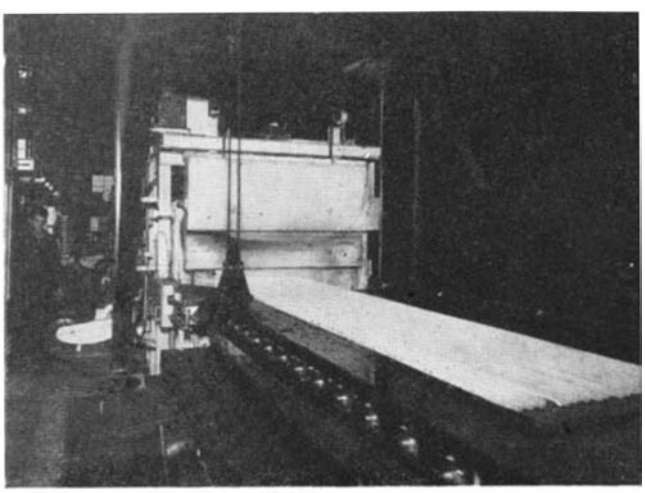
Precision quenching is itself an application of machinery to establish and control the shapes and sizes of finished pieces. It is a mechanical engineering art. But it is mechanical engineering wed to metallurgy. And its real effects will extend far beyond the development and use of equipment for its own operation.

To the extent that precision quenching proves practical, every production machine from the humblest lathe or drill press to the most highly organized automatic will find the work assigned to it affected. Grinding and lapping—those final operations of super-finishing and of ultimate accuracy—will be displaced from one operation, be given brand new opportunities to improve another.

Product designers will select materials and design parts in shapes which never before were practical for production lines. The metallurgist will move still farther out of his cloistered laboratory (he has been inching his way out of there for a long time) and still closer to a post along the production line.

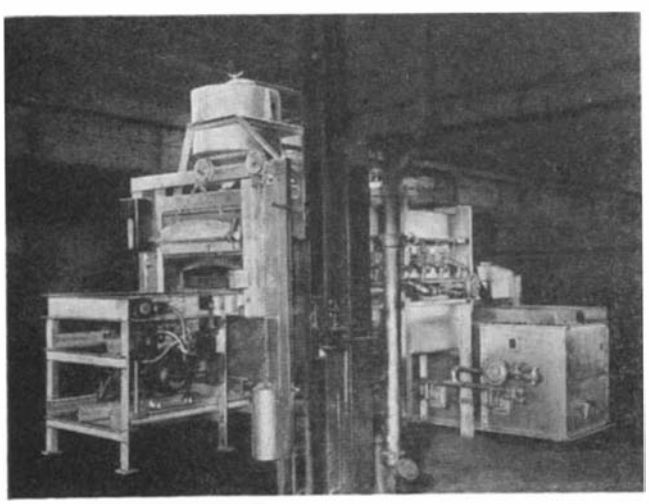
The process of quenching has been known for thousands of years. The steel or other metal part is heated to a temperature which varies with the material. As it approaches this temperature it goes through a "critical range" during which its granular structure changes. If it is then allowed to cool slowly enough the granular structure may change back again. But if it is cooled quickly enough the granular structure can be trapped in its changed condition. Then the metal, in accordance with its nature and the way the whole heat-treating operation was carried out, will be harder, stronger, more elastic, or have other characteristics which are more desirable for its purpose than the ones it had before it was heat treated. The quick cooling is accomplished by plunging the heated part into water, oil, air, salt compounds, soft metals, or other media; this operation is known as quenching.

MORE USES—It is not surprising that the makers of precision shaving machines and of other equipment which machines so accurately that final grinding of parts can be eliminated, should be among the pioneers in precision quenching. Precision quenching aims at the accurate control of surface finishes, dimensions, and contours of parts as well as control of granular structures and characteristics. If the surfaces and dimensions are changed by non-precision quenching then they must be restored — and in some cases created — by grinding. This means that many a part will not be finished accurately until after it has been quenched, since that accuracy would only be destroyed by the heat treatment. Thus, accurate machining proponents could even be opposed to the need for leaving enough "grinding stock" so that no matter how the



Courtesy Bethlehem Steel Company

Hot metal bars being removed from high temperature chamber of heating furnace onto quench tank rollers



Courtesy Surface Combustion

Hardening metal parts without brittleness may be done on the production line by quenching in molten salt

part might warp in the quenching it could still be ground true to size and shape. But with precision quenching the parts can be machined accurately before hardening and high-accuracy machining equipment will find more employment accordingly.

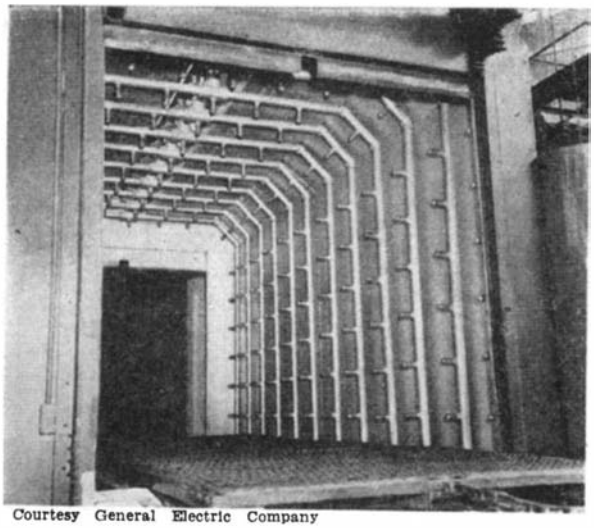
Hard on the heels of these machine makers are the producers of inexpensive plain carbon and "low" alloy steels and of aluminum, magnesium, and other alloys. There is many a low cost alloy which could be given hardnesses and other characteristics good enough to enable it to displace higher cost alloys if only it could be quenched without warpage, internal weakening, or outright breakage. Moreover, the higher cost "high" alloys could find brand new fields of usefulness if this same quenching problem could be solved for them.

Warping and other deforming is almost entirely a function of the speed with which the heat is removed from the part. Usually the entire part is heated, although there is some "skin hardening" in which only the surface of the part is heated before being quenched. But in any case the heat must travel from its innermost penetration out to the surface of the part and then be removed. If a part has thin sections integral with thick ones (example: the teeth of a gear integral with its main body or hub) then the heat will tend to travel out of the thin sections while the thick one is still very hot, and the teeth may warp. But if that same gear can be so quenched that the thick part and the thin parts cool at rates which are not out of satisfactory balance with each other then the warpage can be held within controllable limits.

And those amounts of warpage, together with their directions, can be predicted. Thus the art of precision quenching becomes one of foretelling exactly what the warpage will be and of allowing for it, and quenching becomes a means of making planned changes in dimensions and contours of parts — an art to take its place beside those of machining and grinding as a means of obtaining final shapes and sizes.

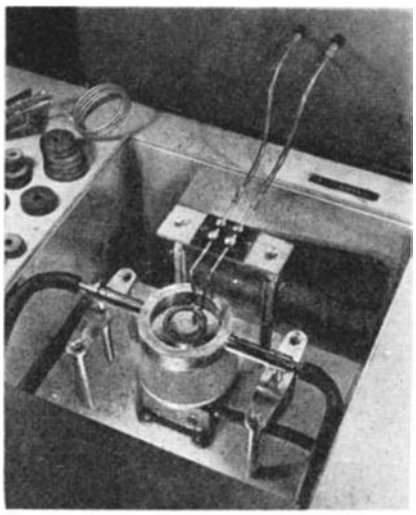
Side by side with the warpage problem is that of the natures of alloys. If heated above their critical ranges and then plunged into cold water, some high alloy steels would literally explode into small fragments when their exteriors cooled and contracted much more rapidly than their interiors. Some low alloy or carbon steels, by contrast, fail to harden because there is no quenching medium which will remove their heat rapidly enough. Between these two extremes, various alloys can acquire all sorts of locked up or residual stresses during quenching operations. The locked up stresses may not warp or break the part at once, but they will cause it to warp or "creep" gradually over a period of years or they will make their presence known by warping the part the first time it is machined, strained, or slightly injured so as to afford the stresses a path of escape. And all of these problems are related to the speeds with which quenching mediums remove heat from the parts. So the precision quencher must predict the exact amount and direction in which the part will warp or change in size, must make the part so that after warping it will be to the required size and shape within a few ten thousandths of an inch, and must do all this while respecting the behavior of the alloy of which the part is to be made.

Right: "Jet" quench nozzles in roller-hearth electric furnace



Courtesy General Electric Company

Below: Gear revolves in heater coils during automatically controlled heating and quenching cycles



Courtesy Lepel High Frequency Laboratories, Inc.

MODERN MEDIUMS—The first resource of precision quenching is the wide list of modern quenching mediums. It is the boast of large oil companies and other makers of quenching mediums that they can give the metallurgist any quenching speed he wants, from the extremely rapid one of wetting-out additives in water to the extremely slow ones of lime and asbestos products, with all the speed gradients of various oils in between. The medium can be suited to the desired speed.

Mechanical control of the entire quenching operation is the second but by far the more important resource. In fact, precision quenching depends far more upon mechanical engineering than upon outright metallurgy.

The temperature of the quenching medium must be controlled mechanically. This is largely because the speed with which the medium quenches is largely dependent upon its temperature. Quenching involves the transfer of heat from the metal to the medium, and since the rate of heat transfer is directly affected by the temperature difference between the hot and the cold body, a heated medium (medium for medium) will quench more slowly while a cooled one will quench more rapidly.

Viscosity of an oil, or of any other medium which is subject to wide changes in viscosity, will be affected by temperature. And the quenching speeds of oils can vary widely with their viscosities. Furthermore, the viscosity of an oil affects the ease with which it can be caused to impinge upon all surfaces of the metal part simultaneously or to reach selected surfaces in selected sequences, whichever is desired; heavy bodied oils are much harder to control in this respect than light bodied.

Water and oil vary directly in the effects of their gasifying when used as quenching mediums. The steam from water has less cooling ability

than the water but the vapor from oil has slightly more than the oil itself. The water therefore may be used at the coldest practical temperature so as to increase the amount of heat it will take away from the metal before turning into steam, while oil is quite commonly used at temperatures ranging from 110 to 120 degrees, Fahrenheit.

One effect of gasifying is that the medium will impose one cooling rate where it is striking the metal as a liquid and another where it is impinging as a gas only. Control of this factor is among the newest and least developed arts of precision quenching. Water may be mixed with such additives as sodium chloride to decrease the rate at which it will gasify and thus increase the net area which it contacts as a liquid — thus increasing both the speed and the uniformity with which it will quench—or it may be mixed with soaps and other additives to achieve the opposite effects. Oil may be fed at varying temperatures to change the areas impinged upon by liquids and gases — shop men say "for every oil and every job there is an ideal temperature" — and it, too, can be varied in its action by the use of additives.

SPEED REDUCED—Oil under high temperature conditions will oxidize, with the result that its quenching speed is reduced. Large batches of quenching oil, as much as 5000 gallons at a time, have had to be discarded for this reason. Oxidation inhibitors can be used, but tests have shown that after the oils have been held for more than two or three hours at greatly elevated temperatures, some of the most common of these inhibitors lose their effectiveness and the oils oxidize just as rapidly as if they were not present. This is just one more reason for the mechanical control of the temperature of the quenching medium.

In precision quenching, materials handling must be exact. Parts must be taken from the furnaces or other heating means to the baths with minimum exposure to the air. They must be held in exactly the right positions and go through the bath or be exposed to the jets of quenching medium while travelling at the correct speeds.

Cleaning of the parts to be quenched is another mechanical engineering function. Research has shown that any fine chips or other "metallic dirt" placed in the oil bath at quenching temperatures will act as a catalyst to hasten the oxidation of the oil. This has definitely been proved for alloys which contain any iron or copper, but aluminum and magnesium are suspect as well. Lead is a catalyst; it must not get into the bath. Any shop dirts can be contaminants.

Courtesy Rustless Iron and Steel Corp.

Stainless steel being subjected to regularly conducted pilot tests to determine response to heat treatment

TURBULENCE—Feeding of the oil to the parts to be quenched is one of the most important mechanical engineering functions. Turbulence in heat transfer from metals to liquids is a vital aspect of the problem. It has been shown that oil can be made to approach the quenching speed of still water if directed against the work with sufficient pressure and turbulence—that those factors of pressure and turbulence alone can multiply the quenching speeds of various mediums by three or, through control, by any desired amount up to three. Many engineers prefer to use just one quenching oil for all of their work and to vary its cooling speed by the temperature, pressure, and turbulence with which it is fed.

Often the solution of a quenching problem is to direct a stream of the quenching medium at some one part or area of a part, or at selected or successive areas, before the part as a whole is quenched. Tricks like these bring quenching into the realm of the designing and operating of quenching machinery. Modern precision quenching, then, is a marriage between metallurgy and mechanical engineering, with the metallurgist saying what is to be done and the mechanical engineer showing how. And this new art may change many phases of metals production and machine design.

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STIFFENING SHEETS

Can be Accomplished by Backing or Denting

IT IS nearly impossible to bend the edges of large sheets of thin metal without bulging or curving the main or "flat" areas to some degree. Even when dead-soft sheet stock is used there is some spring-back of the sheet after making the bend at the edge, and if the unbent area is large enough this spring-back will appear as slight curvature near the edges.

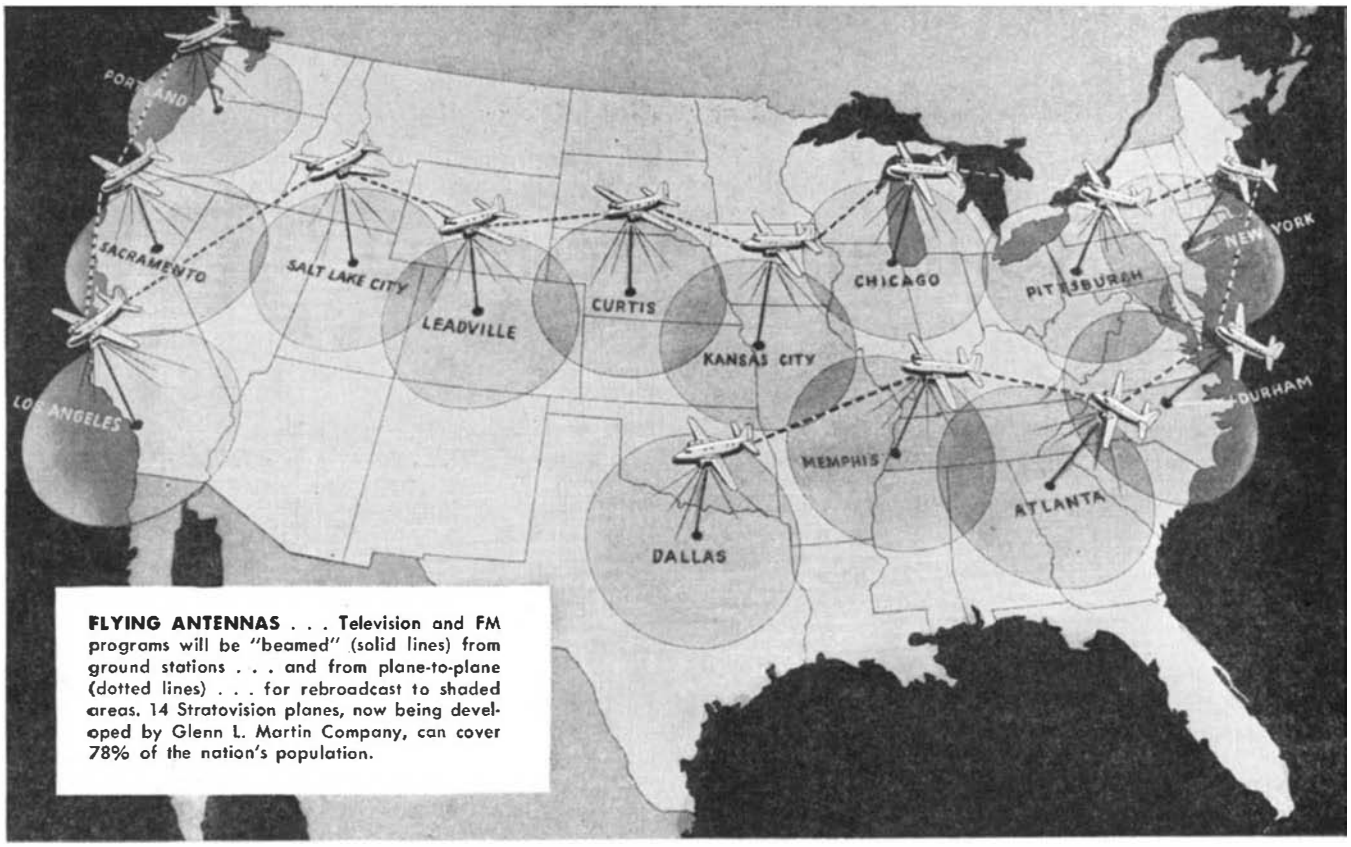
In most cases the only damage done by this bulge is that the metal makes a slight noise when anything presses against it—that noise often being called the "oil-can effect" because it is caused by the same action that makes the well-known noise of pressing a thumb against the bottom of an ordinary oil can. But this noise almost never is desirable and in some cases (for example, the large thin sheet surfaces of airplane parts) it can be highly undesirable.

One way of removing or minimizing the noise is to fasten the thin sheet to a thin but stiff backing material such as plywood. Here the modern glues are valuable. They will hold the metal to the wood while compensating for the differences of thermal expansions and contractions of the two materials.

Another way is to corrugate or otherwise bend the metal to stiffen it and reduce its motion under pressure. And here many new techniques are being developed.

Rather than going to the extreme of actually corrugating the sheet, special pressing dies are used to put slight bends or dents into the flat area after fabricating or shaping the edges. Corrugating could have the disadvantages of adding to the total weight of sheet necessary to cover a given area, or of providing hollows in which dirt could be entrapped or by which air resistance would be increased. Controlled bending or denting can minimize if not eliminate such disadvantages while adding the exact degrees of stiffness desired. The areas to be dented can be selected in many cases to reduce further the disadvantages of irregularities of surface.

Like so many techniques originally developed for aircraft, this one can have important effects upon other industries. It can be used to reduce both noise and cleanliness problems in ducts, chutes, bins, and louvers. Sheet metal roofs can be made less noisy during rain and hail storms; machine guards quieter when machines vibrate.



FLYING ANTENNAS . . . Television and FM programs will be "beamed" (solid lines) from ground stations . . . and from plane-to-plane (dotted lines) . . . for rebroadcast to shaded areas. 14 Stratovision planes, now being developed by Glenn L. Martin Company, can cover 78% of the nation's population.

How Westinghouse STRATOVISION took the final headache out of Television and FM

EVEN before the war ended, Television and FM transmitting and receiving equipment had reached a high degree of perfection. But a final difficulty remained—the problem of broadcasting such programs on a *nationwide basis.*

Because of the ultra-high frequencies employed, Television and FM waves travel only in straight, "line-of-sight" direction. They do not *bend* around the earth's surface . . . as do those of standard-band radio.

This limits the range of a Television or FM station to a *maximum of 50 miles*—even when perched atop the tallest building.

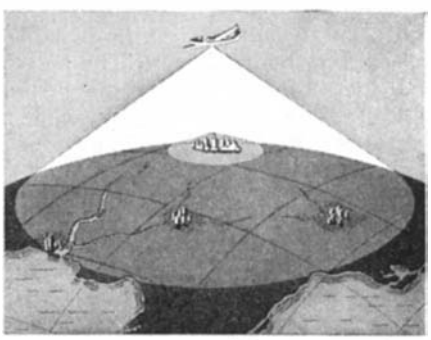
A chain of radio-relay stations across the country—or coaxial cables spanning the nation—have been proposed as a solution. But these are terrifically expensive and, worse yet, cause serious distortion of long distance programs.

Now, at last, Westinghouse research engineers have discovered a practical solution through "STRATOVISION"—broadcasting Television and FM programs from *planes flying six miles high in the stratosphere!*

At this altitude, a single Stratovision plane can cover an area 422 miles in diameter . . . 103,000 square miles . . . approximately the combined area of New York, New Jersey and Pennsylvania.

Westinghouse engineers predict that 14 of these flying broadcasting stations can transmit 4 Television and 5 FM programs simultaneously to *78% of the nation's population.*

The conception and planning of Stratovision broadcasting are a tribute to the ingenuity and engineering "know-how" of Westinghouse radio technicians . . . gained through producing $400,000,000 worth of Radar and radio equipment for our armed forces.



HERE'S THE SECRET . . . Stratovision broadcasting, serving an area of 103,000 square miles, will require only *1/50th as much* power as a 50 kilowatt ground transmitter covering only 7,900 square miles. That's why a *single Stratovision plane* can easily carry and power the equipment needed for simultaneously transmitting 4 Television and 5 FM programs.

Westinghouse

PLANTS IN 25 CITIES OFFICES EVERYWHERE

Tune in: JOHN CHARLES THOMAS—Sunday, 2:30 pm, EST, NBC.
TED MALONE—Monday through Friday, 11:45 am, EST, American Network

Refinery Electronics

Temperature Recorder Aids in Accurate Separation of Compounds Whose Boiling Points Are Very Close Together. Another Electronic Instrument Measures the Thickness of Walls of Pipes and Tanks, and Gages Liquids Heights in Vessels Without Access to Their Interiors

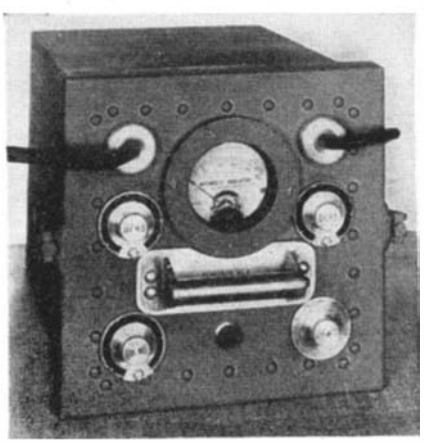
By VIN ZELUFF
Associate Editor, *Electronics*

IN MODERN oil refineries the boiling points of the various constituents to be separated by fractionation must be predetermined accurately. This is now accomplished with an electronic instrument that utilizes electron tubes to magnify small temperature changes.

A high-sensitivity, fine-wire thermocouple, consisting of six individual couples spaced about half an inch apart, is located in the reflux zone of the fractionating column. The voltages produced by these thermocouples are amplified by the electron tubes and recorded continuously by pen on a time-temperature strip chart.

The instrument finds particular application at present in the rapid and accurate analyses of four- and five-carbon hydrocarbons. The special thermocouple covers all possible positions of a wandering condensation ring, which is known to vary several inches up or down in the fractionating column. Thus the true boiling point of a compound is accurately recorded no matter which couple is located in the coldest zone. The Brown Instrument Company's electronic recorder and a special Podbielniak fractionating column makes possible rapid and accurate separation of compounds whose boiling points are only one and one half degrees apart, a feat which cannot be accomplished by older types of apparatus.

To accomplish the perfect blendings necessary in producing 100-plus octane gasoline, Richfield Oil Corporation has installed this electronic equipment in its newly expanded refinery near Los Angeles. The new development considerably reduces distilling time, gives increased accuracy, and opens up a new field in fractional distillation.



Control box of the Penetron. Meter in center gives readings in microamperes

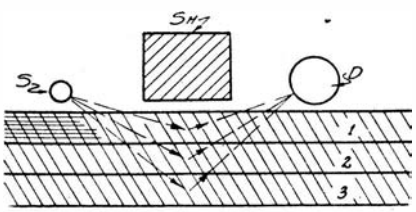
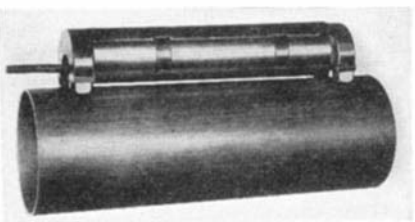


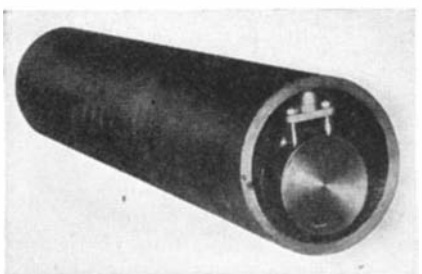
Diagram illustrating the principle of the Penetron. *S* is the source of gamma rays, *Sh* the shield, and *D* the detector, all in the instrument head. Arrows indicate back-scattered rays

THROUGH STEEL WALLS—Wall thickness and liquid level measurements are important in many phases of oil refining. Such measurements can now be made from the outside of sealed vessels with an instrument called the Penetron. This instrument, utilizing electronic and radioactivity principles, can measure wall thicknesses when access can be had to one side only, can gage liquid height and density from the outside of sealed storage tanks, and can be adapted to control levels in process units, such as the solvent-oil interface in a solvent refining tower, or to determine and control the catalyst level in catalyzed chemical reactions—all through solid walls of steel or other material.

The Penetron consists of two main parts—the head and the control box. The head contains the radiation source, the detector, a shield between the two, and a three-stage preamplifier. It weighs about seven pounds and is connected by a cable to the control box which contains a measuring circuit and the power supply. The head is completely sealed in its metal housing, to insure safety in refineries and other locations where explosive hydrocarbons may react to sparks.

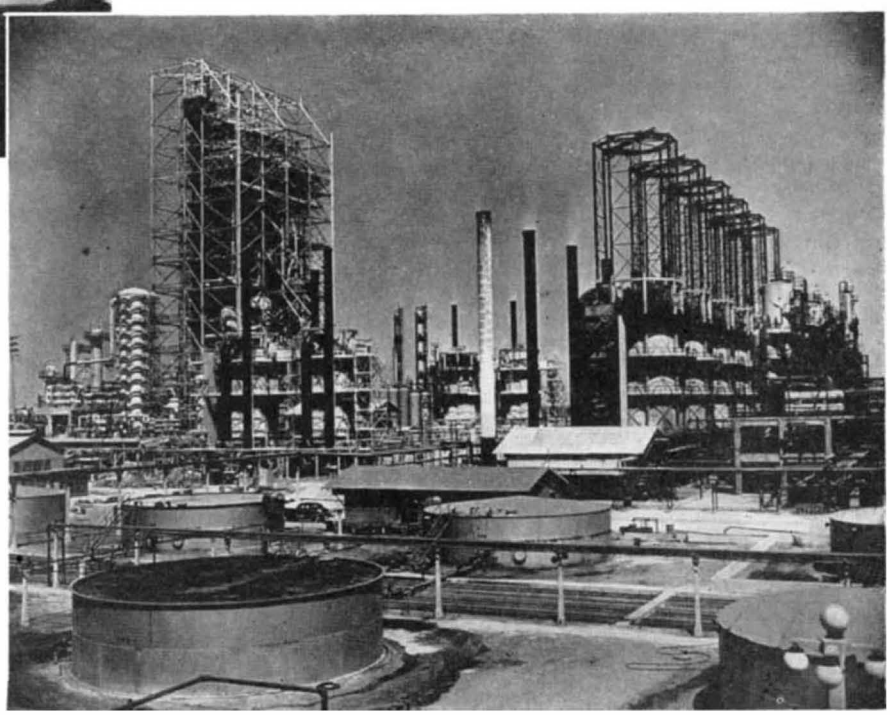


Above: Showing how Penetron is used in measuring wall thickness. Magnetic holder secures it outside of pipe. Below: In measuring wall thickness from inside, head is held against pipe by means of a pneumatic holder



In operation, the instrument bombards the tank walls and the material inside with gamma rays which are derived from a needle

Electronic tubes of various types monitor and control many of the vital processes in petroleum refining. Shown below is the new Richfield high-octane refinery in California



containing one milligram of radium in the form of a commercially available salt. These gamma rays travel with the velocity of light, and are not deflected by magnetic or electric fields. Some of the rays are back-scattered by the electrons of the atoms in the material being inspected, so that they emerge from the material on the same side as they entered.

By measuring the intensity of this back-scattered radiation, the thickness of the material, whether it be aluminum, steel, plastics, brass, wood, or other material, can be determined with extreme accuracy. By the same means, liquid levels and liquid densities are found.

The radium source in the Penetron is surrounded with a shield containing a window which directs the beam of gamma rays in the desired direction. The source of radiation, the tank wall, and the detector are set up in accordance with a predetermined geometric arrangement. A metal shield between the radioactive source and the radiation detector prevents direct radiation from entering the detector.

The radiation picked up by the detector creates current discharges which are amplified and integrated to produce a direct current. The amount of current produced is measured by a microammeter.

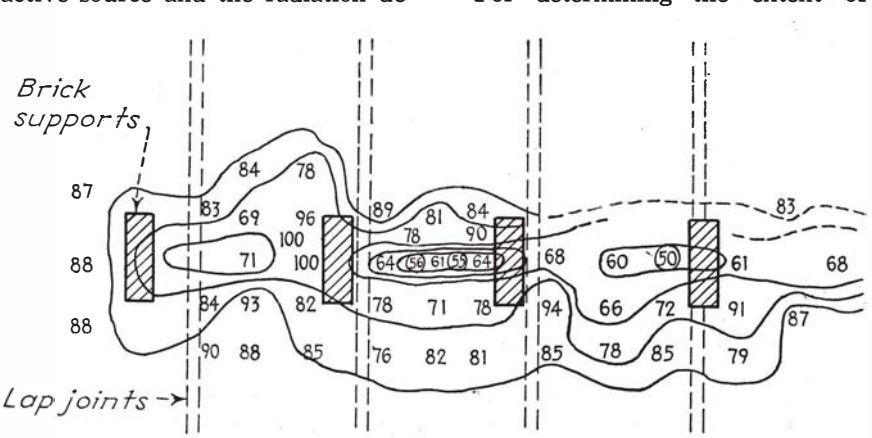
For determining the extent of wear of tubes and vessels due to corrosion, fuming, or erosion, the reading of the microammeter is converted into wall thickness in inches. The instrument is calibrated on specimens of tubing and flat plates having known wall thicknesses. Because the geometrical relationship between the measuring head and the wall changes with the curvature of the wall, the calibration curves for a wall of a given composition will vary depending on the diameter or curvature of the wall or vessel being measured.

Calibration curves are furnished with the instrument. Walls of similar materials produce the same curves. Thus the calibration curves for iron also can be applied to alloyed steels.

Wall thickness measurements can be made on pipes which contain fluids, if a correction is made to take into account the influence of the fluid on the reading of the instrument. This is made simply by establishing a calibration curve for pipes of known wall thickness filled with the **same fluid.**

The Penetron can be used for measuring iron or steel walls up to approximately 0.75 inch thickness. For other materials the limit is different, being approximately one inch for aluminum. Since the penetrative power of deflected or scattered gamma rays is less than that of the primary rays, rays which are deflected beyond a certain depth are completely absorbed before reaching the surface as back-scattered radiation.

The accuracy of the instrument has been established to be within



Measurements of wall thicknesses made with the Penetron from the outside of a large surge drum. The contour lines are drawn through points of equal thickness; the numbers indicate hundredths of an inch. Severe erosion of the interior of the tank wall is revealed by the presence on the chart of several very small closed contour loops

the limits of plus or minus 3 percent.

The Penetron measures the average thickness over an area of approximately one square inch. It measures the total thickness or volume and not the thickness of any one layer. If, however, a laminated wall is composed of, say, two layers of different materials, the Penetron can be used to measure the thickness of either layer provided the thickness of the other layer is known.

The individual pulses of current created in the detector do not follow each other at regular intervals because the rate of emission of gamma rays by radium is quite irregular. The emission follows certain statistical laws and fluctuates around an average value. The accuracy of the instrument thus increases as the time of observation is increased. The minimum time for each reading is 25 seconds. Including moving the instrument, set-up time, and recording of results, in actual field work it is possible to make measurements at 150 or more points during a working day.

FLUID MEASUREMENTS — The density of a fluid inside a container may be determined directly without access to the fluid itself. In experimental work employing a Penetron situated on the outer wall of a container having a wall thickness of 0.3 inch, it was found possible to check the specific gravities of fluids having values of between 10 and 75 degrees Baume with a high degree of accuracy. This measuring technique can be used advantageously for determining specific gravity of liquids in tankage, routing the flow of oil in pipe lines, control of blending operations in which two materials of different densities are mixed, determination and control of proportions of reactants in chemical processes, and in other applications to determine the density of a substance without sampling or without access to the material.

If the head of the Penetron is placed on the wall of a vessel partially filled with liquid and above the level of the liquid, the amount of back-scattered radiation is due entirely to the wall of the vessel, since the density of the air or vapor in the vessel is negligible by comparison with the density of the material comprising the wall.

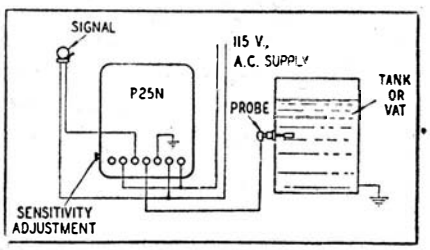
If the head is moved down the wall, the reading of the instrument remains constant until it reaches a point opposite the level of the liquid in the container. At this point, the meter of the instrument will indicate an increase in back-scattered radiation since the radiation passing through the wall is scattered not only by the wall but also by the liquid in the vessel. The point on the wall at which an increase in reading is obtained indicates the level of the liquid. In the same manner, the interface between two fluids of different densities can be located easily and accurately from the outside of a container without actual access to the interior of the container.

By proper instrumentation, the Penetron may be adapted to control as well as to locate liquid levels. In addition, a continuous record of levels may be obtained by employing a recording device.

SOLUTION CONTROL

Made Possible By Electronic Device

CONTINUOUS measurement of the electrical conductivity of a solution, and sounding of an alarm when predetermined limits are exceeded, is now made possible by a unit available in a packaged form from Photoswitch, Inc. Automatic control is easily added, so that the electronic unit will open and close valves or start and stop pumps so as to maintain the concentration at a desired value. A 5 percent change in the resistance of the fluid in the circuit of the detecting probe is sufficient for operation. The voltage at the probe does not exceed 25 volts, which eliminates the possibility of electric shock or explosion hazards.



Arrangement of solution control unit

RAZOR BLADES

Inspected by Photocells

IN AT least one razor-blade factory, the sharpness of each finished blade is checked automatically by an unusual electronic technique. A narrow, intense beam of light is directed at an angle across the shaving edge. Light reflected by dull portions of this cutting edge enters a self-generating photoelectric cell that feeds an indicating galvanometer directly. The sharper the blade, the less light reaches the electric eye and the lower is the meter reading. Automatic rejection of excessively dull blades is but a step further, involving use of a phototube, amplifier, and relay arranged to actuate an electromagnet that knocks a blade off the conveyor if it reflects more than a predetermined amount of light into the phototube.

FILM WIDTH

Now Measured Accurately By Vacuum-Tube Gage

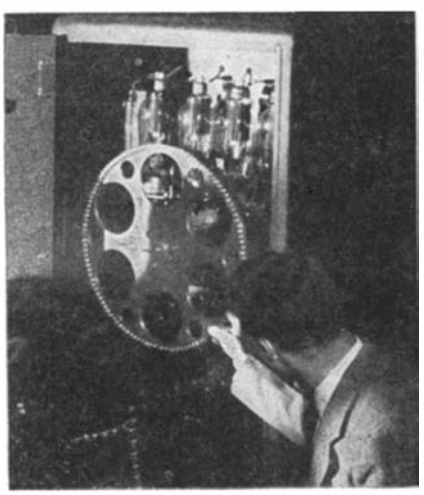
A NEWLY developed vacuum-tube gage is capable of measuring the width of motion-picture film to an accuracy of 0.002 millimeters while the film is in motion, without injury to the film from pressure. A small lever swinging on a bearing has a rounded surface that presses lightly against one edge of the film as it passes through the gage. The lever swings outward and inward as the film width varies, causing corresponding movements of an attached metal disk that forms one plate of a two-plate variable capacitor.

A change in film width is thus converted into a change in capacitance, and this change is amplified electronically by vacuum tubes and made to actuate a meter which is calibrated to read film width directly in millimeters.

METAL STITCHING

Controlled by New Electronic Unit

A COMBINATION electronic and electro-mechanical seam welding control unit has been developed by Westinghouse primarily for stitching together metal sheets. It is being used for the fabrication of such units as oil drums. The duration of each welding pulse can be changed by inserting or removing pins from a 120-hole disk.



Disk of the seam welder or stitcher

Cargo By Air

Cargo Airliners of Tomorrow Will Bring Choice Tree Ripened Fruits, Fresh Vegetables, and Flowers from Far-Off Corners of the World in Special Refrigerated Compartments. Many Industries Will Profit by Using Air Freight to Ship Light-Weight and Perishable Merchandise

Most important of the many questions confronting the airlines today are those concerning the amount of air cargo that will be carried in the future and the characteristics of such cargo. Air cargo, according to William A. Patterson, president of United Air Lines, is an all-inclusive term that excludes only passengers and should be applied to passengers' baggage, mail, and what is commonly referred to as express and freight. No matter what definition may be accepted, the answers to the questions regarding air cargo will affect not only the design of airplanes themselves but the whole future of airline organizations as well.

Furthermore, the problems of air cargo interest many more people than just airline executives. Every business man in the country who is concerned with the shipment of goods is almost equally involved. Every shipper wants to know what is coming in the air age—what can and should be carried by air, what rates may be expected, and how reliable the carrying of air cargo will be. These questions cannot yet be answered in definitive fashion, but an examination of the opinions of well informed men, of the statistics which have come from reliable surveys, and of the actual results of carrying cargo by air to date is well worth while.

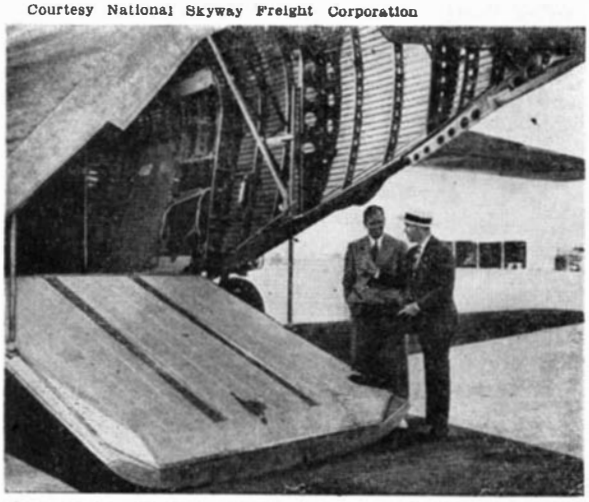
The air transport operators are most optimistic of the future of their operations in general. In their early expanded post-war fleets, 19 airlines of the United States expect to have 975 planes operating at higher speeds than formerly, with many new comforts, and seating 36,180 passengers. And to raise their equipment to meet post-war programs, the airlines have ordered or have an option on 409 new planes, according to the Air Transport Association. But what is of more immediate interest is that these new planes will have greatly enlarged compartments for cargo. There will be improvements in type and location of hatchways to facilitate loading and unloading. Some of the planes will have quickly adjustable cargo space, so that the number of seats and size of the cargo hold can be varied to accommodate the proportions of the load.

The increase in cargo capacity contemplated is remarkable. The airlines last year carried a total of 202,879,006 pounds of mail, express, and excess baggage. With their new planes, cargo capacity will be increased five fold. They will be able to handle in the coming year *a billion pounds of cargo.*

Courtesy United Air Lines

Shipment of gardenias kept fresh in cooled Fiberglas insulated container

Courtesy National Skyway Freight Corporation



Spacious interior of cargo plane permits handling of many types of air freight—even household furniture

One of the first modern all-cargo planes to be built has a maximum gross weight of 45,000 pounds; a tricycle landing gear; a fuselage floor level with truck floor height and fitted with skid strips and tie-down rings for fast and secure loading. It has a useful load of about 18,000 pounds, a payload of 13,113 pounds at a range of 500 miles, and a cruising speed of 190 miles an hour. The cargo compartment has a storage capacity of 2870 cubic feet and a floor area of 347 square feet. Such cargo carriers will undoubtedly supersede all the converted military transports. It will, indeed, be better for the aviation industry, better for

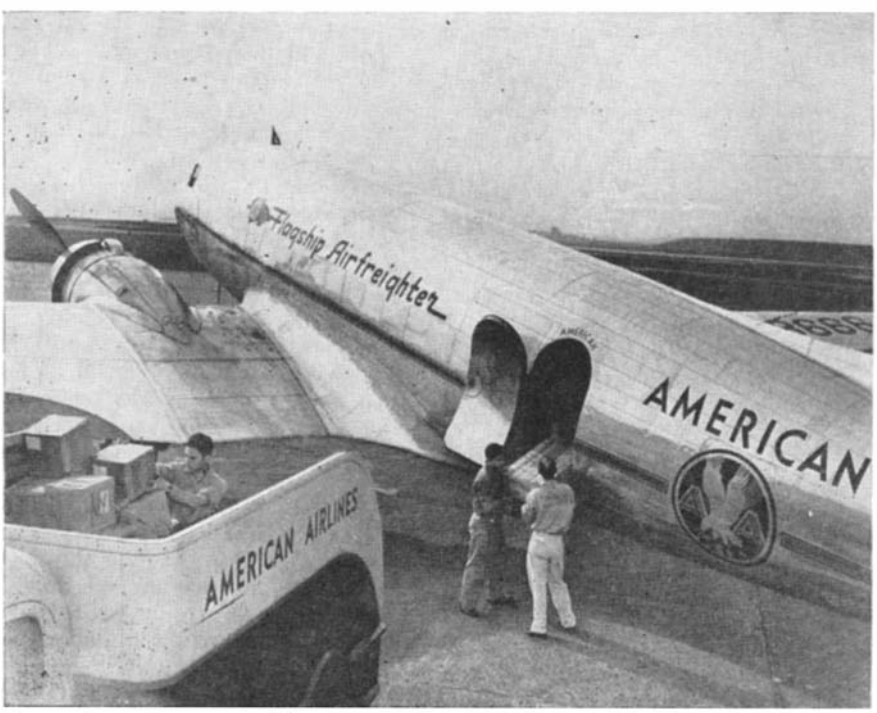
the airlines, and better for the nation at large if the great bulk of military air transport equipment be frankly regarded as obsolete.

AIR CARGO TODAY—What are the airlines already doing in air cargo work? American Airlines (now become American Airlines System since it absorbed American Export Airlines and has undertaken services to Europe) has converted the famous Douglas DC-3 to all-cargo use and named it the "Airfreighter." In the first six months of this year American flew almost two billion air freight pound miles. This is definite accomplishment to back up prophecy or expectations.

Freight by air will be selective in character; it is hardly to be expected that coal will be flown from the mines, or wheat from the western plains. As United's Mr. Patterson has said, passengers when delayed merely grumble; air cargo unduly delayed may turn to garbage! For no class of merchandise is time more important than flowers, the ultimate in perishability. United, working in co-operation with Owens-Corning Fiberglas Corporation, has developed what has been called "a floral ice box."

Gardenias have thus been carried in an airliner, packed in Fiberglas cloth containers insulated with light Fiberglas insulation. Each container weighs 25 pounds and has a capacity of approximately 120 cubic feet. The top is equipped with five pockets which accommodate slabs of dry ice, one inch thick and ten inches square. The walls of the containers are approximately one inch thick and access to the interior is made possible by a zippered opening running almost the entire height of one side. Tests in a United "Cargoliner" were completely successful; 35 boxes of gardenias, weighing six pounds per box, were flown via air-express from San Francisco to Chicago. Cabin temperatures sometimes rose to 100 degrees when the ship was on the ground. Flowers carried outside the refrigerated box became dehydrated; gardenias in the containers arrived in perfect condition.

Of course it may be argued that gardenias are a de luxe commodity which can demand great care and corresponding expense. But does not the experiment warrant a belief that other perishable goods can profitably be carried by air? Claude N. Palmer, of the United Fresh Fruit and Vegetable Association, has a vital interest in the problems of carrying perishable fruits and flowers on a large scale. Mr. Palmer recently said: "I believe I can tell you that the future of all air transport of goods hinges to a greater extent upon a large and continuous volume of perishable soil products than upon any other source of payload. Why? The answer is simply that fresh fruits and vegetables hold a key to the profitable operation of transport planes on their west-to-east and south-to-north flights." Mr. Palmer also reported on the work of the Ralph E. Myers Company, of Salinas, California, which has been conducting test shipments to eastern markets for the better part of a year, and which has launched a program of thrice-weekly air cargoes, the first of which consisted of 18,500 pounds of California tomatoes, plums, apricots, strawberries, and lettuce. These 18,500 pound shipments, the largest civilian freight movement by air ever undertaken, are being made in a new transport plane which was designed and built by Consolidated-Vultee. There will be great competition for the carrying of fruits, vegetables, and flowers by railroads and trucks. But a tremendous potential in air cargo seems to exist also.



Cargo hatches are designed to facilitate quick handling of freight

COSTS—It is too early to speak specifically of costs, and difficult to say what industries will first take full advantage of air freight. The costs will depend on volume and the volume will depend on costs. Air shipment will be expensive for a long time to come, and will have to depend for its development upon greater speed and convenience. But a survey made by the Evans Transportation Research has done a great deal to clarify the situation. When Colonel L. H. Britain launched the survey in co-operation with the Detroit Board of Commerce, he asked but one question:

"If a reliable daily all-air freight service was provided that would leave Detroit at the close of every business day, and arrive at San Francisco early next morning, at a rate of $10.00 per hundred, or ten cents per pound, airport to airport, how much poundage would your company be likely to ship in an average month by such service, for redistribution to Pacific Coast points and for export from San Francisco?"

Replies were promptly received from 30 percent of those firms to whom inquiry was sent and removed a great deal of the guess work which has accompanied industrial thinking about air cargo thus far. The survey indicated that at the above costs, and at the above rate of speed, 200 Detroit factories would ship over 350,000 pounds per month from Detroit to the San Francisco gateway. And this at 10 cents a pound, be it noted, for the long haul.

The three leading shippers by air would be the following, in order: the small tool and die industry; the automobile and automotive parts industry; and the pharmaceutical industry and related producers. The chief reasons given by these firms for regular air shipments were emergencies, reduction of inventories, and the offsetting of local Pacific Coast competition. Other firms saw possibilities of expanding limited local markets. About 200 firms were interested. Negative replies were received from 236 firms who gave as their principal reasons

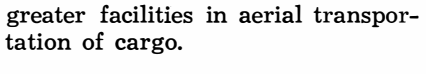
that the shipper could not commit his customers to increased shipping expense, and that for heavy articles, ten cents a pound might increase cost of the product by a third of its value, which would be prohibitive. It is also interesting to learn that 93 percent of all shipments would be in units of 1000 pounds or more.

FLYING COSTS—On the question of cost, what may be expected from the plane builders whose engineers are busily constructing aircraft of greater size and with lower operating costs? Fred B. Collins, of Boeing Aircraft, summarizes the situation as follows: "There are several ways in which economies of operation can be obtained. One of the most important is by cutting the cost of flight itself, through more advanced performance characteristics which are inherent in the newer airplane design. Another is by designing to decrease the time and cost of maintenance and of ground operations. Increased speed of flight becomes a means of saving cost because it enables the operator to spread his fixed operation costs over a greater number of miles per hour. . . As a result of advances in these various directions, transport planes will be available for immediate post-war use which will operate at as low as 8 mills per passenger mile for standard passenger versions or 4 cents per ton mile for all-cargo versions. These figures compare with operating costs of present type transport equipment in airline use ranging from 1.8 to 2.5 cents per passenger mile and approximately 17 cents per cargo ton mile."

There are other straws in the wind. The Manhattan Storage and Warehouse Company, for example, is experimenting with special air shipping containers for fine china, glass, medicine, and the like. After packing these articles in containers of fiber board, plywood, and so on, they were dropped from a height of 52 feet onto a concrete surface with astonishingly little damage.

Other experiments are being continued on dropping of air cargo by parachute. And Air Cargo Transport is operating non-scheduled charter flights, ready to pick up and deliver by air any special cargoes, of which the recent shipment of 40,000 vials of penicillin to Latin America from La Guardia Field is typical.

POTENTIAL—While fantastic prognostications of air cargo operations that will equal truck or railroad shipments are hopelessly out of line, there is solid support for the conviction that air cargo has a tremendous potential, that it will rapidly find its proper sphere of action, that it will interest a few industries greatly, and almost all industries to some degree. Economists are making reasonable surveys, designers are building better planes and handling equipment, airline operators are making intelligent and courageous bids to industry and business, and business men show every interest in and desire for greater facilities in aerial transportation of cargo.

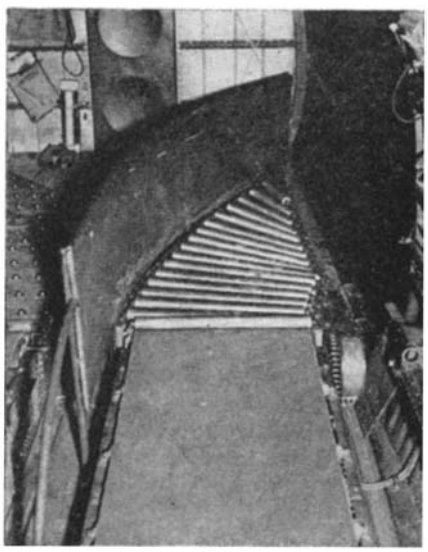


CARGO DROPPING

From Conveyor Belt in Airplane

THE Air Technical Service Command of Wright Field has developed a conveyor belt for dropping cargo by parachute.

The belt is an endless chain-driven conveyor operated by a 3.87 horsepower electric motor. Power



Air-cargo conveyor

is provided by the 24-volt direct current system which is now available on every plane. The belt extends from behind the pilot's compartment to the rear door of the plane, a distance of 22 feet, and runs at approximately six feet per second, or from one end to the other in four seconds. The belt terminates at a roller-bearing platform mounted at the cargo door. Packages are deflected round a corner and launched in containers from the airplane. Static lines open the parachutes when the containers are 15 feet below the airplane. Not only is speed in dropping increased, but it was found possible to drop 4000 pounds at a time.

The containers each hold 300 pounds, and are carefully engineered. They are made of strong cotton duck and webbing or fiberboard. Another feature of the development is that the area within which the cargo is dropped is very much reduced.

WAR TRENDS

As Foreseen by General H. H. Arnold

DISCUSSING the air war of the immediate past, and the air war of the future, General H. H. Arnold recently made some highly interesting remarks regarding the following "observable trends":

1; Manned or pilotless airplanes traveling at supersonic speeds. At such speeds aerial combat as it is known today would be impossible. 2; The development of guided missiles and the refinement of their controls so that exact hits can be made on targets of a mile square or less, at any part of the world from any part of the world. 3; Improved atomic bombs, destructive beyond the wildest dreams. 4; Great developments in defense both against aircraft and guided missiles. Every new weapon of offense brings forth a weapon of defence, and this should remain true even in the case of the atomic bomb. 5; Perfected communications systems between air and ground, making possible the most intricate maneuvers either by piloted planes or pilotless missiles. 6; Extraordinary developments in the launching and landing and supplying of air-borne troops.

ASPHALT AIRSTRIPS

Surfaced With Prefabricated Material

AIRFIELDS are being surfaced by United States Army Engineers with a new type of material called "P.B.S." (prefabricated bituminous surfacing). The surfaces have taken the steady pounding of fighter and cargo planes as well as medium bombers. The new material is nothing more than burlap, impregnated and coated with asphalt, which gives it the appearance of roll roofing.

One of the unusual features of P.B.S., which is made by the Texas Company, is the ease with which it can be repaired. Small repairs can be made by two men with a mop, a bucket of asphalt, and a strip of surfacing. Swab it, lay it, walk across it, and the patch is made. For larger repairs, such as bomb damage or soft spots formed by trapped water, the surfacing material is slit and folded back, repairs are made to the soil underneath, and the surface is replaced and sealed by adding fresh strips of P.B.S.

How Soon Atomic Energy?

Does the Atomic Bomb Indicate the Future Mass Destruction of Every Living Thing? Or, Properly Controlled, Will Its Limitless Energy be Utilized and Harnessed to Serve Mankind as has Electricity and Water? The Next Five to Ten Years May Possibly Provide the Answer

WHAT may be the beginning of a new era for the human race started on August 6, 1945, when, for the first time on a scale larger than microscopic, the energy of deliberately induced atomic disintegration was applied to the purposes of man. What the characteristics of this new era will be is the most exciting and most important question now before humanity. The possibilities clearly lie beyond present scientific treatment; perhaps they rather belong in that curious realm of super-stimulated imagination, the so-called "comic strips," where stupendous power has long been commonplace.

Will man's future lead through ever-mounting terror and destruction to a climax in the suicide of all living things? Or will this source of tremendous new energy in our hands create the means to freedom, prosperity, and plenty for all men beyond our most sanguine dreams? The problems immediately facing humanity are beyond all question the most serious we have ever encountered. The control of this vast new force poses problems of the highest magnitude and significance in the physical sciences; at the same time its social and spiritual implications are incomparably greater than any we have faced before.

Literally everything depends on correct and timely solutions to these problems. The present state of knowledge on the subject of atomic disintegration cannot justify specific predictions, but certainly we are entitled to guidance by the best views of those closest to the matter. The whole subject is so intimately tied up with military considerations and consequent secrecy, that details cannot now be revealed, but hints and bold speculations point to tremendous utility for atomic energy in the future. Therefore it is easy to justify efforts to gather and to summarize the best informed available opinion on the subject as it stands today for the readers of Scientific American.

EDITOR'S NOTE: After the article "Atomic Bomb" (page 238, October 1945 Scientific American) was prepared for publication, the now famous Smyth Report appeared. The accompanying article, based upon extensive correspondence with outstanding American physicists and upon the Smyth Report, complements our October article. Taken together, the two articles present the whole picture of the present status of atomic energy and the possibility of utilization of it in the future. Any further attempt at prophecy regarding atomic energy applications and their economics would be largely guess work.

In pursuance of this objective, the writer addressed a letter to 25 men of science, leaders in the development of the new weapon, asking three specific questions. The questions asked are given in the box on the following page.

Responses were generous and thoughtful. Above all they reflect the grave responsibility felt by each of the scientists as the custodian of an essential part of a secret of such overwhelming significance.

The protection placed around the development of the military weapon was complete in every respect. Secrecy surrounded not only results but every phase of the work. For more complete secrecy, the subject matter was subdivided into such small units that no one person and no small group ever knew, and does not yet know, of the whole matter. Furthermore, the intense preoccupation of each person engaged in the tremendous enterprise with his small segment of it precluded his interest beyond the narrow assigned area. Necessarily the details of a military weapon of such stupendous power as the atomic bomb will properly continue under strict secrecy. But the possibilities inherent in controlled atomic disintegration are so freighted with human destiny that they must be discussed and their implications must be understood by every thinking American. The matter must be freely discussed, debated, and pondered.

The implications of the military weapon are already sufficiently evident in the surrender of Japan. Preliminary reports of the terrible destruction of Hiroshima and Nagasaki will undoubtedly be much amplified before this article can appear in print. Clearly the facts, when fully known, will prove the strongest possible stimulus to peace.

Most responses to the writer's questions emphasized the necessity for continued observance of the secrecy imposed upon all connected with the project. These generally referred to what is commonly called the Smyth Report, an official document of 174 typewritten pages written by Dr. H. D. Smyth and entitled "A General Account of the Development of Methods of Using Atomic Energy for Military Purposes under the Auspices of the United States Government. 1940-1945."

This report, issued August 12 and subsequently published by the Princeton University Press, contains the scientific background of atomic disintegration as a source of power, the history of the project resulting in the atomic bomb, and such details of the whole matter as are proper to reveal at this time. Quite probably this will be the only publication regarding most aspects of the project. The Smyth Report contains a brief prophecy as its concluding paragraphs. These, in broad general terms, answer the questions asked of the 25 physicists and hence are quoted here:

"Prognostication

"13.4. As to the future, one may guess that technical developments will take place along two lines. From the military point of view it is

reasonably certain that there will be improvements both in the processes of producing fissionable material and in its use. It is conceivable that totally different methods may be discovered for converting matter into energy since it is to be remembered that the energy released in uranium fission corresponds to the utilization of only about one-tenth of one percent of its mass. Should a scheme be devised for converting to energy even as much as a few percent of the matter of some common material, civilization would have the means to commit suicide at will.

"13.5. The possible uses of nuclear energy are not all destructive, and the second direction in which technical development can be expected is along the paths of peace. In the fall of 1944 General Groves appointed a committee to look into these possibilities as well as those of military significance. This committee (Dr. R. C. Tolman, chairman; Rear Admiral E. W. Mills (USN) with Captain T. A. Solberg (USN) as deputy, Dr. W. K. Lewis, and Dr. H. D. Smyth) received a multitude of suggestions from men on the various projects, principally along the lines of nuclear energy for power and the use of radioactive by-products for scientific, medical, and industrial purposes. While there was general agreement that a great industry might eventually arise, comparable, perhaps, with the electronics industry, there was a disagreement as to how rapidly such an industry would grow; the consensus was that the growth would be slow over a period of many years. At least there is no immediate prospect of running cars with nuclear power or lighting houses with radioactive lamps although there is a good probability that nuclear power for special purposes could be developed within ten years and that plentiful supplies of radioactive materials can have a profound effect on scientific research and perhaps on the treatment of certain diseases in a similar period.

"Planning for the Future

"13.6. During the war the effort has been to achieve the maximum military results. It has been apparent for some time that some sort of government control and support in the field of nuclear energy must continue after the war. Many of the men associated with the project have recognized this fact and have come forward with various proposals, some of which were considered by the Tolman Committee, although it was only a temporary advisory committee reporting to General Groves. An interim committee at a high level is now engaged in formulating plans for a continuing organization. This committee is also discussing matters of general policy about which many of the more thoughtful men on the project have been deeply concerned since the work was begun and especially since success became more and more probable.

"The Questions before the People

"13.7. We find ourselves with an explosive which is far from completely perfected. Yet the future possibilities of such explosives are appalling, and their effects on future wars and international affairs are of fundamental importance. Here is a new tool for mankind, a tool of unimaginable destructive power. Its development raises many questions that must be answered in the near future.

"13.8. Because of the restrictions of military security there has been no chance for the Congress or the people to debate such questions. They have been seriously considered by all concerned and vigorously debated among the scientists, and the conclusions reached have been passed along to the highest authorities. These questions are not technical questions; they are political and social questions, and the answers given to them may affect all mankind for generations. In thinking about them the men on the project have been thinking as citizens of the United States vitally interested in the welfare of the human race. It has been their duty and that of the high government officials who were informed to look beyond the limits of the present war and its weapons to the ultimate implications of these discoveries. This was a heavy responsibility. In a free country like ours, such questions should be debated by the people and decisions must be made by the people through their representatives. This is one reason for the release of this report. It is a semi-technical report which it is hoped men of science in this country can use to help their fellow citizens in reaching wise decisions. The people of the country must be informed if they are to discharge their responsibilities wisely."

BEFORE preparing the accompanying article, Mr. Killeffer, the author, asked the following questions of 25 physicists who had parts in the development of atomic bombs:

(1) Do you see a possibility within a reasonable time of the application of atomic energy on a reasonable scale to industrial purposes?

(2) What general forms do you anticipate applications of this kind are likely to take?

(3) Are you willing to hazard a guess as to the probable length of time that will be required from now on to develop any general usefulness for atomic energy?

How these men of science responded is told in these pages.

THE ESSENCE—That represents the essence of the thought of the principal workers on the project. It remains merely to add to this general view a brief summary of the specific thoughts supplied by those queried.

Emphasis is universally placed on the restricted view of each person engaged on the project. Even those who occupied key positions found their interests, activities, and information confined within limited areas. Thus it has so far been impossible for anyone to view the whole problem in proper perspective, and consequently a considered opinion of future possibilities is virtually impossible to form under the circumstances.

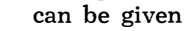
The view is expressed that present use of atomic energy in a destructive bomb is in no sure sense a guarantee that this type of power will be usable in other ways. A great deal remains to be done before an operable method of utilizing energy of such enormous concentration can be devised. When an operating device is reached there will still remain vital problems of efficiency and cost as compared with other power sources to be solved. Involved in all this will undoubtedly be many basic inventions. These may be made at any time and such is the intensity and pace of present-day research that the most important of these can scarcely be delayed more than a very few years (say 5 or 10).

On the basis of the meager information now available to anyone on the entire subject, it seems futile to attempt any estimate of the engineering phases of power development. The high penetration and extraordinary power of the radiation emitted by present nuclear reactors requires such heavy shielding as to preclude their use in any presently practicable vehicle with the possible exception of large steamships.

While this aspect of present reactors keeps them out of vehicles and limits their possibilities in stationary units, it is clear that even present rudimentary techniques provide a source of practically boundless supplies of radioactive materials for medical and industrial purposes. Many of these applications are yet wholly unexplored, such possibilities having been neglected in the

past in view of the extreme scarcity and high prices of radium.

Finally, one must realize that the whole matter of power from this new source is and undoubtedly will remain for a considerable time in a state of flux. Its interrelations with the military applications are too close to permit open discussion of all details soon. Yet the whole problem is substantially closer to solution that it was even months ago. We can look forward to a better day for all men to come from this development within, let us say, a decade or two—certainly well within the lifetimes of many now living.



RAT KILLER

Does not Affect Acceptability of Bait

SODIUM FLUOR-ACETATE, a new synthetic compound, has shown great promise as a poison for mice, rats, prairie dogs, ground squirrels, and other small mammals that constitute serious pests. The high toxicity of the compound, known as "1080," allows it to be administered in poisoned baits and food without seriously affecting the acceptability of the food for the pests. The compound is also intensely poisonous for man and other animals and must be used under the most carefully controlled conditions.

FUNGI

Found Readily by Use of Ultra-Violet Light

DETECTION of fungi and location of infected areas are necessary in cleaning up valuable equipment and instruments returned for repair or salvage from tropical war areas. In normal light fungi are difficult to see except in lush growth, but ultra-violet light immediately reveals their presence by causing the organisms to glow by natural fluorescence. Clearly outlined in this manner, eradication of the fungi is much simplified.

PENICILLIN PRODUCTION

Involves Large Usage Of Banana Oil

ALTHOUGH the 400 billion units of penicillin now being produced monthly weigh only some 530 pounds, the amount of material that must be processed in production sometimes is so great as to be critical. Recent reports suggest that 85 to 90 percent of the nation's amyl acetate ("banana oil"), important as a solvent, is consumed in this production. That proportion is too great for the comfort of other industries needing this solvent and hence steps are being taken to develop efficient processes for its recovery.

TORPEDO RECOVERY

Made More Certain by Synthetic Resin

A WATER-SOLUBLE synthetic resin disk placed in a naval torpedo dissolves when the torpedo is lost and releases a float that enables searchers to find it. The resin used is one of a family that can be prepared from polyvinyl alcohol. These resins can be given any desired degree of solubility in water, from complete insolubility to easy solution. The safety disk is designed to dissolve in a predetermined time, long enough to allow the torpedo to be completely tested, but short enough to expedite searches for any that escape and sink.

DDT TROUBLES

May Hinder Use of its Valuable Properties

RELEASE of DDT to civilians for general use recently, led to a flood of preparations presumably containing this highly effective insecticide but actually too dilute to be useful. Warnings promptly issued pointed out that abuse of the compound in this way by unscrupulous persons is likely to lead users to conclude that DDT has no value, when as a matter of fact it is highly effective when properly used.

Legitimate insecticide producers are proceeding cautiously to be sure that any preparations they offer are effective and that correct instructions for their use are also provided. DDT itself (dichloro-diphenyl-trichloroethane) requires to be compounded with other materials to be fully effective and at the same time safe for use. Some additives, notably solvents, increase the toxicity of DDT for human beings unduly and thus introduce excessive hazards into its use. Fear is expressed that unfortunate experiences with early improper DDT preparations may prevent its legitimate later use for valuable purposes.

SPECIFIC GRAVITY

Quickly Determined by Vacuum Method

A NEWLY devised and rapid method of determining the specific gravity of an unknown liquid consists in comparing the height to which it will rise in a tube with the rise of a known liquid in a tube under equal vacuum. In practice, the unknown and the standard liquids are drawn up into two parallel glass tubes joined at the top and connected to suction at the junction point. The heights of the columns in the two tubes are in inverse ratio to the specific gravities of the two samples. Accuracy can be increased by calculating from measurements of differences in the height of the columns under two different suctions. The specific gravity, accurate to the fourth decimal place, can be quickly determined in this way.

PENICILLIN

When Properly Protected Can Be Taken by Mouth

EFFORTS to find a way to administer penicillin effectively without the use of a hypodermic syringe have developed various methods designed to protect the active principle of the drug while it is passed through the stomach when taken by mouth. Apparently absorption of penicillin takes place from the small intestine, but the drug is delicate and cannot survive the high acidity of the human stomach. Several suggestions have been based on the inclusion of various anti-acids with the penicillin in the dose but it has been found that high alkalinity also destroys its effectiveness. One successful method dissolves the drug in oil. Latest successes have been scored by the use of calcium carbonate—precipitated chalk—to neutralize stomach acidity without creating alkalinity since the neutralizing agent is insoluble except in acid.

SAFER LABELING

Important in Handling Of Hazardous Chemicals

THE FIRST comprehensive effort to systematize and standardize labeling of hazardous chemicals, considered of special importance in view of the pace of developments in the industry, has just been completed and published by the Manufacturing Chemists' Association of the United States.

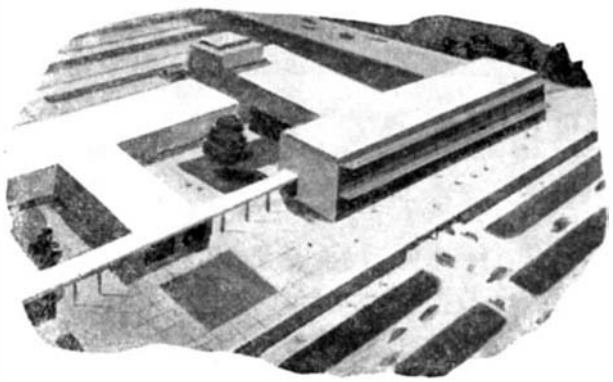
The main objective of the work is to discourage use of code labels which leave the user with no information about the product. Principles are established to govern preparation of precautionary labels, with maximum emphasis on protecting the users, handlers, repackers, jobbers, and distributors of chemical products or others who may be less familiar with them than the manufacturers.

TO SPEED THE PACE O

—and bring you better thing

THE BUILDINGS of the Technical Center will face a seven-acre lake. These buildings will be connected by a covered walk and vehicular roadway. Sketched below is the Advanced Engineering Building in which improvements will be quickly made in existing products.

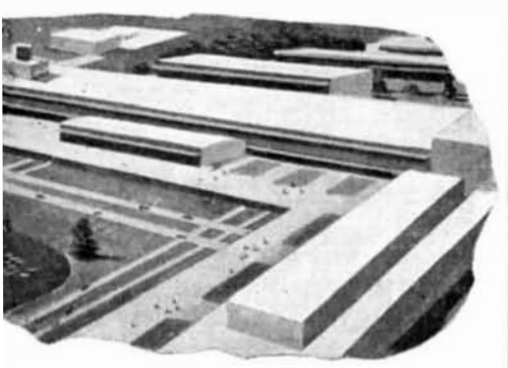
LOCATED ON a major highway leading from Detroit, access to the Center will be through the Administration Building sketched here. A system of modern roadways will provide practical opportunity to study traffic control as well as to make simple road tests of new car developments.



PROGRESS

more quickly

A FLOOD OF SUNSHINE will pour into the southern windows of the Research Buildings where experimental work is carried on in such diverse fields as the study of chlorophyl, research into fuels and engine design.



The New GENERAL MOTORS TECHNICAL CENTER will be created to stimulate opportunities, promote employment and bring about MORE and BETTER THINGS FOR MORE PEOPLE

THESE are times when the world cries out for new and finer things. There is a great hunger, broad as all mankind, for happier relationships among men — for greater individual opportunity for accomplishment, for more and better goods within reach of everyone.

It is by satisfying this hunger that we can bring greatest benefit to our national economy in the future. Through such action lies the road to more good jobs, to an ever-rising standard of living through the continual replacement of old things with new and better ones.

The General Motors Technical Center is dedicated to such an objective. It will occupy a 350-acre tract of land outside of Detroit as soon as conditions permit. Its purpose is to develop new things that add to the comfort and security of our living, and to enable existing things to be made more efficiently, hence at lower selling prices, so more people may own and enjoy them — all with expanding job opportunities.

It will shorten the time required to bring the work of creative thinkers out of the idea stage and into usable reality.

Here in groups of buildings designed especially for the purpose, General Motors will gather in advantageous and inspiring new surroundings the most modern facilities for research, advanced engineering, styling and the development of new manufacturing techniques.

Here physicists and engineers will discover new facts and convert them into new improved products. Stylists will give them new and more attractive form. Process engineers will develop better manufacturing techniques for making them.

Science here will go to work in the interest of economic progress. And history is full of proof that when science is so harnessed, more jobs are created, more comforts and conveniences are brought within reach of more people.

Serving as a source on which the engineering staffs of all of our Divisions may draw, the General Motors Technical Center will stimulate improvement in all General Motors products. Automobiles, refrigerators, Diesel engines, locomotives and other good and useful things may be expected to be improved at even faster pace than in the past.

But the work of the Technical Center will not be confined to existing things. It is dedicated to the idea that progress is the servant of mankind and that whosoever advances it not only helps himself but his fellow men. Its goal will be "more and better things for more people," whether that comes through improvement of the old or development of the new.

GENERAL MOTORS

MORE AND BETTER THINGS FOR MORE PEOPLE

CHEVROLET • PONTIAC • OLDSMOBILE • BUICK • CADILLAC • BODY BY FISHER
FRIGIDAIRE • GMC TRUCK AND COACH • GM DIESEL

Every Sunday Afternoon
GENERAL MOTORS SYMPHONY OF THE AIR—NBC Network

MAKE VICTORY COMPLETE—BUY MORE WAR BONDS

Lithium, Servant Metal

As a Scavenging Agent, This Lightest of All Metals Makes Possible Alloy Castings that are Stronger, Less Porous, and Higher in Electrical Conductivity. Because of its Extreme Chemical Activity it Purifies Alloys and Gives Them Much Finer Grain Structure

NATURE seems to have given the United States another world-wide superiority in a resource to join those of iron, petroleum, and so on. This latest one is lithium. The best source of lithium is Searles Lake, at San Bernadino, California. Searles Lake is a dry lake in which the evaporating water left all kinds of valuable salts which are processed by heavy chemical industries. One of the by-products of processing contains over 10 percent of lithium as compared to a top of 3.3 percent in spodumene, the most used ore.

There is plenty of spodumene, too, in the Carolinas and in the Rockies. The trouble is, it has never been possible to get the price of lithium extracted from this and other ores down below the present level of from $12.50 to $20.00 a pound, nor is the Searles Lake concentrate any better in this respect so far. But with the uses of lithium advancing rapidly and with the bright promises of the Searles Lake development, the price might get down to $5.00 a pound. And that would make big differences to many an industry. Lithium is making big differences even at its present price.

Lithium is a strange metal. It is the lightest of metals—a cubic foot of it weighs only 33 pounds *vs* 108 pounds for the same amount of magnesium and 176 pounds for aluminum—and yet it very seldom will be used as a light-weight structural metal itself nor to lighten the weights of other alloys. It can be purified to a commercial degree very easily, yet it seldom will be used in pure form. It can be alloyed very easily with other metals, yet only a fraction of its total production will be used as a constituent of alloys. It already is an important metal of industry and is destined to be a far more important one, yet in its largest commercial applications it does not gain its markets by displacing other products.

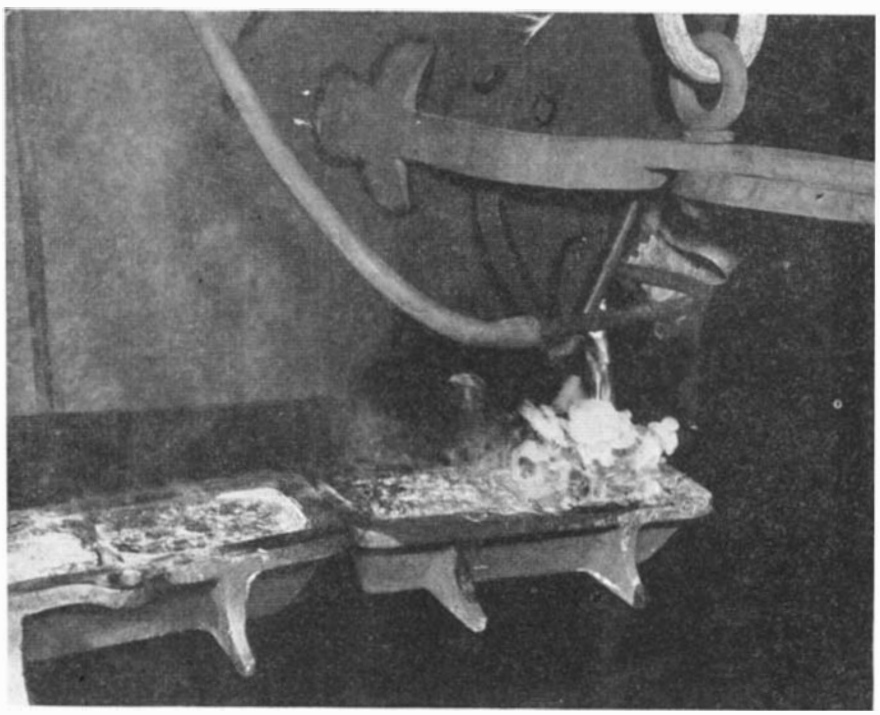
The reason for these seeming contradictions is simple. Lithium is a "servant" metal. Its big function in metallurgy is to help other metals to behave better. It does the same thing for gases, welding-rod fluxes, lubricants, soaps, and air conditioning.

IMPORTANT TASK—One major use of lithium is in the making of nonferrous alloy castings. Only about 0.01 percent of lithium is used in the ordinary metallic mixture, and only about 0.05 percent is, in most cases, found in the finished casting. Sometimes only a trace of lithium remains. And yet the task of the lithium in the making of the casting is an important one.

Nonferrous alloy castings are made of metals (copper, zinc, and so on) which have different melting points. They also solidify at different temperatures when being individually cooled. Melted and cooled together, as they must be for casting, they have all sorts of behaviors toward each other. They form solutions, emulsions, matrixes. They combine in varying grain sizes and shapes.

While all of this is going on, various "unwanted" elements also are at work within the melt. Gases and impurities like hydrogen, oxygen, nitrogen, sulfur, and particles of sand, are having bad influences on the ways in which the "wanted" elements are behaving toward each other. The unwanted elements are changing the grain structure for the worse, causing porosity and setting up weak spots.

Here is where the lithium goes to work. Lithium is the most chemically active of all the metals. It combines with almost any gas, taking that gas unto itself and away



Pouring molten lithium from an electric furnace into ingot molds

Lithium is so soft that it can easily be cut with an ordinary pocket-knife

from the wanted metals in the melt. It takes hold of sand particles, too, and of other impurities. Opposite to the corruption resisting "noble" metals like gold and platinum, lithium welcomes corruption.

Now the extremely light weight of lithium comes into play. It rises to the surface of the liquid, molten metal, bringing the impurities with it. Behind is left a melt of cleaner, purer metals.

The grain structure of the lithium-scavenged casting is likely to be much finer, as much as 98 percent finer in some cases. Gas pockets, "blow holes," and porosity can be completely eliminated.

The real story is summed up in the metallurgist's expression: "theoretical maximum values." For every alloy which is cast there is a list of such values in tensile strength, electrical conductivity, coefficient of friction, and others. If a melt is mixed and cast perfectly it can reach those values—be at the best which is theoretically possible for it. If handled perfectly it will have lower values or abilities in various respects. And lithium-scavenged castings are likely to approximate many of their theoretical maximum values.

Electrical conductivity is an example. Lithium-scavenged castings often reach their maximum conductivities at normal temperatures. Thus their desirabilities for electrical purposes are greatly increased.

GREATEST STRENGTH—Most important of all, the castings can approximate their theoretically greatest strengths. This is partly a matter of uniformity, of being sure that all parts of the casting are more nearly alike and that the whole casting is more dependable. Outright additions of strength as compared to ordinary castings can be had too. A maker of Navy composition "G" castings found that before lithium was used the tensile strength was 42,000 pounds per square inch; lithium-scavenging raised it to a range of 48,000 to 52,000. Similarly, the elongation was raised from about 35 percent to a range of 45 to 65 percent. With every equipment maker trying to work with more and more power at higher and higher speeds while fitting his machine parts into smaller and smaller spaces, increased strength with increased uniformity means that lithium-treated castings may be used for many purposes from which the same alloys might otherwise be excluded.

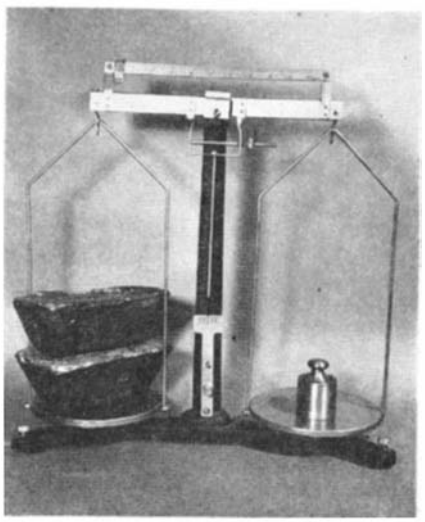
Pure lithium is not likely to be used in any foundry. It is added to copper and brass products in electrical furnaces in copper and brass mills, but for most foundrymen it would be bothersome to handle.

Rather, "master alloys" containing varying proportions (usually from 2 to 10 percent) of lithium are purchased from such companies as the Lithaloys Corporation. The balance of these alloys is copper, zinc, or some of the other "wanted" metals of the castings. These "balance metals" enter directly into the castings, and if the mix is to be carefully controlled then their amounts are considered in proportioning it.

The amount of lithium in a master alloy depends first upon the scavenging to be done—there must be enough for this—and second upon the degree of grain refinement needed for the purpose of the casting. The more the lithium the finer the grain. Very seldom is more than 1 pound of master alloy added to each 100 pounds of melt, and almost never more than 1½ pounds. These points require careful metallurgical consideration for which the master alloy maker supplies a consulting service.

In the foundry, the master alloy must be added early enough, usually from three to five minutes before the mix is poured, so that the lithium will have enough time to do all of its work. And the stirring-in must be so controlled as to do a thorough job without unduly disturbing the mix.

Castings made by these methods are likely to approach the "no spoilage or rejections" ideal of mass production. One foundryman averaged 25 percent of weepers (castings rejected for porosity) before using lithium-scavenging—less than 1 percent afterwards. When spoilage ran so high he always had to guess what it would be, and to pour extra castings accordingly. If his guess was



The lithium ingots are so light they are balanced by small brass weight

wrong—as it nearly always was—then he either had extra castings or else too few to fill his orders. With spoilage nearly eliminated he avoided this extra cost. Lithium-scavenging often saves its cost by the reduction of the percentage of rejections.

Fine grained, highly uniform castings work better on the lathe and milling machine than do their coarser grained brothers. Accuracies, surfaces, and finishes are better. This makes for better products at lower machining costs.

FOR STEEL, TOO—Lithium soon may do as much for the ferrous as for the nonferrous industries. Important studies are now being concluded and their results may be announced any day. When this news breaks, every steel mill producing every kind of steel from plain carbon to stainless and other high alloys, may be offered brand new advantages.

The bearings industry, also, is being helped by lithium. Many of the toughest bearings problems are in the mixing of lead-copper alloys for heavy-duty, heavy-pressure, high-speed bearings such as are used in modern engines and other machines. The lead has the antifriction qualities and the copper the compressive strength needed by

these bearings. But the trouble has been that some of the most desirable proportions of these two metals either could not be cast together at all or else they would form stratified grain structures which are too weak for this purpose. With tiny amounts of lithium in the mix some of these mixtures can be cast with complete success. The lithium takes care of the troubles which had previously caused the separation of the copper and lead.

Sometimes, lithium requires new industrial techniques. The die casting of zinc metals is an example. If lithium is alloyed with the zinc and the melt is kept in special types of closed melting pots and is fed under controlled atmospheric conditions such as are used in heat-treating furnaces (these methods will be brand new to many a die caster) then the alloys will flow with enough extra freedom to provide new opportunities to the die casting art.

Alloyed with magnesium—another of the up-and-coming "new" metals —lithium adds to tensile strength and hardness. And there are other lithium alloys as well which will be found in industrial products of the near future.

One odd use of lithium is in the production of hydrogen. A little less than five pounds of lithium hydride immersed in water will release 225 cubic feet of this gas. Our military forces used this process. Hydrogen from a small container of lithium hydride immersed in the ocean inflated a rubber balloon, the balloon raised one end of a copper wire 300 feet into the air, and the wire became the antenna by means of which the shipwrecked aviator or sailor radioed his call for help.

The figures on such hydrogen production are intriguing. Each pound of lithium hydride will yield a by-product of about three pounds of lithium hydroxide which is worth about $2.00 a pound today. With lithium hydride costing $12.50 a pound, even with the value of the by-product counted in, the hydrogen from it would cost about $15.00 a hundred cubic feet as compared to less than $2.00 (all factors considered) for hydrogen which is bought in rental-return steel containers. But if the price of lithium were to come down to its hoped-for $5.00 a pound then the cost of hydrogen from its hydride could become less than that of hydrogen in steel containers—the fact that the by-product hydroxide also might have less value being given full consideration. And even now, wherever the cost of transporting and handling the 140 pound steel cylinder is high enough to overbalance the price differential, hydrogen from lithium hydride will find a market.

In lubricants lithium both increases and decreases the temperature limits at which it is possible to use bearings. Although not an application of lithium in the metallic form, the use of lithium compounds in the production of atmospheres for metal-heating is receiving increasing attention. In industry after industry lithium pushes back other limitations. Lithium is a metal on the march. It is a valuable servant of industry and will become a more valuable one.

PUMPING MAGNESIUM

Molten Metal Can be Handled Economically by Pumps

TEN years ago the pumping of a molten metal was generally considered impossible, but today molten magnesium is being pumped in melt-shops and foundries with mass-production benefits not previously attainable.

Ordinary cast iron and steel pumps are used for magnesium, which melts as low as 1200 degrees, Fahrenheit, whereas special refractory equipment must be used for other higher melting point metals. According to Dow Chemical Company, molten magnesium is being pumped over distances from a few inches to 25 feet and in capacities from a trickle to a ton per minute.

With the use of pumping equipment, one operator can empty a 4000-pound pot of molten magnesium alloy into ingot molds in 30 minutes, or at the rate of one ingot every 12 seconds. Formerly two men, dipping metal from the pot and pouring it into each ingot mold, could empty one 2000-pound pot in about an hour—an efficiency improvement of about eight times on a man-hour basis.

ALLOY STEELS

Will Find Greater Use in the Future

THE FUTURE of alloy steels in this post-war era, the types of steels that will be used, and the relative importance of the electric furnace and the open-hearth furnace for their production are questions of great interest to the steel-producing and steel-using industries. The following forecast, based on the answers to a survey conducted by Edwin F. Cone, of *Metals and Alloys*, can now be made:

The post-war volume of alloy steels will be higher than pre-war and may even exceed the war-time level. A chief reason for this will be many new uses for alloy and stainless steels, especially in gas turbines, superchargers, jet-propelled planes, railway and automotive equipment, and so on. Most of the "lean" N.E. alloy steels will be discarded in favor of the older higher alloy types, but some N.E. steels will remain.

Post-war use of electric furnace steel will represent a greater percentage of alloy steel than pre-war, and consumers strongly believe the extra price charged for electric furnace grades over open-hearth alloy steel is warranted by the quality and uniformity advantages of electric steel. Steel producers do not expect to be able to lower the selling prices of electric furnace steels, although some large electric furnaces can approach the open hearth in their economics.

STEEL RECONVERSION

Costs Will Include Repair of Worn Facilities

TO RECONVERT plants and equipment to handle the expected production of steel for non-military and civilian use, steel companies are planning to spend more than $200,000,000. Reported costs of reconverting steel plants do not include any expenditures which individual steel companies may be planning.

Part of the $200,000,000 will be spent for reconverting to peace-time production the big continuous wide-sheet mills, which during the war were adapted to permit the rolling of large tonnages of heavy plates for shipbuilding and so on. Other reconversion tasks facing the industry include realinement of steel fabricating departments and plants from production of such war goods as deck houses for merchant ships, artillery shells, and tank armor to production of commercial products.

Large expenditures will be required for the repair of facilities which have become badly worn under the strain of operations during the war. Heating facilities of all descriptions are reported to be particularly in need of attention. Because furnaces are difficult to repair quickly, patching jobs have been resorted to frequently during the war emergency period by some steel companies to save time.

The estimated cost of reconverting the steel industry is less than 10 percent of the total amount of money spent since 1940 by the steel industry and the government to expand and supplement steel plants and properties for war-time production.

Is there a way to get 4 times the service from things made of steel?

THE ANSWER to this question may soon affect your life . . . *and* your pocketbook . . . in a big way. Because there is a remarkable discovery that will enable you to get up to *4 times the service* for every dollar spent on items made of steel! From washing machines, automobiles, hardware, tools, wire fencing, screens—dozens of products whose life was formerly cut short by rust.

This remarkable discovery is CORRONIZING, a new patented process of plating steel with a tissue-thin "armor" that *far outlasts other rust-protection coatings.*

Actual use in the war, in every kind of climate, gives proof to that statement. Now, America's more progressive manufacturers and retailers will be able to bring you many articles with the sensational advantages of "Corronized" steel. New model automobiles, always famous for progress, will be among the first to bring you these advantages.

So, if you want utmost dependability, lasting beauty and safety in things made of steel, wisely inquire whether they are made of "Corronized" steel. If they are, you'll be the winner in years of service . . . *by as much as 4 to 1!*

Standard Steel Spring Co.

ORIGINATORS OF

CORRONIZING

CORRONIZED
For Enduring Protection
Against Rust

Quick Facts for Manufacturing and Sales Executives

Do not confuse CORRONIZING with other metal coatings. This patented process provides a permanent alloy "armor" with 5 layers of defense against corrosion! It becomes part of the steel base . . . can be worked in any manner. Permits using lighter materials by prolonging steel's period of greatest strength. Write for samples and complete information.

STANDARD STEEL SPRING COMPANY
CORAOPOLIS, PENNSYLVANIA

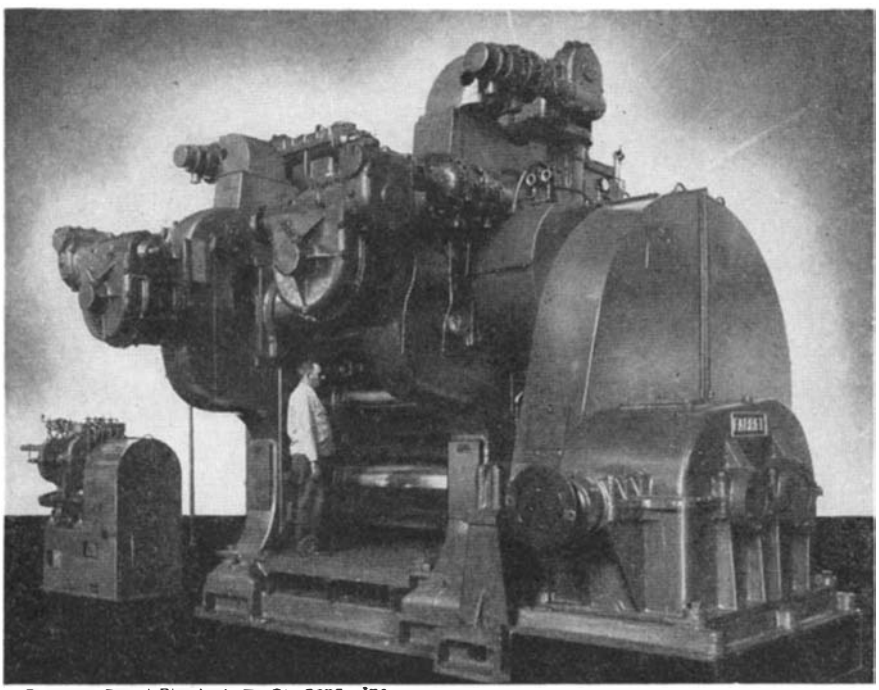
Petroleum In Plastics Processing

Hydraulic Presses, Operating Around the Clock, Must Use the Correct Fluid for Continued Economical Operation. Heat Transfer, Rust Prevention, and Adequate Lubrication are Other Special Problems of the Plastics Industry that are Being Solved by Petroleum Products

MENTION of petroleum in the plastics industry immediately brings to mind the various synthetic compounds which have petroleum as one of their basic ingredients. But petroleum has another and equally important role in the industry. As lubricants, hydraulic fluids, and heat exchange mediums, petroleum products are used in all types of plastics processing equipment.

In the machinery used in the production of such basic materials as esters and monomeric hydrocarbons, petroleum has been instrumental during the past four years in keeping the mechanical equipment necessary to the production of plastics articles in running order. And this in the face of day and night operating schedules which taxed the newest equipment as well as the over-age machines that had to be kept running for want of replacements.

Now, as plastics processors turn to peace-time civilian and industrial articles, there is no abatement in the importance of using the right petroleum product in the right place. To meet the anticipated demand, plastics machinery must continue to operate on a rapid, accurate, full-time basis. And machinery which is running at repair or maintenance cycles because operators are ignorant of the newer and more suitable petroleum products, can seriously retard the flow of plastics articles to the civilian market—and add considerably to their cost because of low production and expensive machine repairs resulting from incorrect lubrication.



Courtesy Farrel-Birmingham Company, Inc.

This calender, designed for double coating and multi-pass sheeting of rubber and plastics, uses special oil and grease in operation of its heavy rollers

It should not be thought, however, that petroleum products are cure-alls, that the use of the correct oil at the correct spot will prevent all mechanical difficulties. But just as bad is the belief that any quality of oil will be satisfactory for all classes of service.

The truth lies somewhere between these extremes. Petroleum products are, rather, preventive maintenance materials that greatly influence continuity of equipment service and, to an important degree, overall operating costs. In the following list are presented some of the factors that are influenced or controlled entirely by lubrication in modern machinery:

1. Machine down-time and labor for cleaning oil systems.
2. Lubricating oil cleaning (filtering, filter material replacement, centrifuging, and so on).
3. Oil consumption or make-up.
4. Machine parts failure and replacement costs.
5. Power costs.
6. Costs of lubricants and their application.

How well-informed use of petroleum products can thus affect the operation of plastics production equipment will become evident as the various uses are discussed in some detail.

HYDRAULIC PRESSES—The most widely used machine tools in the plastics industry, hydraulically operated presses cover the entire range of compression, transfer and injection molding, and extrusion. For these methods of processing, smooth functioning of the moving parts is all-essential. This means that there must be no sticking of the pistons, no leaking valve, no worn pump parts. Also, the fluid must not deteriorate and foul the pump and the control mechanism.

One of the prinicipal causes of pump wear in hydraulic presses,

particularly in vertical units operating in the plastics industry, is the abrasive ferrous oxide formed on the interior of the reservoirs which combines with microscopic particles of plastics dust blown from the mold platens at the end of each operation. Adhering to the oil wetted plunger, these dust particles are gradually drawn through the packing gland into the oil system.

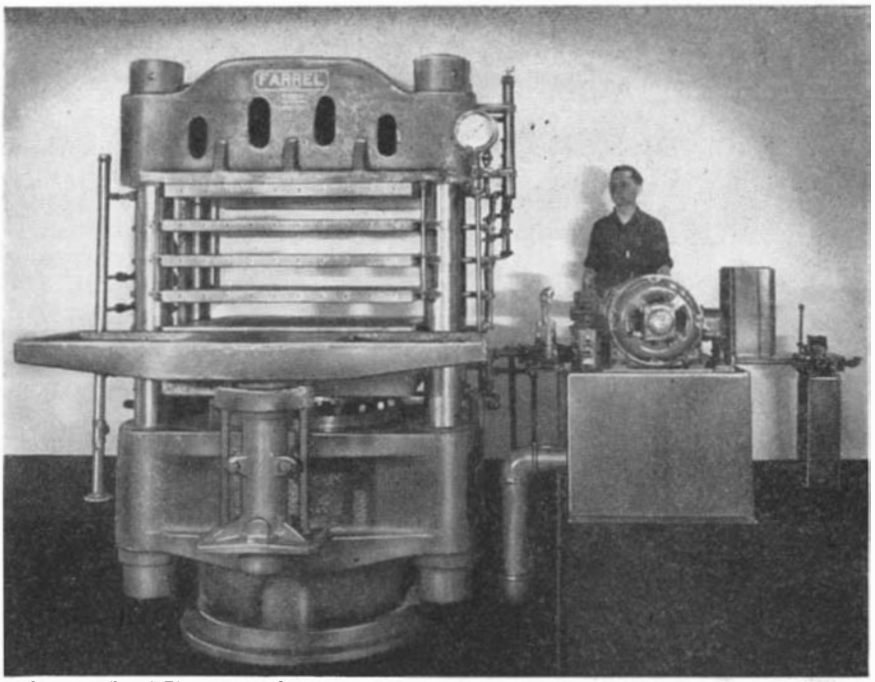
A further source of contaminants that accelerate pump wear is found in the metallic soaps which may be formed in the deterioration of petroleum. These soaps form sludges which are picked up from the bottom of the reservoir and circulated throughout the entire system. When these sludge formations become aggravated they deposit on the metal surfaces and, at times, varnish hydraulic plungers to a point where the presses operate erratically and tear the packing gland from its seating.

Where water collects in the hydraulic system the problem of pump and plunger wear is further aggravated. This is because many oil decomposition products are water-soluble organic acids and tend to attack the metal surfaces of the hydraulic system, often etching them quite badly. This etching action also releases finely divided metal particles into the system where they act as an abrasive, grinding away machined surfaces.

Some of the older press installations employ water alone as the hydraulic fluid. This type of fluid, however, is not as economical as it would at first appear, due to the cost of periodically replacing packings and refinishing control valves and plungers. One solution is the addition of wetting agents and soluble oils to the water—a blend of one part soluble oil to 60 parts water. A reduction in corrosion within the fluid system is an immediate result of this addition, a circumstance which exerts a protective influence on the control mechanism. But to maintain the fluid stream in a physically clean condition by reducing the concentration of solids to the lowest possible degree, inexpensive mechanical filtering devices are required.

Oil is the best hydraulic fluid for modern presses which usually are equipped with individual reservoirs, pumps, and control mechanisms. To assure continuous service of this equipment, oxidation resistant hydraulic oils containing corrosion preventives are often used since these oils lessen oil and machine maintenance and do not precipitate deterioration products.

Sometimes, however, corrosion occurs independently of the oil in the system. For example, the underside of the top of the oil reservoir may corrode to a point where rust drops into the oil and contaminates the oil stream. This danger can be eliminated through the use of an oil- and water-impervious coating on the inside of the reservoir.



Courtesy Farrel-Birmingham Company, Inc.

Multi-platen hydraulic press employed in precision processing of single sheets or laminates uses oil in the cylinders for the operation of the rams

Foaming of hydraulic-press oils, however, *is* dependent upon oil quality and its resistance to deterioration. The entraining of small air bubbles, which is common in hydraulic oils that contain even small amounts of acidic and saponifiable material, will reduce pump capacity and produce erratic plunger operation. The more thoroughly refined oils will reduce these troubles since they contain fewer oil decomposition products and hence have less tendency to hold moisture and finely divided air in suspension.

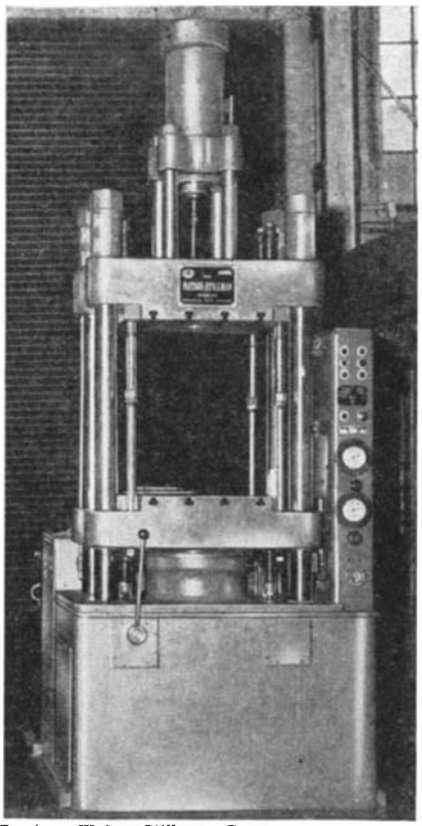
That the use of oxidation-stable hydraulic oils is economical as well as good operating practice is evident from the fact that these oils almost completely eliminate control mechanism wear. Since the lubricant does not tend to deteriorate in service, waxy or varnish-like substances are not deposited on the plungers and controls; therefore oil leaks through packing glands are reduced and the life of the packing is greatly extended.

A further economy is achieved by periodically filtering the oil in each hydraulic system without removing the press from service. Much less labor and expense is involved than when efforts are made to salvage deteriorated hydraulic oils in an independent recovery system. And this filtration will also reduce to a great extent the frequency of oil changes in a given system.

HEAT EXCHANGE OILS—Heat is essential in mold platens, extrusion press cylinders and nozzles, dip coating tanks, mill and calender rolls, and so on. The older conception of petroleum as a heat-transfer medium calls for steam refined cylinder oils having high flash points. These oils, however, contain unsaturated hydrocarbons which cause them to deteriorate and form tarry deposits when subjected to elevated temperatures for long periods in the presence of air. Since these tarry deposits soon coat the heating elements and the surfaces of the vessels being heated, the heat transfer rate is soon lowered. Then, to counteract this lowered rate the temperature of the oil is increased. But this only accelerates the oil deterioration rate. So the vicious circle simply speeds up.

Field investigations of heat-transfer liquids over the past few years have shown that temperature ranges from −20 to +500 degrees, Fahrenheit, can be served by relatively light bodied, highly refined, oxidation resistant oils.

In open heating systems operating at atmospheric pressure, temperatures of 350 degrees, Fahrenheit, can be safely maintained without undue vaporization or the formation of explosive vapors if the area is well ventilated. However, when the temperature is to be carried beyond 350 degrees, Fahrenheit, the boiling point of the oil must be raised by



Courtesy Watson-Stillman Company

Quality of the oil used as a fluid medium in this type of press machinery is of paramount importance

exerting a pressure of not over 10 pounds per square inch. Continuous operating temperatures of 550 degrees, Fahrenheit, with intermittent short intervals of 650 degrees, Fahrenheit, are being studied to note the behavior of oil in these ranges. It has been recognized that as 750 degrees, Fahrenheit, is approached, regardless of the pressure that is carried, the zone is reached where oil will crack into gasoline, light oils, and heavy ends. It would appear that temperatures above 500 degrees, Fahrenheit, are best served by some of the commercial heat exchange fluids rather than by oil.

As with the hydraulic fluids, filtering devices improve the efficiency of heat exchanger systems. It has been found possible to keep units functioning at their peaks by allowing the filtered fluids continually to scrub the surfaces free of all deposits that tend to interfere with the free flow of heat.

RUST PREVENTION — Just as presses must operate smoothly and accurately, and the platens must be heated evenly if plastics items of good quality are to be produced at minimum cost, so the molds themselves must be maintained in good condition.

Molds are not always in production, and whenever they are placed in storage—even of the shortest duration—their highly polished surfaces are protected from rust which would destroy the usefulness of the mold even though the rust can subsequently be removed.

When the period of storage is short, washing the molds with a polar type thin film rust preventive having good solvent properties is enough protection. This preventive removes all sweat stains from the mold surface and displaces any water or moisture that may be present. But for longer or an indefinite period of storage the cleaned mold should be further coated with a soft petroleum rust preventive. Similar treatment should be given other machinery spare parts. There is no problem involved in the removal of the coating. The metal surfaces need only be washed with regular petroleum solvents.

LUBRICATION—Roll temperatures not above 350 degrees, Fahrenheit, in plastic mills and calenders of conventional design present no unusual lubrication problems. However, it has been discovered that light lubricants possessing high oiliness and load carrying properties give the equipment better protection than do the heavy-bodied cylinder oils which have been customarily accepted as the best.

There is the possibility that rolls may someday carry a temperature of 550 degrees, Fahrenheit, for the processing of plastics and synthetic rubbers. When and if such equipment goes into production it may be necessary to use hydrocarbon lubricants that become effective in bearing temperature ranges above 500 degrees, Fahrenheit. Then there is the further modification of machine design where a given calender will have some heated and some refrigerated rolls. The presence of two temperature extremes in a single unit will make necessary the use of lower viscosity or more fluid lubricants if unnecessary equipment and service complications are to be eliminated.

Lubricating greases for plastics processing machinery raise few problems. In fact, the toggle joints and stops on a press are almost the only points where special attention is necessary. The difficulty here is that the motion is very slow and purely oscillating. Consequently it is difficult to apply the lubricant at the point of greatest pressure and keep it from being forced from between the surfaces when the press goes into operation. The best protection has been found to be active extreme-pressure greases of pressure-gun consistency compounded so as to provide a strong affinity for metal. This lubricant resists the shearing and wiping effect of the oscillating motion.

There are, of course, many other applications for petroleum in plastics processing equipment. But the biggest mechanical elements—hydraulic presses, mills and calenders, heat exchangers, and molds—have been touched upon. The facts indicate the importance of the selection and use of the correct petroleum product for the correct job.

✣ ✣ ✣

OXYGEN TENTS

Made of Clear Plastics
In Small Size

MINIATURE oxygen tents for babies born prematurely are now being fabricated from Ethocel sheeting. Still in the experimental stage, the tents consist of a center curved section of heavy gage sheeting and ends of laminated sheeting. The transparency of the plastics material permits a full view of the tiny patient.

COMPACTS

Combine Use of
Metal and Plastics

HOW WELL plastics can work with other materials is evident in the Lucite and silver compacts which are fabricated by Alzac California Jewelry Creations. Assembled entirely by hand, these compacts have lids of black methyl methacrylate to which is laminated the sterling silver design. The base, with its powder compartment, is fabricated from transparent acrylic.

FURNITURE

Uses Plastic Straps
For Comfort and Durability

VINYL elastic strapping forms the backs and seats of "Put-A-Way" folding and demountable garden chairs that can be readily adjusted to different positions. Not only does this Koroseal webbing add a touch of color but it withstands the often damaging effects of outdoor weather.

Washable, acid-proof, non-abrasive, the extruded vinyl elastic strappings are resilient enough to conform to the shape of the body and to provide a maximum of bodily comfort—an advantage which is often sadly lacking in summer furniture. The frames of these chairs, which were designed by V. F. V. Gerstel and Ferdinand Kramer of Products Development Division, are built of cypress.

DUREZ

PHENOLIC RESINS

- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- OIL SOLUBLE RESINS

MOLDING COMPOUNDS

THE "EYES" HAVE IT

There are literally thousands of applications for Durez phenolic molding compounds . . . applications which the casual observer is likely to overlook. Bausch & Lomb's "Arc Ban" and "Chip Ban" safety goggles, for example, have eye cups of molded Durez. These possess high-impact strength and are not affected by moisture, sterilization by steam, or most acids. The unusual versatility of the more than 300 Durez phenolic molding compounds has made their use throughout industry practically all-inclusive. Such properties as impact and dielectric strength, moisture, heat, and acid resistance, highest dimensional stability at temperature extremes, diversity of finishes, and excellent moldability make them the logical starting point when you're searching for the plastic that fits your job.

INDUSTRIAL RESINS

LET'S GET DOWN TO CASES

Another interesting application for Durez industrial resins is the war-proved Armed Forces binocular case where a Durez phenolic-impregnated fabric is combined with other materials to form a weather-proof case which is virtually indestructible. Durez impregnating and laminating resins have many new peacetime applications developed from wartime counterparts which promise to be big profit-makers for progressive manufacturers.

OIL SOLUBLE RESINS

NO SENSE "RUBBING IT IN"

Emulsion "no rub" waxes having a wide range of properties can be made with Durez resins. Though all have rich, full gloss films, the films may be varied from those which may be removed with mild soap to those which permit the cleaning of waxed floors without harming the waxed surface. Well-known throughout the entire protective coating industry, Durez resins promise many profitable applications for peacetime markets.

HERE'S WHAT YOU'VE BEEN WAITING FOR

Right off the press, the Durez Plastics Primer is a brand new, illustrated booklet about phenolic plastics and is especially designed for quick reading by today's overburdened executive. Not for the technical man who is already familiar with the subject, the Durez Plastics Primer is a brief, simple, crystal-clear digest filled with basic facts covering the part the phenolics play in the overall plastics picture. Clip the attached coupon and send for your free copy. Absolutely no obligation, of course.

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PLASTICS THAT FIT THE JOB

Chasing Water Pockets

Soft Spots in Railroad Tracks, Caused by Pockets in the Subsoil, Create Maintenance Problems and Frequently Necessitate Speed Reductions. Effective Use of Cement Mixtures is Eliminating Such Pockets Without Interfering with the Use of the Track

RAILROADS have always been accustomed to worry along with occasional "soft spots" in their tracks. As wheel loads have grown heavier, train speeds higher, and the gross tonnage of traffic movement greater, however, this old annoyance has become a problem of major importance. These changes in conditions have all helped to create more miles of soft track; as schedules have been stepped up, the reduced speeds required for safe operation over unstable track become a serious operating embarrassment. Keeping the track on these spots in line and up to grade is an extremely expensive job and most of the former methods of restoring stability interfered seriously with the use of the track.

In recent years a number of railroads, as the result of extensive study and experiment, have learned that a mixture of cement and sand, injected into the affected spots, eliminates most chronic soft track conditions. They have developed effective means of injecting such mixtures, or "grouting," without disturbing the track or interfering with its use.

WHAT CAUSES IT—Soft track is caused by wet subsoil below the rails which, because of its more or less water-saturated condition, has relatively low weight-bearing capacity. Certain spots along a given track, for various reasons are never stable. In such spots frequent additions must be made to the ballast and the subgrade may require occasional refilling to restore the track to its normal surface level. In extreme cases the instability is such that soil squeezed out from under the track dislocates the right-of-way fences.

Such are the occasional soft spots which have long had to be tolerated. Those which have been created or aggravated under the stress of heavy, high-speed traffic arise from the destruction of normal drainage conditions.

When a train passes over a track at high speed, each rail is subjected to a series of vertical loads varying from around five to upwards of 18 tons each, depending upon whether the passing wheels are those of an empty freight car or of a large steam locomotive. In the case of a freight train operating at 70 miles per hour, the impulses, passing along the track in waves of alternately increasing and decreasing load on the rail, occur most frequently in groups of four at the rate of about 15 per second as the ends of the cars pass, the groups recurring at intervals of a half second or less. The rail, ties, and ballast tend to distribute these loads over a considerable area of subgrade, but nonetheless the surface of the subgrade directly underneath the rail is subjected to a series of blows at air-hammer rapidity, the total effect of which is to create pockets in the surface of the subsoil in which water tends to collect and from which there is no drainage. Thus the softening process proceeds and the pockets tend to become deeper until the track instability has to be dealt with.

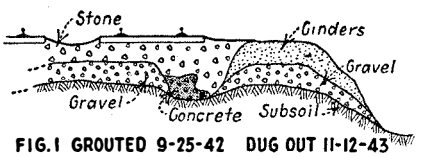


FIG. 1 GROUTED 9-25-42 DUG OUT 11-12-43

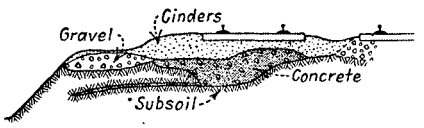


FIG. 2 GROUTED 10-12-43 DUG OUT 8-1-44

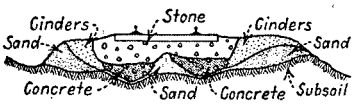


FIG. 3 GROUTED 5-10-41 DUG OUT 6-23-42

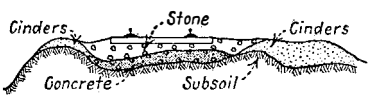


FIG. 4 GROUTED 1-12-42 DUG OUT 6-25-42

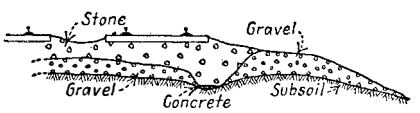


FIG. 5 GROUTED 9-10-42 DUG OUT 10-14-43

Test cross-sections on the New York Central show how the injected concrete grout seals off the soft sub-grade and helps to spread the load over it

SPEED RESTRICTIONS — Where such track conditions have developed, it becomes necessary to add ballast, sometimes at frequent intervals, to restore the sagging track. It may also be necessary, in the interest of safety, to issue "slow orders" limiting train speeds over the soft spots. These slow orders may be removed after repairs have been made, only to be required again in all too short a time as the pocket continues to grow. On important main lines where traffic is heavy, such soft spots may have to be worked on several times a week, and may be subject to speed restrictions for more than half the time.

Not only is such attention very expensive as compared with maintenance requirements on normal track, but the slow orders interfere with the smooth and economical movement of traffic. With passenger trains frequently running on schedules requiring many miles of line to be passed at speeds upwards of 100 miles an hour and freight-train speeds running up to 70 miles an hour, the incidence of enforced speed reductions is far more serious, both as to the number of trains affected and as to the disruption of schedules, than they were two or

three decades ago when top speeds in the two services were more nearly 60 and 50 miles an hour, respectively.

REMEDIES—Methods of remedying these conditions have included installation of special drains, digging out and backfilling the pockets, and even removing the track to permit placing wood or concrete mats to distribute the track loads over a large area. But, even where effective, these methods are expensive to apply and most of them involve serious interference with the use of the track.

About 1940 several railroads undertook investigations and experimental programs intended to develop more satisfactory means of dealing with these conditions. One of these roads, the New York Central, selected six spots for investigation on its Toledo-Detroit branch. At each spot a series of trenches, spaced 25 feet apart, were dug across the roadbed; the bottom in each case was carried down to dry subgrade material. No free water was found in the pockets exposed by these trenches, but the subsoil in the bottoms of the pockets was sufficiently wet to be oozey. The cross sections also disclosed invariably that the point at which the pockets were deepest was directly under the rails.

The investigations of this and other railroads led to the conclusion that whatever treatment was developed should cut off the supply of moisture from the subsoil in the water pockets, and that whatever material was used should be forced into the pockets under pressure.

GROUTING—In December, 1940, the New York Central began grouting with a sand-cement mixture at the six test locations already referred to. In an expanding program this work has progressed until, at the end of 1944, such treatment had been applied at over 200 locations having a total length of 36,379 track feet. The future program contemplates the correction of conditions at some 1200 additional soft spots on main-line track, with possibly as many more on branch lines.

The New York Central method comprises the use of a rich 1-to-1 sand and cement grout with enough water to make it soupy; this is injected into the soft spots below the rails by pneumatic pressure. The rich cement mixture not only serves to seal out the water from the subsoil around the water pockets but it develops considerable strength which aids in distributing the traffic load over the bottoms of the pockets.

Essentially, the equipment for grouting these pockets includes a mixing tank, a portable air compressor, a supply of injection pipes, a pneumatic hammer suitable for driving the injection pipes into place, suitable lengths of air and grout hose, and portable water tanks.

The injection pipes are driven through the ballast outside the ends of the ties, using the pneumatic hammer on the capped ends of the pipes. The pipes are slanted to bring the end as nearly as possible directly under the rail when it has reached well into the pocket. Then the water, cement, and sand for a batch of grout are mixed and the grout forced into the water pocket through an injection pipe. The quantities injected are said to have varied up to as much as 50 one-sack batches through a single injection pipe.

LEAN MIXTURES—Another road which has made an intensive study of the soft-track problem is the Atchison, Topeka & Santa Fe. For a number of years prior to its adoption of cement grouting, this road had been trying to find a practicable means of filling water pockets with a very fine drifting sand commonly known as "blow" sand, of which there are quantities available at many points west of Kansas City. That water could be sealed out of the pockets with this material had been proved by experience with soft spots which had been dug out and back-filled with it.

Based on this experience, unsuccessful efforts were made to inject dry sand into water pockets with air pressure. Then in December, 1941, the Santa Fe began experimenting with cement grout pumped into the pockets. It should be noted

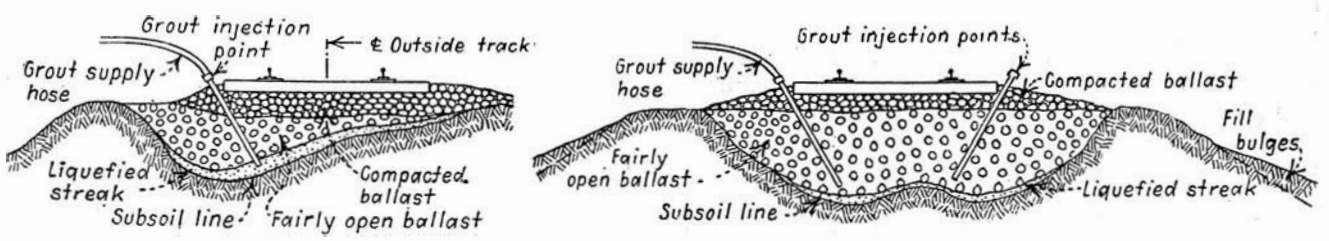
Two crews at work grouting soft spots in track of New York Central System

that, unlike the New York Central and other roads, the objective of the Santa Fe was confined to sealing out the water and restoring original drainage conditions. The cement and water served as a lubricant to enable the blow-sand grout to penetrate and fill all the voids: no thought was entertained of creating concrete "beams" under the rails.

The initial experiments were made with mixtures ranging from one part cement and six parts sand, to one part cement and 13 parts sand. Eight gallons of water were introduced for each cubic foot of dry mixture. This grout was injected into the pockets under 100 pounds per square inch air pressure.

Research has continued since these early experiments. Many variations in the richness of the grout mixtures have been tried, and numerous materials have been substituted for blow sand. In the end, however, the best combination was found to be within the original range of cement-sand mixtures, and the fine sand—the finer the better—was found to be the most effective material.

EMULSIFIED ASPHALT—In 1944 extensive laboratory experiments were undertaken in co-operation with the Texas Company in an at-



Cross-sections showing locations of injection pipes for filling different types of water pockets under tracks

tempt to work out a combination of asphalt and cement for use in track grout. The results were encouraging and after a series of track trials a grout consisting of one part of either Portland cement or mortar cement to 6 to 20 parts of sand, to which were added 1/5 to 1/10 gallon of emulsified asphalt per cubic foot of sand and from 4½ to 8 gallons of water for each cubic foot of dry material, was finally adopted as most satisfactory. This formula gives the same penetration and is considered even better in water-sealing properties than the richer cement-sand mixture.

Much of the experimental work done by the Santa Fe has been devoted to the improvement of methods and equipment for getting the grout into subsoil. One of early developments was the substitution of hydraulic for pneumatic injection. The latter was slow and otherwise unsatisfactory and a piston-and-cylinder grout pump which forces the mixture into the roadbed under a maximum pressure of 450 pounds per square inch was developed. Then began the successful development of complete mechanical equipment for mixing and injecting the grout as a continuous process.

Unlike the New York Central, the Santa Fe method involves driving holes into the water pockets and then inserting injection pipes into the holes. The holes are spaced about 5 feet apart. Since May, 1942, the Santa Fe has grouted wet spots aggregating considerably more than 50 track miles in length.

COSTS RETURNED—Results so far observed have shown satisfactory improvements in track stability and reduction in maintenance costs. For instance, on the New York Central system, two soft spots not far apart, aggregating 312 feet in length, were grouted at a cost of $300.88. Prior to grouting these spots required maintenance at least three times a week at a cost of $248.96 a month. Grouting reduced these costs to $17.70 a month. The grouting thus returned its cost in savings in maintenance within less than 1½ months. While the aggregate results are not as striking as this specific example, they are highly satisfactory.

One of the oldest sections of grouted track on the Santa Fe involves 4.2 miles of single-track main line over which speeds up to 100 miles per hour are permitted. In 1940 slow orders had been in effect on this track for 262 days of the year. In 1941, after an attempt was made to improve the track, it was still necessary to keep slow orders in effect on a 1½ mile section for 163 days during the year. This track was grouted in 1942. Since the work was completed no slow orders have been required at this location. The cost of stabilization is said to have been returned within one year by the reduced expenditures required for maintenance.

From the standpoint of the American traveling public this development spells better riding qualities of passenger trains, the on-time performance of which will be progressively improved as the number of soft-spot speed restrictions are reduced.

• • •

DRAGGING EQUIPMENT

Spotted Before Loose Parts Can Cause Derailment

OCCASIONALLY, but rarely, some part of a railway car truck may fail in such a way as to drop down and drag along the track. To avoid the hazard which such parts cause if they are dragged into a switch, where they may catch and derail the car, the Pennsylvania has installed dragging-equipment detectors on its main tracks.

Each installation consists of four castings, the tops of which are made of U-section bars. These are placed across the track, two between the rails slightly below the level of the top of the rails and one outside each rail. These castings are connected in an electrical circuit which energizes a relay that in turn controls the circuits for the next interlocking home and distant signals. The detectors function by being broken by the dragging member, thus interrupting the electrical circuit.

These detectors are located a suitable distance ahead of the roadside signals so that the breaking of a detector allows the signals to come to the most restrictive aspect in time to permit the engineman to stop the train at the home signal. When the train stops, the signal-tower operator advises the crew that the dragging equipment detector has functioned. The crew then inspects the train and repairs or removes the affected car.

ALUMINUM TANK

Still in Excellent Condition After 17 Years

THE FIRST aluminum tank car was built in 1928 by the General American Transportation Corporation. In August, 1945, it had been in service for 17 years. At the outset it was handling glacial acetic acid for the Niacet Chemical Company and since March, 1930, it has been assigned exclusively for the handling of glycerin for Procter and Gamble. During this period it has traveled 408,000 miles and, except for minor running repairs, was shopped but five times. The tank itself has never required any repairs, beyond replacements of aluminum heater pipes. The only repairs had to do with the trucks, brakes, and draft gear. The tank, built of Alcoa 3S alloy, was butt welded throughout by the gas process.

This tank has a capacity of 8000 gallons and was designed for a working pressure of 25 pounds per square inch. Weighing 33,900 pounds, the car represented a saving of about 8300 pounds as compared with a steel tank of the same capacity. It and other aluminum tanks subsequently built have demonstrated the ability of this material to transport such commodities as glacial acetic acid, hydrogen peroxide, glycerin, formaldehyde, naphthenic acid, nitric acid, and other chemicals and food stuffs in bulk which do not require a special tank lining.

RAILROAD RADIO

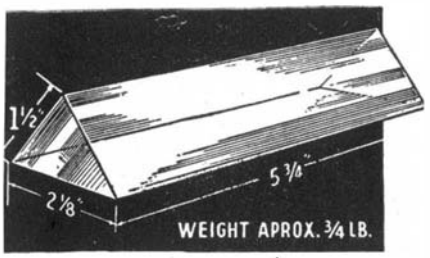
Network Uses Portable Frequency-Modulation Sets

EQUIPPED with mobile frequency modulation radio sets in an industrial version of the Army's "walkie-talkie," five Diesel-electric locomotives of the Westinghouse Electric Corporation now roll over 25 miles of switchtracks in Pittsburgh, their crews in constant radio communication with the yard office.

The new static-free radio communication system which allows two-way conversations between engine and yard office, quickly proved its worth. Now, instead of the engine running back to the yard office for instructions, the yard office communicates with the engine crew in any part of the yard and gives instructions. The saving in time and also in the physical labor of throwing switches, which was necessary when engines had to keep running back and forth to the yard office, has speeded up the movement of freight in the yard. Where, heretofore, hours were consumed in moving certain cars, minutes are now required.

The little network consists of five mobile stations on the five locomotives and one stationary transmitter and receiving set in the yard office. Frequency modulation radio was chosen because of its elimination of static.

SENSATIONAL WAR BARGAINS in LENSES & PRISMS



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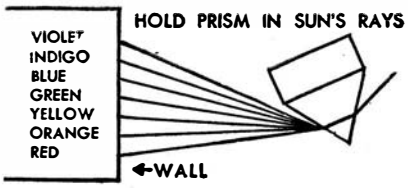

TANK PRISMS

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

TO SEE THE COLORS OF THE SPECTRUM, hold a plain tank prism in sun's rays as shown in drawing. White incident light which passes through prism is thus broken up into a band of primary colors known as the spectrum—a beautiful sight! By looking through a tank prism at a certain angle, you can see a world of colors everywhere. Truly amazing!

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3001-S	Lens Surface	20 mms.	14 mms.	2.00
3009-S	Porro	52 mms.	25 mms.	1.00
3016-S	Pentagon	45 mms.	22 mms.	.75
3029-S	Dove	16 mms.	65 mms.	1.25
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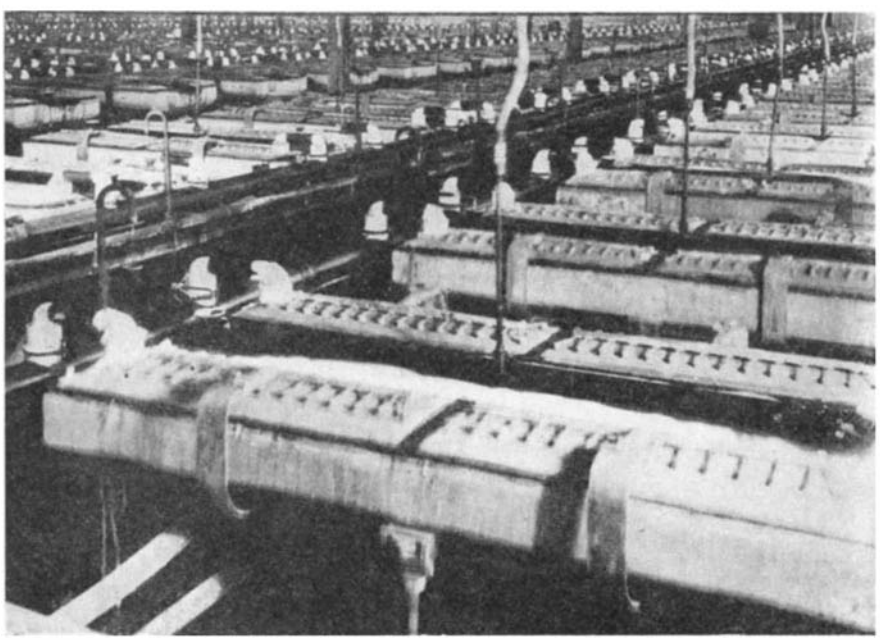
Sodium Methylate, Now Available Commercially, is Used in Drugs and Cosmetics, in Perfumes and Lacquers, in Dyes and Insect Repellants

KNOWN as a laboratory product for some time, sodium methylate is used in research and is essential in the manufacture of sulfadiazine and a number of other products. But its use in industry has been limited because, until recently, there was no "ready-made" sodium methylate on the market.

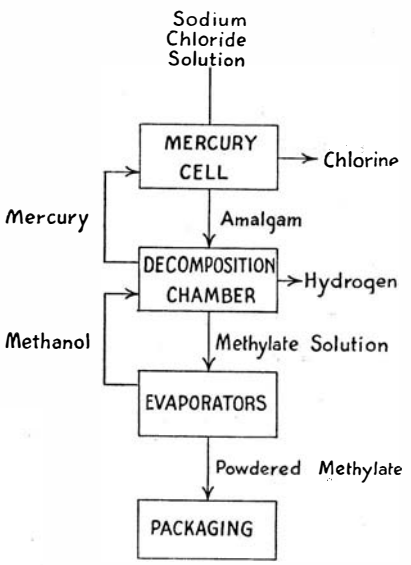
Whenever methylate has been needed, the user has had to make it himself, by dropping small pieces of metallic sodium into methyl alcohol. The resulting solution is not completely satisfactory where high yields of certain products made from the methylate are desired, since it may contain various impurities and may be too dilute. Now, however, the chemical is being made on a commercial scale.

HOW MADE—Commercial sodium methylate may be made by a modification of the Castner electrolytic process which has been used for years to produce chlorine and caustic soda. In the Castner process, brine is electrolyzed in a cell containing mercury as its cathode. The sodium chloride is separated into its elements, the sodium combines with the mercury to form sodium amalgam, and chlorine gas is liberated at the anode. When sodium amalgam is treated with water, the sodium reacts to form sodium hydroxide (caustic soda) and hydrogen, and the mercury which remains is returned to the electrolytic cell.

In the production of sodium methylate in The Mathieson Alkali Works, the same process is used, but the amalgam, instead of being treated with water, is brought into contact with methyl alcohol (methanol). The sodium amalgam is circulated through a specially designed contact tower (or decomposition chamber) which is packed with pieces of graphite flooded with the amalgam. Methyl alcohol preheated to reaction temperature is forced in at the bottom of the tower under sufficient pressure to overcome the head of amalgam in the tower. The sodium in the amalgam reacts with the alcohol, producing gaseous hydrogen and a solution of sodium methylate, as the amalgam and alcohol move in opposite directions along the pieces of graphite. The mercury is returned to the Castner cell from the bottom of the contact chamber by means of a riser. The solution of methylate and the hydrogen formed with it are separated at the top of the tower. The methylate alcohol is then evaporated from the solution to give a white, dry powder containing at least 95 percent methylate. The powder is packaged in airtight containers to prevent reaction with components of the atmosphere.



Castner mercury cells in which the salt is electrolyzed into its elements, sodium and chlorine. The sodium forms an amalgam with the mercury and is then treated with methyl alcohol in a reacting tower to form sodium methylate which is dryed and packed



Flow diagram of sodium methylate commercial manufacturing process

DRUGS AND EXTRACTS—Among the drugs, in addition to sulfadiazine, which require sodium methylate in their manufacture are sulfamerazine, atabrine (the quinine substitute), the barbiturates (vero-

nal, phenobarbital), and some of the vitamins.

The perfume industry, too, uses considerable quantities of sodium methylate. Flowers owe their scent to chemical compounds—aldehydes, ketones, and esters. When synthetic perfumes are manufactured, similar compounds can be prepared with the help of sodium methylate. For example, nonaldehyde is used in making rose oil, benzaldehyde for heliotrope perfume, methyl nonyl ketone for the sweet pea odor, and ionone for violet perfume.

Sodium methylate is useful in the food industry for the preparation of flavorings, essences, and extracts—compounds which are chemically similar to scents.

In the field of cosmetics, sodium methylate is used to prepare a variety of beauty preparations, including a light screen medium for sun tan lotions and creams.

OTHER USES—Sodium methylate is used in preparing xanthates, required in metallurgy to extract copper, lead, and zinc from their ores by the flotation process.

Components of nitrocellulose lacquers involve the use of sodium methylate. The solvent for the lacquer and the plasticizer added to make the film strong and pliable are made with the help of this versatile chemical.

Methylate is widely used, both in research and industry, for the preparation of organic intermediates—chemicals used in the preparation of other chemicals. One of these is acetoacetic ester, used in the manufacture of innumerable compounds. These include many dyes and pigments, such as the "Hansa Yellows," used in lacquers and inks, and the pyrazolones, used in textiles because of their fastness to light. Among the new insect repelling compounds is indalone, a product also prepared from methylate intermediates.

EXPANDING RESEARCH

Predicted by Educator As Result of War

A RAPID expansion of industrial research after the war was predicted by Dr. Harvey N. Davis, President of Stevens Institute of Technology, in a recent address before the American Society of Refrigerating Engineers.

"American post-war industry will be definitely on the move," he said. "It will be changing rapidly. The total volume of production will, we all hope, continue to be as it is now, greater than ever before in our history.

"The kind of things produced will be very different from our present output, and probably different in many significant respects from pre-war production. And the keynote of all this change is going to be industrial research. Even if one prefers to limit the term to what goes on in our 2000 to 3000 industrial *scientific* laboratories, it is still true that active vigorous industrial research will be a far more important factor in post-war industry than was ever before the case in this or any other country.

"The first World War, and particularly the spectacular developments in military aviation, drew general attention both to the actual and to the possible achievements of applied science, and by 1940 the number of industrial research laboratories was more than seven times that of 20 years before. There is every reason to expect that the after-effect of the present war will be even greater.

"Furthermore," Dr. Davis continued, "this country has experienced an immersion in war research in the last two or three years that is

The Editors Recommend

Best Sellers In Science

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

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

PLANNING TO BUILD — *By Thomas H. Creighton.* Answers many of the questions asked by prospective home builders. Planning, design, and construction are fully covered. **$2.60**

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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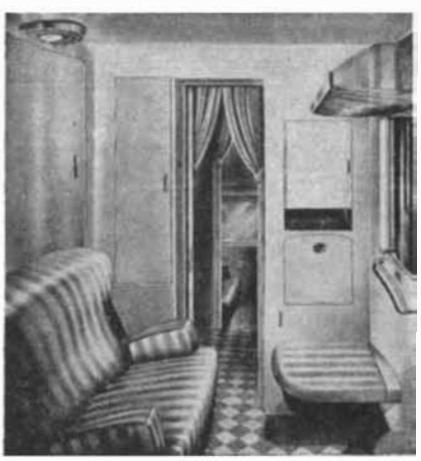
bound to be contagious. Even our Office of Production Research and Development in Washington had more than twice as large a research fund at its disposal during the fiscal year of 1943-44 as was initially allotted by Parliament some 12 years earlier to the whole of England's national Department of Scientific and Industrial Research. Also during that same year 1943-44 the Office of Scientific Research and Development had a budget something like 12 times as large as O.P.R.D.'s, and I have no doubt that the funds directly spent on research by the armed services were even larger. A very large proportion of these vast expenditures bore more or less spectacularly useful fruit. This concentrated national experience with research is sure to have an important influence on post-war industrial thinking."

CABIN-CAR

Will Provide Privacy For Day-Night Travel

AN 85-foot railway sleeping car which will have 22 unusually commodious private rooms, all on one level, designed to satisfy the need for individual day-and-night accommodations and provide every possible comfort at a nominal tariff, was recently announced by the Edward G. Budd Manufacturing Company. In this new "Cabin-Car" the beds are to be six feet four inches long and 35 inches wide. Beds will be lowered into place or returned to their daytime positions electrically by the flick of a switch. The bed frames supporting the springs will be of lightweight magnesium, the mattresses of foam rubber. When the bed is in night position, a case for valuables and a combination bed and night light will be conveniently located.

In daytime a deep cushioned, wide, adjustable chair-type seat with curved head rest is provided. With



Daytime make-up of cabin-car

the club-type arms folded the seat is wide enough for two. A clothes closet, toilet, and stainless-steel wash basin are fitted into the aisle wall of each room. The top of the toilet, arranged as a second seat, is upholstered to match the chair.

Heated or cool air, controlled by thermostats, for ventilation, is provided through an overhead diffuser outlet, behind which is concealed a semi-circular fluorescent tube, providing general indirect lighting. Secondary lights are also fluorescent. Baggage space is large enough for a full sized suit-case. A locker above the wash basin contains a water carafe, glass, and drinking cups. An electric outlet is provided for razors and curling irons.

Sound deadening features have been employed throughout the car, which is of Budd standard stainless steel construction.

SCORCHED FIBERS

Revived by Application of Ultra-Violet Rays

BY BRINGING grandmother's bleaching technique indoors, engineers have developed a scorch-removing process which will make extra thousands of scarce white shirts available to men in the next year.

Instead of summer sunshine, a large shirt manufacturer is now using a standard electric sunlamp to eliminate scorch marks. In effect, explains Eugene W. Beggs, Westinghouse vapor lamp specialist. the

Reviving scorched fibers with sunlamp

long-wave ultra-violet rays generated by the lamp administer a water transfusion to parched fibers of shirts scorched slightly during ironing.

Irradiating previously dampened singed areas, the ultra-violet pumps the moisture into the fibers, restoring the shirts to their original whiteness in ten minutes. The phenomenon is the result of a photochemical action, or the ability of visible and invisible light rays to cause a change in the chemical makeup of matter which absorbs those rays.

"Grandmother probably never heard of photochemistry or of ultra-violet rays," says Mr. Beggs, "but she took advantage of them when she bleached her white clothing and linens under the ultra-violet radiations of the summer sun. That is why we adapted the sunlamp for the job."

The bleaching process was developed primarily for commercial use but eventually the housewife and hand laundry may adopt a similar scorch-removing method. Ultra-violet also may offer a valuable bleaching tool for the entire textile industry, Mr. Beggs adds.

He estimates that the sunlamp process during the coming year would expedite shipments of more than 10,000 shirts from one shirt plant alone.

The parched area in the shirt is dampened and the shirt is placed five inches distant from the lamp, which is three times more powerful in its bleaching and suntanning properties than natural sunlight. After 10 minutes' exposure, the scorch is eliminated. By using the sunlamp in this manner, results are quicker and better than those obtained under rays of a summer sun.

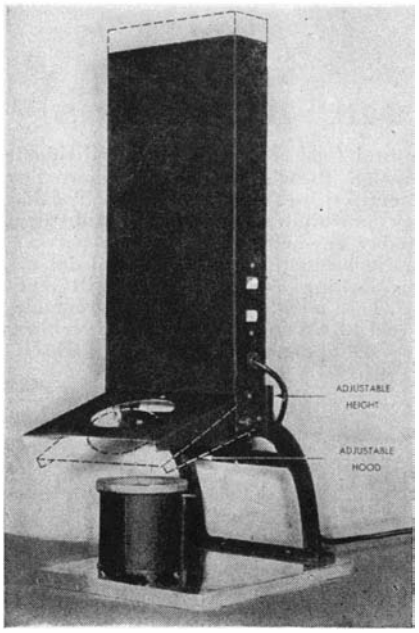
New Products and Processes

SOLDERING STAND

Features Adjustable Hood And Fume Stack

EMBODYING the flexibility required for soldering with iron, torch, or soldering pot, the hood and fume stack of a new soldering stand can be raised and lowered to accommodate any of the three heating elements used in soldering.

This SS11 soldering stand, developed by the Ess Specialty corporation, permits interchangeable soldering, greater protection against injurious fumes, minimizes hand fatigue, eye strain, and so on, and increases soldering production and efficiency.



Three different types of soldering can be accomplished in this stand because of flexibility of its design

Soldering with this stand allows maximum freedom for work passing and enables the operator to focus attention on the soldered joint by means of the plate-glass window (or magnifying glass) in the hood, thus quickening the soldering pace by elimination of lost motion.

GAS PACKING

Preserves Foods From Effects of Oxygen

A PROCESS which may some day match the popularity of "vacuum packing" as a guarantee of flavor freshness in canned foods such as coffee, nut meats, candy, and dehydrated products, is "gas packing." Both processes have the same purpose—to prevent rancidity, off-flavor, and vitamin loss by eliminating oxygen from the containers in which the foods are packed.

According to R. V. Wilson, director of customer research for Continental Can Company, gas packing has been in commercial use for a number of years, but has not enjoyed the publicity that made vacuum packing famous. Each process has certain advantages, but it is impossible to tell which is best for any particular product until specific laboratory tests have been made.

Whereas vacuum packing is the process of drawing air out of a can before it is hermetically sealed, gas packing works on the opposite principle of displacing the air with an inert gas. Actually the two processes are usually combined—the air is first exhausted, and the gas is then allowed to rush in and take its place.

The gases used are either carbon dioxide, the well-known "soda-pop" gas, or nitrogen, which makes up 78 percent of the atmosphere. Both gases are harmless, and do nothing but take up space.

"Oxygen has always been a troublemaker in the preservation of certain foods," Mr. Wilson says. "Unquestionably, its greatest deleterious effect is upon flavor. Rancidity and staleness are caused by the oxidation of natural oils. This rate of oxidation is affected not only by the amount of oxygen available, but also by the moisture content of the product and the catalytic effect of light." However, when foods are vacuum or gas packed in hermetically sealed containers, no oxidation can occur and the foods remain fresh as originally packed.

He also points out that it is immaterial whether a vacuum exists in the container or not so long as the amount of oxygen present is low enough to preserve the product. Common practice is to limit the amount of oxygen to 1 to 3 percent.

One of the advantages of gas packing, according to Mr. Wilson, is that it permits packing any size container with an extremely low oxygen content. Since the containers are then sealed at atmospheric pressure, there is also less likelihood of subsequent strain or air leakage.

ACID-PROOF WOOD

Produced by Plastics Impregnation

STRUCTURES exposed to rapid deterioration by contact with acid solutions or fumes can be made acid-resistant through use of a plastics-impregnated

wood. Such acid-resistant wood has been found to be sound and firm after 18 months service when untreated wood under identical conditions lasted only two to three weeks.

The plastics treating material, developed by Koppers Company, Inc., is liquified by high temperature and the wood to be processed is immersed in the compound in sealed retorts. The plastics is forced deeply into the wood fibers by high pressure at temperatures sufficiently high to hold the compound in the liquid state. After an impregnation period of 10 to 20 hours, the compound sets-up as a plastics-solid distributed in the cells of the wood as it is allowed to cool, to produce the material known as Asidbar. The treatment increases the weight and hardness of wood, and gives it a black surface which need not be painted; resistance to wear and abrasion, water and chemicals is considerably increased. The properties of Asidbar make it suitable for many requirements of severe service conditions at temperatures up to 180 degrees, Fahrenheit.

Wood thus treated is non-toxic and can be installed with ordinary woodworking tools.

PRINT MACHINE

Uses Dry Developing Method

RAPID and automatic reproduction of engineering and architectural drawings, printed matter, office forms, specification sheets, letters, advertising layouts, and a wide variety of other materials, is possible with a new machine developed by the engineering department of the Ozalid Division of the General Aniline and Film Corporation. Known as the Printmaster, this machine will print and dry develop as much as 30 feet of material a minute, producing positive prints, which have blue, black, red, or sepia lines on a white background. These prints may be reproduced on paper, cloth, foil, or film.

High-speed, versatile printing unit

These materials are sensitized with special azo dyes which react in the presence of ammonia vapor, which is the developing agent employed in the Printmaster. They require no washing, drying, or fixing, as is the case in blueprint and the "wet" processes. In addition, this same machine can be used to produce photographic prints in a matter of seconds without the use of wet developing solutions.

LAMINATE PLASTICS

Can Be Made in Any Color or Thickness

COLORFUL and lightweight refrigerators, luggage, and furniture of any size, shape, or color you want, made from a new cellulose plastics laminate, is a post-war possibility, according to the Hercules Powder Company.

Made like a sandwich, the cellulose laminates actually are tougher than steel of equal weight, lighter than aluminum of equal thickness, and have unlimited color possibilities.

To make the laminates, pieces of textile, paper, or similar material are coated with ethyl cellulose or cellulose acetate, stacked, inserted between two highly coated stainless steel plates, and placed in a press. Under heat and pressure, the plastics textile combination is welded into one sheet of laminate.

The thickness of the finished laminate sheet, determined by the number of plastics-coated textile pieces stacked, varies according to the use for which the laminate is designed.

The inherent strength of the cellulose derivatives is greatly reinforced by this laminating technique. Some of the laminate samples cannot be broken on standard plastics impact strength testing equipment.

Industrial design artists will be able to let their imaginations run rampant when thinking about new articles made from cellulose laminates, because color possibilities are endless. For example, plaids, flowered designs, and prints can be imbedded in the laminate to create products of deep, lasting beauty.

The flat laminate sheets can be turned into end products with inexpen-

sive equipment. Operations such as drilling, punching, and riveting usually are unnecessary because the plastics in the laminate sheets forms its own adhesive, or a solvent-sealing process can be used.

PUNCH PRESS

Adaptable to Many Different Jobs

An OPEN-FACE punch press, suited to a wide range of small punch press operations, does work fast and accurately in stamping, perforating, blanking, punching, piercing, light drawing, forming and assembly jobs, crimping, die work, and many similar operations.

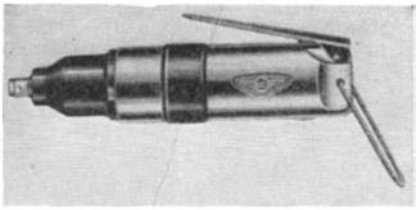
Unskilled workmen can quickly learn its operation and turn out precision work within exceedingly close tolerances. The press is said to work equally well on metal, cloth, rubber, wood, synthetics, and plastics. The body is heavily reinforced and the slides are designed for maximum wear. Pilot bars are solid ground alloy steel. Automatic wick-oilers provide guide-rod lubrication. The shaft is a hammered steel forging. The clutch is positive and made of heat-treated alloy steel. The flywheel is solid metal, grooved for V-belt drive, and balanced for smooth operation and maximum power.

V-belt drive, open face press

IMPACT WRENCH

Eliminates Thread Stretching and Burning

Delivering ample power for stall-proof operation, a ¼ inch capacity pneumatic impact wrench with straight-type grip and lever control is particularly suited to assembly-line jobs of nut-setting and screw-driving. Through its torque control mechanism, stretching or "burning" of threads is eliminated. Control is obtained primarily through the construction of a roller clutch impacting mechanism which consists of only four major parts—anvil, hammer, and two cylindrical steel rollers. When in operation, centrifugal force throws the two steel rollers out against the hammer where they are caught in shear between the hammer and anvil members. This transfers the full torque through to the work in the form of a sudden impact. When the selected torque is reached, the rollers rebound from the anvil face and do not allow the hammer to engage for impact. This method of impacting prevents any stretching of the threads on either the stud or bolt and guarantees maximum torque. The simplicity of design of the roller clutch impacting mechanism insures long life and ease of maintenance. The motor itself is of rugged construction, governor controlled, employing a six-bladed rotor mounted on precision ball bearings and is housed in an aluminum case. The complete tool made by the Aro Equipment Corporation, has been designed for perfect balance and easy handling.



Air-operated automatic wrench

APRONS

Have Strong Neck And Waist Tapes

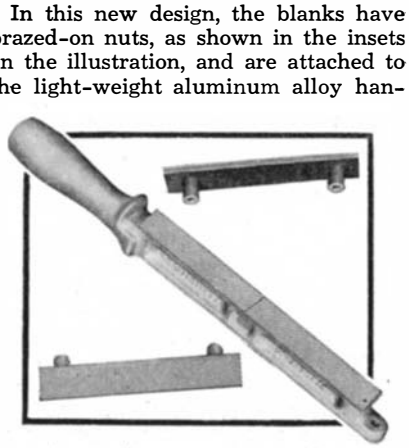
Lightweight and acid, alkali, and oil resistant, a new apron is made from fabric coated on one side with a black vinyl resin, for use in the canning and other industries. Announced by The B. F. Goodrich Company, all edges of the apron are hemmed and the neck and waist tapes are in one piece, sewed into the hem of the arm cut-out, giving the apron strength and rigidity as well as a good drape.

LATHE FILE

Has Easy Replacement Feature

Development of a new lathe file which retains the advantages of previous models in that it will cut steels no ordinary file can cut, at speeds three to ten times faster than steel files, and with a life of from 50 to 200 times as long, has just been announced by Kennametal, Inc. It also provides a longer filing surface, quick and easy blade replacement, and greater handling convenience.

In this new design, the blanks have brazed-on nuts, as shown in the insets on the illustration, and are attached to the light-weight aluminum alloy han-



File handle shaped for convenience

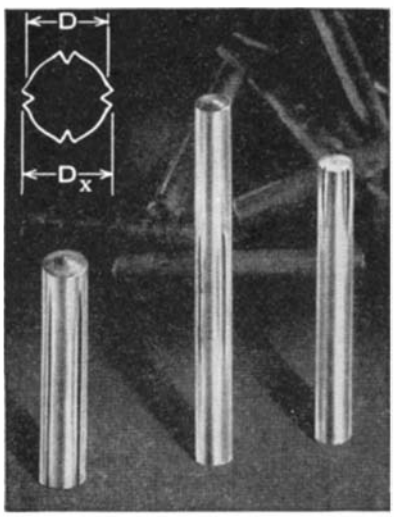
dle by screws. They can therefore be readily replaced when worn from long service. The handle grip is shaped to fit the hand, and has a thumb rest and knuckle guard. An extension beyond the filing surface supplies a convenient finger hold.

SELF-LOCKING PINS

Used to Replace More Expensive Fastenings

STANDARD and special self-anchoring, vibration-proof pins, designed to replace more expensive taper pins, keys, cotter pins, set-screws, rivets, and so on, are pressed or driven into standard drilled holes. These pins have four flutes on the surface parallel to the axis, the length and position of which can be controlled accurately, so that fully or partially grooved pins are available. Fully grooved pins have a pilot at one end so that the pin can be easily inserted.

The raised, work-hardened edges of these flutes provide an expanded diameter of a few (specified) thousandths greater than the nominal diameter of the pin. When the pin is inserted in a drilled hole, these raised edges are compressed inwardly, providing a resilient self-locking element which, it is claimed, will hold indefinitely under vibration or shock conditions. Manufactured by the Driv-Lok Pin Company, they are available in sizes from 3/64 inch to ½ inch diameter, and from 3/16 inch to 4½ inches in length, in any material, and in a wide variety of types.



Pins lock themselves when driven

DIESEL FUEL

Improved by Use Of Additive

ESPECIALLY prepared as an additive to Diesel fuel oils (four ounces to each 10 gallons of regular Diesel fuel oil), a new concentrate prevents corroding and sticking of injector nozzles and at the same time gives top-cylinder lubrication where ordinary oil fails, thus preventing the formation of hard carbon and sticking rings.

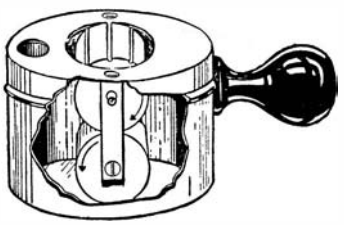
Gibraltar Diesel Fuel Oil Concen-

trate is claimed to give instant overhead lubrication where the ordinary oil system does not reach. It penetrates the pores of the metal and, in addition to giving proper lubrication, prevents hard carbon from adhering to the metal surface. Any carbon which is formed will be soft, and because the metal pores are impregnated with oil capable of withstanding high temperatures, the carbon will be expelled from the engine through the ports.

MARKING POT

Is Economical of Stencil Ink

CONSTRUCTED with two rotating wooden rollers which convey the liquid marking ink from the bottom of the closed metal container to the top roller and then to the stencil brush, a new marking pot is economical of ink. All the ink in the pot is used and, because there are two rollers which automatically stir the ink to prevent settling, there is no pigment accumulation on the bottom and no thickening of the residue of ink left in the pot.



Rollers convey marking ink

Ink capacity is 12 ounces. The cover has the two roller assembly attached to it. This is easily removable for filling and cleaning.

GLOVES

Protect Hands of Industrial Workers

HIGH temperatures and humidity greatly increase susceptibility to industrial dermatitis and call for the constant wearing of protective clothing. To protect the hands from irritating solvents, Resistoflex Corporation has developed a transparent glove made of compar, a vinyl resin derivative.

These gloves give complete protection

Courtesy Grumman Aircraft Engineering Corp.
Hands protected by plastics gloves

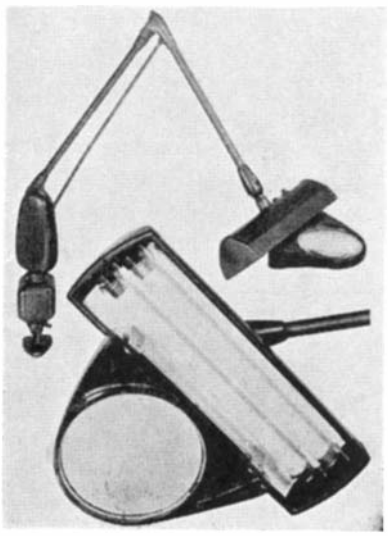
because skin surfaces are prevented from coming in contact with fuels, oils, paints, lacquers, thinners, dry cleaning fluids, degreasing solvents, sulfur-base cutting oils, and so on. Impervious to all organic fluids and many that are inorganic, the gloves are highly abrasion-and-tear resistant. In a wide variety of plants where varsol is used for degreasing metal parts or where kerosine is employed in the Magnaflux inspection process, compar gloves are used to protect the skin.

MAGNIFYING LENSES

Now Built Into Fluorescent Fixtures

AN ADAPTION of "Super Sight" magnifying units to fluorescent lighting has been announced by the Safety Division of The Boyer-Campbell Company. The combination is mounted on a balanced bracket that can be instantly placed in any position.

Where the units are used continuously—in engineering for reading the slide rule, making detailed layouts,



Close-up shows lens and lamps

checking prints, and so on; in the shop, for work over a surface plate; at the bench, for reading verniers and micrometers; for inspection, in checking hardness cracks and similar work—the cool fluorescent lighting adds substantially to the comfort of the operator.

FLUORESCENT HOUSING

Made of Transparent Plastics To Protect Glass Tubing

ANOTHER practical use of "Lucite" methyl methacrylate resin, which already has revealed a number of other possibilities for the plastics in the fluorescent lighting field, is a cylindrical transparent housing used with portable industrial lighting equipment.

According to lighting manufacturers, the light-weight plastics housing, which is machined from tubes of the clear plastics, provides good light transmission, is practically unbreakable under normal working conditions, and is water and vapor tight—an important

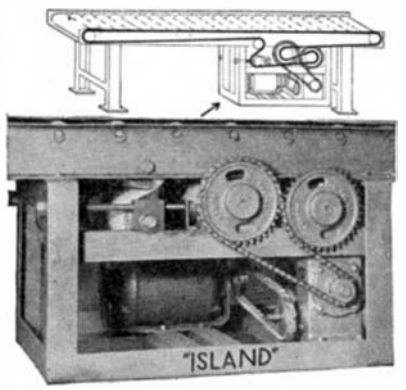
advantage over wire guards commonly used with this type of lighting equipment.

The complete lighting units, which are especially designed to bring illumination to remote, out-of-the-way places, are available in 6, 8, 15, and 30 watt sizes. They have been found practical for inspecting large gun barrels as well as the interiors of tanks and planes, and are being used by repair men in the plumbing and electrical fields and in underwater salvage operations.

CONVEYOR DRIVE

Can Motorize Existing Conveyor Equipment

TO MEET the demand for an efficient power unit for motorizing conveying equipment a self-contained assembled unit has been developed, built solidly in an iron frame, ready to be quickly



Drive unit and motorized conveyor

and securely bolted to the chassis of any piece of conveying equipment that needs to be mechanically operated.

The Island Equipment Corporation's "Power Pac" unit consists of motor, driving rolls, switch speed reducers (where wanted), controls, correct gears, and all necessary mechanism to enable the user to make the proper connections to their equipment.

With this unit, an ordinary gravity conveyor can be motorized, allowing it to carry up grade where needed.

DIE CHANGING

Made Easy With Special Trucks

DIES weighing 10 to 20 tons or more, as used by builders of heavy industrial equipment, require frequent removal and replacing on presses. These large, cumbersome loads are now handled quickly, safely, and economically with a modern die-handling truck.

The illustration shows such a truck in operation in an airplane plant. In this method of handling dies, the driver pulls up to the press bed and elevates the platform to the height of the bed. He then reels off wire cable, on both sides of the truck, passes each length through a pulley on the end of the platform, and hooks it to the rear side of the die. When the cable is wound on the drum the die slides off the truck on to the press. In removing the die

Moving a heavy press die

from the press the cable hooks are attached to the far side of the die and it it pulled forward from the press onto the platform. One man only, the driver if necessary, can change dies, once the die is unbolted from the press.

This method of handling is finding extensive application in forging departments doing a wide range of work, because of the ease and safety of the operation. The Elwell-Parker truck conserves manpower and avoids tying up expensive presses while changing dies manually.

LOUPE

Has Light and Comfortable Frame of Plastics

USEFUL in occupations involving eye-tiring close work, a new Berger loupe has a light-weight plastics frame which is held securely and comfortably before the eyes by an adjustable elastic headband.

Also adjustable for different facial contours and widths between eyes, the loupe is well-ventilated and will fit any type of face. It can be worn over glasses comfortably, thus providing for both magnification and eye correction. Precision-ground glass lenses give a magnification of 2.5x.

The American Optical Company's new loupe has innumerable applications in different fields where magnification is desired, with free use of the

Eye comfort for close work

hands. For example, inspectors, die makers, draftsmen, dental and laboratory technicians, doctors, stamp collectors, and artists represent a few of the many occupations and professions where the loupe will conserve eyesight and improve efficiency.

VERSATILE ALARM

Will Serve as All-Around Time Control

AN ELECTRIC alarm clock which will awaken the soundest sleeper to the strains of radio music, turn the radio on for selected programs throughout the day or night, and automatically switch the set off upon retiring, heads the list of post-war products developed by Warren Telechron Company.

Besides automatically turning on the radio, the "Selector" can be used for starting a coffee percolator at a given

Appliance timer, 1650-watt capacity

time, switching household lights on and off, timing roasting operations, and defrosting refrigerators. Due to its switch mechanism, which is rated up to 1650 watts, it will time and control any household appliance or similar device that can be plugged into a conventional outlet.

ANTI-FOG

Preparation Keeps Glass Clear

GOGGLE lenses, face shields, and welding plates are kept clear by a preparation which penetrates the ultramicroscopic pores of glass. It deposits a thin film which helps prevent fogging, steaming, and frosting of all types of glass surfaces. In addition, it removes grease and dirt from glass, and allows perfect visibility.

The American Optical Company's preparation is easily applied by simply spreading it on both surfaces of glass, rubbing the surfaces thoroughly, and then polishing them with a soft cloth or paper. The anti-fog preparation is obtainable in one-ounce or one-pound jars.

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.)

THE INCENTIVE WAGE is a 24-page booklet based on a survey of incentive wage plans now in use. A three-page introductory summary of the survey is followed by direct quotations of those answering survey questionnaires. In conclusion the principles of wage incentives, set forth by the National Association of Manufacturers, are listed. *The Douglas T. Sterling Company, Research Division, Stamford, Connecticut. —Gratis.*

FEDERAL PRESENTS FM BROADCAST TRANSMITTERS WITH ANTENNAS is a four-page brochure announcing a new line of FM transmitters designed for the new 88 to 106 megacycle band. Technical data, answering questions 18 and 19 of Federal Communications Commission Form Number 319, are supplied. *Federal Telephone and Radio Corporation, Radio Equipment Division, 200 Mt. Pleasant Avenue, Newark 1, New Jersey.—Gratis.*

INTRODUCTION TO ELECTRONICS is a 20-page educational booklet written to provide an understanding of the principles of electronics and an idea of the part electronics will play in future industrial developments. Request Booklet E-6358. *Allis-Chalmers Manufacturing Company 568, Milwaukee 1, Wisconsin.—Gratis.*

PHYSICAL AND CHEMICAL PROPERTIES OF PENNSYLVANIA ANTHRACITE is a 26-page booklet presenting a technical digest of a number of research studies and standards for the better understanding of the value of this product for fuel and non-fuel uses. *The Anthracite Industries, Inc., 101 Park Avenue, New York 17, New York.—Gratis.*

BULLETIN NUMBER CB-45 is an eight-page bulletin covering a complete line of thread milling cutters that are heat treated and finish-machined ready for thread grinding to customers' specifications. There are 52 shell type and 32 shank type standard cutters listed in various sizes and with any thread form. *Detroit Tap and Tool Company, 8432 Butler Avenue, Detroit 11, Michigan.—Gratis.*

BOOKS, PUBLICATIONS, AND PATENTS OF BATTELLE MEMORIAL INSTITUTE, 1929-1944, is a 72-page catalog which lists the institute's published contributions to education, science, and industry. More than 800 contributions in the following fields are listed: organic chemistry, electrochemistry, chemical engineering, graphic arts, welding technology, applied mechanics, mineral dressing, industrial physics, ceramics,

fuels, and metallurgy. *Battelle Memorial Institute Columbus 1, Ohio.—Gratis. Request this catalog on your university or company letterhead.*

SELECTED REFERENCES ON INDUSTRIAL USES OF CERIUM WITH ALUMINUM AND MAGNESIUM are two lists of references to the uses of cerium as an alloying agent in conjunction with aluminum and magnesium. Included are: Annotated bibliographies; summaries of important articles; sources; and patent listings. *Cerium Metals Corporation, 522 Fifth Avenue, New York 18, New York.—Gratis.*

SHIPS OF THE MERCHANT MARINE is a 30-page booklet presenting pictures, data, and silhouette models of the principal types of vessels of the United States' merchant fleet. An introduction by Admiral Chester W. Nimitz is followed by definitions of various terms used in giving factual data of ships, and a section describing how merchant vessels are named. *Tide Water Associated Oil Company, Publicity Department, 79 New Montgomery Street, San Francisco, California.—Gratis.*

DEMING PUMPS EVERYWHERE is a 32-page booklet compiled to acquaint the reader with the history of the company, giving typical views of the plant, a list of owners of Deming pumps, and illustrations and descriptions of how these pumps and water systems can be used. *The Deming Company, Salem, Ohio.—Gratis.*

ELECTRICAL CONTACT AND DATA BOOK is a 36-page catalog describing many types of contact materials with applications of each type, factors in the choice of materials, methods of attaching contacts, and other pertinent data. Request Contact Catalog Number 12. *Stackpole Carbon Company, St. Marys, Pennsylvania.—Gratis.*

SHIPMATE RESTAURANT AND HOTEL RANGES is a 16-page catalog describing and illustrating 16 different ranges for coal, wood, oil, or stoker-fired operation. Complete technical information on each model is included. Request Catalog Number 45. *The Stamford Foundry Company, Stamford, Connecticut.—Gratis.*

DILLON DYNAMOMETER MANUAL is a 20-page booklet telling the story of the traction type dynamometer and its increasing number of uses for testing and weighing procedures in various industries. *W. C. Dillon and Company, 5410 West Harrison Street, Chicago 44, Illinois.—Gratis.*

THE BIOLOGICAL, HYGIENIC, AND MEDICAL PROPERTIES OF ZINC AND ZINC COMPOUNDS is a 44-page bulletin on zinc and its relation to health. Compiled by the United States Public Health Service for scientific, industrial, and medical reference libraries, as well as other interested persons, it is aimed to correct much misinformation on the subject. *American Zinc Institute, Inc., Department A, 60 East 42nd Street, New York 17, New York.—Gratis.*

Our Book Corner

THE BOOK DEPARTMENT of Scientific American is conducted, with the cooperation of the Editors, to make available for you a comprehensive book service. Each month the Editors select and review in these columns new books in a wide range of scientific and technical fields. In addition, they are ready at all times to advise you regarding the best available books on any subject. You are invited to use this service freely. Tell our Book Department what kind of books you want, and you will be furnished with the names of available books, including prices. When inquiring about books, please be specific; remember that we can be of the greatest help only when you tell us just what you are looking for. Books listed in these columns may be ordered from our Book Department. Add 25 cents per book for mailing outside U. S. All remittances are to be made in U. S. funds. Prices given are subject to change without notice.

TO MAKE CERTAIN that books ordered by or for men in the Army, located in the United States, or men in the Navy, Marines, or Coast Guard, located anywhere, will be delivered, insurance fees should be sent with orders, as follows: To $5 in value, 3¢ additional; from $5 to $25, 10¢; from $25 to $50, 15¢.

CATALYTIC CHEMISTRY

By Henry William Lohse

BRIEF, factual consideration of the underlying principles of catalytic phenomenon and the application of catalytic reactions in industrial processing is the aim of this compact volume designed to aid the industrial chemist in pursuing his work. Numerous references are given to more extensive sources of information on specialized phases of the work. (471 pages, 6 by 9 inches, 30 illustrations.)—$8.60 postpaid.—*A.P.P.*

UNIVERSAL MILITARY TRAINING

By Col. Edward A. Fitzpatrick

AN INTELLIGENT discussion of all angles of a question intimately affecting almost every American family—peacetime military training for all youths. The author explains the delicate international situation today and its influence on our future military and naval policy, together with the effect of compulsory military training on the civilian. (374 pages, 5½ by 8 inches, unillustrated.)—$3.10 postpaid.—*W.D.A.*

ENGINEERING PREVIEW, HOME STUDY EDITION

By Seven Technical Writers

SENIORS in high school or freshmen in college will find this introduction to the whole broad field of engineering to be a great help in determining their future careers; moreover, those who have been away from academic halls for several years will find the contents equally informative and stimulating. A review of mathematics is included for those who may have become rusty. The avowed purpose of this volume is to open the field of engineering study in its entirety, and then break it down into specific subjects, each treated by an expert in the field. Chemistry, physics, and mathematics—tools of all engineers—are treated compactly yet completely. Not only is the material presented for study, but the reader is shown how to study it. A comprehensive examination section is included, with an answer key, so that the reader may examine and grade himself. (619 pages, 6 by 9 inches, over 400 illustrations plus logarithmic and trigonometric tables.)—$6.10 postpaid.—*A.P.P.*

THE AUTOBIOGRAPHY OF SCIENCE

Edited by Moulton and Schifferes

MANY times in scientific books you have read about the famous world-changing key writings of the great scientists but it is hard to get actually at many of these same passages; instead you get somebody else's rehash. This book is an anthology of careful selections from such key passages from the master works of all the sciences of all times. Its editors have hunted them up and brought them together in one volume which you can pick up at any time, wherever you are, open anywhere, and dip into some such classic. For example, Roentgen discovered the X rays; wouldn't you like to read the actual paper in which he first so lucidly announced them to a local scientific body? Here, too, is Mendel's famous lost paper on his experiments in hybridization. (666 pages, 5¾ by 7¼ inches, unillustrated.)—$4.10 postpaid. —*A.G.I.*

YOUR PERSONAL PLANE

By John Paul Andrews

MANY aspects of private flying—the planes themselves, safety, initial costs and costs of operation, landing fields, airparks, air routes and the way to go home, the problem of municipalities in establishing air facilities, and vacations by air—are covered in this timely book. A chapter entitled "Personal Planes for Personal Gain" discusses gainful activities in private flying for a man of small capital seeking

a business of his own. A directory of small airports is included. A comprehensive, conscientious book dealing fairly well with a subject of vital interest, but poorly illustrated, written somewhat at second hand, and containing a number of misconceptions. (230 pages, 5¼ by 7½ inches, illustrated.)—$2.60 postpaid.—*A.K.*

INDUSTRIAL PLASTICS

By Herbert R. Simonds

REVISED and enlarged, this third edition of a standard text includes a list of important industrial plastics, the latest war-time developments and processes, and a section on the chemistry of plastics. This is at once a source book on plastics in general and a specific text on practices and procedures. (396 pages, 6 by 9 inches, well illustrated with photographs and drawings; several tabulations.)—$5.10 postpaid.—*A.P.P.*

FIBER TO FABRIC

By M. D. Potter

AN INTERESTING textbook on textiles, both natural and man-made, which everyone connected with the textile or related industries should study, as well as every woman responsible for buying family wearing apparel, household linen, rugs, carpets, and so on. It contains valuable information which might be of considerable economic worth in the course of a year. The chapters "Testing Fabrics for Identification" and "Care of Fabrics" alone are well worth the price of the book. (314 pages, 5¾ by 8½ inches, amply illustrated with photographs and drawings.)—$2.10 postpaid.—*W.D.A.*

REFRIGERATION AND AIR CONDITIONING ENGINEERING

By B. F. Raber and F. W. Hutchinson

PRACTICING engineers and engineering students will find this thorough treatment of refrigeration and air conditioning fundamentals and procedures to be invaluable as a reference text. There is no descriptive material on specific equipment nor are performance data presented; emphasis is entirely on the science of the subject. Chapters cover: Thermodynamic Principles, Fundamental Cycles, Analysis of Cycles, Heat Transfer, Heat Flow, Psychrometric Principles and Processes, Ventilation Systems, and so on. (291 pages, 6 by 9 inches, thoroughly illustrated with drawings.)—$4.10 postpaid. —*A.P.P.*

MACHINE TOOL GUIDE

By Tom C. Plumridge, Roy W. Boyd, Jr., and James McKinney, Jr.

TOOL and mechanical engineers, millwrights, and tool equipment salesmen will find much of interest and value in this convenient compilation of data on all types of machine tools. True, the assembled information has previously been available in service manuals or catalogues but has never before been assembled in organized form. The text is entirely composed of photographs, drawings, data sheets, and specifications covering all of the principle forms of machine tools in use by industry. Some of the machine tools covered are automatics; boring, broaching, and drilling machines; gear cutters; grinders; lathes; millers; presses; tapping machines; and specialties. (630 pages, 9 by 11 inches, loose-leaf binding.)—$7.70 postpaid.—*A.P.P.*

CALCIUM—METALLURGY AND TECHNOLOGY

By C. L. Mantell and Charles Hardy

CALCIUM is an important metal quite aside from the abundance and immense usefulness of its chemical compounds. Even traces of calcium impart useful properties to alloys or modify existing properties in important ways. Particularly in the present period of avid demand for metals, both old and new, the family of calcium alloys is proving highly valuable. The present authors review in some detail the preparation and properties of metallic calcium and the alloys containing it. No less than 11 families of alloys are described in addition to the many uses in various metallurgical and chemical operations. (148 pages.)—$3.60 postpaid.—*D.H.K.*

APPLIED MATHEMATICS FOR RADIO AND COMMUNICATION ENGINEERS

By Carl E. Smith

RANGING from arithmetic through calculus, a clear and simple presentation is given of the principles of mathematics used in radio and communication engineering. The text is designed for self-study and each theory is developed from basic fundamentals; the application of each theory to useful design equations is then traced carefully. Practical examples show how the principles are applied in practice. The text is carried far enough to cover frequency modulation, television, and radar. (336 pages, 6 by 8½ inches, numerous drawings and complete appendix of useful tabulations and formulas.)—$3.60 postpaid.—*A.P.P.*

HAY FEVER PLANTS

By Roger P. Wodehouse

HERETOFORE, clinical studies of hay fever, an industrial man-power scourge as well as an individual handicap, have received the major portion of research. In this book, however, the botanical aspects of hay fever are exhaustively treated, covering all plants in the United States known to cause hay fever, most of those suspected of doing so, and many which possibly do not. While not written for "popular" appeal, the intelligent hay-fever sufferer will acquire much valuable information from this volume, as will also the researcher. (245 pages, 7 by 10½ inches, illustrations and index.)—$4.85 postpaid.—*W.D.A.*

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"

THE following is the concluding part of the article on mirror making on the hand-lever spindle machine, which was begun last month by Patrick A. Driscoll of the Eastman Kodak Company Hawk-Eye Works.

CLEAN up all traces of 180 emery around the machine, make up a jar (one pint) of 500 emery, and use a new brush. Mike the glass and *write this figure down*. We must grind with 500 emery until we have removed at least 0.008" and until the surface once more exactly fits the gage.

Before proceeding with the 1200 emery, the mirror must be re-miked on its location mark and the reading noted down. To wipe out all No. 500 pits we must remove at least 0.004".

Assuming that the surface is once more a gage fit we now can look forward to polishing, with the assurance that we have a perfect fine-ground surface, free from pits or scratches. A spindle speed of 200 r.p.m. was recommended for grinding. For polishing, we must reduce this to about 36 r.p.m. Any speed within those respective ranges will, of course, prove quite satisfactory. In Figure 1 (in last month's installment) the pulley or gear trains have been left to the builder's discretion, in the belief that many will have their own gear boxes and pulleys and individual initiative for devising ways to change spindle speed.

For polishing, Hindle's machine ("A.T.M.," page 234) will give a close approximation to the action of the machine in Figure 1 and will be quite satisfactory if the worker prefers it. In either case, the spindle should have a speed of about 36 r.p.m. All belting, Hindle or Driscoll, should be double V-belt. The speed reduction from the motor can be accomplished by belting or, in the probable event of financial affluence, by a gear reduction unit. Try the gear shift unit from the family flivver.

Elaboration or addition of automatic stroke is left to the individual's discretion.

To shape the cold polisher to curve we place it and the mirror in a *large* pan of water and *slowly* heat them until the pitch is fairly soft to the touch and the glass is fairly warm to handle. Next, place the hot, wet polisher on the machine, apply thick rouge, start the spindle rotating and form the polisher to curve, using the mirror as a forming instrument.

If the polisher and glass cool down too soon, dunk them back into the pan of water for a while and proceed as before. The pan of water will stay good and warm if you make it big enough. Do not use soap and water as a lubricant.

The rouge will color the polisher as it conforms to the glass, and any black areas may be assumed not to be in contact. But when the lap is a dull red all over it is formed to curve and contact.

To cut the polisher we place it, cold, on the machine and, with the spindle rotating, hold the corner of a single-edged razor blade against it and scrape, not cut, grooves into it, spaced about ⅜" apart and 1/16" deep. They need not be wide nor deep. I have found nothing better than the single-edged razor blade for cutting the polisher, not because of its cutting edge but for its sharp corner when used as a scraping device.

During the forming of the polisher and in all polishing it *is most important that the grooves in the polisher or lap be kept open.* They do not have to be deep or wide.

On a concave surface a polisher having the same diameter as the work will have a tendency continually to shorten the radius of curvature; that is, it will "drive the center low," polishing the center more than the edge. Therefore a hyperbola develops, even with a rational stroke. In trying, then, to lengthen the radius and get out of his hyperbola, the worker resorts to a very short stroke; and thus, by polishing the edge much more than the center, he lengthens its radius and winds up with two foci, a short center and a longer (turned) edge. The turned edge is caused by trying to correct the tendency of the shortening effect on the radius.

Thus, three fourths of the polishing time is lost in trying to keep the focal length up to standard and, in so doing, three fourths of the abrasive effect of the polisher is put on the edge of the mirror. This is one of the causes of that great bugaboo, turned edge.

By inverting polisher and mirror the worker can reverse the action of his equal diameter polisher but, while the polisher when on the bottom unduly hits the center because it is too small, so does the polisher when on top unduly hit the edge because it is too big—and in both cases much too hard. Thus we have the dilemma: either the turned edge or hyperbola. Of course, by juggling the polisher and glass, and by using all sorts of strokes, a spherical surface is finally attained—if our judgment, timing, and patience are working overtime.

A convex surface with equi-diameter polisher on top will be hardest hit on the edge (and once again a shortened radius). The equi-diameter method holds the worker to a short stroke, less abrasive or polishing action, and a greatly increased polishing time.

Proceeding once more on the assumption of a concave surface to be polished, we place the six-fifths diameter polisher on the spindle, lay the mirror face down on it, adjust the stroke neither long nor short but medium, and give the work a 15-minute polishing spell.

The rouge should be of a creamy consistency. Keep it in a jar and apply it with a soft ½" brush.

The center of the mirror should cross center of polisher at every stroke.

For a 6" mirror a pressure of about eight pounds will suffice. A fair rule for weight on the drive-pin of the stroke arm (which has a slip fit so that the weight of the worker's arm, itself, is not transmitted to the work) is 1½ pounds per inch of diameter.

Remove the work and measure the radius by the Foucault test. Use a ¼" pinhole covered with window screening, and substitute a piece of fine-ground glass for the knife-edge, the two mounted so as to move as a unit together. When the image of the squares of screening is sharpest on the ground glass (scan with a 1" f. l. magnifier) we have ascertained the radius of curvature, and half this distance is the f. l. of the surface within 1 mm.

If the radius is too long, the center of the mirror must be polished more than the edge. Therefore, increase the length of the stroke. If the radius is too short the stroke must be shortened to polish the edge more than the center.

By testing often, the action and effects of the machine will become more and more familiar as we proceed.

Thus far the radius of curvature has been referred to as too long or too short. In optics a concave surface is often referred to as "high" (long radius) or "low" (short radius), and hereafter we shall use these terms.

If the low surface is fitted to the gage it will show space under the center, because the curve is too deep. The high surface will show space under the edges because the curve is too flat.

Let the polishing spells be about 15 minutes in length. When approaching the desired radius of curvature, shorten these spells and test often.

Ring grooving of the polisher affords an additional correction to obstinate zones. An example: The curve is too low (deep) and short strokes do not seem to change the radius during a few polishing spells. Therefore, from the center to half way out on the polisher we scrape additional grooves between each present groove. Conversely, if the surface is high we scrape more grooves on the polisher's outer area.

A warning: Do not make these corrective grooves too deep. Be easy with pressure on the razor blade scraper. The grooves are to correct a temporary fault only, and when this has been accomplished we do not want them to continue their effect. Regroove them lightly and often but only as long as they are needed. If, however, they should remain after the surface is corrected, scrape balancing grooves on the remainder of the polisher, to nullify their effect and from now on let these intermediate grooves close up but do

not fail to keep the regular grooves open at all times. Never let them close.

A corrective method, alternative to local grooving, is to scrape the center or edge with the razor blade held square on. Scrape ever so lightly, my friend, ever so lightly. Even with this warning some probably will scrape too much and get into trouble.

If a slight stain appears on the mirror, a 15-minute spell using plain water and no rouge will usually remove it. If not, add about ½ teaspoonful of vinegar to ½ pint of rouge.

It is not necessary to remove the work every time the tool needs recharging. In applying emery or rouge use a brush and apply while the machine is running.

Since all the foregoing has treated the concave surface for the benefit of the mirror maker, we must now make amends to the refractor builder and not leave him high and dry. Let us bring him down to our lowly level and carry this discussion into the field of convex surfaces.

Our rule calls for the convex surface to be ground and polished face up, tool on top. The grinder will be 4/5, and the polisher 5/6, the diameter of the lens.

In reversing the position of the lens from the top to the bottom we also reverse the action of the stroke for correcting high or low test findings. The high concave would require a long stroke. The high convex would require a short stroke. The low concave would need a short stroke. The low convex would need a long stroke. In sum, on a concave surface, when the curvature is not deep enough it is high. When the curvature is too great, it is low. On a convex surface the conditions are directly opposite. The polishing technique for a convex surface is different from that of the concave only in the inversion of the lap and action of the stroke.

A last and oft-repeated warning: Do not attempt to polish until the surface exactly fits the gage after fine grinding. We do not wish to polish ourselves into an early grave.

Finally, I extend my condolences, in the form of a more simplified polishing machine, to the amateurs who lack the material, space, and so on, for a better one. This machine will do everything the one already described will do, except that the time factor will be extended considerably. The spindle should be vertical, running at about 36 r.p.m., and the stroke arm should be double, consisting of your own two strong arms with sleeves rolled up. Merely place the work in a chuck (Figure 3, insert, last month), and apply your strokes exactly as if you were a part of the machine. The chuck for hand polishing may be made of metal or wood, and lined with glued-in felt. The drive pin notch shown on its top is not for hand work, but with it this same chuck may, if preferred, be substituted for the metal button of Figure 1, in polishing.

After each 15 or so strokes, let go of the chuck. The work will revolve with the spindle. After about three seconds, drop the hands back on the chuck and proceed. Do not be afraid of the work flying off the spindle when you let go; it won't, since 36 r.p.m. is not fast enough to cause alarm on this score.

With this machine no single condition or relation of work to polisher will be duplicated, and neither monad, astigmatism, nor one-sided test (one area of different radius) will occur.

It is my humble opinion that amateur optics can well afford to get away from some of the do's and don'ts prescribed by workers in the past, not omitting the wearing of round-the-barrel ruts in the rug. So roll out the barrels.

End of Driscoll's contribution.

READERS are warned that the 200 r.p.m. recommended in the above articles should not be carelessly exceeded. "Faster, disaster," is Driscoll's warning, in a private communication, while Leo J. Scanlon of Pittsburgh, who has used a hand lever machine, is of the same mind and urges not falling asleep even at 200 r.p.m. Especially is this pertinent in the final stages of grinding, since at this stage the grinding surfaces become dry or warm and seizure may take place so quickly as to end possibly in the disaster against which Driscoll warns. Henry Paul, Norwich, N. Y., also has used a hand lever machine and protects his mid-section by embodying a heavy steel splash pan in his equipment; an added piece of plank would serve the same purpose. In the next number an illustrated description of Paul's hand-lever machine will be published, with numerous sidelights on its operation.

GLEANED while reading a back number of the *Journal of Scientific Instruments* (London, February, 1938, p. 3) is the following fragment abstracted from a paper on "The Mechanical Amplification of Small Displacements," by Professor A. F. C. Pollard, and of probable interest to Carborundum-conscious readers.

Place a well-made agate knife-edge from a micro-chemical balance in contact with a microscope cover-glass under a high power of the microscope, in monochromatic light. Note fringes from the two facets, also black areas surrounded with very irregular contours from the edge.

"One wonders," Prof. Pollard remarks, "how it is that agate knife-edges function as well as they do."

Now select a perfect Carborundum crystal about ⅛" long and similarly test it. Though the crystal edge included by the facets is at an angle of about 117°, this edge is almost perfect and is seen as a black fringe along its whole length. Such perfect crystal edges should form ideal knife-edges for highly sensitive and delicate lever systems, Professor Pollard states, "but I know of no case in which the crystals have been used for this purpose." But he adds that Professors McBain and Tanner have used two sharp points of Carborundum crystals to function as the knife-edge of their highly sensitive microbalance, and with great success.

Printed in the U. S. A. Press of the Wilson H. Lee Company, Orange, Connecticut.

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