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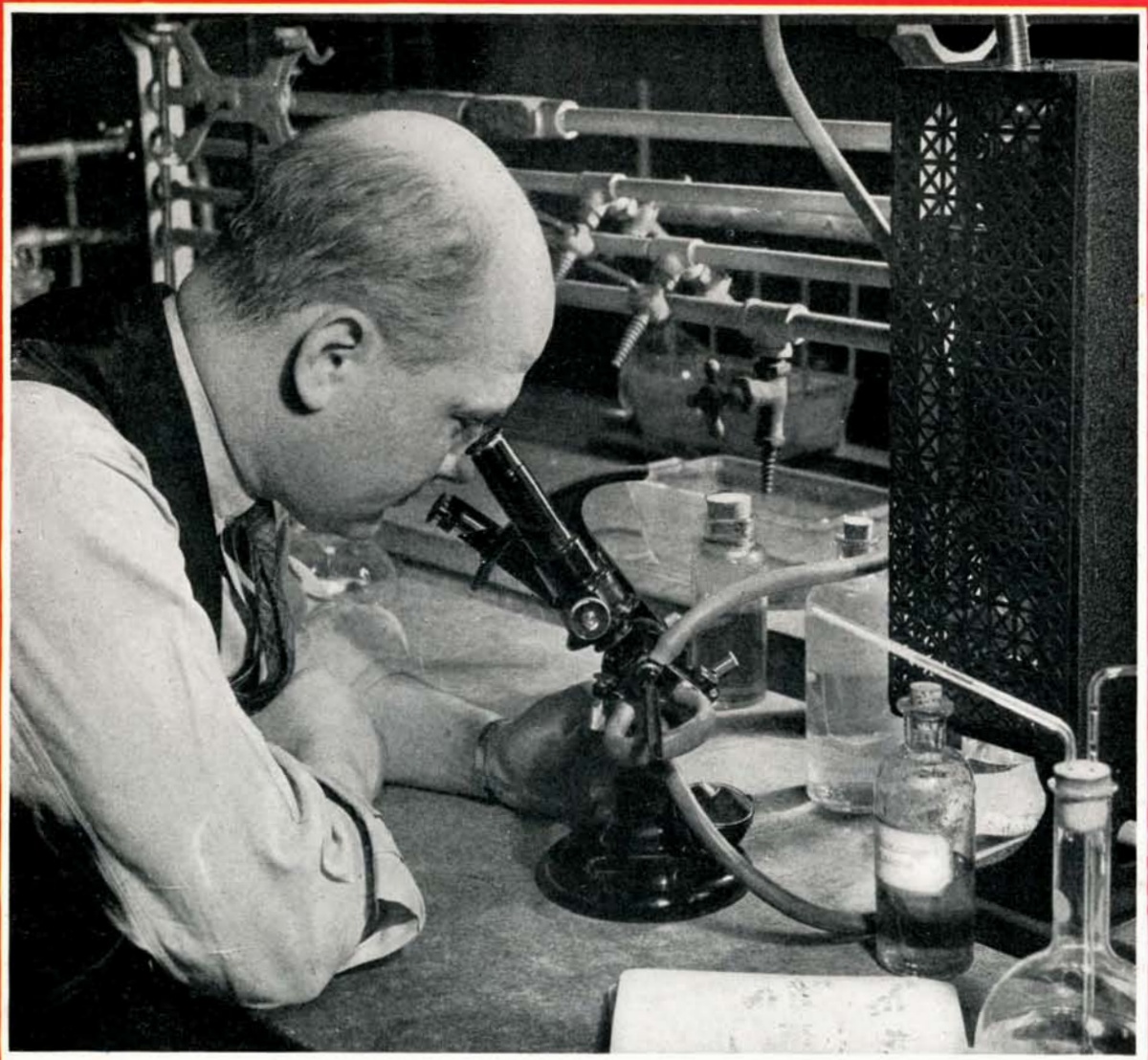
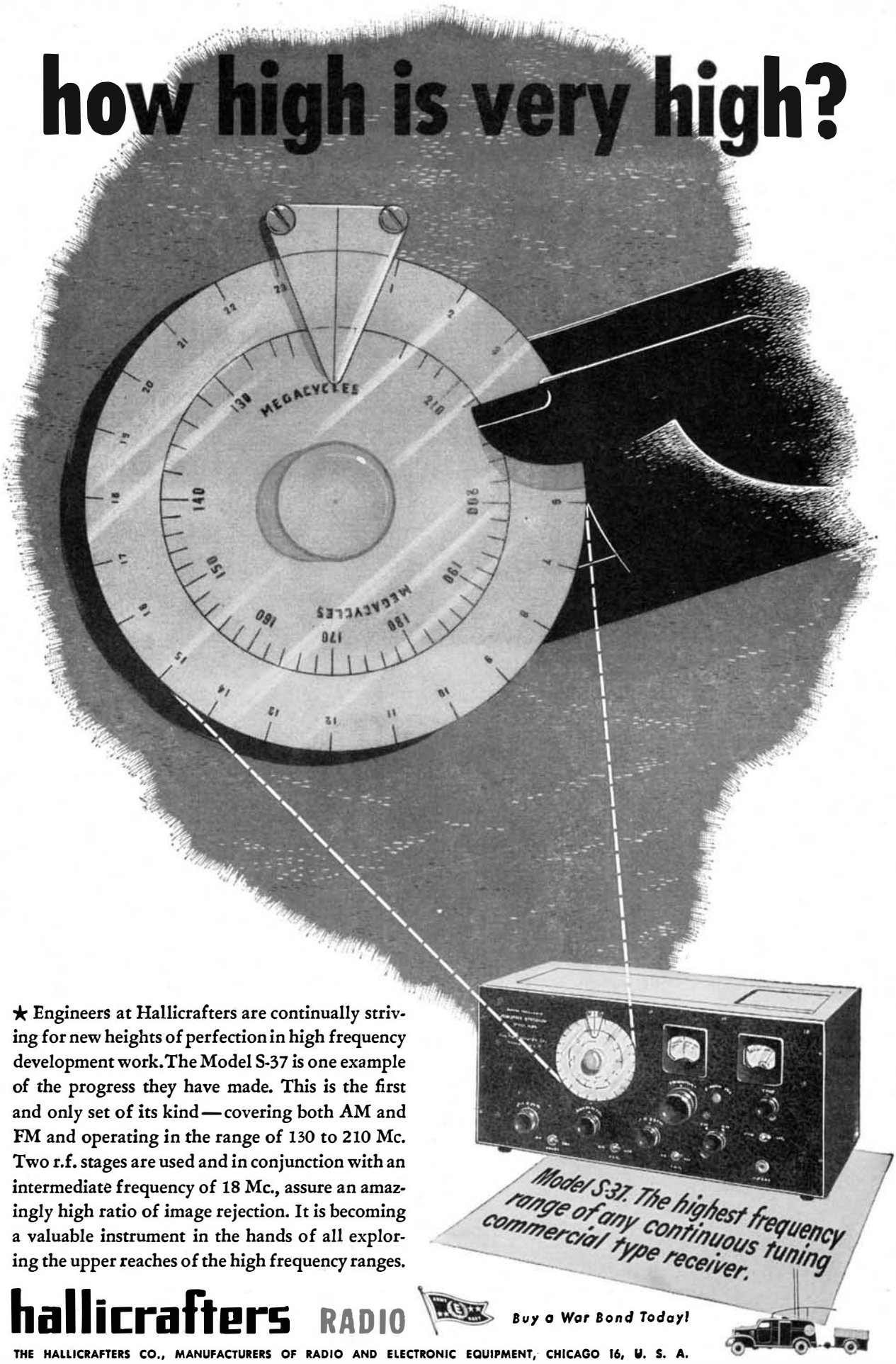


Process Control With Light . . . See page 257

The Story of CHEMISTRY IN INDUSTRY

Anniversary Issue
No. 5

how high is very high?



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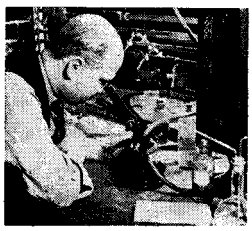

Our Cover: The phenomenon of light refraction was first noticed about 1800 years ago. Today the refractometer (a Bausch and Lomb type is illustrated) has become a production tool of the industrial chemist. With it, accurate check is kept on processes ranging from high-octane gasoline and synthetic rubber to preserved foods.

SCIENTIFIC AMERICAN, May, 1945. Vol. 172, No. 5. Owned and published by Munn & Co., Inc., Orson D. Munn, President; I. Sheldon Tilney, Vice-President; John P. Davis, Secretary-Treasurer; A. P. Peck, Assistant Secretary; all at 24 West 40th Street, New York 18, N. Y. Entered at the New York, New York, Post Office as second-class matter June 28, 1879, under act of March 3, 1879. Additional entry at Orange, Connecticut. Published monthly by Munn & Co., Inc., 24 West 40th Street, New York 18, N. Y.

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Previews of the Industrial Horizon

By A. P. Peck

LABOR DRAFT TROUBLES

FROM England come lusty wails about the labor draft; clear and positive proof that there is no fear of any such thing surviving the war and that the United States would be better off to stick to the volunteer system.

The British law applies to all males and females from 18 to 51 years old. One hundred percent of the available males, 86 percent of the unmarried females, and 30 percent of the married women have been inducted into war work of some kind or have voluntarily "joined up."

England believes that she could not have kept up her war work without labor conscription. But she takes the law as she might swallow some strong and toxic sulfa drug, willing to endure the shivers and headaches in order to fend off something worse.

Main kick of the worker is that there is no uniform wage scale, and there cannot be unless the nation is to be completely socialized. Cases of workers being drafted into higher paid jobs are exceedingly rare since the high-wage industries attract plenty of volunteers. But cases of highly paid machinists being shipped back to the mines, textile mills, and other poverty-pay spots are frequent. Every man gets the pay which is normal for the job he is given. Superior ability means nothing and opportunity for self-improvement is curtailed.

British management has two problems under the labor draft. First, once a worker is assigned to a factory, that plant must pay him whether it has any work for him to do or not. Contract cut-backs, changes in processes and methods, none of the normal reasons for firing a man or of replacing a worker of one skill with a worker of another via the open labor market can be used until the draft board has taken its slow and ponderous action. Without this provision, of course, a man could be drafted to a plant only to be fired the next week, thus practically being drafted into unemployment. Second management agony is that labor is taking this opportunity to press for the annual guaranteed wage. Thus if the war should end suddenly, management might find itself saddled with workers which it had kept in idleness for several weeks and would have to keep for months after its own income had been shut off. The burden on reconversion costs would be unbearable.—*E.L.C.*

JACK-OF-ALL-TRADES

GLYCERINE—glycerol, as the chemists call it—is a chemical jack-of-all-trades if there ever was one. It has been used widely in medicine and industrially as a moisture-absorbing agent, as a solvent, as a lubricant, as an anti-freeze, as a blending agent, and so on. Most important of the chemical combinations entered by glycerine are the alkyd resins, indispensable in modern synthetic coating, ester gums, and nitroglycerine. But the end is not yet in sight.

The alkyd resins have given new impetus to quick-drying finishes and in the offing are water- and ice-repelling coatings, together with fabric and yarn treatments that will provide properties of heat, acid, and alkali resistance. In England, it is reported, rayon fabrics have been treated with these resins to provide a substitute for oiled silk, an essential in wound dressings.

Looking a little farther into the applications of this versatile chemical, it is found that glycerine alkyds are being used increasingly in the art of printing and dyeing of textiles and that photography has welcomed them with open arms as ingredients in color films and the new "self-developable" photographic emulsions.

The facets of glycerine seem almost innumerable. It keeps cellophane from becoming brittle and is used in manufacturing protective clothing for workers which is not affected by acids or petroleum solvents and that will guard the wearer against certain toxic gases. It is an important ingredient in materials used in electro-polishing methods and, by the ton, it enters the manufacture of many base flavors for food products, including soft drinks.

ENGINEERS AND SALES

A SALES-MANAGER who takes a realistic view of the future of America is James H. Rasmussen of The Crosley Corporation. Taking note of present incomes of war workers and the reductions in take-home pay that will come inevitably with war end, he recently gave the nod to engineers by saying that in the immediate future "our engineers will have the task of improving sharply the products which we have come to accept as necessary to our way of living. It has been said that the highest need for the future is a high degree of obsolescence for consumer goods. . . That means 'progressive obsolescence.' Products must be improved to the point where it becomes economically sound for Mr. and Mrs. America to buy the new model.

"We must sell our corporations the idea that the road ahead may be rough," he said. "We must caution them against the over-optimism that pervades our press and trade reports. . . We must sell the necessity for carrying through product improvement and new product development."

PRIME MOVERS TOMORROW

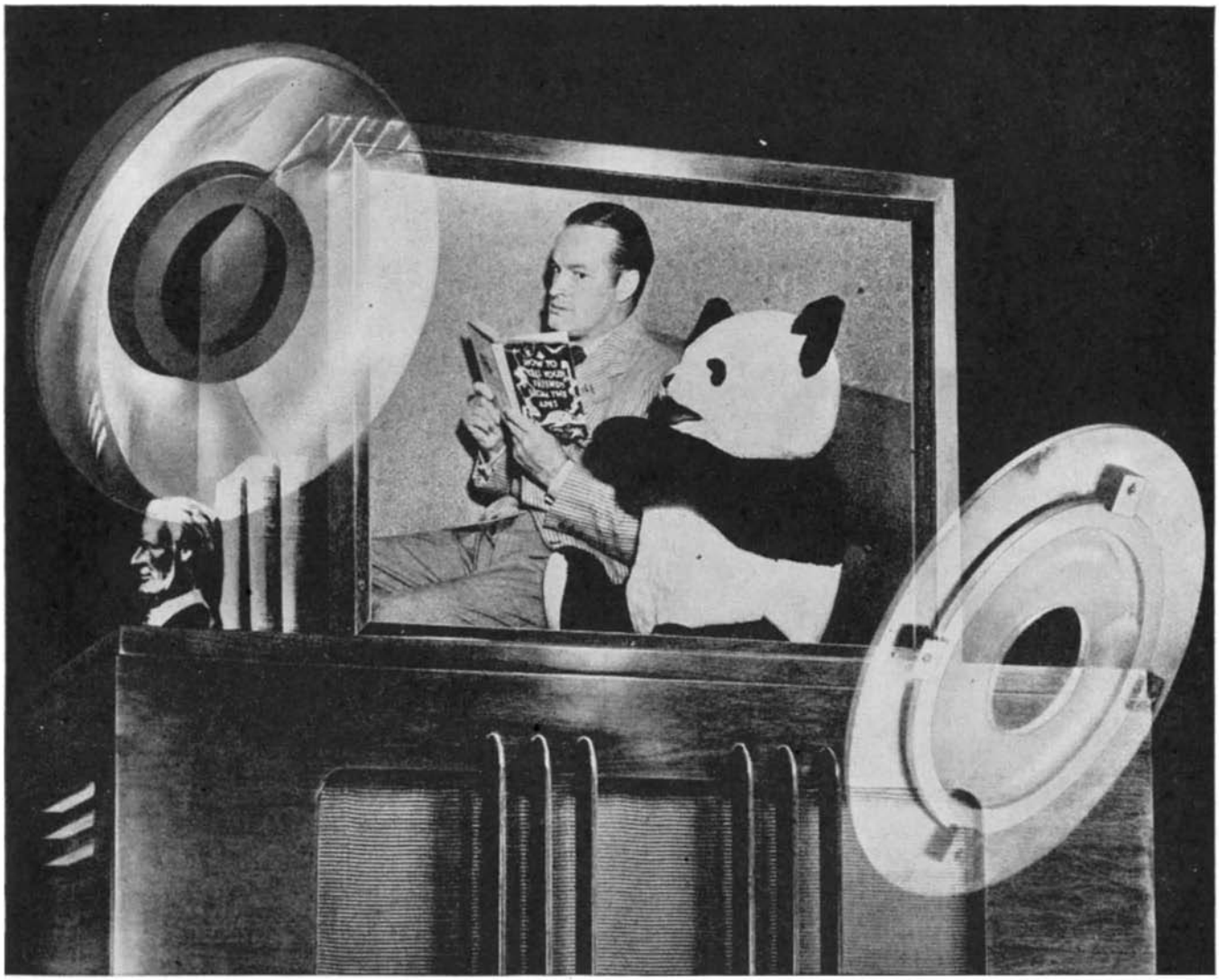
SUPERCHARGERS on bus and truck engines giving 20 percent more power per cubic inch of combustion space, improved fuels and higher compression ratios that will add another 10 to 15 percent to efficiency, automatic timing change mechanisms that will give top efficiency at all engine speeds, bearings that will withstand greatly increased pressures, and new spark-plug electrode materials that will have ten times the life of existing points are some of the developments on the horizon envisioned by forward-looking but hard-headed engineers today.

FUEL POSSIBILITIES

THAT the railroads are not satisfied with locomotive fuels today is shown by the recent start of a million-dollar research project that is aimed toward increasing the efficiency of steam locomotives, strengthening their position in competition with Diesel locomotives, and assuring a continued market for bituminous coal. The important aspect of the program is the fact that a combination of interests can achieve a far greater measure of success than can one industry alone.

FOR FUTURE REFERENCE

EVEN greater accuracy is on the horizon for machine tools. . . Magnesium is rated as a versatile material for development by small industries where weight is important. . . Air conditioning, proved pre-war as a merchandising plus in retail establishments, will assume even greater importance in the future. . . Hand-made glass-ware, long imported in the better grades, can retain its American identity gained during the war only through a strenuous effort to sell the "American style."



RCA Laboratories model with an 18 by 24-inch screen showing how Bob Hope may appear on future home television.

New Projection Television - Bob Hope's face "big as life"

Can you picture Bob Hope on television . . . seeing his face *big as life*—right in your own living room?

Well, you will—for now, thanks to RCA research, all limitations on the size of home television screens have been removed.

RCA Projection Television sets can have 18 by 24-inch pictures, or for that matter, pictures as large as the screen in a "movie" theater!

When you tune in an NBC television broadcast you'll almost think the actors are in the same room with you—and trust NBC, America's No. 1 network in sound broadcasting, to bring you the best in television entertainment.

This revolutionary improvement was achieved in RCA Laboratories by development of an entirely new reflector and lens, shown in phantom above. This lens, of inexpensive plastic, is 8 times as efficient for the purpose as the finest optical lens.

When you buy an RCA radio, phonograph or television receiver—or any other RCA product—you receive the benefit of the latest research development of RCA Laboratories. It is this *plus value* which is your assurance of lasting satisfaction.

The widespread public recognition of this plus value has given to RCA world leadership in the radio, phonograph, television and electronic art.

Dr. D. W. Epstein with a projection television tube, reflector and lens unit. Here the image on the end of the tube hits the reflector, is corrected by the lens, projected to the screen, then enlarged . . . making possible larger and clearer television than ever before.

RADIO CORPORATION of AMERICA

PIONEERS IN PROGRESS

RCA

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of May, 1895)

ALUMINUM BOAT — "The Messrs. Yarrow, of London, have been commissioned to build a small torpedo boat of aluminum, with a view to making a craft that should be very light, and thus be adapted to storage on the deck of a battle ship. The builders adopted an alloy of aluminum and 6 per cent of copper."

PERPETUAL MOTION — "It is but a few years since the mistaken doctrine of the conservation of force was definitely abandoned for the true doctrine of the conservation of energy. Such abandonment indicated a very recent understanding of the true relations of force and energy, for the erroneous expression conservation of force is hardly yet extinct. The many attempts at the production of perpetual motion indicate a want of appreciation of the fundamental bases of science."

JAP COPYISTS — "The war between China and Japan has shown that the Japanese readily turn to account any advantage offered by scientific appliances. Their seizure of the telegraph lines in Corea strengthened their position at once, and any breaks were quickly repaired by men who had been trained in actual construction as well as the manipulation of the instruments. The Japanese are facile copyists."

GASOLINE ENGINES — "The gasoline gas engine, both from a theoretical and practical standpoint, is the most efficient of prime movers. . . This is particularly true of the 'Union' and 'Pacific' engines, built by the Globe Gas Engine Company, for the reason that in their engines the hot gases of the exhaust, usually wasted, are used to heat the air drawn through the vaporizer and into the cylinder. As heat is the essence of the power, the smaller the amount that is wasted, the greater the economy."

ALABASTER — "The alabaster industry dates back to classic times. . . Nowadays, three men, usually relatives, work together in informal partnership, one being a turner, another a modeler, and the third a decorator, who carves such decorative adjuncts on the finished articles as fruit and flowers."

PAVING — "An improved paving consists of concrete made of small lumps of emery stone set in Portland cement. The emery may be in pieces varying from half an inch in diameter down to a powder, and is mixed with Portland cement in the proportion of three parts of emery to two of cement."

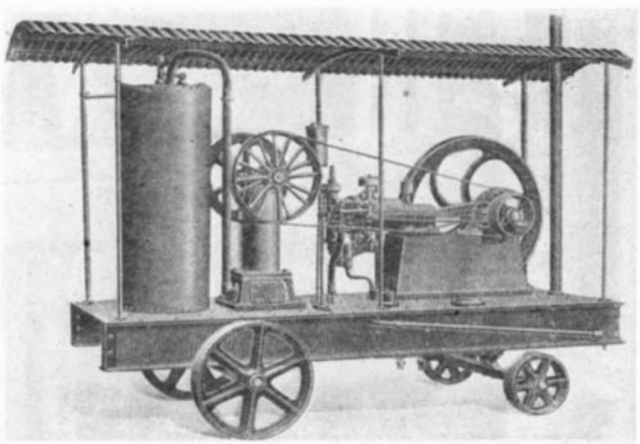
FIRE — "An investigation into the cause of a fire in a dry goods store resulted in demonstrating that an incandescent electric lamp will generate sufficient heat to set flammable material into a blaze. The fire was caused by allowing an incandescent lamp to remain for a few moments on a pile of cotton cloth in the packing room."

HEAT — "Electric heating is now coming to the front, and for certain cases has become a possibility, because of the low economy which seems necessarily inherent in existing domestic processes. It has to compete with heat most wastefully applied; otherwise it would be out of the question except as a matter of luxury. But when to the low economy of the kitchen fire, which is its competitor, there is added its own extreme convenience and cleanliness, it will be seen that a very good case is made out for the employment of the electric current."

SAFES — "The latest burglar proof safes and vaults are magnificent specimens of skillful workmanship. . . The plates are put together, first one of hard steel, then one of wrought iron or soft steel, and so on until the necessary thickness is obtained. From the iron the safe receives its tenacious qualities—it cannot be cracked or broken as easily as steel—and the steel imparts a hardness that defies the burglar's drill."

NIAGARA POWER — "The company which has undertaken to develop electricity, at Niagara, on a large scale, for manufacturing and other purposes, has acquired more real estate there than it needs for its own use, in order to furnish sites to such of its customers as wish to establish their business close to the source of their power supply."

SAND BLASTING — "The uses of the sand blast for ornamenting glass, metals, stone, and other materials is well known. A new application of the process for cleaning down the walls of buildings has been introduced in England. . . It has been used for cleaning the fronts of large public buildings, hotels, etc. Upon a truck is mounted an oil engine which drives



an air compressor which fills an air reservoir to the desired degree of pressure. A flexible pipe conducts the air to the point desired, and blows the sand as required. Building fronts are thus cleaned in a very expeditious manner."

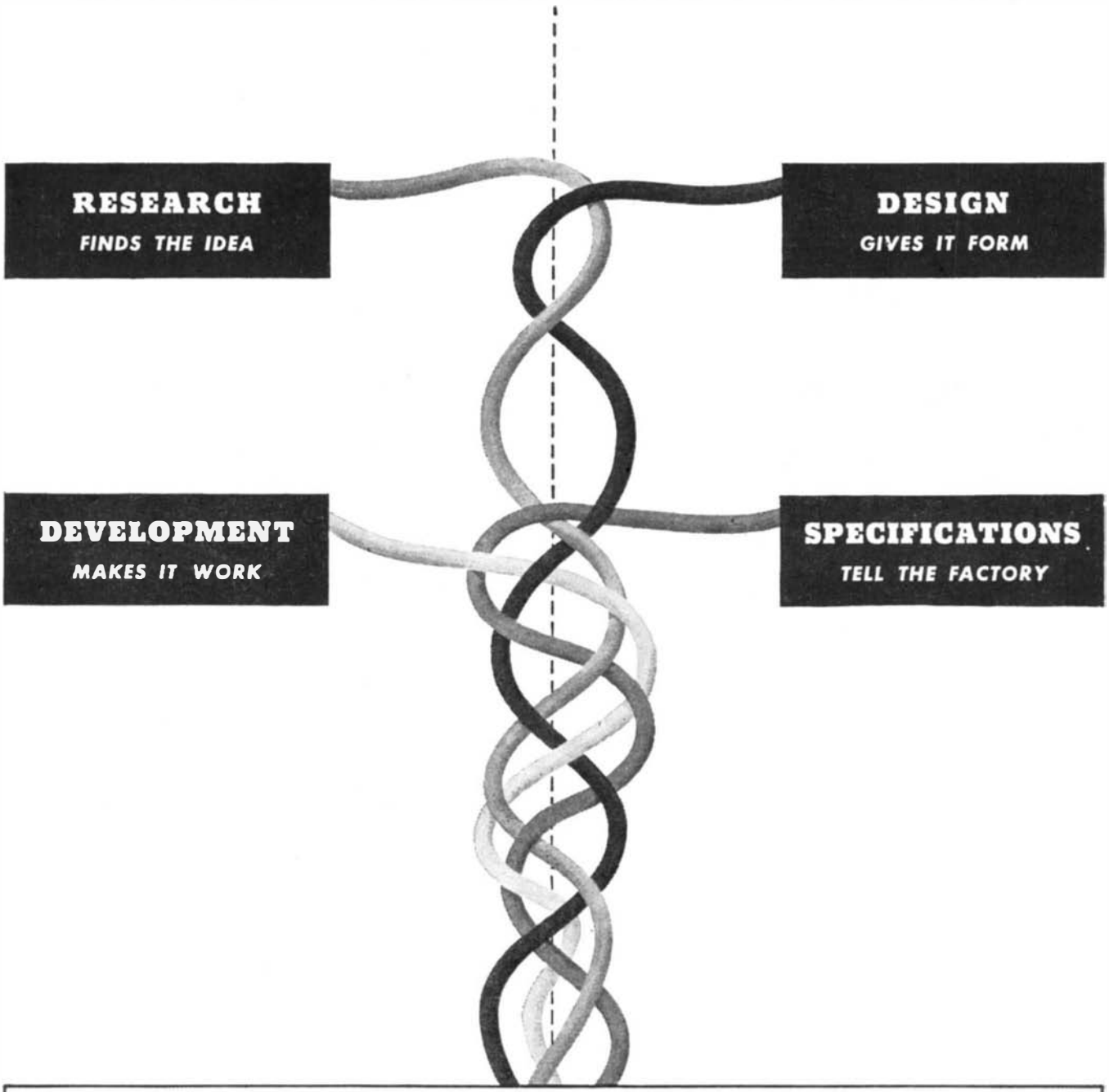
STEAM CAR — "In the competition of automobile carriages held in Paris. . . the steam carriage of M. Scotte, of Epernay, obtained a prize of 500 francs. In this vehicle, which is adapted for eight persons, the boiler is of the vertical type of the Field system and registers 120 pounds to the square inch. The two cylinder motor makes about 300 to 500 revolutions per minute and develops 5 horse power. The power is transmitted to the (rear) driving wheels through an endless chain and a differential gearing. The carriage is 15 feet in length, 6 in width, and weighs, when empty, 3,700 pounds. With 660 pounds of water, 440 pounds of coal, seven passengers and the driver the total weight reaches 5,940 pounds. Consumption of water is from three to four gallons a mile on a level stretch. . . Consumption of coal varies from six to ten pounds, according to the road and the speed."

BARRELS — "It may be economy to use old oil barrels for other purposes, but great care must be taken to clean them carefully, or an explosion may occur which will cause more damage than new barrels would cost."

TOOTHPICKS — "Insignificant articles like the toothpick represent the investment of millions of capital, the employment of skilled labor, utilization of the latest inventions, the consumption of vast quantities of wood, and the operation of a long line of complex activities."

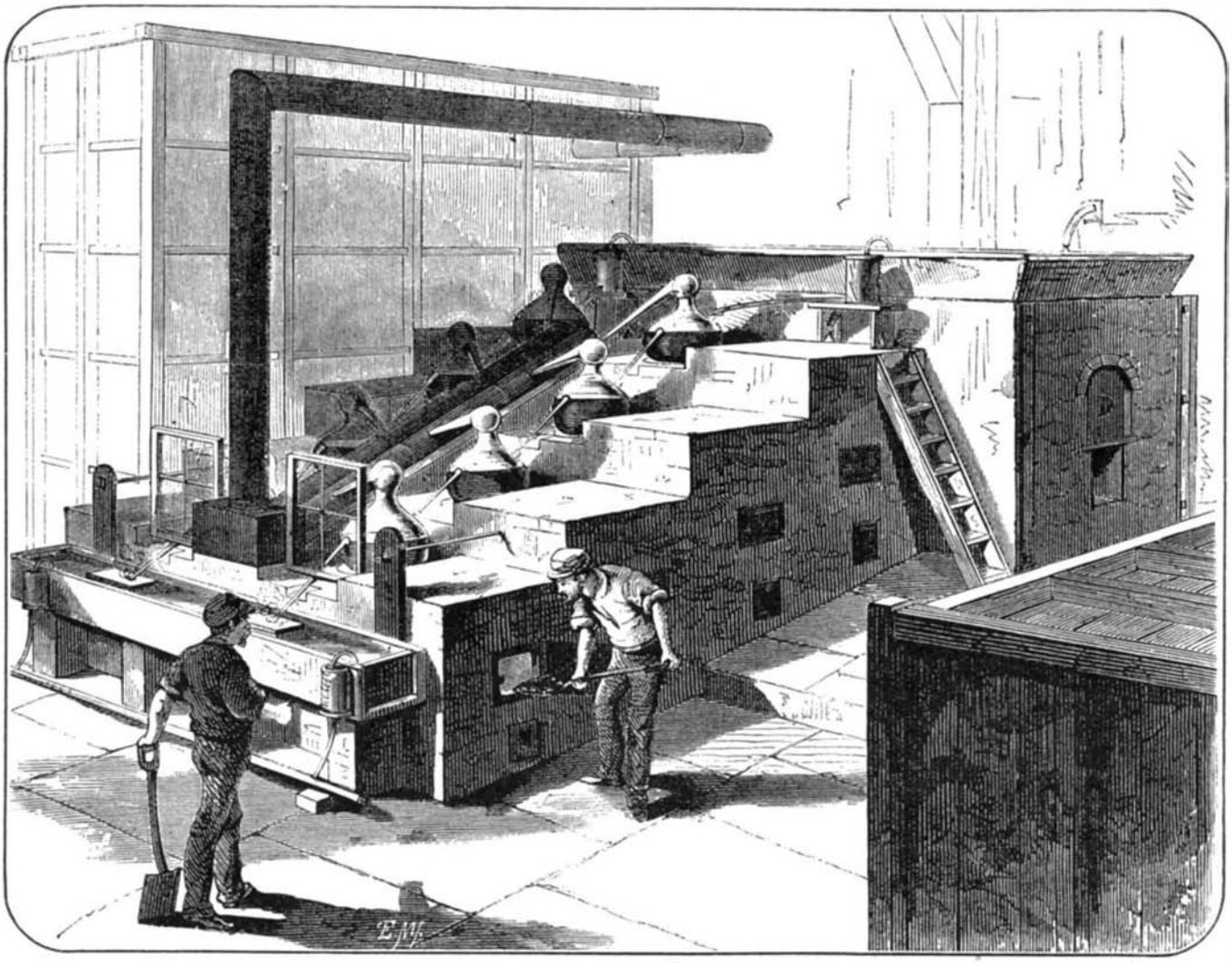
INCENTIVE — "The United States has been prolific of men who, without any advantages, worked their way to the front, and encountering obstacle after obstacle, only grew stronger with opposition. The annals of invention are full of veritable romances of the type indicated. . . Under milder conditions the strong might lack the very incentives supplied by the passive resistance of circumstance."

WEAVING COMMUNICATION HIGHWAYS



BELL TELEPHONE LABORATORIES

brings together the efforts of 2000 specialists in telephone and radio communication. Their wartime work has produced more than 1000 projects for the Armed Forces, ranging from carrier telephone systems, packaged for the battle-front, to the electrical gun director which helped shoot down robots above the White Cliffs of Dover. In normal times, Bell Laboratories' work in the Bell System is to insure continuous improvement and economies in telephone service.



Above: Old woodcut of chamber process for producing sulphuric acid in 1855.
Below: Sketch of a small corner of a 1945 chemical processing plant. This one happens to make penicillin.

This was Chemistry in 1855

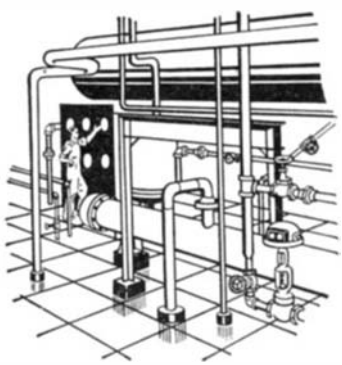
Chemistry was simple in 1855. Hydrocarbons were practically unknown. Fractionating petroleum consisted of boiling off the volatile elements to secure kerosene for lamps. Sulphuric acid was produced by the chamber process illustrated in this old woodcut.

But chemists saw new horizons in their test tubes and retorts. This dramatic research resulted in planned miracles. Whole new industries were born —thanks to the men in the laboratories.

And in the growth of chemistry as in practically every other industrial development that you can think of, piping played an important part. 1945 marks Crane's 90th Anniversary. And since this company was founded it has kept step with this growth, furnishing pipe, valves and fittings to meet the increasing demands of an industrial era as those demands arose.

Year by year, industry changes. New processes obsolete old ones. Huge plants rise, tribute to new developments. A whole era is born through the inventive mind of a scientist. But with all this change, one fact remains constant —it takes piping to make it possible. And supplying the pipe, valves and fittings that industry requires is Crane's job today—as it has been since the company was founded.

CRANE CO. General Offices:
836 S. Michigan Ave., Chicago 5, Ill.



As chemical processes increased in complexity, new demands were made on piping. The Crane line expanded to include specialized piping to meet the requirements of the chemical industry.

CRANE

90 YEARS OF PROGRESS 1855 1945

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

BRANCHES AND WHOLESALERS SERVING ALL INDUSTRIAL AREAS

Scientific American
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* 100th Anniversary Year *

Interior of one of the early Du Pont laboratories, established around 1880 for explosives research

A Century of Chemistry

Although Chemical Manufacture in the United States Was Carried on by the Earliest Settlers, the Real Beginnings of the Chemical Industry in America Must be Placed in About the Middle of the 19th Century

By D. H. KILLEFFER

A THREE-FOLD partnership and interdependence exists between the science of chemistry, the chemical industry, and industry in general. None of these is complete without the others and all prosper or all wane together. The century of American industrial history covered by the life of Scientific American includes all but the early and rudimentary parts of the histories of each of these three vital elements in America.

In the early days of 1845 chemical industry was a magnified version of the laboratories of scientists. The distinction of science from industry in this field was almost indiscernable. The demands of American industry of that day could be readily met with laboratory output. Management, production, sales, and research were the combined responsibilities of a single person in each company. None of the great industries which subsequently were to demand huge quantities of chemicals had yet reached beyond the most rudimentary stages. Many of them had not yet been conceived. And because chemical manufacture has always converted raw materials for use in other industries, its growth in a modern sense had not yet properly begun. The products of its plants were only those things which could not be conveniently imported from abroad, notably sulfuric acid, potash recovered from plentiful wood ashes, a few paint pigments, natural dyes extracted from barks, woods, and berries, and a few other strictly chemical products.

The pace of life and industry in 1845 and earlier was such that we can reasonably connect the chemistry of that time with beginnings. By modern standards the science of chemistry began with Lavoisier, a Frenchman who lost his life in the French Revolution a bare half century before our story begins. And another Frenchman, Nicholas Leblanc, had in 1791 created what is now considered to be the definite beginning of the modern chemical industry, the Leblanc soda process.

It is of course true that a vast deal of chemistry of a sort had been practiced long before Lavoisier's time; but Lavosier, by introducing weighing into his experiments, converted the quasi-magic of earlier chemical experimentation into the modern exact science. Similarly, many chemical processes had been practiced centuries before Leblanc devised his process for converting salt, which was plentiful, into soda, which the French of his day badly needed. But the fact of Leblanc's deliberate intent to devise a process to transform by chemical means a cheap raw material into an expensive product differentiates modern chemical industry from all that went before.

Both of these pioneers had earnest and eager followers in the America of 1845. True, the number of these followers and the extent of their activities were rather severely circumscribed by the fact that American industry was only

beginning its later immense expansion. The transfer of the traditional household arts into the factory and the creation of new industries to utilize and elaborate American natural resources into a thousand useful products can scarcely be said to have begun by 1845.

DIFFERENT VIEWS — In all of this history, one must always bear in mind that there are three quite different ways of looking at American chemical industry. One school of thought sees chemical industry in any practice of any chemical process and discerns its beginnings in pre-historic times. That would make American chemical industry practically co-existent with European settlements on this continent. The colonists at Jamestown, Virginia, included products (tar and potash) within that definition in their first exports made before the landing of the Pilgrims; and John Winthrop, the Younger, actually initiated chemical manufacture of a type in New England as early as 1635.

A second point of view is based on a conception of chemical industry typified by Leblanc's indubitably chemical-economic invention: chemically converting one material into another at a price and a profit. If we narrow our definition to fit that conception, then the beginnings of American chemical industry must be dated from sometime about the period of 1845. The development of an American industrial consciousness behind a wall of protective tariff had progressed by that date to a point where a number of chemical enterprises had already begun to assume forms not unrecognizably different from those of today. Thus one can reasonably date American chemical industry from some rather indefinite years—since there appears no outstanding event from which to date a clear-cut beginning—about a century ago.

A third point of view would date the ultra-modern period of chemical industry in the United States from World War I. The very substantial and active chemical industry then in the United States was deeply overshadowed by those parts of it which were virtually, if not totally, lacking; notably the synthetic organic division of the industry producing dyes, many vital pharmaceutical chemicals, synthetic odors and flavors, and some of the chemicals essential in photography. This deficiency possessed a certain economic justification stemming from the fact that in chemical manufacture, as in other industries, cost goes down as quantity of production increases. The Germans, who had early seized the initiative in the field, consequently were able to produce the world's needs in organic chemicals at cheaper unit prices than any other single nation could produce its own.

By the beginning of World War I, chemical industry had progressed far from the weak beginnings of 1845 but its character had not essentially changed. Management and research were still often the same persons. Small companies had grown, some of them—but very few—even approached greatness. Yet none of them had reached the stage of attracting outsiders. Organizations of many kinds had knit the industry and the profession of chemistry into a coherent brotherhood that looked with something akin to disdain on other less enlightened industries. Many chemical commodities were made abroad in quantities and imported at

The first Du Pont chemical laboratory, where research was carried out on improved methods of refining salt-peter, was located on the Brandywine

prices far below production costs here. This left great gaps in the sufficiency of the industry to be revealed by World War I and its accompanying embargoes.

Those gaps in the completeness of our chemical production provided a stinging goad to development. Whatever may have been the other benefits of that war, and they were very small as events have proved, its stimulus to American initiative was the most valuable. Under the necessity of catching up with the rest of the world, Americans set earnestly to work and the habit of research was firmly planted in the minds of our industrialists. Its fruition during the inter-war period has been abundant.

MILEPOSTS OF PROGRESS—To select any particular event in the history of chemical industry as originating within it and as afterward affecting the outside world is extremely difficult. Similarly, it is difficult to choose an event brought about within chemical industry entirely by external forces demanding solution of a particular problem. Here, as in other fields of endeavor, the processes of development are revolutionary and interdependent and flow through time as a continuing current. Hence, any historical scheme must emphasize the effects of chemistry and chemical industry on others, and then reverse the process and examine the effects of wholly external causes on the chemical industry's progress. Here are a few:

Solvay Soda Process—We have mentioned the Leblanc process of manufacturing soda from salt as the earliest clear-cut case of purposeful and planned chemical manufacture. It was an effective process and had consequences, as the chemical habit is, far beyond expectations. While Leblanc's process, using large amounts of sulfuric acid, produced the desired soda, it yielded at the same time large quantities of highly objectionable hydrochloric acid gas and solid calcium sulfide. Both of these wastes possess

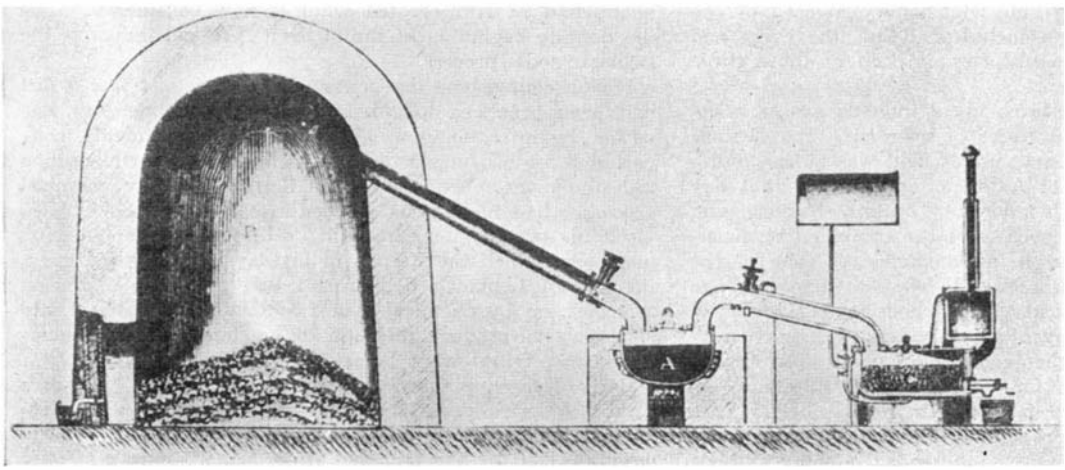


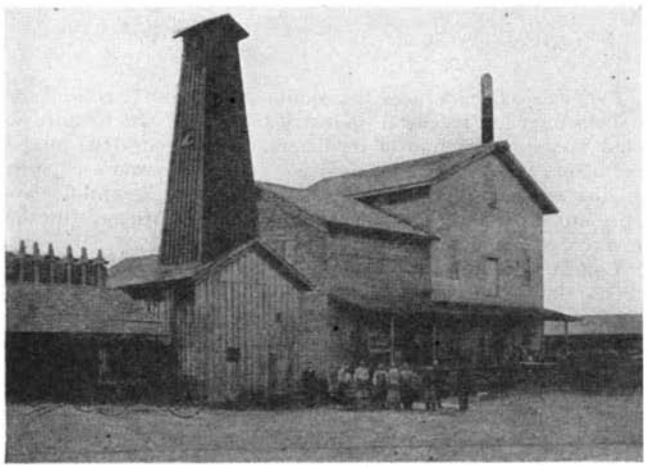
Diagram of a sulfur refinery of the middle 1800's, in which distilled sulfur was delivered to the water-cooled vessel at the right. This type of sulfur was preferred for the manufacture of gunpowder

a certain value to an integrated group of other chemical operations. But without such related processes the problems of disposal were serious handicaps to Leblanc soda plants. Conversely, once the integrated chemical structure was established, the complete utilization of all products put the Leblanc soda plants in enviable competitive positions against any influence from the outside that would upset them.

This situation was early established by the British who seized upon the Leblanc process before it could be fully established in France, and adopted it as their own. It gave the British a strong hold upon the world's alkali business which they maintained over a long period of time and which led to a certain disdainful complacency toward a new and promising soda process developed by the Belgian, Ernest Solvay, in 1863.

Solvay's process, which avoids much of the complexity of the elder Leblanc process, consumes salt and limestone —plus water and fuel—and produces only the desired soda and a by-product of calcium chloride, which is far less objectionable than hydrochloric acid or calcium sulfide.

The refusal of British chemical manufacturers to upset the delicate equilibrium of their enterprises to use the new process sent its promoters to the United States. Here it was eagerly adopted as a means of rendering American industry independent of British alkali, which had previously supplied demands here at prices discouraging the heavy investment necessary to establish the Leblanc process on this



The brine well utilized by Dr. Herbert H. Dow in his early work (about 1890) on extraction of bromine

side of the ocean. In spite of its alien origin, the Solvay process can be said to have become thoroughly American through adoption. It is the principal dependence of the United States for soda alkalies and it supplies all these essential products except for caustic made by the electrolytic process.

Sulfuric Acid—No chemical compound or product of chemical industry approaches sulfuric acid in importance. It is universally required in chemical operations of all kinds, the *sine qua non* of the industry for its own use as well as the largest single product in its output to other industries.

In the United States the two ruling demands for sulfuric acid came from the fertilizer industry and from the petroleum refineries. German chemical industry, developed primarily around the production of synthetic dyes and related compounds from coal tar, early demanded sulfuric acid of a high strength beyond that economically obtainable from the chamber acid process and consequently the contact acid process found ready acceptance in Germany where it was developed to commercial practicability.

The lead chamber process of sulfuric acid manufacture was first developed in England before the time of the American Revolution. The principal characteristics of the process are: a chamber plant will continuously produce low-strength sulfuric acid—70 percent concentration or less—which must be concentrated and purified for many purposes; it can use impure by-product sulfur dioxide as a raw material without affecting the operation of the plant, and hence it is convenient to utilize smelter waste gases; and finally the plant requires a minimum of skilled labor once the process is in operation.

The expense of concentrating chamber acid fostered the development of what is known as the contact acid process. This process was developed in England in 1831 but was of limited usefulness until Frasch invented a method of mining the huge deposits of pure sulfur on the American Gulf Coast and made this raw material cheaply available.

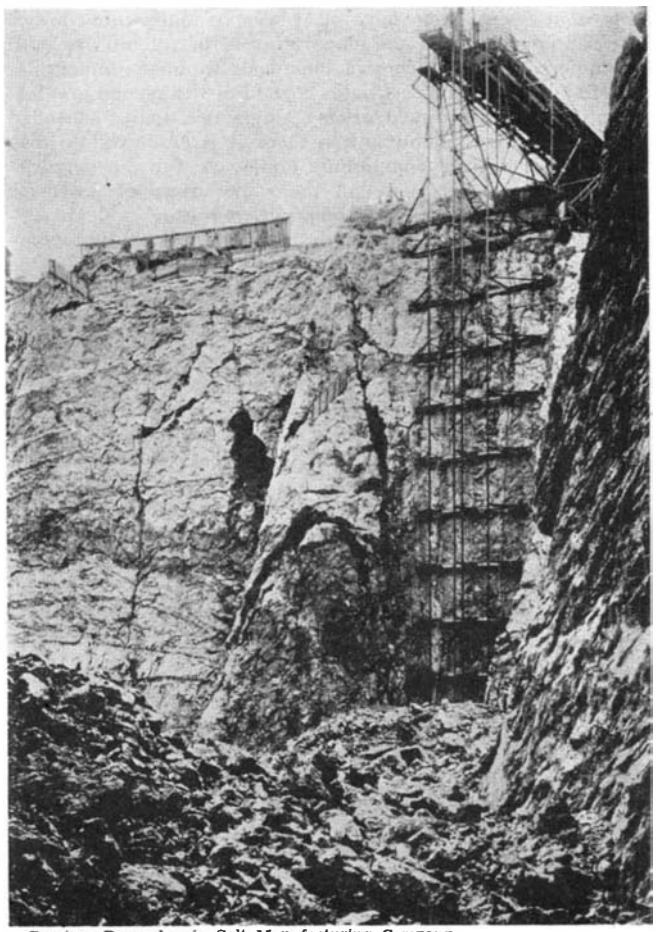
The contact process was introduced into this country shortly before 1900. Now more than half the United States' peace-time production of sulfuric acid comes from contact plants which have replaced older chamber plants and have made old-time acid concentration obsolete.

Frasch Sulfur Mining Process—It is difficult to overestimate the significance of the vast supply of sulfur of highest purity which the Frasch process made available at low cost to chemical industry. Sulfur deposits of enormous extent were long known to exist in deep-lying strata in the Gulf Coast area but overlying these were thick layers of quicksand which had proved an impenetrable barrier to ordinary mining methods.

Herman Frasch devised the method now employed to melt the sulfur underground and bring it to the surface in liquid form. The mine consists of concentric pipes down one of which superheated water (100 pounds gage pressure) is forced and up another of which flows the sulfur melted below ground in the original deposit. Compressed air is forced down a third pipe to act as an air lift and assist in pumping the water-sulfur mixture to the surface.

This process has yielded as much as 2.5 million tons of pure sulfur annually and has rendered other sources of sulfur practically obsolete. Exceptions, of course, are sources of by-product sulfur which must be recovered to prevent damage to the countryside, as at smelters. Here recovery of sulfur fumes, usually by conversion to sulfuric acid, is mandatory.

Petroleum Refining—Discovery of oil in a well drilled



Courtesy Pennsylvania Salt Manufacturing Company

A mine in Greenland from which comes cryolite used in making aluminum and in glass and ceramics

In the early days of Monsanto Chemical Company, mules furnished power for transportation of materials and products. Contrast this mule-and-wagon combination with modern, lightweight railroad cars especially designed for handling chemicals of all kinds in lots of thousands of pounds each, often under pressure and always with safety to the chemicals and the cars alike

for brine at Tarentum, Pennsylvania, in 1845 led to a thorough investigation by Benjamin Silliman, Jr., of Yale University, into the properties of "rock oil"—petroleum. From that chemical investigation of oil and the products of its distillation dates the oil industry. In 1859 Colonel Drake's famous oil well was completed, the first deliberately drilled to obtain oil, and the industry was on its way. That was an important event chemically as it was in many other ways. The refining and later the elaboration of petroleum are both consumers and producers of chemicals in huge tonnages.

Refining petroleum distillates consumes the second greatest quantity of sulfuric acid of any single use, being exceeded only by fertilizer manufacture. Here it is employed to dissolve out undesired compounds and leave the pure hydrocarbons. Other treatments of the same group of processes consume caustic soda and soda ash and lead oxide in removing objectionable impurities, particularly sulfur compounds. Solvent refining of lubricants utilizes the selective solvent power of such compounds as furfural to effect other separations difficult or impossible by distillation.

Development of the cracking process by Burton in 1913 created a new and strong link between the petroleum and the chemical industries. Cracking in essence consists in breaking the large molecules present in petroleum into smaller ones by the application of heat and pressure.

Built upon the original cracking processes are modern reforming processes which control catalytically the recombination of the molecular fragments produced in the cracking zone and, what may be even more vital in the long run—as it is now in war—the conversion of petroleum hydrocarbons into benzene, toluene, and other compounds previously obtainable only from coal. These are essential to military explosives and synthetic rubber.

Production of high octane aviation gasoline, essential today and likely to have revolutionary consequences in future transport by air and highway, similarly knits chemical industry closer to petroleum. The discovery in 1922 by Midgley of the extraordinary effectiveness of tetraethyl lead in suppressing detonation in spark-ignited internal combustion engines marked the beginning of a new era of efficiency of these prime movers. This development has had important chemical consequences in the production of tetraethyl lead itself, in the chemical transformation of the various fuels derived directly from petroleum into more desirable forms, and in the recovery of bromine by new techniques from sea water to form a constituent of one of the necessary modifiers required with tetraethyl lead.

Fertilizer Production—Exceeding petroleum refining as a consumer of chemical industry's basic product, sulfuric acid, is the production of fertilizers. As early as 1855 mixed fertilizers based on the theories of the German chemist Liebig were produced in the United States. Essential constituents of a mixed fertilizer are potash, nitrogen (in the form of a compound), and phosphorus.

Potash salts generally are soluble in the soil solution that feeds plants and hence can be used in suitable dilution in mixed fertilizers. Usually, however, the potash salts preferred are the chloride and the sulfate, which can be prepared from any others available. Previous to World War I, American farmers were entirely dependent upon potash from German-controlled mines for this essential. Now, however, mines in New Mexico supplemented by potash salts recovered from the dry Searles Lakes in California and a few other sources, provide ample domestic supplies.

The cases of nitrogen and phosphorus differ in requiring chemical intervention of an important sort to make useful to plants the natural products in which these elements occur.

Compounds of nitrogen are distinctly scarce in nature but nitrogen itself, which is of itself quite useless as fertilizer, comprises four fifths of our atmosphere. During the

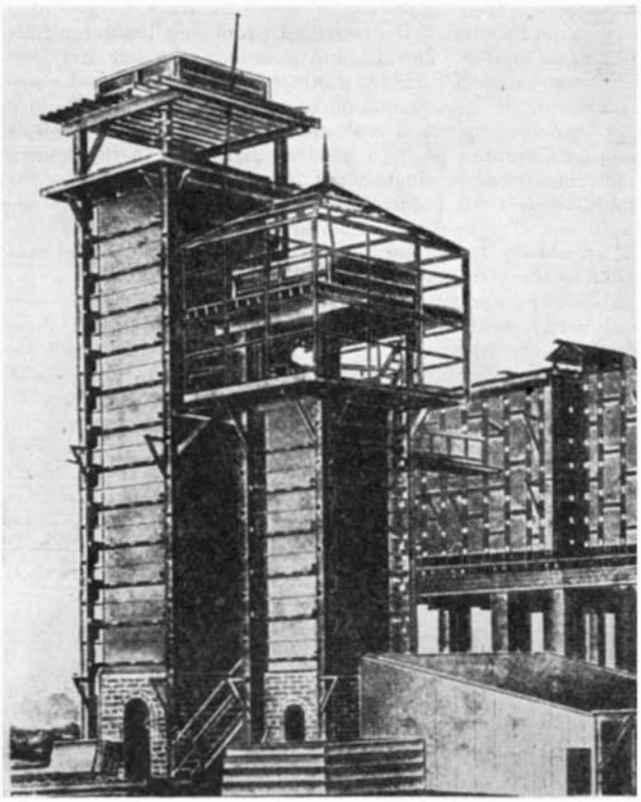
Courtesy Merck and Company

A chemical packaging "production line" of 1893

latter part of the 19th Century methods were devised and put into successful practice for utilizing atmospheric nitrogen, but their application was limited and it was not until the method of synthesis of ammonia was discovered in 1912 by the German, Fritz Haber, that the problem of nitrogen for fertilizer could be said to be solved. This process requires only minor amounts of power. The ammonia produced can be converted into any of a number of forms for application to the soil. Smaller, but still substantial, is the ammonia by-product of coke ovens and gas works used commonly as ammonium sulfate.

Phosphorus occurs abundantly in phosphate rock but this too is unsuitable for direct use as fertilizer. Treatment with sulfuric acid converts the ground raw rock into acid phosphate, the most simply prepared form of available phosphorus.

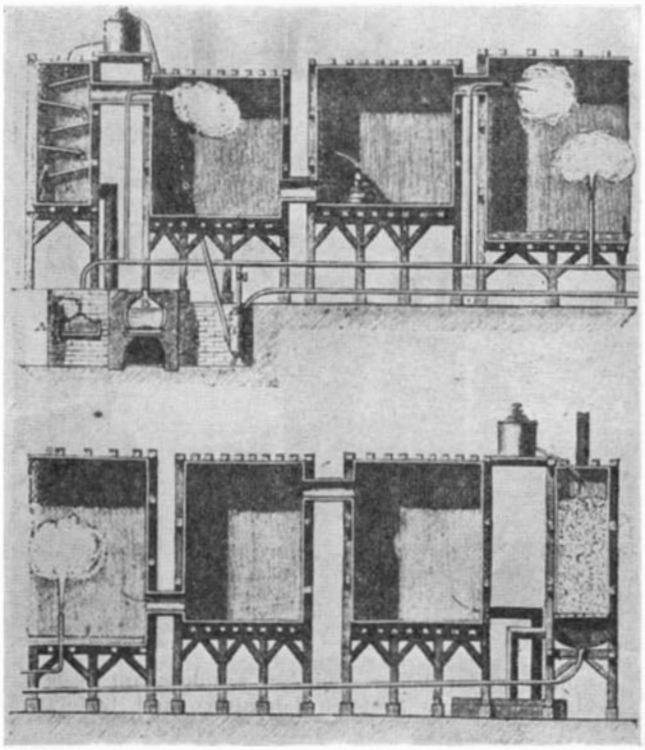
The subject of fertilizer suggests the many other products of chemical industry vital to agriculture. Insecticides and fungicides produced in volume and variety by chemical industry protects seeds, crops, and the harvested produce from destruction by pests. Similarly, veterinary medicines and other chemicals protect livestock. Latterly, certain substances found to have controlling effects on the growth and development of plants, the so-called plant hormones, promise new usefulness for chemical industry's products in agriculture.



One of the problems that beset the constructors of 19th Century sulfuric acid plants was that of erecting timber towers strong enough to carry the load

Photographic Chemicals—The photographic process, still new at the beginning of the century we are considering, was based on the chemical effect of light and has thus had important chemical consequences. The preparation of sensitive plates, films, and paper, as well as the processing of these, consumes huge quantities of the products of chemical industry. Furthermore, the discovery by Ives in 1893 of the half-tone process opened a new field for the graphic arts and at the same time created a new demand for chemicals.

Chemistry in Medicine—The introduction in the 1840's of anesthesia and the use of ether in surgery may properly be said to have opened a new era for both chemistry and medicine. The names of Long, Morton, Warrne, Wells, and Jackson figured largely in the controversies which raged over credit for this American discovery which revolutionized surgery quite as truly as antisepsis did later. Production of ether may be considered to be the first large-scale organic chemical synthesis of a substance to meet a defined need of medicine. Other medicinals previously made had been largely extractive or simply of mineral origin.



A sulfuric-acid chamber plant of the 1870's. The contact process later offered great competition

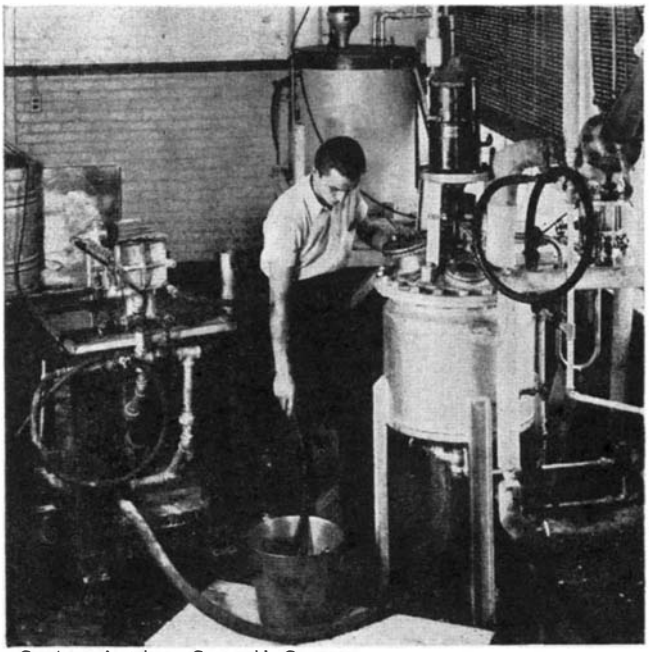
Subsequently an entire large section of American chemical industry has developed to supply the needs of medicine by production or purification of chemicals. Included today are the sulfa drugs, several of which were originated in this country, penicillin, anti-malarial drugs, a range of antiseptics, chemicals for producing various degrees of anesthesia and hypnosis, synthetic vitamins, and the broad requirements of chemical remedies and alleviators of suffering.

Plastics—The industry built upon Hyatt's Celluloid of 1869 and more definitely on Baekeland's phenol-formaldehyde resin of 1907 has reached such proportions and acquired such stature both as a consumer of chemicals and a producer of values as to justify separate treatment by Charles A. Breskin in the feature article next following.

Electricity and Chemicals—Morse's telegraph, Edison's electric light, Bell's telephone, and De Forest's vacuum tube have each required the chemical industry to supply certain essential materials needed for their full operation. The electric batteries of the early, as well as later, days are distinctly chemical products and have consistently required high purity chemicals in their construction. Insulation, as well as copper wire of the high purity essential to high conductivity, tungsten filaments in lamps, and chemicals needed to remove residual gases from electric lights and vacuum tubes are all products of chemical industry, as are the phosphors employed in modern fluorescent lights and the gases which glow in neon and similar gaseous discharge lights.

Chemical industry has built two of its important divisions on electric developments, the electrolytic chemical industry and its running mate, the electrothermal industry. The first produces primarily pure metals—copper, aluminum, magnesium, and manganese, particularly—caustic soda, caustic potash, and chlorine. The electrothermal division of chemical industry produces artificial graphite, silicon carbide, and boron carbide abrasives, many metals and their alloys, and calcium carbide.

Rubber Chemicals—Goodyear's discovery of the vulcanization of rubber in 1839 was fraught with great consequences for American chemical industry. A century later,



Courtesy American Cyanamid Company

Synthetic resins being made on a pilot-plant scale bridging the gap between laboratory and factory

rubber manufacture consumed huge quantities of a wide variety of specifically designed chemicals intended to improve and modify the properties of the finished product. Latest development is the synthesis of a number of valuable rubberlike synthetics to replace the natural product.

COMPANY GROWTH—A company may develop, spread, and grow from within outward; or it may draw other companies, possessing something of value to it, into amalgamations and mergers. Of the first type, the outstanding example in chemical industry is probably Dow Chemical, which thrives alone with a minimum of external alliances. Typical of the second kind of growth is the American Cyanamid Company, which has reached substantial size by the merging of a number of small companies.

One may clearly distinguish three *methods* of growth among chemical companies. A single raw material may be elaborated to a single group of closely related products and by-products. The alkali companies have grown this way from the processing of rock salt and the manufacture from it of the essential alkalies, soda ash, caustic soda, bicarbonate of soda, chlorine, bleach, dry ice, and lately even magnesium.

Although it has now grown far beyond the bounds of any such plan, the development of the Du Pont companies, largest in the chemical group, illustrates a second method of growth based on full utilization of a particular technique followed now in all of its potential ramifications. The explosives manufacture of Du Pont required the development of its own heavy acid production for converting cotton and wood pulp into the nitrocellulose of smokeless powder and for making dynamite and nitroglycerine from the glycerine by-product of soap making. The limits of explosives were too narrow for vigorous growth within the organization and step by logical step its energies have been given exercise in following up the leads to new lines developing out of explosives manufacture. Gradually this has led to lacquers, paints, varnishes, rayon, dyes, medicinal chemicals, dry cleaners' solvents, refrigerants, synthetic rubber, and the broadest of all chemical producing programs. In a sense this is similar to development based on raw material advantages but more essentially it follows the evolution of techniques.

Similarly, the original development of Monsanto was based on the expansion of the techniques of organic chemistry to yield diverse products from coal tar and at the same time production of needed raw materials. Lately the list has grown to include products made from petroleum, natural gas, and phosphate rock.

The third type of growth of chemical industry is based on a primary purpose to supply a particular group of needs. Merck, developed from a pharmaceutical beginning, exemplifies this in confining its manufactures to chemicals required by pharmacy and medicine and others closely related to this field. This leads to close attention to a particular group of needs and the technique of supplying them. Naturally this limiting of market objectives materially simplifies the problem of sales while complicating that of diverse production.

Illustrations of these types of development are difficult to find uncomplicated by other factors and influences. Thus the development of Union Carbide has partaken of all of these schemes from time to time. Its manufacture of calcium carbide in the electric furnace left but a short step to the Presto-Lite Company, large consumer of calcium carbide for the manufacture of acetylene. The slow death of acetylene lighting and the rise of oxy-acetylene welding encouraged the merging of Linde Air Products, producer of oxygen from liquid air. The electric furnace skill of the parent company naturally brought in National Carbon, maker of electric furnace carbon products. Already this technique had been employed in metallurgy of alloys by Carbide's Electro Metallurgical subsidiary. At the time Presto-Lite entered the merger, it had already been actively seeking other sources of acetylene to free it from Carbide's dominance. These efforts had not succeeded in reaching their objective but had unearthed promising leads for further development. The original plan was to make acetylene not from calcium carbide, product of coal, lime, and electricity, but by transformation of oil or natural gas. Failure to reach an economical and practicable method of circumventing Carbide's position was not fruitless. In the trying, numerous other products were found which could be profitably made from natural gas or oil even though acetylene could not. The result was the formation of Carbide's chemical subsidiary for exploiting this new field, now a vital element in the company.

Tomorrow chemical industry will continue to supply new and better products for tomorrow's living. Many of these products are now working for war as they will work for peace. New synthetic fibers and plastics will vie with chemical modifications of those which nature provides. Trees in the East Indies will have to compete with petroleum wells in Texas in the world rubber markets. New medicines of power yet scarcely imagined will cure such rare diseases as are able to penetrate the strong health armor of a vitamin-fed race. Color photography, television, radio, aviation, rockets . . . these and countless other yet unborn necessities of the future will be built upon science materialized by an expanding chemical industry.

Courtesy Du Pont

An explosives test in 1896, using a "ballistic mortar" to measure explosive energy by means of the recoil

Plastics Through The Years

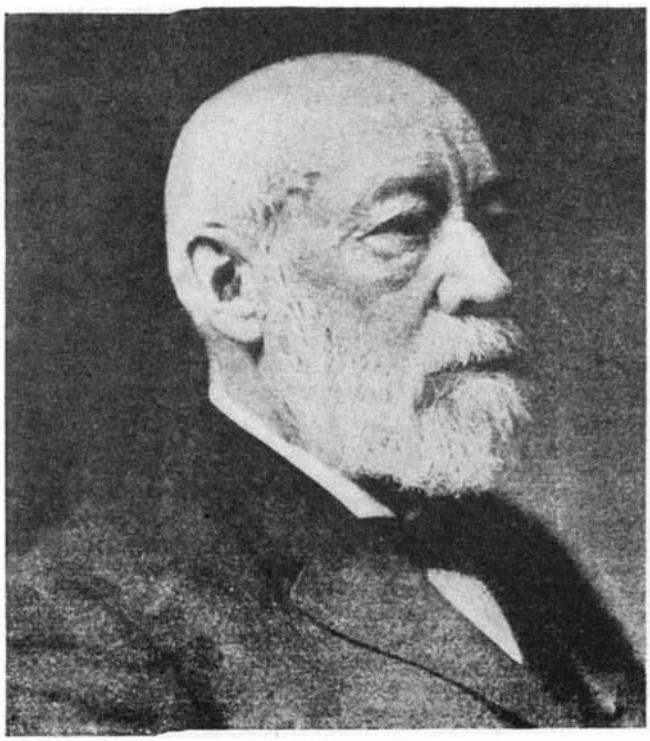
From Hyatt's Original Celluloid through Baekeland's Epoch-Making Bakelite to the Most Recent Discoveries in the Plastics Field, the Record has been One of Progressive Achievement. Out of the Welter of Present Plastics Will Come Even Greater Triumphs for the Future

By CHARLES A. BRESKIN

THE DISCOVERY and development of plastics have been conceived by one artist as a billiard ball, surface etched with the map of the world, which, when struck by a billiard cue, explodes into a myriad of tiny bits that take the form of the plastics products which are such an essential part of present-day living. Oversimplified, giving no hint of the years of research involved in the development of each of the many different materials used in the products thrown off by the bursting ball, this drawing is yet correct in its basic ideas—the billiard ball did supply the impetus for the development of the first commercial plastics.*

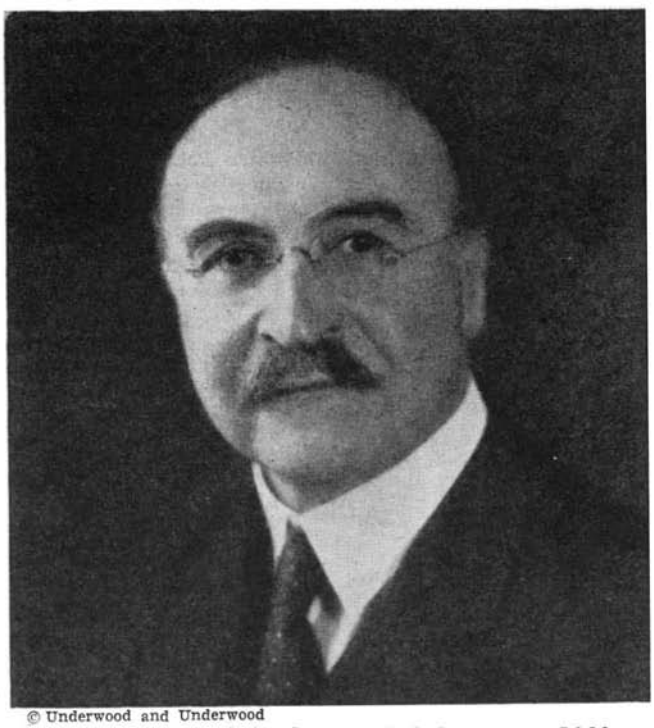
CELLULOSE NITRATE—In the decade after 1850, a serious shortage developed in many of the natural materials used in the decorative arts—tortoise shell, ivory, and amber. Decimation of the great elephant herds, in particular, brought the supply of ivory so far below the demand that prices of ivory articles went sky high. Since the chief commercial outlet for ivory was in the manufacture of billiard balls, the price and supply situation led the American firm of Phelan and Collender to offer a reward of $10,000 to whoever could invent a substitute for ivory which would be suitable for fabrication into billiard balls.

*Much of the information in this article is based on "A History of Plastics," by Gordon M. Kline.



John Wesley Hyatt . . . Celluloid . . . 1869

As a result of his determination to win this reward, John Wesley Hyatt, a young printer, is generally credited as being the first to work with cellulose nitrate as a plastic mass rather than in solution. Hyatt, however, hit upon the idea of using solid camphor and making the collodion by dissolving pyroxylin under pressure and with a minimum of solvent. The first patents were taken out in 1869 in the names of John Wesley Hyatt and his brother, Isaiah. Improvements in the process of mixing the pyroxylin and camphor were noted in patents issued in 1870 and in 1872, and the name "Celluloid" was coined for the product.



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Dr. Leo H. Baekeland . . . Bakelite . . . 1909

Although the Hyatts are credited with having manufactured some very acceptable billiard balls, there is no record of the $10,000 reward having been paid to them—or to anyone else. However, the need of dentists for a satisfactory substitute for hard rubber in denture plates soon engaged the interests of these two men, and the Albany Dental Plate Company was organized in 1870 to handle this first application of the cellulose-nitrate-camphor plastics. By January 28, 1871, the demand for the material for miscellaneous uses had become sufficiently great to bring about the formulation of the Celluloid Manufacturing Company, the predecessor of the Celanese Plastics Corporation of America. The material is now made by many manfacturers and is known by many other trade names.

Despite the fact that the material is somewhat hazardous

to handle, is readily decomposed by heat, and is unstable to sunlight in its unpigmented form, it has been, until recently, the best available thermoplastic material for many purposes because of a variety of unique properties. Its ability to take color, and the many distinctive mottled and variegated effects that may be obtained, were among the boasts for early Celluloid articles.

SHELLAC—In the commercial development of plastics materials, molding compositions containing shellac are listed second. However, in actual chronology, the basic ingredient of these compositions is the oldest of all the natural substances that enter into modern plastics. Shellac is produced by an insect which lives upon certain trees in India and Southern Asia. It has been known and utilized for many centuries for various purposes, such as a component of sealing waxes, polishes, and varnishes. Some of the patents relating to its use in molding compositions are contemporary with Hyatt's discovery of pyroxylin plastics. However, the first application of any magnitude for shellac molding compositions dates from its use by Emil Berliner in 1895 for phonograph records.

About 1900 shellac was adopted for electrical insulation, and it is still used in insulators for very high voltages because it offers good arc resistance and does not burn if a flash passes over the surface. Developments in recent years have been primarily in its application as a resinous binder for cloth, paper, silk, mica, and other insulating materials.

BITUMINOUS PLASTICS—The third plastics material to become industrially important in this country was of bituminous origin, utilizing asphalt, pitch, coal tar, and so on. It is more commonly known as *cold molded.* Emile Hemming was the pioneer in its development in the United States and introduced it on the market in 1909. His purpose was to "produce a commercial heat-resisting molded insulating product for extensive use, particularly in the electrical, the wiring device, and the automotive fields." The great advantages of the cold-molded products were in the saving of time over that required for other purposes, their excellent resistance to heat, and their comparatively low cost; but improvements in phenolic materials have caused great inroads into the application of this material in recent years.

PHENOL-FORMALDEHYDE RESINS—The first and most versatile of the commercial synthetic resins, the phenol-formaldehyde condensation product, was introduced and patented in this country in 1909 by Dr. Leo Hendrik Baekeland. Dr. Baekeland's research took up the thread where several predecessors had tried and either failed completely or dropped their work for other interests. In 1909, contemporary with the bituminous plastics, Dr. Baekeland received the so-called *fifth-mol* patent in which it was indicated that a heat-hardenable resin could be produced by using an alkaline catalyst in proportions not exceeding 20 percent of the total mixture. A later, *heat and pressure,* patent covered the technique for quickly converting this resinous product into a molded article of excellent mechanical and electrical properties. Other patents for making solutions and for their use in laminated articles followed in rapid succession.

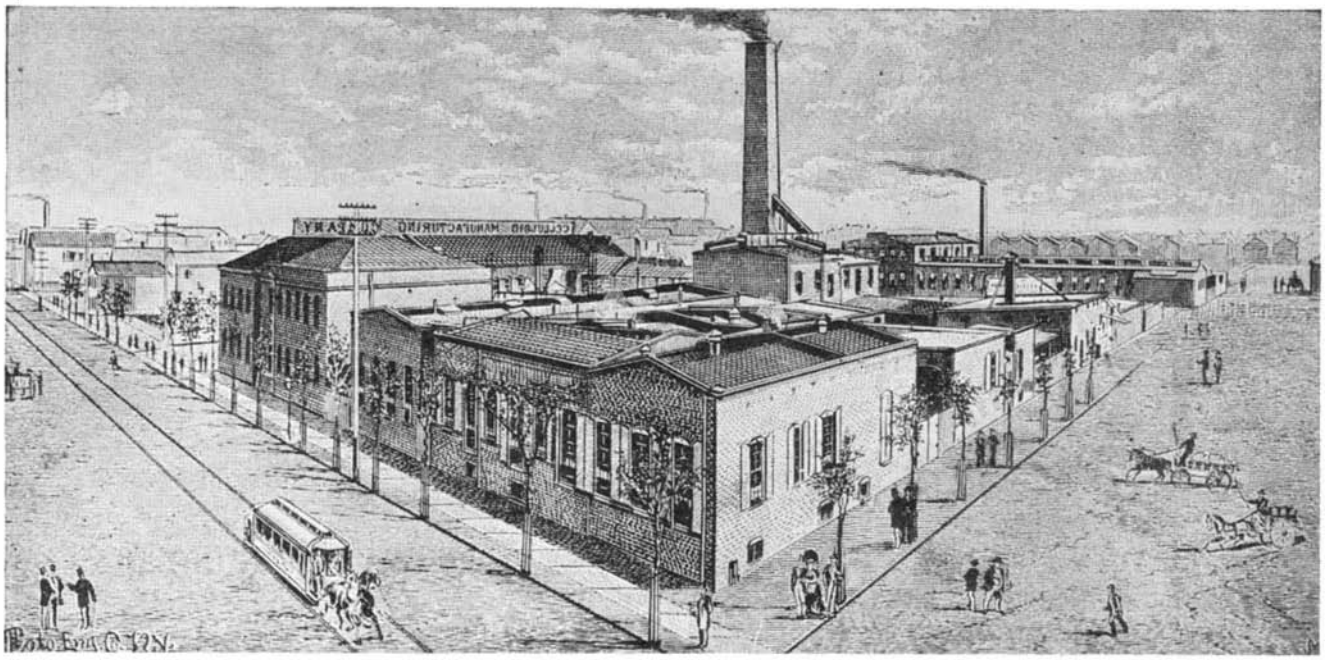
The manufacture of Bakelite was begun in Dr. Baekeland's laboratory in 1907. The General Bakelite Company was organized in 1910 and was merged in 1922 with the Condensite Company and the Redmanol Chemical Products Company into the Bakelite Corporation. Since the expiration of the basic patent in 1926, many other firms have marketed phenolic resins under various trade names. An important modification of this general type of resin is the use of furfural in the place of formaldehyde for the condensation reaction with phenol. Patents for the preparation of these resins, involving the use of both basic and acidic catalysts and no catalysts, have been granted to E. E. Novotny (Durite Plastic, Inc.) and others, and these products have been on the market since 1922.

Enormous quantities of phenolic plastics have been used in the automotive industries, later in the radio, and most recently in the communications and aircraft industries. The use of phenolic resins as bonding agents for other materials opened up another entire field of development.

CASEIN PLASTICS—Although formaldehyde-hardened casein plastics was discovered in Europe and its manufacture begun about 1900, its commercial development in this country did not get under way until after the original patents had expired. The pioneer for casein plastics in the United States was Christensen who introduced Aladdinite in 1919, and by 1925 four other American firms were in production. The primary limitation on its more extensive use is its hygroscopicity which leads to warping and cracking of the plastics when subject to wide variations in relative humidity.

Mention should also be made here of the research and development work which is under way to utilize proteins from sources other than milk as raw materials for plastics. Chief among these are soybean protein and zein obtainable from corn.

CELLULOSE ACETATE—A period of very active development of new plastics materials in this country started with the appearance of cellulose acetate in the form of sheets, rods, and tubes in 1927. The firm which pioneered in the development of pyroxylin plastics also introduced cellulose acetate plastics to the American market. This was accomplished



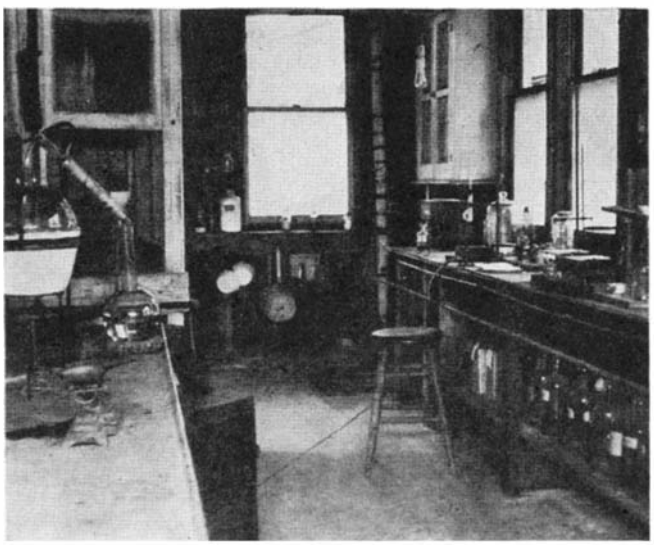
First factory of the Celluloid Company, pioneer plastics manufacturer, in 1875

by a combination in 1927 of the Celluloid Company with the Celanese Corporation. For two years the new corporation's cellulose acetate plastics was available only as sheets, rods, and tubes; but in 1929 the first cellulose acetate molding powder was marketed. The advent of the injection molding press greatly increased the speed with which molded articles could be produced; the wide range of colors available, the adaptability to all sorts of applications, and the generally excellent properties have made this material most popular. Both the plastics and the molding powders are now available from several commercial sources and are being satisfactorily applied to the production of innumerable consumer articles that are finding ready acceptance by the general public. This plastics material, along with many others, is also being adopted by industry for many work-a-day purposes.

UREA-FORMALDEHYDE—The appearance of the urea-formaldehyde resinous molding compounds on the American market in 1929 meant the extension of unlimited color possibilities into the field of thermosetting molding. The American Cyanamid Company were pioneers in the marketing of the new type of synthetic resins, and in 1931 a similar product was introduced by the Toledo Synthetic Products Inc. (later the Plaskon Company). The extensive use of urea plastics in the illuminating industry has resulted from their efficiency in providing a diffused light, plus their lightness of weight and shock resistance. These resins have also been introduced into the field of laminated plastics in order to take advantage of the many stable colors in which they are available. They are now produced by several other companies.

MELAMINE—Melamine resins are among the comparative newcomers in plastics, having been introduced by the American Cyanamid Company in 1939. However, melamine itself dates from the early days of synthetic organic chemistry. Many of its reactions are similar to those of the urea-formaldehyde materials, and it has been utilized in many of the same applications. The material is now produced by a number of companies.

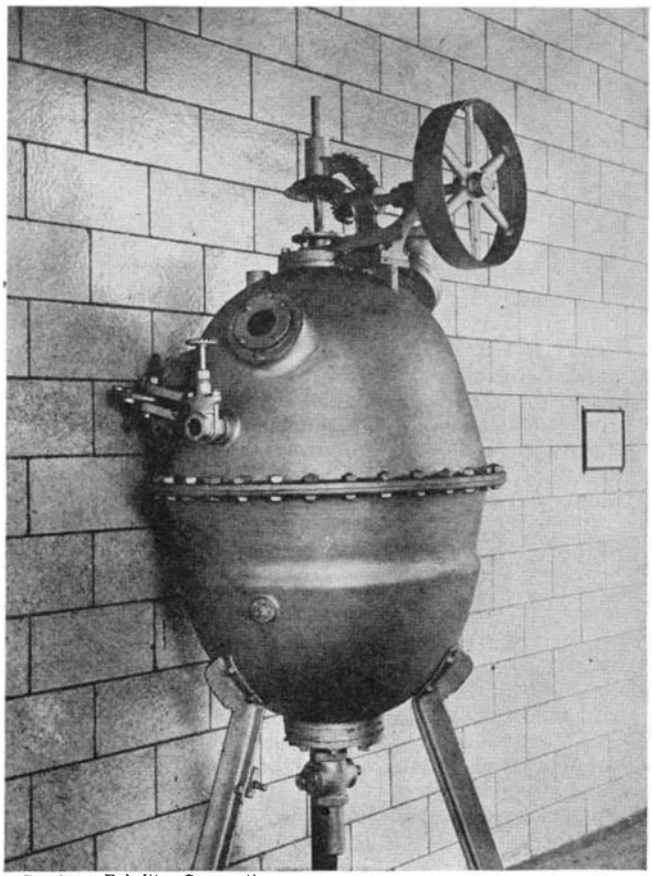
CAST PHENOLIC—A phenolic resinous product, distinctly different from the early Bakelite type in appearance, processing, and field of application, was put on the market in 1929 by the American Catalin Corporation. These cast phenolics



owe their popularity quite largely to their beauty and decorative value. However, their widening use has also been brought about by their ease of fabrication and other favorable properties. They are now manufactured by several of the larger companies.

VINYL RESIN PLASTICS—The polyvinyl ester resins have been known for over a hundred years, yet their commercial development in this country began only about 15 years ago. The most important of these resins industrially are polyvinyl acetates, polyvinyl chlorides, copolymers of vinyl chloride, and vinyl acetals. The vinyl ester resins were first made in the United States by the Carbide and Carbon Chemicals Corporation. At about the same time Shawinigan Chemical Ltd. introduced polyvinyl acetates in Canada. Of the acetal compounds, the vinyl formal compound has been made by Shawinigan (now part of Monsanto Chemical Co.) since 1938; and the vinyl butyral by Shawinigan, E. I. du Pont de Nemours and Company, and Carbide and Carbon Chemicals Corporation since about the same time. Rubber-like materials from polyvinyl chloride have been developed by the B. F. Goodrich Company, Carbide and Carbon Chemicals Corporation, and General Electric Company.

VINYLIDENE CHLORIDE—Vinylidene chloride resins were introduced in 1939 by the Dow Chemical Company. They have



Courtesy Bakelite Corporation

Above: The original still used by Baekeland, inventor of modern thermosetting plastics, for production of first pilot-plant lots of phenol-formaldehyde resins known as Bakelite. A corner of Baekeland's early laboratory in Yonkers, New York

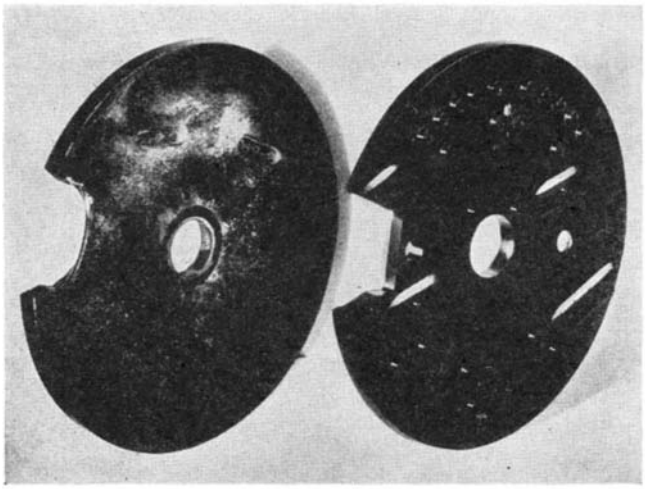
appeared in sheets and extruded tubings and filaments which have been adopted for many applications in the vast war program.

STYRENE—Polystyrene is one of the oldest known synthetic resins, but its industrial development in the United States is of comparatively recent date. This may be attributed to disadvantages in the appearance of the early product and in competitive price which delayed its acceptance. The Naugatuck Chemical Company introduced the resin in the United States in 1930. In 1937, the Dow Chemical Company made available a synthetic monomeric styrene of high purity and a corresponding polymeric product in clear, transparent form. These plastics are now also supplied by several other companies. The most significant properties of polystyrene are its low power factor and practically zero water absorption. In addition, it is resistant to moderately strong acids, alkalies, and alcohol.

ACRYLIC—The acrylic type of resin is another example of a synthetic plastics which has been known to chemists for many years but which has become available in quantity

only through an intensive development characteristic of present-day industrial research. These resins were first prepared in this country industrially by the Rohm and Haas Company in 1931. Methyl methacrylate resin was introduced on the market in transparent sheet form in 1936 by this same company, and the company's molding compound became available in 1939. In 1937 the material was marketed by E. I. du Pont de Nemours and Company in both sheets and powder.

The optical properties of cast methyl methacrylate sheets



Left: Controller plate from one of the first molds made about 1909 for Bakelite molding. Right: Another plate from a mold made in 1916. Part from the 1916 mold shows improvement in finish produced by this mold over that made in the 1909 mold. The older mold, however, is still in service

make this material exceptionally well adapted to the gun turrets, cockpit enclosures, and other structural parts of airplanes.

ETHYL CELLULOSE—The first patents granted in the United States on ethyl cellulose, went to Lilienfeld—in 1916 for the preparation of the material and in 1917 for its use as a plastics material. Commercial production was initiated by the Hercules Powder Company in 1935 and other companies now have formulations of this material. The material's chief applications to date have been in protective coatings, adhesives, paper and fabric coatings, and wire insulation.

CELLULOSE ACETATE BUTYRATE—The successful production of a plastics material from the action of acetic acid on cellulose inevitably led to research on similar treatment of cellulose with higher aliphatic acids. It was found that best results are obtainable from mixtures of the acetate with esters of the higher homologs, and an early patent for the preparation of a cellulose acetate propionate and a cellulose acetate butyrate was granted to Clark and Malm in 1932. Hercules Powder Company introduced the latter product to the American market in 1932, and, in collaboration with the Tennessee Eastman Corporation, introduced the propionate mixture in 1937. Tennessee Eastman Corporation also introduced the acetobutyrate as a molding composition in 1938.

COUMARONE-INDENE—The development of coumarone-indene resins, used as binders, received a great impetus in the establishing of the American coal-tar industry during and following World War I. Manufacture was started by the Barrett Company (now the Barrett Division of Allied Chemical and Dye Corporation) in 1919 and by the Neville Company in 1929.

REGENERATED CELLULOSE—In addition to the work on the creation of new compounds, investigations were made on the conversion of solid cellulose into liquid chemical compounds, and the later reconversion of these solids in the form of films and filaments. Although the process of manufacturing this material was perfected by 1912, Cellophane was not launched on the American market by E. I. du Pont de Nemours and Company until 1924. A similar wrapping material is now made by the Sylvania Industrial Corporation.

ALKYD RESINS—The development of alkyd resins came about through the investigation of all possibilities for coatings, to meet the ever-increasing demands of the automotive industry. After a period of intensive research, the General Electric Company, introduced alkyd resins in 1926. At first, large quantities of the alkyd resins were introduced into the cellulose nitrate lacquers to obtain better adhesion and diminish the porosity of the cellulose nitrate films. During the past decade, a number of companies have entered the market.

PLASTICS FROM WOOD—The utilization of waste wood and sawdust for the production of molding compositions has been the objective of a considerable number of investigators for the past ten years. In 1937, the first lignin plastic in sheet form for laminating was manufactured by the Masonite Corporation, and the development of lignin molding compositions of both the thermoplastic type for injection and impact molding and the thermosetting type involving curing reactions in the mold was announced in 1939 by the Marathon Chemical Company.

Under the more familiar name of veneer, plywood has been well known and used for many purposes since the days of the ancient Egyptians. The use of resins as adhesives to hold together the thin layers of wood was first noted about 1920, but they did not become commercially available until about 1930.

High-density plywoods have been on the market for several years following a period of successful application in Europe.

NYLON—One of Du Pont's latest developments is nylon which was introduced in 1938 for bristles in tooth brushes and later successfully adapted to surgical sutures, synthetic fabrics, and women's hosiery.

ALLYL RESINS—The resins based upon allyl alcohol are new materials which satisfy the demand for resins possessing some of the properties of thermoplastics and the chemical resistance of the thermosetting materials. With the introduction of this type of compound considerable impetus has been lent to the field of manufacture of resinous compositions, particularly by casting techniques.

POLYETHYLENE—In commercial production in this country since 1943, polyethylene is used practically exclusively for the insulation of high-frequency wire and cable. Reports on its characteristics by Du Pont and the Bakelite Corporation have indicated that many other important uses may be expected from its combination of flexibility and toughness over a wide range of temperatures, low water absorption and impermeability to moisture, chemical inertness, and excellent electrical properties.

SILICONES—Organo-silicone oxides include fluids for use over a wide temperature range with little change in viscosity, chemically resistant greases, insulating resins, high-temperature lubricants, and heat-resistant silicone rubbers. Information regarding their properties and wartime uses have only recently been made public by the Dow Chemical Company and the General Electric Company.

THE FUTURE—At present, the panorama of materials development is one of steady growth of the already familiar products rather than the introduction of numerous radically new types of compounds. An estimate of the individual-material production figures gives a total of about 790 million pounds as the current annual rate of production of all major classes of plastics and resins. Of this, approximately 413 million pounds may be considered as structural or rigid plastics. These are the plastics which, we are told, will find themselves in post-war competition with light metals. In some isolated cases there may be some competition. It will, however, in all probability be only temporary; and each material will ultimately find its own sphere of usefulness. Wise designers will take advantage of the divergent properties of metals and plastics, and will combine them so that they are complimentary instead of competitive.

DUREZ

PHENOLIC RESINS

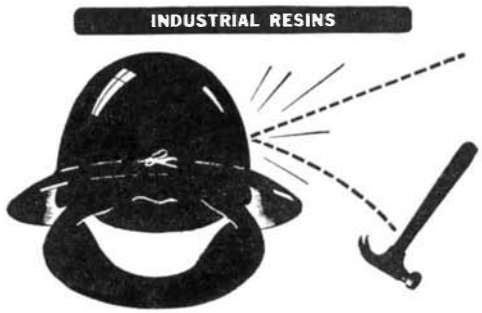
- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- OIL SOLUBLE RESINS

MOLDING COMPOUNDS

LOOKING FOR A LONG-DISTANCE OPERATOR?

The unusual impact strength of the Durez phenolic casing is what makes this telephone a real long-distance operator. Few people realize what a terrific beating the average telephone takes even under the most favorable circumstances. However, the rigid requirements of this telephone for impact strength, dielectric strength, and moldability were more than met by the Durez phenolic molding compound selected. Durez plastics provide the design engineer with such desirable properties (in addition to those mentioned above) as heat resistance, moisture resistance, highest dimensional stability, and resistance to mild acids and alkalies. Add to the product versatility of Durez phenolics the many new molding methods and processes developed by your custom molder, and you can appreciate the almost unlimited scope which is available to progressive manufacturers with a "weather-eye" on post-victory markets.

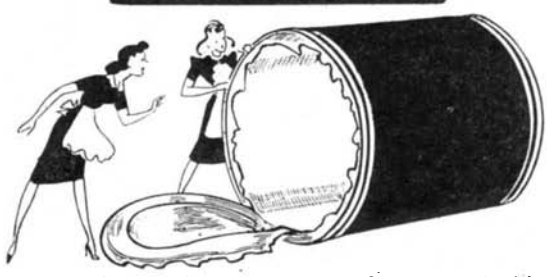
INDUSTRIAL RESINS



GETTING HIT WITH A HAMMER CAN NOW BE A PLEASURE

Safety helmets that are said to possess almost double the impact strength of laminated headgear formerly produced are now being low-pressure molded from Durez-resin-impregnated duck. The use of Durez phenolic resins for impregnating such materials as duck, paper, or sheeting is now being practiced successfully on such a wide scale that the design engineer has a myriad of proven applications available for study to assist him in selecting the resin that precisely fits his job.

OIL SOLUBLE RESINS



THE INSIDE STORY ON METAL CONTAINERS

Durez phenolic resins used as sanitary coatings on the inside of food containers are resistant to fruit acids, wines and beer . . . are odorless and non-toxic. The versatile properties which Durez phenolic resins impart to paints, varnishes, enamels, lacquers, and inks, make them of unusual value to the progressive manufacturer with post-victory markets in view.

You are a scientist. This means that you are a man of imagination . . . a man who knows how to develop ideas. The above at-a-glance picture of Durez operations should serve as a ready reminder to you of the versatility of phenolic resins and molding compounds . . . of the unusual value which the phenolics offer to the developer of imaginative ideas. For the past quarter century, Durez has specialized in the production of phenolics so that, today, Durez resins and molding compounds are leaders in their respective fields. Combine these facts with the background which Durez technicians have acquired through active participation in the successful development of many and varied products—and you can readily understand their worth to you. The services of the Durez staff are available at all times towards aiding the successful development of practical • industrial products. Durez Plastics & Chemicals, Inc., 525 Walck Road, North Tonawanda, N. Y.

PLASTICS THAT FIT THE JOB

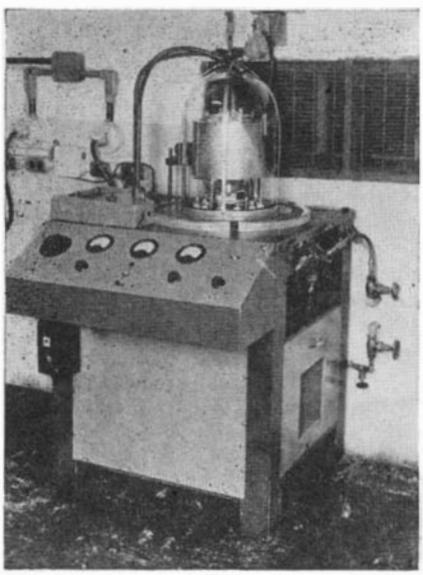
Working For Industry

In High-Frequency Heating, in Production Control and Regulation, in Lens Coating Processes, in Measurement and Analysis, in Liquid Level Control, and in a Wide Variety of Other Applications, Electronics has Established its Value as a Working Tool for the Chemical Industry

By JOHN MARKUS
Associate Editor, *Electronics*

A LARGE number of chemical applications of electronics are of a measuring nature. Examples of this are controlling combustion, liquid levels, temperature, and pressure; quantitative determinations of the conductivity of solutions, dielectric properties, humidity, transparency, color, and turbidity; also electron diffraction, x-ray diffraction, and mass spectrometer analyses.

PRODUCTION HEATING—The use of high-frequency methods for heating dielectric materials involved in chemical processes has in the past proceeded mostly by a process of trial and error. Actually, however, the amount of heat produced in a particular load of material is directly related to two factors —the dielectric constant and the dissipation factor—both of which are functions of frequency, temperature, and impurities. The product of these is called the loss factor, and determines the amount of heating for a given voltage and frequency. The higher the values of frequency, voltage, and loss factor, the greater is the heating effect. The limiting factor has been the development of oscillators with appreciable output at higher frequencies.



During the process of coating lenses with magnesium fluoride to reduce surface reflection, a phototube and an exciter lamp (mounted above the bell jar) measure the diminishing intensity of light reflected from a test lens to determine when the proper coating thickness has been reached

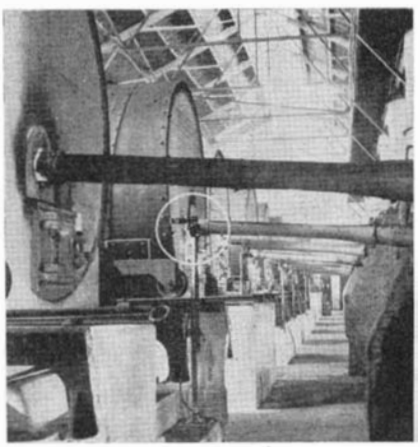
War-time developments in radar oscillators point the way to ultra-high-frequency oscillators with considerable power output.

Dielectric measurements of three cellulosic fillers—cotton duck, kraft paper, and alpha paper—have revealed several factors significant in dielectric heating. Simulating production conditions, without purifying the samples, plastics laminates were made by impregnating the materials with resins. The tests showed that relative humidity, fillers, and impurities have pronounced effects on the heating while the resins have negligible influence. Relative humidity has a very pronounced effect, increasing the rate of heating, particularly above 50-percent relative humidity. The effect is more pronounced at high frequencies, and cotton duck is more affected than the wood pulp papers.

Fillers and impurities are often more important than the main ingredients insofar as dielectric heating is concerned. Porous materials are more affected by moisture than homogeneous solids. The air gap between electrodes also influences heating since an increased gap reduces the field strength in the material. Irregularities in the thickness of the material result in irregular heating unless compensation is made by adjusting the air gap so that it is greater in the region where the material is thinner. Finally, the distance between electrodes may be critical at certain frequencies. Careful consideration of these factors in dielectric heating is an important step in the quantitative determination of the applicability of dielectric heating in a given production problem.

NEW MATERIALS—The chemist has played an important part in the recent advances in radar, radio, and television. The search for new insulating materials, for example, has culminated in commercial production of a new family of materials called silicones.

The silicones, in a sense, combine mineral and organic plastics. They fill



Photoelectric pyrometers provide automatic temperature control of ten cement kilns. The General Electric phototube in the circle is aimed at a clinker zone of high temperature

in the previously unexplored territory between glass—a mineral plastics—and the hydrocarbon compounds which make organic plastics. Processed into resins and bonded with spun glass, asbestos, or mica, they produce an insulating material almost indestructible by heat.

An entirely different kind of material, colloidal graphite, has been another chemical contribution to electronics. Aircraft radio sets, according to Acheson Colloids Corporation, will work more quietly and efficiently if the grids and plates of the tubes are treated with this product.

LENS COATING—An electronically controlled process is now being used to coat lenses used in military and naval optical equipment with special chemical films which increase the transparency of the glass by reducing its tendency to reflect light. Electronic equipment determines the critical thickness of the films as well as the degree of vacuum which has a bearing on their hardness.

The low-reflection coating is applied by evaporating chemically pure mag-

Typical Electronic Applications in Use Today in the Chemical Industry

Purification of carbon dioxide by electrostatic precipitation

Recovery of acid and catalyst used in petroleum refining, by electrostatic precipitation

Use of electrostatic precipitation to remove water particles from gases used in production of petrolatums, lube oils, petroleum sulfonate, and so on

Maintenance of liquid level in vacuum crystallizers by regulating outflow with electronically controlled valves, in a plant that produces alumina and potassium sulfate

Controlling the level of damp common salt in a bin

Electrode-type electronic control of levels of liquids and dry materials in a plant making industrial chemicals

Motor speed control in chemicals mixing equipment

Controlling the entire heat cycle on a plastics molding press; a single temperature control unit initiates all valving action of steam, water, air, and hydraulic pressures

Temperature control with thyratrons, phototubes, and amplifiers monitoring the processing of cement products by the color of the flame

Chemical analysis by colorimeter of drugs, cosmetics, soaps, glycerine, chemical and ceramic raw materials, petroleum products, and so on.

Electronic titration control in manufacture of chemicals

Photoelectric weighing for automatic filling of containers to predetermined levels or weights

Photoelectric weighing apparatus for automatically weighing powder used in making hard rubber and plastics goods

Regulating specific gravity of muriatic acid by electronically controlling the reverse-acting valve on water feed

Use of phototube to measure amount of nitrate in hopper in manufacture of fertilizer by a meat packer

Feeder control on a roller mill producing high-grade talcs

Electric ear serving as milling control in production of chemical and ceramic raw materials

Electronic conductivity meter for control of water flow through heat exchangers in production of aluminum and potassium sulfate

Use of ultra-violet lamps for bactericidal action in a plant turning out butanol, acetone, methanol, butyl acetate, and ethyl acetate

Use of ultra-violet for bacteria control in a tire and rubber plant

Automatic pH control of acid feed to treated water used in an explosives plant

Automatic photoelectric equipment to control the gloss and finish of the paper output of supercalenders

Speed and regulator controls for coating machines used in production of photographic film and paper

Automatic starting and stopping of conveyors and machinery in a plant making chemicals and related products

Photoelectric turbidity control in manufacture of pharmaceuticals, plastics, bicarbonate of soda, sodium hydroxide, chlorine, lime, Portland cement, roasted dolemite, and so on

Detection of low and empty bottles on production lines in a plant producing drugs and cosmetics

Geiger-Müller counter for potassium determination by its own radioactivity

Fluoro-photometers for checking and analysis of product quality in plants producing pharmaceuticals, flour and feeds, vitamin-D products, butanol, acetone, ethanol, and methanol

Flame failure control by conduction and by light of flame, in plant making heavy chemicals

Overflow alarm system on dentrifice storage tank

Explosion meter for sounding alarm when hydrocarbon vapors escape into room in a petroleum products plant

Photoelectric control of weighing to provide automatic cutoff of cylinders being filled with compressed gas, in a plant making organic chemicals

Colorimeter for vitamin analysis of cereal foods

Colorimeter for color-testing soft brown sugars

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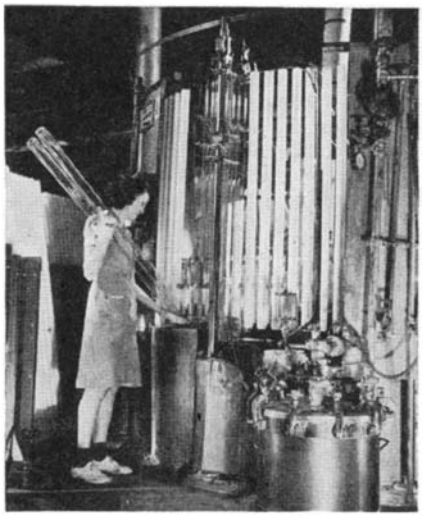
nesium fluoride powder in a vacuum bell jar, so as to bring the resulting vapor into contact with the lens surfaces under low-pressure conditions. A baking operation is carried on within the jar by means of radiant heaters.

As developed by RCA, the process employs a conventional electron multiplier phototube to measure the diminishing amount of reflected light from the lens. This enables the operator to stop the coating operation when exactly the proper thickness of film—about five millionths of an inch—has been established.

Vacuum gages, electronic amplifiers, and meters are used to determine quickly and accurately whether the degree of vacuum within the jar is such as to produce a coating of satisfactory hardness.

Although the forming of the magnesium fluoride film is carried out in a vacuum, it is imperative that the room in which the lenses are washed and prepared for coating be free of dirt and dust—a speck of dust could create an image behind which an enemy ship or factory might hide while the periscope or bombsight is in use. Air entering the coating room is kept free of dirt by an electronic air cleaner, the Westinghouse Precipitron.

LIQUID LEVELS—Chemical industries are frequently concerned with the sensing of liquid levels in storage tanks. These tanks may provide reserve storage or may be a portion of a complete processing plant in which the levels vary constantly as the product is added to or subtracted from the tanks. The materials encountered may range from hydrous and anhydrous mixtures and compounds to highly corrosive fluids such as acids and alkalis.



Phosphors that give off the light from fluorescent tubes are mixed in the tank in the foreground. The phosphor mix is forced into three tubes at a time, the excess draining back into the tank for immediate re-use

A float mechanism introduced into the storage container has been the conventional solution to the liquid level measurement and control problem. A shaft and stuffing box, a diaphragm seal, or a pneumatic or hydraulic transmission system is then used to bring the resulting level indication out of the tank where it in turn controls the position of a remotely situated valve or an indicating or recording mechanism.

These essentially mechanical devices are subject to many types of trouble because they are continuously exposed to unfavorable operating conditions such as chemical attack, mechanical erosion and friction, high temperature, and high pressure. Reliability can often be secured by constructing the float mechanisms with extreme care and attention to detail in view of the conditions under which they operate, but cost and upkeep may then become disproportionately high.

The chemicals usually stored in a liquid or solid state may be electrolytes (having electrical conducting or semiconducting properties) or dielectrics (having electrical insulating properties). By allowing these chemicals to become a portion of the structure of an electrical capacitor, they can be made to produce a change in capaci-

tance large enough to affect an electronic oscillator circuit and thereby actuate an indicating device or operate a relay in an automatic control circuit. With such a relay arrangement to open or close an electromagnetic valve or to start or stop an electric pump, the chemical in the tank may be maintained automatically and accurately at any desired level.

ELECTRONIC SENSING—An electronic level-sensing capacitor may consist of a pair of semi-cylindrical metal segments clamped around the outside of a glass manometer column that is indicating liquid level by manometric means, or may be a capacitor element mounted with a nonmetallic, leakproof protecting tube that is mechanically designed for immersion in storage containers under conditions of high pressure and/or temperature.

The manometric capacitor arrangement will work for both dielectric and electrolyte liquids in the manometer. If the liquid is an electrolytic (conductor), the capacitance of the sensing capacitor will be a minimum when there is no liquid between the plates, and the increase in this capacitance as liquid level rises will be a direct function of the height of the liquid between the plates.

Many electrolytes may leave a conducting film on the interior surface of the manometer column as the liquid level drops, and this may cause error. An agent must then be applied to the interior surface of the column to prevent this wetting action and film formation.

With liquid dielectrics (such as some types of oils) in the manometric arrangement, and with all types of liquids used with immersion capacitors, the capacitance change will also occur between minimum and maximum limits and will again be a function of the height of liquid in the area of the sensing plates.

The oscillator relay mechanism developed by Wheelco Instrument Company is ideally suited for sensing the change in capacitance of level-sensing capacitors. It consists essentially of a vacuum tube connected as an oscillator, with a relay in the plate circuits and the level-sensing capacitor connected to the tuned grid circuit. With proper adjustment of the circuit, a change in liquid level can be made to start or stop the oscillator and open or close the relay, as required to provide the desired type of automatic control.

Capacitive level-sensing systems are also used to measure and control the position of the interface boundary between two liquids of differing density and differing dielectric and conductive properties. Examples of this in the chemical industry are sensing of the interface between gasoline and water in underground reservoirs and sensing the interface position between an oil and an alcohol.

The movement of the interface over the sensing area of the manometric or immersion capacitor produces an appreciable change of capacitance. The greater the difference in the electrical properties of the two liquids, the greater will be the change in capacitance and the more accurate will be the control of interface level, other conditions being equal.

Because of the extremely low radio-frequency energies present in a level-sensing capacitor that forms a portion of the grid resonant circuit of an oscillator, fracture of the protecting tube does not expose flammable or explosive vapors to possibilities of ignition by sparking.

VULCANIZING—In electronic vulcanization of rubber, high-frequency oscillation shakes the molecules of rubber and sulfur millions of times a second, creating uniform heat throughout the product being vulcanized in a fraction of the time required when steam is used.

Sponge rubber mattresses and pads have been cured by this electronic method in one eighth the time needed by conventional processes. Tires, molded rubber goods, brake bands, and many other products can also be cured much more rapidly by electronics, with decided improvements in the products obtained. The same electronic heating removes difficulties in the molding of thick plastics products, by providing quick and uniform heating of plastics preforms so that the material flows readily into all parts of the mold when placed in the molding press.

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CAMERA SHUTTER

Tripped by Light From Flash Bomb

An electronic control that automatically synchronizes a new type aircraft camera shutter with the bursting of a flash bomb has been developed by General Electric in collaboration with the Folmer Graflex Corporation. The device enables military observers to photograph from high altitudes, and at night, destruction caused by explosives. It takes advantage of the peak illumination of the bomb by beginning an exposure approximately 1/100 of a second after the flash starts. A sensitive photoelectric cell acts on the light impulse coming from the bomb, amplifies the resulting signal, and transforms it into a current to which the shutter responds in less than 1/500 of a second.

EYES AND EARS

Provided by Untiring Electronic Equipment

Two distinctly different types of electronic control units are being used in the mining industry to keep ore crushers operating automatically and continually at the peak load corresponding to maximum efficiency. In one type, a microphone is positioned alongside the crusher and connected to an amplifier and relay combination that controls the conveyor feeding ore into the machine. When the noise level drops to a point indicating that the crusher is running too nearly empty, the electronic ear detects this and calls for ore to be fed in.

In the other type, an electronic eye is used to monitor the amount of electric power drawn by the electric motor which drives the crusher. This power consumption is high when the crusher is fully loaded, and drops as the machine empties. A light source and phototube are mounted over a wattmeter in such a way that the meter pointer interrupts the light beam when the power drops. The phototube feeds an amplifier-relay combination controlling the ore feed mechanism, as before. Electronics thus provides either eyes or ears to do a job that would otherwise require the continuous services of one man in a noisy position not conducive to accurate control of the ore feed.

CARRIER CURRENT

Communication System Used By Power Companies

Utility companies use power-line carrier current to provide a highly reliable type of communication by utilizing the power line for the communication channel.

Improvements and developments such as electronic switching, high-voltage line-coupling equipment, and other refinements, have been given an impetus unequalled in more normal times.

The frequencies usually utilized range from 50 to 150 kilocycles. The radio-frequency energy is confined almost entirely to the wire lines and is not radiated into space as is common in radio broadcasting. This results in greater efficiency and makes it possible to transmit greater disturbances with less energy.

An important application of the power-line carrier system is to provide reliable, high-quality voice communication between such points as generating stations and dispatchers' offices, or between dispatchers' offices of interconnected systems.

ELECTRONIC CASTING

Produces Electrodes of Purified Copper

In the manufacture of metal electrodes for vacuum tubes and x-ray tubes at Machlett Laboratories, a purified copper rod is placed over a mold in a graphite crucible and the whole enclosed within a double-walled quartz-silicon tube. A vacuum of about 10^{-5} mm of mercury is maintained in the tube. A coil surrounding the quartz tube connects to an induction-heating electronic oscillator.

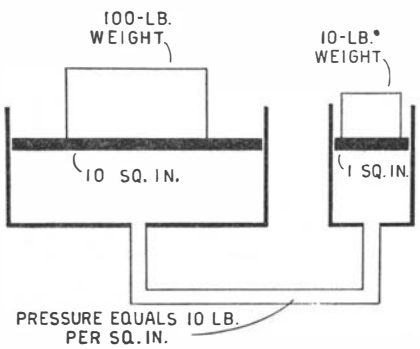
When the oscillator is turned on, the copper melts and flows into the mold. Cooling is precisely controlled by adjusting the position of the heating coil so that crystals form longitudinally for maximum heat transfer under operating conditions. Dimensions of the casting can be held to about 1/10,000 of an inch. No gases can be occluded in the metal of the casting, nor can oxides form.

Oil Pushes Production

Hydraulic Devices Provide Resiliency and Flexibility for the Complex Machine Tools of American Industry. The Oils that are the Lifeblood of These Hydraulic Systems Have Been Treated by Petroleum Refiners to Give Qualities Needed for Long Service Under Difficult Conditions

THE GROWING use throughout industry in recent years of hydraulic applications for the transmission and control of power has created a demand for oils that would bear up under the rigorous burdens imposed by their use in hydraulic systems. To create such specialized oils was a job for the petroleum industry and with characteristic energy and thoroughness it went to work. The research men in the laboratories of America's leading oil refiners took under consideration all the many and complex problems connected with hydraulic fluids. They studied the blue prints of machine-tool designers and the reports of production men in scores of industries using hydraulic-powered machines. With their notebooks in their hands, and their minds as well as their ears and eyes wide open, they paid long visits to the factories and shops where these machines were engaged in actual production runs.

They went back to their laboratories taking similar machines with them.



In this diagram illustrating the hydraulic principle, a ten pound force applied to the one square inch area of the smaller piston is transmitted to act with equal force on each of the ten square inches of the larger piston, creating a pressure of 100 pounds

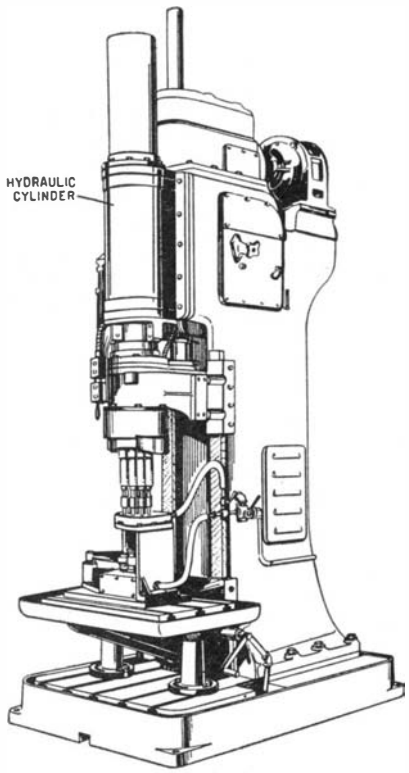
These were set up and put in operation doing the work they were designed to do. The petroleum research men sweated over these machines a long time and they sweated over their laboratory work benches, too. The result was a series of hydraulic oils that function efficiently. But they are not perfect yet. The research men are still working on them and they are making them better and better. Among the oils now widely in use, created especially for hydraulic systems, are the Gargoyle Vacuoline Oils produced by Socony-Vacuum, Texaco's Regal Oils, Houghton's Hydro-Drive, and Shell's Tellus line.

The demand for specialized hydraulic fluids arose because industrial engineers were utilizing to a greater and greater extent the unique advantages of the hydraulic principle in their persistent search for better and more economical ways of actuating and controlling production machines. Outstanding among these advantages is adaptability to complex control with relatively simple mechanisms.

There are other advantages, too. Hydraulic power transmission applied to machine tools permits for example a wide range of cutting speeds, which may be controlled with great accuracy yet changed frequently during operation. It permits a rapid tool approach, but a slow cutting speed when desirable, and then a rapid return at the end of the working stroke. Other important advantages are smooth, vibrationless action that is not greatly affected by load variations; a cushioning effect on tools which helps to extend tool life and improve surface finish; and heavy cutting without disturbances in the operation of the machine. Hydraulics can also be depended upon to provide great pressure when it is needed, with or without motion, and automatic release at overloads as well as automatic shutdown when tools become dull.

Oil is the lifeblood of these hydraulic applications. To grasp how it does its work, it should be recalled that an elementary hydraulic system consists of a piston in a small cylinder which is connected by a pipe to a much larger cylinder fitted with a proportionately larger piston. As every bright schoolboy knows, this arrangement will transmit power because pressure applied to an enclosed fluid is transmitted undiminished throughout the system so as to act equally in all directions.

In other words, if the small piston were one square inch and the large piston 10 square inches in area, a one pound weight placed on the small piston would cause a pressure of one pound per square inch to be transmitted through the piping so as to act on every square inch of the larger piston, producing a pressure of one pound on every square inch of the larger piston or an aggregate pressure of ten pounds. Of course, any movement of the larger piston would be only one tenth of that of the smaller piston.



A multiple speed drill whose feed is controlled by hydraulic pressure

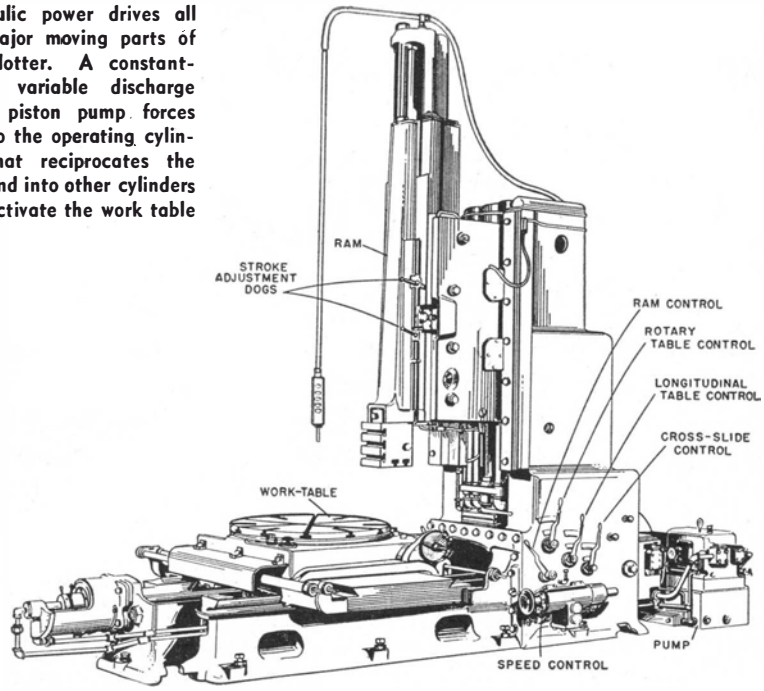
Utilizing this basic principle in hydraulic machine tools, a pump is substituted for the small piston, cylinder, and weight. The pump forces oil into an operating cylinder (corresponding to the large cylinder of the example) thus moving the piston and the attached machine parts. The volume and rate of oil flow into the working cylinder determine the extent as well as the speed of the piston's movement.

In hydraulic machine tools, two basic methods are used for controlling the flow of oil. The first, the constant-volume system, uses a constant-speed pump, discharging a uniform flow of oil at constant pressure. For this, gear or vane pumps are generally employed. Discharge pressure is held constant by spring-loaded relief valves and

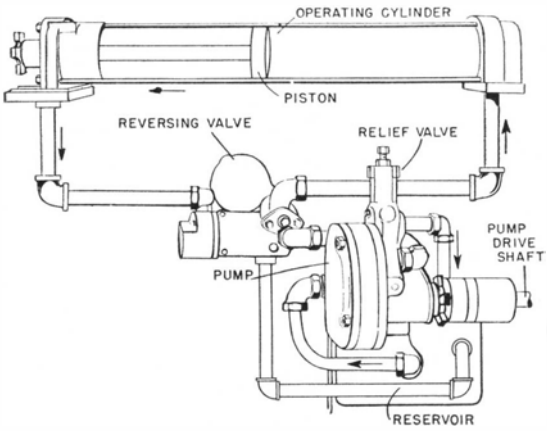
the flow of oil from the pump to the working cylinders is throttled, by-passed, metered, or reversed by means of various other valves.

In the second method, the variable-volume system, a constant speed pump is also used, but the design is such that the rate of discharge can be varied at will from zero to maximum in either direction. Plunger pumps are generally used, in which the length of stroke can be changed to vary the rate and reverse the direction of oil discharge.

Machines usually employ a constant-volume system where the oil pressure is not required to be more than a few hundred pounds per square inch or where variation is small, where small machine parts and work are to be accelerated and decelerated, and where cost of installation is a consideration.



Hydraulic power drives all the major moving parts of this slotter. A constant-speed, variable discharge radial piston pump forces oil into the operating cylinder that reciprocates the ram, and into other cylinders that activate the work table



Here in simplified form are the essential parts of a hydraulic system as applied to a shaper. A pump draws oil from a reservoir and forces it into an operating cylinder where it activates the piston which moves the tool

On the other hand, where pressure is needed in thousands of pounds per square inch and close control is necessary, or where massive machine parts and heavy work must be moved smoothly and without shock, a variable-volume system is generally used.

Many machines use features of both systems, either completely separated to operate different parts of the same machine, or combined for alternate control during varying portions of the operating cycle. Sometimes the systems are combined to work simultaneously with each other. An extremely wide range of combinations is possible. The increasingly complex functions which production men are devising for modern machines leads to the engineering of increasingly complex hydraulic drives for them.

ON MACHINE TOOLS—Typical of machine-tool applications is a hydraulic shaper. Here a constant-discharge gear pump draws oil from a reservoir and moves it under pressure through piping and a reversing valve alternatively to each end of the operating cylinder so as to produce a reciprocating movement of the piston and hence of the shaper head and the cutting tool. A throttling valve controls cutting speed. The extent of stroke is controlled by stops or dogs which actuate the reversing valve when the shaper head reaches the desired limit of travel. The same type of power transmission is used for creating reciprocal motion in other machines, as, for example, surface grinders.

Hydraulic systems of widely varying complexity and design are used on other machines. These include broaches, of which a notable example is a broach for rifling gun barrels; planers; milling machines; drill presses; lathes; boring mills; and honing machines. Other applications are on cylindrical grinders and special purpose grinders. Hydraulic power transmission and control are used to guide and feed the work to the wheel or the wheel to the work, whatever the set-up may be. Punches, presses, and shears also make use of hydraulics to generate the immense pressure needed to force punch, die, or knife through or against the work during a single stroke of the operating ram.

OIL MOVES MACHINES—For all these hydraulic applications the petroleum industry supplies correctly functioning oils, and the problems the refiners overcame in producing them point up the importance of this one phase of the chemical industry. Prime among the essential qualities of good hydraulic oils is correct viscosity. As is shown in Socony-Vacuum's handbook of hydraulic systems, there is always more or less internal leakage, known as slippage, in hydraulic pumps. This lowers the capacity of the pump and increases oil temperature. In variable-stroke piston pumps, moderate slippage can be compensated for by lengthening the stroke of the pistons, but this causes a corresponding increase in the consumption of power.

Where a hydraulic system employs a gear or vane pump, the volume of oil discharged is always greater than the demands of the working cylinders. A by-pass relief valve serves to control the discharge pressure and to divert the excess oil flow back to the reservoir.

Moderate slippage in this type of pump—that is, loss of capacity—consequently does no more than reduce the flow of oil lost through the relief valve. In this case, moderate slippage does not increase power consumption. It does increase, however, the temperature of the oil at the pump. To keep slippage down and to maintain maximum pump capacity with minimum power consumption and low oil temperatures, the viscosity of the oil used should be suited to the particular design of the pump that is employed.

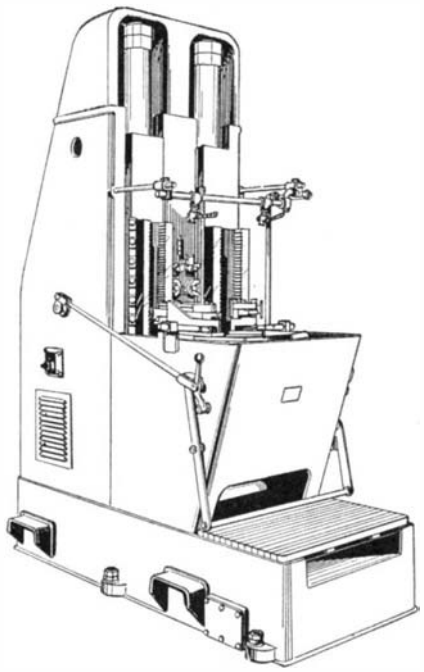
Viscosity has other aspects, too. It must be considered from the viewpoint of the ready flow of oil through the system and the prompt response of valves and other parts. Light-bodied oils assure ready flow and quick response, but their use may cause excessive internal leakage and needless power consumption. Heavier-bodied oils offer a higher resistance to leakage, but are more sluggish. Hence more power is needed to circulate them through pipes, valves, and orifices. The drop in pressure between pumps and working cylinders increases as oil body increases and machine efficiency is consequently reduced.

On the suction side of the pump, under theoretically ideal conditions, the force that causes the oil to flow can be no greater than that exerted by a perfect vacuum, which is approximately 14.7 pounds per square inch. Where the suction area is fixed, the volume of flow to the pump will vary inversely with the body of the oil. If the oil is too heavy in body, the pump will receive an insufficient supply and erratic machine action will be the result. Consequently, all these differing factors must be given due consideration in

selecting an oil of suitable viscosity for the most efficient machine operation.

The temperature of an oil is also an important factor in its viscosity; the temperature under which the oil will be used must be considered in selecting the correct viscosity for best service. In systems where a variable discharge pump repeatedly reverses its suction and discharge, the same oil may pass back and forth through the pump and only a small volume of oil is drawn from or discharged into the reservoir. In such cases the reservoir temperature *may not* represent the true operating temperature of the oil; the crucial factor, then, is the temperature at the pump.

A hydraulic oil that would maintain the same viscosity at all temperatures



The vertical rams and the work table on this duplex vertical broaching machine are all hydraulically operated

would be highly desirable. Such an oil would be just as prompt in its action when the machine was first started as it would be after a warming-up period. As yet, no such oil is available, although some oils have a minimum viscosity change over a wide range of temperatures. The use of such oils cuts down the period of sluggish action, lowers power consumption, and reduces the non-productive time needed for warming up the machine.

LUBRICATING QUALITIES—In addition to transmitting pressure, hydraulic oils must also lubricate the moving parts of pumps, cylinders, and valves. In fact, on some machine tools, oil is bled from the hydraulic system to lubricate the ways. To prevent excessive wear, particularly where fluid pressures are high, good hydraulic oils must provide strong lubricating films that resist the pressure and wiping action between moving parts at whatever operating temperatures the machines may develop. A lubricating film under these conditions must possess unusual strength since it is only microscopic in thickness.

Deficiencies in film strength cause excessive wear and unnecessary power consumption. Wear inside a machine increases internal clearances and therefore internal leakage. Wear at glands and stuffing boxes increases external leakage. When wear occurs, the metallic contact between the moving parts develops excessive frictional heat, increasing the oil temperature and consequently thinning the oil. Thinner oil still further increases internal leakage and power consumption, and impairs as well the value of the oil as a lubricant by reducing its load-carrying capacity. Furthermore, lack of film strength, in some machines, may result in piston, table, and slide chatter, which in turn causes inaccurate and imperfectly finished work. In all machines, deficient lubrication causes excessive maintenance costs and premature replacement of expensive parts.

Another necessary quality of good hydraulic oils is demulsibility; in other words, the ability of oil to resist emulsification when mixed with water. This quality is important because moisture is often present in the hydraulic system of a machine. It may result from leakage of water-soluble cutting fluid into the system, or it may arise from condensation of the moisture in the atmosphere as air surges in and out of the reservoir breather pipe. When water mixes with some oils, permanent emulsions are formed. These may be of thin and slimy nature, or of a sticky, pasty consistency, or may be heavy gummed deposits, depending upon operating conditions. Such emulsions interfere badly with the correct functioning of valves and other precisely adjusted parts.

Resistance to emulsification in an oil depends upon its ability to separate readily from moisture so that water which enters the system can settle to the bottom of the reservoir and not be circulated with the oil.

CHEMICAL STABILITY—The most important overall qualification of serviceable hydraulic oils is chemical stability. Constant churning and circulation in the presence of air tends to cause chemical changes in hydraulic oils. If they cannot resist this tendency, oxidation occurs and the oils sooner or later thicken and become sluggish in service, retarding the operating cycle and slowing down production. Sludge and gummy deposits form, interfering with reliable action of the machine. Hence the oil which resists chemical change and retains its original character for the longest time will give the best service.

High operating temperatures tend to accelerate the oxidizing process. Therefore the lower the operating temperatures can be kept, the less will be the tendency toward destructive oxidation. In most hydraulic systems, operating temperatures do not exceed 130 degrees, Fahrenheit. Where oil coolers are used the temperatures may be kept within relatively narrow limits. Of course, operating temperatures vary according to the design of the machine and the kind of work being performed. In some machines, the circulating oil is discharged for extended periods through a relief valve. Such conditions may increase the temperature of the oil in the working part of the system beyond 130 degrees, Fahrenheit. In some cases, it may go as high as 200 degrees, while exceptional cases have been noted where the oil has become heated as high as 280 degrees, Fahrenheit. Under these high temperatures, superlative chemical stability is needed to guard the oils against oxidation and the formation of gummy deposits.

Hydraulic applications in machine tools are bound to grow in the years following the war. Here is an expanding market for the petroleum industry where quality is primary and price secondary as far as the consumer is concerned. To date, the industry has kept pace with the specifications of mechanical engineers and manufacturers of hydraulic equipment. In doing so it has fulfilled the immensely increased demand for hydraulic oils stimulated by the urgencies of war production. But its work along these lines is by no means finished. A significant portion of the future achievements of the petroleum industry, once peace returns, will lie in the improvement of hydraulic oils for use in the machines that cut, stamp, grind, and drill the useful things men and women everywhere want in order to live a more abundant life.

NEW ENGINE

Uses a Variety of Fuels Without Sparking Devices

A DEVELOPMENT in Diesel engines, which will enable the operator to use either gas or oil as fuel without any electrical sparking device, and which will cut fuel consumption of gas engines as much as 25 percent, has been announced by Ralph L. Boyer, chief engineer of The Cooper-Bessemer Corporation.

Experimentation which began in 1928, Mr. Boyer said, recently has been rewarded by the successful operation of a natural gas engine on the Diesel principle. This enables the unit to operate on a wide variety of fuels including fuel oil, natural gas, manufactured and coke oven gases, sewage gas, and refinery by-products. According to Mr. Boyer, conversion from liquid to gas fuel is as simple as the closing of one valve and the opening of another with the engine operating continuously at full load. Although conversion from one fuel to another has been possible in the past, it has always been necessary to shut down and exchange major or minor parts of the engine.

The new principle, it is said, will enable the engine to have the same fuel economy regardless of the type of fuel used.

Aide To Aviation

One Chemical Plant Alone Produces 80 Chemicals Used in the B-29. This Fact Brings Home the Close Relationship between Chemical Industry and the Mass Manufacture of Airplanes, Both Those Used Today for War and Those that Will Fill the Skies in the Coming Days of Peace

CHEMISTRY supplies to the science of aeronautics many of the ingredients essential to large-scale aviation as it exists today. Leaving out of the picture the well-known subject of fuels, it can be said that one of the most striking as well as most recent of chemistry's contributions is the use of glass-reinforced plastics. Before the advent of Fiberglas, plastics had proved eminently satisfactory in many non-structural parts of the airplane, but had served less frequently for structural parts; airplane designers raised objection to the low specific strength-weight ratio of plastics. The use of glass-reinforced low-pressure resins seemed to remove this objection, and officers of Wright Field, with Colonel Paul H. Kemmer in the lead, initiated a research project in co-operation with Owens-Corning-Fiberglas Corporation, which, in turn, sought the help of seven leading manufacturers of thermosetting resins. Glass was the common denominator in the use of resins with such famous trade names as Plaskon, Laminak, and so on. Combinations of resin and glass fiber were prepared in the form of cross-laminated sheets. With specific gravities between 1.69 and 1.81, tensile strengths of over 50,000 pounds per square inch were obtained, and flexural values ran higher still, up to 84,600 pounds per square inch.

To enormous strength and low density were joined hardness and resistance to abrasion, impact, flame, and moisture. Thanks to the cross-lamination, a fair balance of strength in all directions of the material was obtained. Another advantage of Fiberglas, with its copolymer resins, is that it lends itself to low-pressure molding at moderate temperature, thus avoiding complicated and expensive equipment.

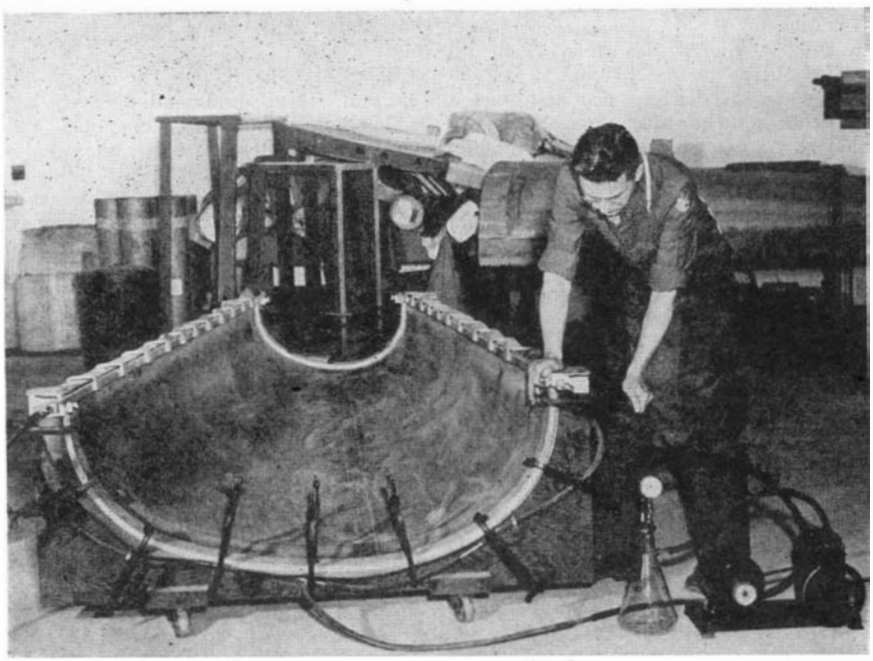
The next step in the program was the development of sandwich construction in which multi-plies of the glass-reinforced plastics are used for faces, with a balsawood core having grain parallel to the faces. The advantage of such sandwich construction is that, with the heavy fibers separated by the light core, far greater local strength against buckling is secured. Sandwich construction is a valuable addition to aviation technology and is being applied to other materials besides Fiberglas.

PLASTICS AIRPLANES—When this new structural material had been perfected, Wright Field decided to see what could be done in duplicating the aluminum fuselage of a BT-15 training airplane with the aid of the Fiberglas-balsa sandwich. A molding technique was also developed in which glass cloth is laid upon an impregnating table, and laminating resin is applied uniformly to the cloth by the use of squeezes. Then the material is transferred to the male mandrel where the five plies comprising the outer face of a fuselage skin are carefully trimmed. The face plies are then transferred to a female mandrel.

Then the prefabricated balsa core is placed in position, and on top of this the inner five plies. A rubber blanket is placed over this assembly and sealed on the edges. By means of a small pump a partial vacuum is drawn between the blanket and mold, with inserts in place. Once this has been done, the assembly is ready to be cured. The mold, mounted on wheels, is rolled into an oven where it is subjected to a temperature of 220 degrees, Fahrenheit, for a period of three hours. Thereafter, the molded section is withdrawn and its rough edges trimmed off. To join the two halves of a fuselage, a spline is inserted into the core and glued with a cold-setting resin glue. Bulkheads are assembled and glued into place, and the completed fuselage is ready for assembly.

The fuselage was subjected to destructive tests in direct comparison with a 24ST aluminum fuselage. With a weight only a few pounds greater than that of the metal fuselage, the destructive load for the Fiberglas-balsa fuselage was increased nearly 80 percent. The reasons for this excellent result lay partly in the greater specific strength of the Fiberglas and partly in the sandwich construction.

There are other important applications of Fiberglas in airplane construction. Light, flexible sheets of resin-impregnated Fiberglas cloth are used as protective linings in fuel-cell cavities built into the wings of a Boeing Superfortress. Because the glass sheets possess high impact strength, they prevent "flowering" of the metal walls of the fuel cell if struck by a bullet. Thus they

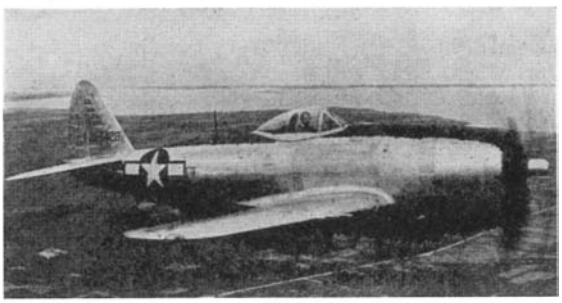


After the elements of a Fiberglas-balsa fuselage are assembled in the female mandrel and sealed with a rubber blanket, a partial vacuum is applied by pump at right

safeguard the rubber fuel cell against protrusion of the jagged petals of such "flowers" into its wall—and therefore do not prevent the self-sealing material from closing the hole.

SAFETY IN OIL LINES—A contrast to Fiberglas in both composition and use is compar, another plastics that serves aviation. It was developed by Resistoflex Corporation and the name was derived from the words "Compounded Modified Polyvinyl Alcohol Resin." These compounds and modifications take on some plastics- and some rubber-like properties during the compounding and processing, but all appear to be flexible, tough, and resistant to abrasion.

Some types of the compar group have exceptionally low permeability to gases, others freedom from aging or oxidation, while still others retain their valuable properties through the wide temperature range of -70 to $+300$ degrees, Fahrenheit. All have a high degree of polymerization, high molecular weight, and low specific gravity. Perhaps the outstanding characteristic is resistance to the action of gasoline, oils, and most of the organic solvents. Tensile strength is high. The production of compar includes some methods common to the plastics industry and some to the manufacture of rubber. It is milled like rubber, for example, but transformation into finished products is accomplished by extrusion or molding.



The bubble shaped canopy used on this Thunderbolt gives unobstructed vision in all directions. The canopy is fabricated of one piece of Plexiglas, requires no metal framework, and is light in weight

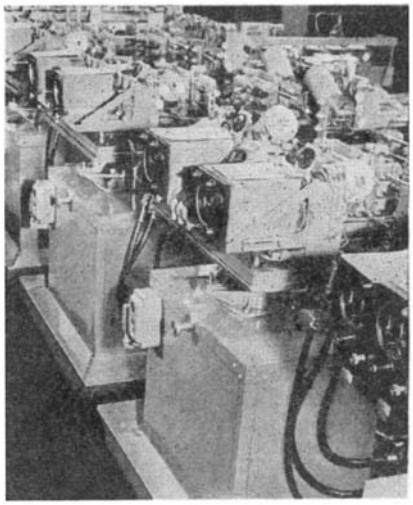
Some of the aircraft applications in which compar has been employed are of great interest. For example, the Sperry Gyropilot is an essential element of long-range flight and of precision bombing. In production testing, the Gyropilot with its various hydraulic lines must be submitted to rolling, pitching, and yawing motions of great violence, and of 'round-the-clock operation on the vibrating stands. The lines have to be oil-proof, flexible, capable of indefinite service, and resistant to "hammer" or suddenly applied hydraulic pressures of between 150 and 200 pounds per square inch. The short flexible lines have to withstand constant coupling and uncoupling and remain flexible. Lines must be bent on a five-inch radius to permit cleaning of machines and to make certain connections at sharp angles. The hydraulic fluid must not permeate the walls of the tube. The compar lines have met all these requirements and on the test stands a single line has served for five years without showing any deterioration.

An equally important application of this plastics lies in maintenance work. After Pearl Harbor, it became necessary to apply camouflage finish to the upper and lower fabric-covered surfaces of Boeing Clippers used by Pan American Airways, instead of the aluminized dope used during peace-time. Operational difficulties developed because the camouflage finishes caused rapid deterioration of doped surfaces, particularly in tropical climates, and necessitated frequent replacements. There was delay in replacement because doping could not be undertaken during humid weather. Then a new technique was developed, "hot doping," in which heating the viscous colloidal dope to 175 degrees, Fahrenheit, lowered its viscosity sufficiently to permit of spraying with a standard spray gun. Heating the dope, instead of reducing its viscosity with thinners, allowed the deposit of more solid material in each coating, so that four or five coats instead of eleven became sufficient. But then another difficulty arose: no ordinary hose could stand the organic chemicals employed at elevated temperatures. Compar hose, however, came to the rescue, and the hot doping of the control surfaces became commonplace.

Recent advances in aircraft engine design involving the use of fuels with an increasingly high "aromatic" content, have shown the need of fuel lines that are resistant to benzol, toluol, xylol, or other aromatic fractions. Here the problem has been solved by the use of hose of varied types, with cores made of vinyl plastic which neither breaks down nor sloughs under the action of lubricating oils or fuels. These lines are widely used on Douglas, Grumman, Boeing, and other aircraft.

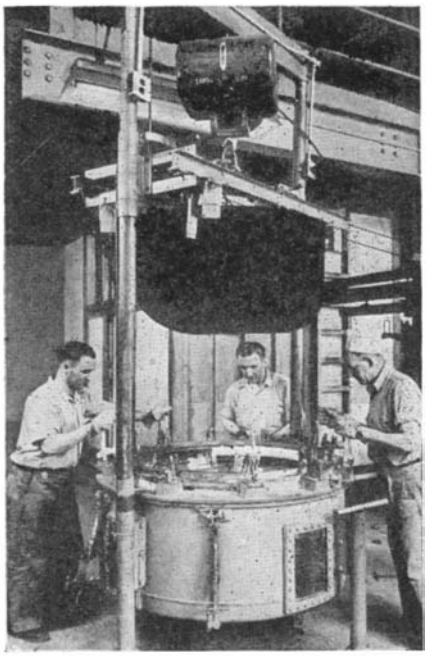
Still another application of plastics tubing lies in flight testing. It is sometimes necessary to obtain actual measurements of static pressure, shock pressure, and so on, over many points of the wing surface. Large numbers of flexible lines become necessary, lashed together so that they will not vibrate and rub against metal. If these lines are transparent and filled with mercury, picture records of the fluid movements during test flights make possible an accurate check of flight instruments. Compar lines have met all these requirements.

CHEMISTRY IN THE B-29—Other leading chemical companies are making significant contributions to aviation. For example, at a single plant, the Du Pont Chambers Works, 80 chemicals are produced that go into the Superfortress as ingredients or finished products. By electrolysis of a water solution of salt, chlorine and caustic soda are obtained. From these two neophrene is made. A synthetic rubber resistant to oils and to flame, neoprene is used for covering on electric wiring and for carburetor diaphragms on the B-29. Again, chlorine enters into the ethyl-chloride used in making tetraethyl lead, the anti-knock compound essential for high octane gasoline. Rubber has to be well-compounded before it goes into the molds, and to improve the rubber compounds' resistance to aging, "Zenite" made from coal-tar chemicals is employed. A few drops of anti-oxidant made from petroleum chemicals prevents gum formation in gasoline.



Sperry Gyropilots on vibrating test tables, connected with plastics tubes

Such examples could be multiplied indefinitely. Thus, huge tires of Army bombers or cargo planes can withstand the heavy punishment involved only because the tires are made of nylon cord. In "air pick-up" work, All-



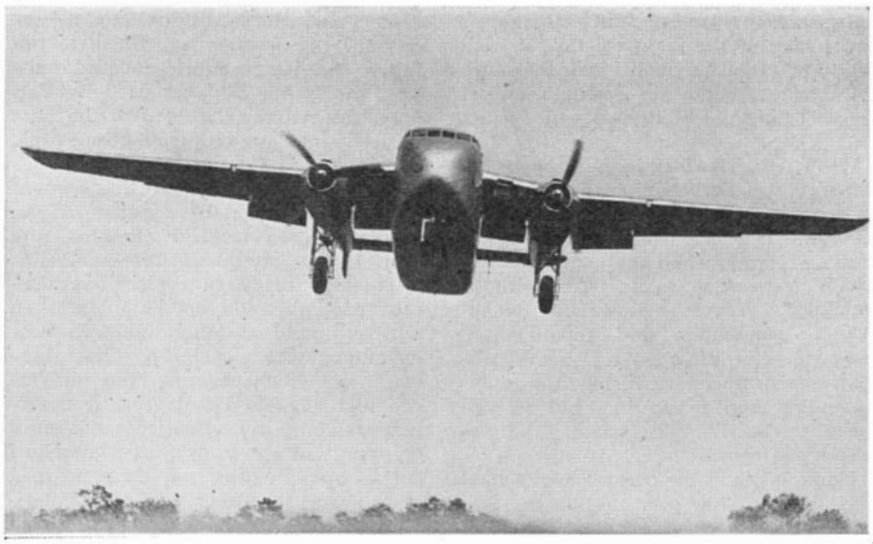
In making an airplane turret, a Plexiglas sheet is clamped to a vacuum pot and drawn downward before the cloth-covered, turret-shaped form, shown above the pot, is released

American Aviation in its first year of operation used manila rope and steel cable. The combination worked well but involved the use of a mechanical shock absorber. Now the work of the chemist has replaced the steel cable by nylon rope which stands abrasion better, and also avoids the use of a mechanical shock absorber. The shock-absorbing property of nylon is explained by hysteresis, or internal friction. When a rubber band is stretched and let go, the energy is released in the form of a quick snap. But the energy stored up in a nylon rope when the airplane's grappling hook catches the mail pouch at 110 miles an hour, is released largely as heat, owing to this internal friction. Only a part of it is converted to recoil, which accounts for the smooth performance of nylon rope in air-mail pick up.

While for structural airplane parts thermosetting plastics are used, the transparent parts employ thermoplastics, with acrylics as a foundation, for the Plexiglas used in bomber noses, gun blisters, and other airplane enclosures. In the latest version of the P-47 Thunderbolt, the "bubble" canopy of one-piece construction not only gives the pilot unobstructed vision in all directions, but it also eliminates metal framework, saves weight, and reduces head resistance.

It is not too much to say that chemistry, by bringing forth the synthetic adhesives, has revolutionized the whole art of aircraft wood and plywood construction, since it has removed bacterial decay, provided water-proof glues, and suggested new and remarkable processes of fabrication. An example of this is the Redux process of bonding metal to metal, and metal to wood. Redux is a new type of thermosetting synthetic resin adhesive. By its aid, joints are produced without riveting or welding. This process opens up many possibilities in composite construction. The bonding process involves cleaning of surfaces, application of Redux liquid and powder, and joining the metal surfaces under substantial pressure at approximately 240 degrees, Fahrenheit.

Sheets of impregnated glass cloth are used to line fuel-cell cavities



Above: The Packet takes to the air
Below: An armored car rolls aboard

To the chemist there is also credited a new inorganic compound which prevents the dangerous thickening of aviation oils at sub-zero temperatures or their excessive thinning in tropical heat. The importance of this will be realized when it is remembered that oils are used in lubrication, in brake actuation, in lowering and raising landing gears, and in operating turrets, control surfaces, and variable pitch propellers.

All these contributions of chemistry to aviation and many more for which there is not space in this article are cogent testimony that the chemist is indispensible to the expanding science and industry of flight. They show with equal weight that aeronautics offers the chemist a wide field for further research.

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CARGO PLANE

Can Readily be Converted To Passenger Use

THE War Department has finally permitted information to be released on the Fairchild military cargo plane already successfully test-flown by the AAF and now in production. The new ship is officially designated as the Fairchild C-82 and has a number of distinctive features which will give it a peace-time future as well as immediate military importance.

The fuselage is almost square in cross-section, with the interior wholly unobstructed. Because the tail surfaces are carried at the ends of two booms running from the wing, the rear of the fuselage can be opened up completely, giving space enough for a tank to roll up the ramp under its own power. Vertical walls and unobstructed cargo space for the entire length are provided. Use of a tricycle landing gear makes the floor of the cargo compartment parallel to the ground. The fuselage platform is the same height as that of a standard truck floor, for easy transfer of freight from a truck to the airplane.

The machine is primarily designed for carrying tanks, ammunition, supplies, troops, or paratroops to combat areas, but it is estimated that the "Packet," as the C-82 is also called, can carry as many as 76 passengers by day and 30 by night in upper and lower berths on both sides of the aisle.

The construction of wing and fuselage is of the most modern monocoque and high-strength aluminum alloy type. The lower portion of the fuselage is provided with seven longitudinal beams which take the floor and tie-down loads in the main cargo area, beneath the plywood covered floor.

ASSISTED TAKE-OFF

Would Make Use of Driven Landing Wheels

IN THE London *Aeroplane*, S. W. G. Foster suggests a new method of providing assisted take-off.

The idea is to drive the wheels directly from the engine at a time when the airscrew itself is somewhat inefficient. There is little doubt that take-off would be shortened, but would the additional complexity of mechanism be worthwhile?

Metals Fight Corrosion

Improvement of Alloys and Coatings to Combat the Ravages of Corrosion is One of Today's Most Hopeful Industrial Trends, Involving Both Metals and Chemicals. Industrial and Consumer Products Last Longer, Look Better, and Make Everyone Concerned Happier

MANY of the applications of metals and alloys in industry and everyday life are fronts in that perpetual battle between metals and chemicals that man calls corrosion. For centuries the combat has been an expensive one for metals and for society at large. It was once reliably estimated that losses traceable simply to the corrosion of metal products are in excess of two billion dollars each year. Yet so much progress has been made in recent years in retarding this evil that we may look with reasonable assurance for a continuing decline in the proportionate economic loss represented by metal-corrosion.

Certainly the checking of corrosion is recognized as one of today's most important engineering and scientific fields. Hundreds of first line metallurgists, chemists, electro-chemists, and engineers are continually investigating it from either the fundamental or practical point of view.

The leading technical societies have formed the Coördinating Committee on Corrosion, while every important metal producer and many large metal consumers like the Bell system, General Electric, Westinghouse, the War Department, the Navy Department, General Motors, Crane, Babcock and Wilcox, and so on, maintain a staff of corrosion specialists to find out why and to what extent metals are corroded by specific environments, or to develop alloys, coatings, or inhibitors to resist or eliminate the corrosion.

Corrosion problems may be divided into four broad types. The most prevalent manifestation (and the most costly to society) is corrosion of metals by the ordinary atmosphere. The chief example of this is the familiar rusting of iron. The second major corrosion field is marine corrosion—the attack on ship parts and cargoes by sea water or the salt sea air—and may be considered a special case of the first.

The third is the corrosion of machinery parts, industrial equipment, and other products by corrosives other than air or salt water. Outstanding representatives of this are the attack of lubricating oil on engine bearings; the embrittlement of steam boilers by the combined effects of alkali in the water and heat; the damage done to cooking utensils by certain foods; the destruction of pickling and plating equipment and parts by the solutions used; and so on.

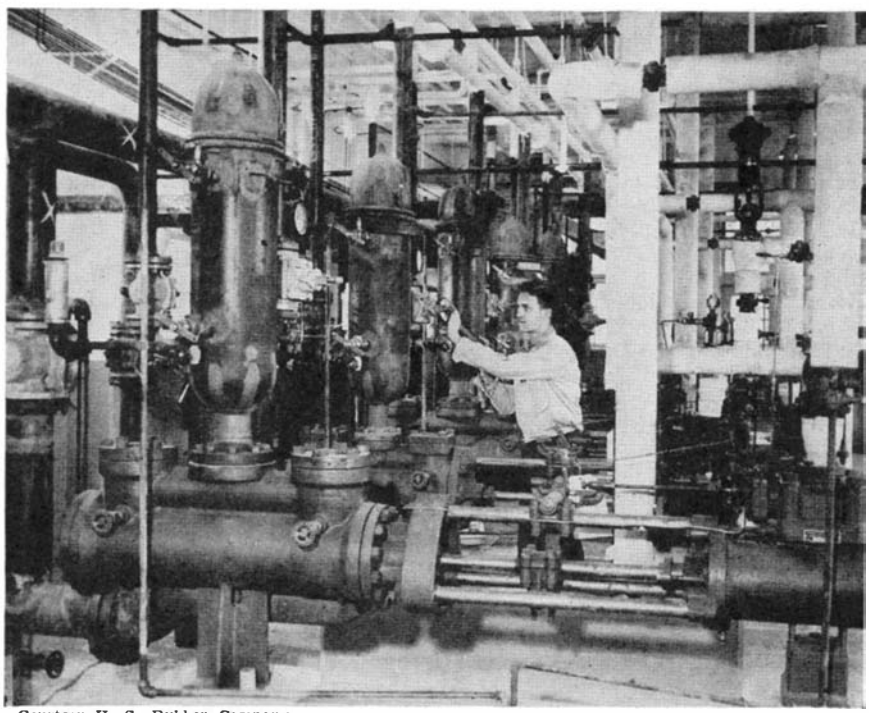
The fourth, again, is a special case of the third, but is perhaps the most important technical phase of corrosion: the corrosion of equipment used in the chemical manufacturing and process industries. Much of the broad general advance in battling corrosion has stemmed directly or indirectly from work originally done specifically to solve a corrosion problem involving equipment used in the chemical process industry.

WHAT CORROSION IS—The questions of how and why metals corrode—the so-called "mechanism" of corrosion—have produced several answers down through the years. The theory enjoying widest acceptance at the present time is called the electrochemical theory. According to it, each case of corrosion involves a flow of electric current, something like the flow of current in a battery and the accompanying corrosion of the plates, on a miniature scale.

Virtually every metallic surface or structure contains non-homogeneities. Each of these behaves like a little electrode, while the metal itself acts as another electrode in contact with it but differently charged. Finally there must be a driving force or "potential" to start the flow of ions from the metal into the attacking solution.

This potential is different and characteristic for each metal and a listing of metals in accordance with the potential of each—that is, its relative tendency to dissolve in solutions of its salts—gives rise to the so-called "electromotive force series," of which a condensed form is shown in the left-hand column of the accompanying table. The right-hand column is a somewhat "practicalized" version, showing the position of several familiar alloys as well as the more common pure metals.

This table may be used for a variety of practical corrosion problems. It



Courtesy U. S. Rubber Company

The equipment in this pumphouse for synthetic rubber chemicals illustrates the need in industry for metals that are strong as well as highly resistant to corrosion

shows, for example, the general tendency of the individual materials to be corroded by the atmosphere, those near the top being more rapidly attacked than those near the bottom. Aluminum, for example, is near the top and is avidly attacked by ordinary air, while Monel metal, near the bottom, is affected but slowly. That aluminum kitchen equipment remains just as bright and uncorroded as Monel is caused by the fact that the quickly-formed oxide on aluminum is highly impervious and is so thin a layer as to be invisible, but nevertheless adequately and immediately protects the underlying metal against further attack.

The table also shows *very roughly* the relative corrosion resistance of the metals to chemicals in general. However, it could never be used with safety for predicting their relative resistance to a specific corroding solution, say sulfuric acid or sodium hydroxide or salt water. Only tests—usually full-size service performance tests—will show that accurately.

"GALVANIC" CORROSION—An important practical use of the table by corrosion engineers is to determine whether "galvanic" corrosion is likely to occur in a given design and how to avoid it. Galvanic corrosion is the corrosion of one metal in contact with a second in an environment which the first metal alone (that is, not in contact with the second metal) would normally resist. For example, an aluminum shaft for the mixing paddle in a tomato juice vat might operate without noticeable corrosion if the paddle blades also were aluminum. If the blades were made of bronze, however, the aluminum shaft might be seriously corroded.

Each of the metals listed in the right-hand column of the table will tend to accelerate the corrosion of any metal *above* it when the two are placed in contact in a corroding solution, while the lower-placed metal will be relatively unaffected—actually protected sacrificially. Metals grouped together in the table have no important galvanic effect on each other and may be coupled or allowed to come in contact in a product-assembly without trouble, but other in-contact combinations (except where one metal completely seals the other from exposure to the environment) are studiously avoided by the careful corrosion engineer.

This and other knowledge about metals has been applied to improving the resistance of materials to corrosion in three broad ways: (a) developing and utilizing new alloys possessing special resistance to atmospheric or chemical attack; (b) formulating and applying protective coatings, either metallic or non-metallic, to shield the vulnerable metal from destruction; and (c) controlling the service conditions—either the design of the corrodible equipment or the character of the corroding medium—of individual situations.

For example, in the first of the broad corrosion-problem fields—atmospheric corrosion—the basic problem of the rusting of iron and steel has traditionally been solved with varying degrees of success by painting, vitreous enameling, galvanizing, tinning, chromium-plating, and so on, all representative of protection by the application of coatings. The iron is also alloyed with chromium or nickel or both to produce alloy steels with considerably better rust resistance than ordinary steels, and to produce stainless steels which, although not really "stainless", are virtually "rustless" or non-rusting under usual conditions.

Painting, the most-used method of protecting metals against atmospheric corrosion, has been radically improved in effectiveness in recent years. Better primers and especially "inhibiting" primers that protect the metal chemically as well as physically have been developed.

New resin lacquers provide protection and flexibility once difficult of attainment simultaneously. Used on tinplate closures and food containers during the war, these finishes have demonstrated post-war possibilities in fabricating metal parts from pre-coated sheet metal. The successful use of baked resin coatings on the inside of steel pipes and tubing for heat exchangers and low-pressure boilers has also opened up new fields to these highly corrosion-resistant coatings.

Metallic coatings, too, are entering what promises to be a new era of usefulness. Lead alloy coatings developed during the war are harder, more fatigue- and creep-resistant, and more corrosion-resistant than earlier lead coatings. The electrolytic tin plating process, developed to save critical tin, has shown that thinner tin coatings of adequate protectiveness can be advantageously used for many products, especially when treated with a new filming agent that inhibits the rusting of the tinned material.

Zinc coatings have made remarkable progress—new chemical treatments for zinc-coated steel have improved the utility of that material, while the expansion in use of continuous electrolytic lines for depositing high-purity zinc at high speeds on steel sheet offers many possibilities for pre-plated metals in the post-war period, with some interest being shown in the possible use of zinc coated steel for automobile body stock.

COATED STEEL—A recently developed flat-rolled corrosion-resistant product of considerable interest for the future is hot-dipped aluminum-coated sheet and strip steel, which combines the corrosion-resistant characteristics and surface-appearance of aluminum with the strength of steel. New virtreous-enameling steels and enamels have also been introduced that permit the production of white or colored one-coat (no ground coat necessary) finishes direct to the base metal that are equal in protectiveness and appearance to former multi-coat wares and which last longer because of the reduced chipping of the thinner coat.

Sea-water corrosion problems, especially prominent in wartime, have stimulated metal-protection developments of far-reaching importance. The most spectacular have been in the rust-proofing and packaging of steel war products to assure their arrival at the point of combat use free from rust and other damage. Rustproofing treatments ranging from improved slushing oils all the way to highly engineered chemically applied rust-inhibiting black coatings have been successfully developed for tiny parts.

One outstanding new development in this field is the plastics-dip-coating, applied by dipping the cleaned part in a hot ethyl-cellulose mixture and removing. The film dries immediately to give a continous, tight-fitting, perfect-seal wrapping for the part. For larger parts, loose-fitting film bags, containing a desiccant like silica gel, are widely used.

Sea-water corrosion has always been one of our toughest engineering problems. Copper alloys as a class have given the best service, with such materials as manganese-bronze, aluminum-bronze, the silicon-bronzes, admiralty metal, the cupro-nickels, and aluminum-brass outstanding performers in this group. Nickel and its alloys have also been highly useful in sea-water or sea-air applications. A seldom-appreciated

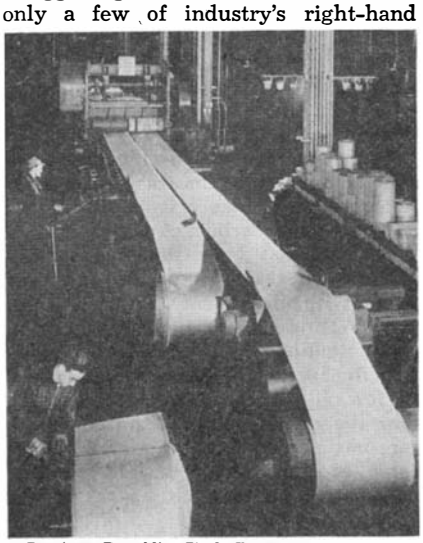
The Electromotive Force Series of Metals

Theoretical Listing	Practicalized Version
Anodic or Corroding End	
Lithium	Magnesium
Rubidium	Magnesium Alloys
Potassium	Zinc
Strontium	Pure Aluminum (2S)
Barium	Cadmium
Calcium	Aluminum Alloy (17ST)
Sodium	Steel or Iron
Magnesium	Cast Iron
Aluminum	Chromium-Iron (active)
Beryllium	Stainless Steel, 18-8 (active)
Uranium	Lead-Tin Solders
Manganese	Lead
Zinc	Tin
Chromium	Nickel (active)
Gallium	Nickel-Chromium Alloy (active)
Iron (ferrous)	Brasses
Cadmium	Copper
Indium	Bronzes
Thallium	Copper-Nickel Alloys
Cobalt	Monel Metal
Nickel	Silver Brazing Alloys
Tin	Nickel (passive)
Lead	Nickel-Chromium Alloy (passive)
Iron (ferric)	Chromium-Iron (passive)
Antimony	Stainless steel, 18-8 (passive)
Bismuth	Silver
Arsenic	Graphite
Copper (cupric)	Gold
Polonium (18° C.)	Platinum
Copper (cuprous)	
Tellurium	
Silver	
Mercury	
Lead	
Palladium	
Platinum	
Cathodic or Noble End	

but highly important property of modern gray cast irons is their superlative resistance to sea-water corrosion, a characteristic that has led to their application for marine propellers and similar jobs.

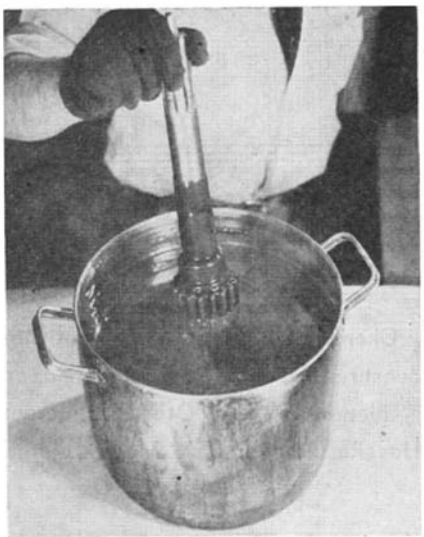
ALLOYING AGAINST CORROSION—It is in the industrial-corrosion field, of course, that the greatest diversification of problems and materials exists. Here the problems are more likely to be solved by alloying rather than by surface coating, for first cost is usually less important in industrial equipment than it is in finished consumer products. There has, however, been a trend to the use of clad metals (especially steel clad with stainless steel or nickel or nickel alloys or copper alloys), which combine a highly corrosion resistant but expensive thin surface layer with a cheap underlying material.

Among the newer alloys or applications of outstanding interest in the solution of industrial equipment corrosion problems are the cobalt-chromium-tungsten and the nickel-base molybdenum alloys. While these are more expensive and not as workable as less corrosion-resistant materials, they have found increasing use, nevertheless, because of their resistance to most chemicals and to high-temperature oxidation. Other innovations include bearings made by heavily plating silver on a steel back, then plating lead and indium over the silver, and finally diffusing the indium into the lead. Treated in this fashion the bearings have excellent resistance to lubricant corrosion and good bearing qualities in general. Another development is that of new aluminum alloys containing zinc and magnesium whose generic tendency toward stress-corrosion cracking has been reduced to such an extent as to permit full utilization of their excellent mechanical properties. Specially-treated (stabilized) stainless steels containing titanium or columbium are also widely used in the struggle against corrosion. These are only a few of industry's right-hand men wherever resistance to corrosion, scaling, or mechanical failure, alone or together, are involved.



Courtesy Republic Steel Company

Straight-line pickling and normalizing equipment for wide stainless steel strip was constructed to meet the expanding demand for this metal



Courtesy Dow Chemical Company

When dry, the hot plastics in which this metal part has just been dipped will leave a tight-fitting corrosion-proof, and protective wrapping

In the construction of their equipment, the chemical process industries have done remarkable things with aluminum alloys, copper alloys, and the noble metals like silver and platinum. Tantalum has found new prominence in the process-industry equipment field because of its unusual resistance to acid attack. Stainless steels containing molybdenum do yeoman duty in petroleum processing equipment. Glass lined vessels and piping become ever more numerous as their almost universal corrosion resistance is increasingly recognized. The clad steels previously mentioned are becoming standard equipment for heavy chemical equipment, the linings being applied either to fabricated vessels by spot welding, plug welding, or strip lining, or in multi-layer construction.

Attention to the service factors surrounding individual corrosion problems has also been successful. Designers of salt-water condensers limit the water velocities to suit the materials used. Knowledge of galvanic corrosion fundamentals leads to the use of valve trim materials (like Monel) more noble than valve bodies (bronze) so that the vital working parts will be protected without serious harm to the bodies. Cathodic protection, too, is being utilized on a more scientific basis than ever before.

The story of corrosion and how it its being licked is an outstanding example of scientific co-operation, for the pooled knowledge and effort of the chemical engineer and the metallurgical engineer have brought us farther in the last 20 years of our battle against this worst ravager of man's handiwork than we had gone in all previous centuries of history.

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MAGNESIUM ALLOYS

Have Greater Toughness, Higher Yield Strengths

RECENTLY announced by Dow Chemical Company is a new sheet magnesium alloy, having 5 percent aluminum and 1 percent zinc, designated as Dowmetal 251X. This alloy retains the strength and weldability of the previous 6.5 percent aluminum, 1 percent zinc alloy, and has greater ductility and toughness.

Another interesting development is a heat treating practice for extruded magnesium alloys of the 8 percent aluminum, 0.5 percent zinc type which gives higher yield strengths, especially in compression, than have been previously available. Originally developed as an experimental alloy for all magnesium aircraft primary structures, this material is now commercially available with minimum yield strengths of 30,000 pounds per square inch in both tension and compression.

THREAD GAGES

Made of Cast Iron to Provide Notable Savings

ONE of the war's worst production bottlenecks has been the supply of steel gages for dimensional inspection. Some manufacturers have solved the problem by using specially processed high-strength cast iron for thread gages, with notable savings in production time, operating costs, labor, and critical material.

In the conventional plug thread gage the handle and gaging member are manufactured separately. The cast iron (actually Meehanite iron) gage is a one-piece unit, with the handle and gage cast integral. Engineers who have adopted the practice of making these gages of cast iron report considerable savings in cost because of cast iron's better machining properties and lower material cost than those of tool steel and because the cast gages have about 25 percent longer life in this application.

NICKEL ALLOYS

Represent Advance in Heat-Treatable Metals

A SIGNIFICANT materials-engineering development of recent years has been the growing interest in and use of heat-treatable nonferrous alloys such as beryllium-copper and "Z-nickel" for springs and similar applications. Information on the composition and general age-hardening behavior of the nickel-base alloys has just been released by W. J. Kroll.

Nickel is made hardenable by simultaneous additions of magnesium and carbon, a maximum hardness of 405 Brinell being reported for an alloy of 0.6 percent magnesium and 0.4 percent carbon. Higher hardnesses are available in heat-treated nickel-beryllium alloys, but the costs are not so favorable.

Chemicals On Rails

Expansion of Many Chemical Industries Has Been Made Possible Only by Co-Operative Measures Taken to Reduce the Hazards of Bulk Shipments of Explosive, Flammable, and Other Dangerous Materials. Intensive Research Has Resulted in Safe Methods of Shipping by Rail

AFTER World War I the chemical industries entered a period of rapid expansion, both as to volume and variety of products. The multiplication of plastics materials during recent years has captured the popular imagination. In this expansion railway transportation has played a special part which has brought it into particularly close relationship with many chemical industries. This special relationship has two aspects—the work of the Bureau of Explosives and the development of special types of tank cars which have stepped up the transportation of many chemicals from carboy lots of a few gallons each to carload lots of thousands of gallons each.

The first steps in this transportation progress were taken when a movement was begun through the American Railway Association for the development of a uniform code of rules to be observed by all member roads. Such a code was formulated and adopted and the job of enforcing it was entrusted to a Bureau for the Safe Transportation of Explosives and Other Dangerous Articles created under the auspices of the Association.

The function of this organization, commonly called the Bureau of Explosives, has been far more than that of a policeman enforcing a code of rules. The Bureau has become expert on all conditions affecting safe transportation of all dangerous articles. One of its earliest activities was a series of impact tests to measure the forces of coupling and train-operating shocks and to relate these to the strength required in containers for the transportation of all kinds of dangerous articles.

In carrying out this function it has tested many types of containers to destruction and has developed complete specifications for a variety of steel cylinders; steel barrels with and without linings of lead, aluminum, or rubber; wooden barrels and kegs; metal kegs; fiberboard boxes; wooden boxes, nailed and wirebound; glued plywood boxes; wooden, plywood, and fiberboard drums; rubber, steel, and aluminum drums; mailing tubes; carboys; paper and cloth bags.

The Bureau early won the confidence of the manufacturers of dangerous articles. The industries have co-operated with the bureau in its investigations, in its own chemical laboratory, of the characteristics of many materials. These investigations have brought to light instances where improvement in uniformity of certain characteristics as well as changes in quality have brought hazards under control.

An all-aluminum welded tank car designed for transporting peroxide

SAFE BULK SHIPMENTS—The first concerted effort to bring the hazards of transporting dangerous articles in tank cars under control was made in 1903 when the Master Car Builders' Association recommended simple specifications for improved construction of the tank and of the car as a vehicle. These were approved by the American Railway Association. They included the design of safety valves for use on cars loaded with petroleum products, ammonia, gas liquor, and turpentine. These were constructed so that one or two valves, depending upon the capacity of the tank, provided sufficient venting capacity to prevent a dangerous rise of pressure should the tanks be subjected to the direct heat of flames in fires connected with train wrecks.

Since that time, experience—including a number of disasters resulting from mishandling of highly volatile flammable products—also investigation and much testing, have led to modifications and additions to the first simple specifications so that highly volatile flammable liquids and compressed gases, both flammable and corrosive, are being handled in large quantities with a high safety record, proving the value of the work.

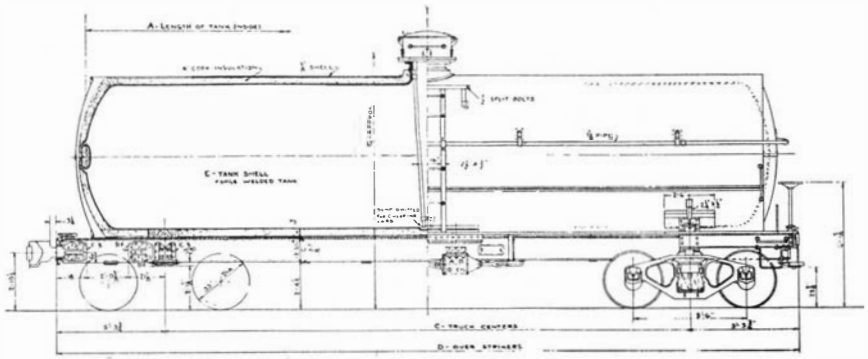
TAILOR-MADE TANK CARS—Since the beginning of organized effort to develop the tank car, the list of materials moving in these specialized cars has expanded tremendously. While many of these materials have been articles of commerce for a long time, their utility was greatly limited by the inability to transport them in containers of more than a few gallons each.

The development of high-pressure cars is one factor in this widespread release of chemicals from the limitations of the carboy. Another important factor has been the development of tanks of special materials, and steel tanks with linings of materials suitable to protect these chemicals from contamination and to resist the destructive action of corrosive materials. A few illustrations will make clear how the development of suitable tank cars has changed the commercial character of many materials by making bulk shipments possible.

Until 1914 the production of chlorine was a very limited enterprise and the gas was transported in small cylinders. When high-pressure tank cars became available, 16 tons of chlorine could be shipped in a single container. Hun-

dreds of these cars are employed in this service. Some of the newer ones move 55 tons of chlorine in a single load. This powerful oxidizer is used in large quantities as a bleaching agent, particularly in the textile and paper industries.

Anhydrous ammonia is another compressed gas formerly limited to transportation in cylinders. It now moves in high-pressure tank cars, 25 tons to the container. Its price per pound in tank-car lots is about one sixth of its former price in cylinder lots. It was formerly used for little else than a refrigerant; at its present price it has become a practicable constituent of fertilizers.



Drawing of an insulated high-pressure tank car developed for shipping compressed gases such as chlorine, sulfur dioxide, anhydrous ammonia, and propane. Some cars of this type are strong enough to withstand gas pressures up to 450 pounds per square inch

The helium tank car is an extreme example of what can be done in the transportation of compressed gases. The considerations which led to the development of this car were set forth in a paper by R. C. Pierce, vice president, General American Tank Car Corporation, presented before the American Society of Mechanical Engineers, from which the following is extracted: "Large quantities of high-pressure gases naturally present problems of safety. . . Several years' study of this problem resulted in the construction of a multi-tank type of helium cars. A long, small-diameter tank with a comparatively thin wall. . . made heat-treatment easier. . . The greatest design problem was in the anchorage of the tanks. The tank stresses, due to their weight and the internal pressure of the gas, could be readily calculated. It would be quite impossible to calculate the stresses which the tanks might receive if they were subjected to forces caused by the twisting of the car structure. . ."

The imposition on the tanks of stresses caused by the motion of the car structure was prevented, he said, "by supporting each end of each tank in a bulkhead, alternate layers being anchored at each end of the car. The anchoring of each tank against longitudinal motion was accomplished at one end, the opposite end of the tank being permitted to slide back and forth with reasonable freedom in the opposite bulkhead."

Each tank is tested at 2750 pounds per square inch. The empty weight of the car is a little more than 100 tons. Despite the fact that the payload is only one ton, these cars are said to have paid for themselves in about 14 round trips.

When synthetic glacial acetic acid reached production on a commercial stage, the rapid growth of the rayon industry called for increasing amounts of this material. Tests indicated that it could be transported in tanks made of certain aluminum alloys. (As a matter of fact, the first aluminum tank car was built expressly for this type of transportation.) In developing this car considerable experimentation was necessary before there was reasonable assurance that it would meet the requirements of railway operating conditions. A number of aluminum cars have since been built for this service.

Everyone is familiar with hydrogen peroxide as a household antiseptic and bleach. In its drug-store form it is a very dilute solution. In concentrated form, however, it is a dangerously active oxidizing agent. Its transportation was formerly limited to carboys of 13 gallons each. In 1931 a 4000-gallon aluminum tank car was built to meet the demand for the movement of hydrogen peroxide in large quantities to be used as a bleaching agent in the textile industry.

In building this car special care had to be exercised in the choice of material. The aluminum alloys had to be low in manganese, iron, and titanium. But such an alloy was of low strength. To develop adequate strength it was necessary to fabricate the tank parts and then heat-treat them before assembly. The tank rivets had to be heated in temperature-controlled electric furnaces and driven quickly within a prescribed temperature range.

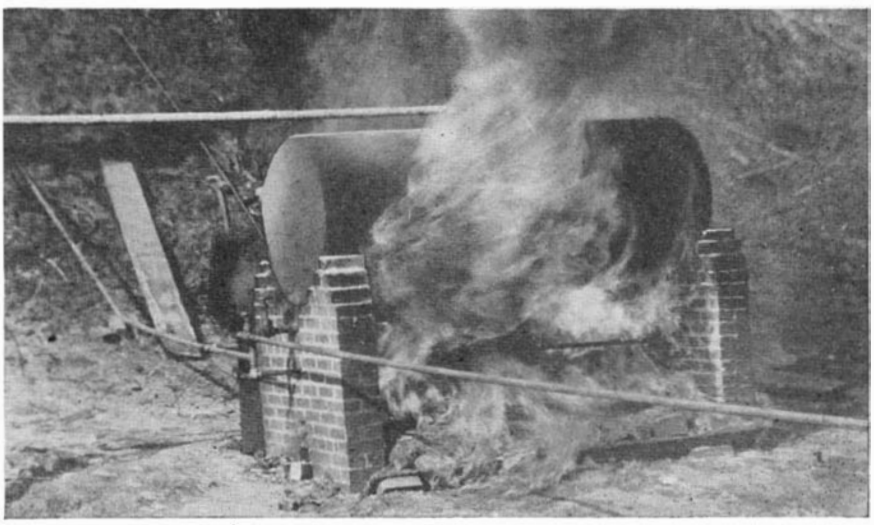
Aluminum cars constructed for transporting peroxide illustrate how a need in one branch of industry influences developments in other industries. To satisfy the desire of a chemical industry to expand the market for its product, a satisfactory aluminum alloy had to be found and the tank-car builder had to develop a special technique of construction.

NICKEL-CLAD STEEL—Another instance of this kind of inter-industry co-operative effort was the solution of the problem of producing nickel-clad steel plates so that steel tank cars could be built with integral nickel linings. The pressure in this case came from a desire to transport phenol and caustic soda in large quantities protected from contamination. The movement of phenol and a growing list of other chemicals in large quantities, free from iron contamination, was one essential in the growth of the plastics industries.

The production of nickel-clad steel involved a problem of rolling-mill technique, in the solution of which the car builder and the metal producer co-operated. In the end it was solved and in the finished sheet the nickel, varying from 10 to 20 percent of the combined thickness of the two metals, is completely welded to the steel.

Highly concentrated sulfuric acid for most commercial purposes can be shipped in steel tank cars. In this state its action on the metal is too slow to constitute a serious corrosion problem and the iron contamination is not detrimental to the commercial use of the acid. In a less concentrated form, sulfuric acid is used in storage batteries. Acids shipped for this purpose must be protected from iron contamination, and this requires a lead-lined tank.

OTHER LININGS—For the protection of the car and the prevention of contamination by muriatic and phosphoric acids, rubber linings are applied to the interiors of steel tanks. This lining



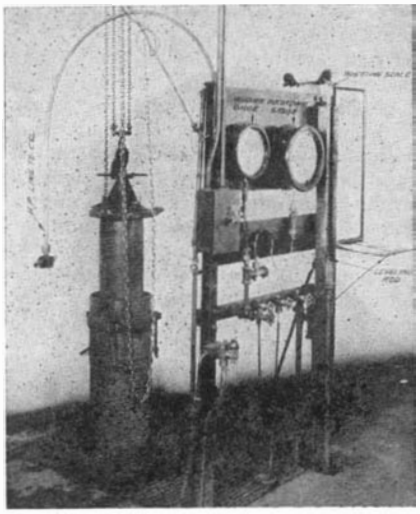
Simulating a wreck fire and its effect on a miniature car tank. From such tests comes valuable information on safe methods of transporting dangerous compressed gases

is also used for the shipment of formaldehyde. Cars with inner tanks of stainless steel are hauling nitric acid, acetic acid, acetic anhydride, butyl acetate, butyl aldehyde, formaldehyde, acetaldehyde, and butyric acid.

A number of baked-on varnish linings are in use for the transportation of caustic soda. They are short lived, however, and not altogether reliable, and nickel-clad tanks are being used in this service.

Neither the sprayed-on metal linings of tin, zinc, or aluminum, nor glass linings are important factors in the chemical industry. Because of their porous nature the sprayed metal linings do not completely seal off the steel from the contents, but do so sufficiently to protect wines and syrups. Glass-lined cars are more generally used for milk and beverages than for chemical products.

A good indication of the close relation of the chemical industries to the agencies that develop and operate tank cars is the fact that the Manufacturing Chemists' Association has a tank-car committee of its own. Thus there are, working together in the solution of the special problems involved in giving new chemicals an opportunity to serve the American people on a vast scale, the Government, represented by the Interstate Commerce Commission; the railroads, represented by the Tank Car Committee of the Mechanical Division, Association of American Railroads, and the Bureau of Explosives; the builders of tank cars; and the producers of materials which are inert to the various active chemical agents now regular articles of commerce.



Apparatus used by the Bureau of Explosives for testing compressed gas cylinders. A water jacket is used to permit accurate measurement of volumetric expansion under pressure

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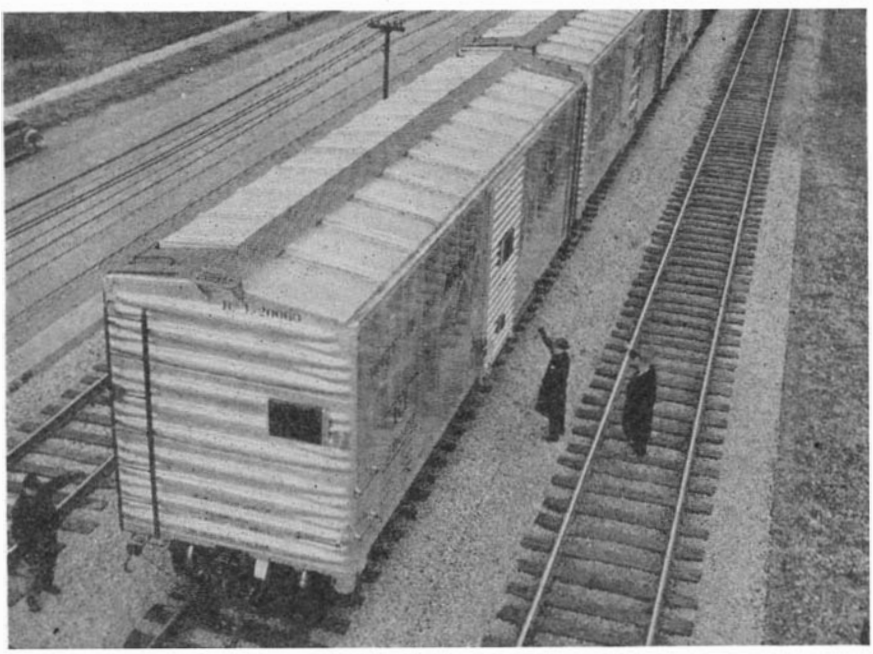
FREIGHT CARS

Superstructures Built of High-Strength Alloy

FIRST orders for aluminum box cars, now being turned out from the plant of the Mt. Vernon Car Manufacturing Company, consist of ten cars each for the Alton, the Rock Island, and the Minneapolis & St. Louis. The superstructure material is the same high-strength aluminum alloy employed in the B-29 Superfortresses. It was furnished by Reynolds Metal Company who also designed the cars.

The entire car-body structure, including the frame members, the side sheathing, corrugated ends, and roof, are fabricated of the aluminum material. The center sills and other underframe parts, however, are all-steel and the underframe is built like that of a standard steel box car. Five of the Rock Island cars are fitted with Timkin roller bearings. The car body has standard inside dimensions.

The cars weight about 4½ tons less than would a standard all-steel car of the same dimensions.



Aluminum alloy in this freight car body structure saves 4½ tons

DIESEL LOCOMOTIVES

Pile Up High Mileages Between Overhauls

BETWEEN August, 1940, and September, 1944, Diesel-electric locomotive Number 9-M-1A of the Union Pacific Railroad, one of six assigned to its Kansas-City-Denver run, completed more than 1,049,000 miles without a major overhaul. At present it is not intended to shop this locomotive until some time in 1945. Diesel locomotives on the "City of Denver" of the Union Pacific Railroad and the Chicago & North Western Railway have traveled more than 3,000,000 miles each in eight years without shopping for general repairs.

Modern steam locomotives require shopping after 200,000 to 275,000 miles, at which time the machinery is torn down, repaired and reassembled, and the boiler tubes removed, cleaned, and reset.

MODERNIZATION

Reflects 30 Years of Locomotive Progress

TEN PACIFIC type passenger locomotives (a four-wheel leading truck, six driving wheels, and a two-wheel trailing truck) on the Alton were built 30 year ago to handle regular trains of seven cars on a schedule of eight hours for the 282-mile run between St. Louis and Chicago. Six years ago these locomotives were improved by adding five feet to the length of the tender and thus increasing its capacity.

The locomotives were also equipped with stokers and improved grates, thereby relieving them of the limitation of the human fireman and improving combustion. The boiler pressure was raised from 200 to 220 pounds per square inch. The regular train was then increased to 11 cars, and the schedule reduced from eight to 6½ hours.

In 1941, because a railroad was not then permitted to purchase new passenger power, the Alton decided to meet its urgent need for added power to handle heavier passenger trains by further improving the old Pacific type locomotives. This time feedwater heaters were added, the fireboxes were rebuilt to include Thermic syphons, new superheaters were installed, and an automatic device was provided to prevent boiler foaming. The feedwater heater increases the locomotive capacity and efficiency by reclaiming from 10 to 13 percent of the heat and saving nearly the same percentage of water, thus in effect increasing the tender capacity.

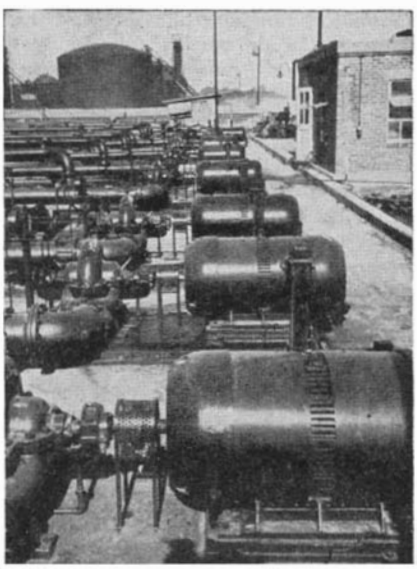
The modernized locomotives, although by no means as good as completely modern new locomotives, now handle 14 cars on a 5-hour, 50-minute schedule.

Minimum Maintenance Motors

With New Markets in Sight, Electric Motor Manufacturers are Bringing Out New Motors That are Proof Against Practically All Industrial Hazards. They Will Operate Under Formerly Impossible Conditions and Will Give Better Service With Less Servicing and Greater Profit

THE chemical age is bringing a brand new era to the electric motor. Motors are now being made so they can be put almost anywhere, without regard for explosive dusts, flammable fumes, lint, abrasives, and other ancient enemies. Oil can drip on them, water from a hose can be squirted full blast on them—they take all sorts of abuses which a few short years ago would have been positive causes of shutdowns. And even more important, every time a motor becomes master of one of its ancient enemies the maintenance cost of keeping that motor running is reduced accordingly, and the motor can be used with greater profit.

Such improvements can have only one result. More motors will be used in factories, homes, mines, on farms—everywhere. And there is room for more. The Electrical Manufacturers Public Information Service tells us that only 200 million electric motors are in daily service in the United States. This is less than one and a half motors for each member of the population. With better protected motors that give



There is no danger when these explosion-proof motors pump aviation gas

less trouble and need less care there will be plenty of use for ten times that number.

To any old-timer the present trend amounts to a revolution. He saw a few "explosion-proof" motors being developed some 25 years ago for use in mines—motors had to be as safe as the miner's safety lamp if they were to be used where explosive gases might accumulate. Most of these motors depended upon labyrinth seals at their ends to keep explosions of gases within the motors from getting out and igniting gases outside them. (Flame refuses to turn the many corners of a labyrinth.)

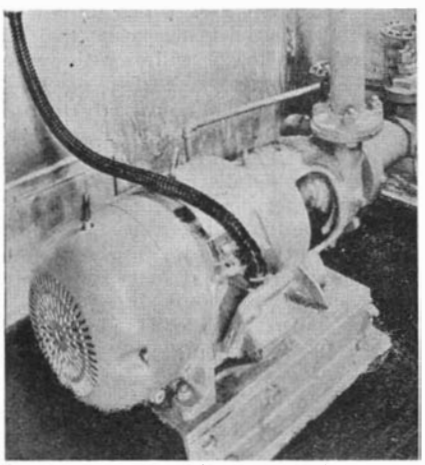
But most of these motors failed to be explosion-proof and few would meet modern safety rules. There also were small enclosed motors for automobile starters, vacuum cleaners, and the like, but these were not expected to deliver much power nor to run steadily for long periods. So the old time electrician treated his ordinary motors like fine watches, keeping them out of the way of dusts and oil fogs and even moisture fogs, cleaning them out carefully at regular intervals, and hoping for the best.

In the chemical industry such treatment of motors was nearly impossible. A few motors could be mounted far from any dangerous dusts and fumes and their power transmitted to the point of work by shafts, belts, chains, and the like. A few more could be put in especially air conditioned rooms close to the dangerous materials—a practice still in use for extra-hazardous places—but these also had to be linked by power-transmission sequences to the work points where the power was needed.

VERSATILE MOTORS—What the industry wanted was motors that could be put anywhere, left alone with very little attention, walled off where nobody could see them, turned on and off or changed in speed by automatic controls. Some of these motors would have to be specially constructed. No one yet has dreamed up a single type which will take every punishment or meet every hazard a chemical plant is likely to give it. Yet trouble-proof motors had to be built if the chemical industry was to develop.

Other industries were glad to get those motors too. The fume-proof motor was welcome at the oil refinery, the dust-explosion-proof one at the flour mill. Machine shops, wood-working plants, laundries, mines, every industrial user of motors wanted the new kinds. The trickle of specially protected types of motors coming on to the market grew into a deluge.

The most common improvement is to make the motor drip-proof or splash-proof: Most factories want to mount motors on the floors or to have them



Serving a pump, this fan-cooled motor is totally enclosed for safety's sake

underneath conveyors or the working levels of machines. There are many reasons for this. First of all, the floor nearly always is strong and rigid enough to hold the motor in place and in alinement while an overhead mounting may require special bracing.

The easiest connection between the motor and the device it is to drive may be at floor level or below the work level of the machine. In the old days of overhead driving shafts and long belts the driven pulley on the machine often was close to the floor level and this same spot is where it is easiest to attach the motor.

Another point is that overhead space is becoming more and more valuable. Controls are located there as well as materials handling equipment. Lighting comes mostly from the ceiling; the motor must not be in its way.

Drip- and splash-proof motors still depend largely upon air being sucked through them to keep them cool. They are so designed, however, that oil, wa-

ter, dust, or small objects falling upon them will not get into their internal parts.

One recent type has only its upper half enclosed, the bottom being open for ventilation. The ventilation is by fan which blows the incoming cool air up inside the casing to displace the warmed air which naturally rises inside the shell. Bearings, windings, magnetic core, and frame all are cooled by the fan.

Another has protected air inlets and exhausts with cross-flow ventilation. A protected top model has air drawn in from the bottom at both ends and exhausted from the sides. There is a fully enclosed job with rotor fan and conical baffles. While most splash- and drip-proof motors are of special dimensions, which seem to be made necessary by their protective shields, several models are being made to standard dimensions.

SPECIAL HAZARDS—Totally or partially enclosed motors protected against special hazards are being designed. One type is used in cotton mills or anywhere that lint is a problem. Lint has a way of gathering in hidden places, drying out, absorbing any oil which the air or any solid material brings to it (and oil will travel as fog or will seep to every part of a factory) and then catching fire. Textile mills have literally thousands of small unreported fires from this cause. But these motors do not hold lint; it simply falls or is blown clear.

Other types are specially designed for machine tools. It took years of slow development to work these out. As motor makers found out more and more about what to do, machine-tool makers put their motors closer and closer to where cutting oils might splash or steel chips and abrasive particles might fly. Now one machine that makes airplane engine cylinder heads has 80 electric motors and 15 miles of electric wiring to power and control its automatic motions—and this is not an unusually complicated machine tool.

Vertical motors (their shafts are vertical instead of horizontal) have been made drip- and splash-proof. In these the top ends may be totally closed. The old difficulty that lubricant put in the upper bearing would run down into the electrical parts, while it was almost impossible to oil the bottom bearing at all, has been solved by cartridge-type ball bearings in which the lubricant is sealed for the life of the bearing so that the motors never will need oiling or greasing. With such bearings, totally enclosed motors can be made to run in any position —horizontal, vertical, or at any angle.

Drip and splash problems are common enough, but explosion hazards are increasing too. Highly accurate machining, for example, is likely to produce metal dusts or chips so fine that they can act like dusts. And nearly any metallic dusts are explosive if mixed with air and ignited. Magnesium, bronze, and aluminum dusts are especially explosive, and the use of those metals is increasing.

Explosive and flammable gases exist not only in mines and chemical plants and oil refineries, but to ever increasing extents in factories of all kinds. Solvent fumes from the thousands of cleaning, lacquering, and stripping operations which are becoming so common, can accumulate rapidly in spaces near where the solvents are being used. Many a motor has to work right in the fumes. Natural and manufactured gases can leak; oils at any process can suffer fractional distillation and give off flammable fumes.

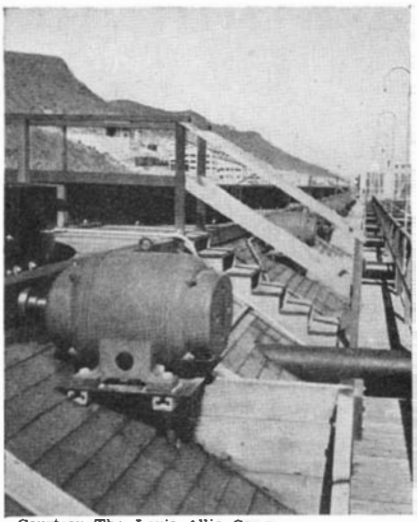
Present also are those organic dusts which have been blowing in grist mills, breweries, and coal screening rooms for generations. But for every one of these hazards the motor manufacturers either have the answer or are busily working it out.

STANDARDS—Their first step was to work with the National Board of Fire Underwriters, the American Standards Association, and others, to get a National Electric Code which covers all electrical practices for hazardous locations. This was done in 1940 and it has been amended since, but it poses some tough problems which have not been licked yet; or at least no solutions of them have been made public.

Acetylene gas is one unbeaten hazard. It stands all alone in Group A of Class 1 in the tables. Some of the other ones, especially those found in powder mills, are still on the recalcitrant list.

The code divides hazards into four classifications in accordance with how hard it is to keep the materials out of the motors, then lets the motor makers design their machines accordingly.

Gases constitute Class 1. The code assumes that they cannot be kept out of the motors and the motor control equipment; therefore all such equipment must stand up against internal explosions. This means that parts must be heavy. It helps to make the motor with inside clearances so small that very little gas can get in to explode at any one time.



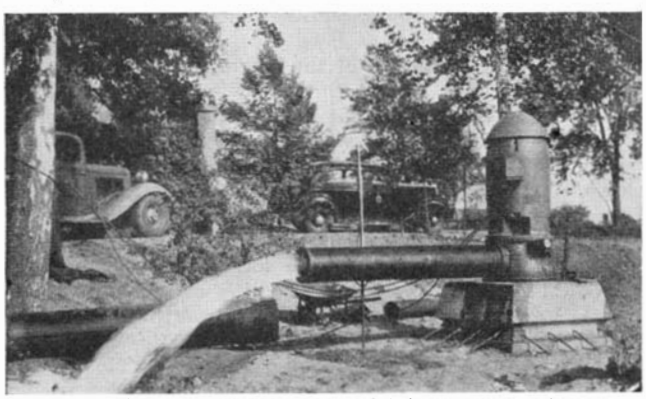
Courtesy The Louis Allis Company

Weather-proof and splash-proof, these motors can do their job out-of-doors

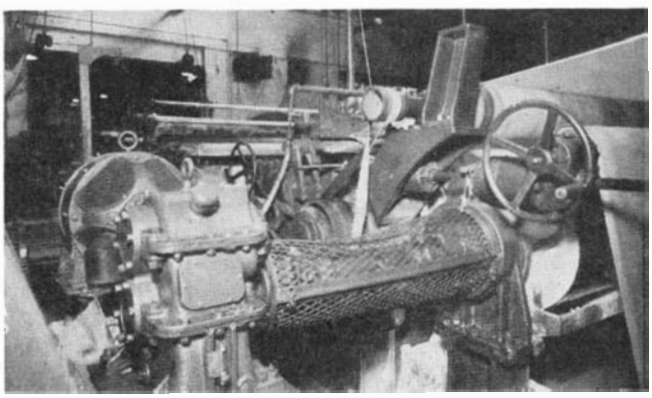
Class 2 includes dusts. Dusts can be kept out of electrical equipment but might go off with more force than dynamite if there was electrical arcing outside of the machine. Class 3 covers lints; easier than dusts to keep out of the motors but hazardous because they fly about in the air and are likely to gather in dangerous places. Class 4 is for fibers which are in storage and not likely to be carried in air currents.

The motor designer does not have to work something out to handle every problem in Class 1 or in Class 2. He can pick a hard one or an easy one, or he can aim at something for which he knows he has a market. To let him do this there are a number of subclassifications.

Class 1 has (A) acetylene, (B) hydrogen and manufactured gas, (C) ethyl ether vapor, and (D) gasoline,



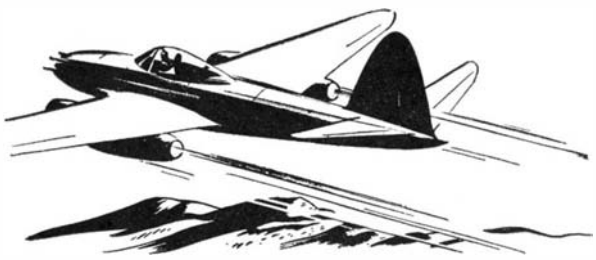
Here a deep well pump is operated by a vertical hollow-shaft motor, weather-proofed for permanent use outdoors



Coupled to a gear reducer for a paper mill drive, this 15-horsepower, direct-current motor is completely enclosed

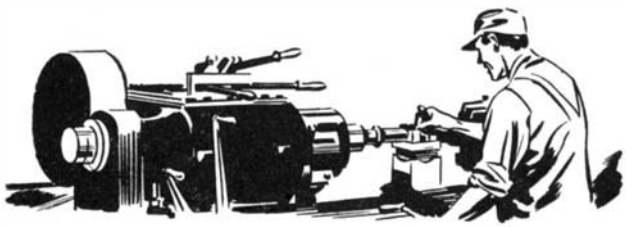
THE YEAR THE TIDE TURNED...

1944 was the year of greatest advance in invention, science and industrial production in world history. Here is a part of that record as written by Westinghouse.

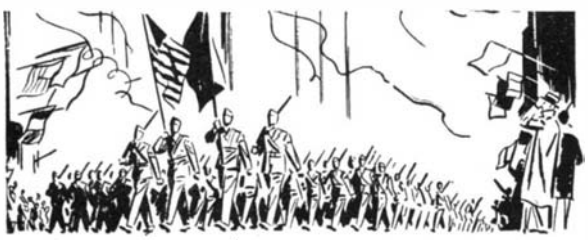


In the new field of jet propulsion for the Navy Bureau of Aeronautics, we developed the first completely American jet propulsion engine, which promises to produce more power, for its weight, than any of the European-designed engines now being built in this country.

Aboard aircraft carriers.. new Westinghouse-designed elevators are in action. We found a way to get carrier planes to and from the flight deck faster, keeping it clear for flying operations. A development that has proved very important in getting more planes in the air quicker.



We stayed on our jobs, 115,000 strong... no major strike or slowdown has occurred in any Westinghouse plant since war began. 14,867 employees earned cash Suggestion Awards for new ways to increase production, cut costs. We employed 5,620 honorably-discharged veterans, many of them wearers of the Purple Heart. In addition to the big job of operating our own plants . . . Westinghouse operated 3 of the 7 great Navy-owned ordnance plants.



A promise for the future.. There is a lot to be done yet . . . and you can count on Westinghouse men and women to do their share of the war job as long as American men still fight anywhere. And when war is won, you can look to us for the best in electric appliances, radios, lighting, electrical equipment for industry . . . and for continued leadership in new fields.

Electric power plants on wheels.. we built and delivered 34 Westinghouse Power Trains, each a complete power plant on railway cars. By means of these remarkable trains, electric service can be "shipped" to liberated and devastated areas behind the fighting fronts.

Against enemies even more deadly than the Jap.. a mighty weapon was developed by Westinghouse engineers, co-operating with the Army and the Department of Agriculture. The enemy . . . disease-carrying insects. Scourge of fighting men through the ages! The weapon . . . the Bug Bomb, no bigger than a can of soup, means sudden death to insect pests in 250 pup tents or 50 big bombers.

A billion dollars' worth of production and service . . . was delivered by Westinghouse to America in 1944. Nearly half the money we received went for wages. Less than 3 cents per dollar were earned as profit on what we did. We paid the Government 102 millon dollars in taxes. For each dollar's worth of goods and services delivered we kept only a little more than 2½ cents as net profit.

Westinghouse Electric & Manufacturing Company,
Pittsburgh 30, Pa.

Westinghouse

PLANTS IN 25 CITIES OFFICES EVERYWHERE

TED MALONE—Monday, Tuesday, Wednesday Evening, Blue Network
Tune in: JOHN CHARLES THOMAS—Sunday 2:30 pm, EWT, NBC

acetone, alcohol, and natural gas vapors, Class 2 has (E) metal dusts, (F) coal or coke dust, (G) grain dust. The higher they are on the list the harder they are to defeat; metal dust is the dust-proof motor's public enemy number one.

The motor manufacturers are accepting any challenge in which the market is big enough to provide good high stakes.

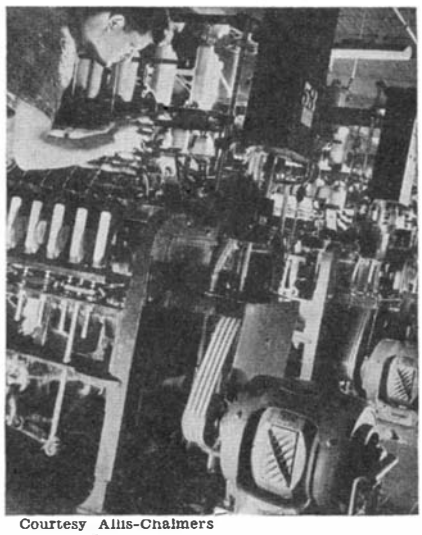
Take magnesium for example. The finer the magnesium dust or chip the greater its hazard. A lighted match can be held to a solid chunk of this metal and nothing will happen, but do not try that with a pile of its shavings. And magnesium, the lightest of commercial metals, is being used in such large quantities that hundreds of machine tools are cutting it.

A new type of motor is specially made to stand magnesium dusts and is good for any dust, metallic or otherwise. The cooling is not done by blowing air through the motor itself but by an external fan which blows air through vent passages which are in the case but do not penetrate to the electrical parts. These passages are straight; dust is not likely to lodge in them and if it does it is easy to clean out. The fan is of non-sparking bronze.

Another motor is hermetically sealed against dusts, gases, and fibers. It, too, depends upon casing vents. Types like this one come closest to being the universal answer to hazardous fumes and dusts. But they are not yet ready for everything—the case still gets too hot for some gases as it throws off the internal motor heat.

There are other tricks. On 400 horsepower and larger motors it can pay to keep the electrical parts filled with an inert gas. The pressure of the inert gas is always a little greater than atmospheric and if there is any leakage it will be of inert gas escaping.

Another method is to give the motor its own fresh air and exhaust piping.



Courtesy Allis-Chalmers

Textile mills now use lint-protected motors belted directly to machines

So long as those ducts do not leak, no explosive gases can get into the motor.

The motor manufacturers are out to make their products fool-proof and fool-resistant. The market is welcoming the new motors as fast as they appear. And in the future far more motors will be used because motors will solve far more problems.

POWER EXCHANGE

Offers Economy Possibilities To Industry and Public Service

A NOTION which will not down is that of having industrial plants feed back power to the municipal or public utility lines during the hours when the industrial load is low and the home load is high.

Much of central power station cost is for "stand by" equipment which is idle except for a few peak hours every day. Factories have to pay for that. In most communities the industrial power bill is in two parts: the demand bill for the extra power needed to start up the machinery in the morning and for other emergencies, and the running-load bill for the much lower ordinary operating load. Often the power needed at the demand peak is more than twice that of the operating load.

The idea is that industries could use steam, gas, or Diesel engines to generate the extra power for their own demand peaks, then could use public-service power for the all-day operating load, and, finally, could run these engines and feed their generated electricity to the public-service lines during the evening hours when the household load is at its highest. By this means the public utilities could get rid of much of their equipment and power could cost less for everybody.

Using industrial power on public service lines would need only the development of a few simple synchronizing devices. In addition to its public economy, this method would rid communities of the fear that if any serious accidents were to happen to their public power stations their industries, hospitals, schools, and homes would be in a bad way.

CONVECTION CURRENTS

Make Heat Treatment More Accurate

HEAT treatment of metals is attaining high accuracies during this war. And one contributor to this accuracy is more skilful use of convection currents in heating and cooling.

An example of this use is the case in which parts to be cooled between hardening and annealing operations are placed in a pit filled with inert gas which will prevent oxidation. The parts are placed at the bottom of the pit and therefore the convection currents from the heat they exude cause heated gas to rise to the top. In a well-insulated pit the rate of cooling is governed largely by the difference in temperature between the parts and the gas which surrounds them and by the ability of the gas to absorb heat. By controlling the temperature at the top of the pit the temperature of the gases returning as convection currents to the bottom is controlled and the cooling of the parts is kept at the desired rate.

MORE MODELS

Made by Co-Operation Of All Departments

A NEW way of using models to develop products and speed production has crept almost unnoticed into the practices of industry.

Based upon the old axiom that "the blueprints cannot tell everything; they must be interpreted," the new method is to have the various parties associated with any development make models independently of each other and then compare them.

A machine-tool maker, for example, makes a wooden model of a special machine, the shop which designed the machine or is to use it makes another, and the two are compared. The usual result is a third model having features superior to both of the original ones—and thus months or even years of experimentation are eliminated.

Models may be made by the product engineer, the tool maker, and the production manager independently of each other, all based on ideas for a new product submitted by the sales department. When all four departments get together to discuss the models, the result is likely to be a product which will sell, contains all of the latest features, and can be produced at low cost and with little expense for tooling.

PRODUCTION TEAMS

Speed Plant Operations and Make Quick Changes Possible

ONE of the oldest tricks in the handling of men is proving to be one of the newest. The trick is to form permanent teams of two or more workers—just as carpenters, coal passers, and other hand laborers used to do before mechanization became so general.

The new method is to educate teams as teams instead of teaching men as individuals. The crew of three which is to serve a centerless grinder, for example, sits down before a motion picture showing themselves at their work, and later views another film showing the ideal method of serving the machine. If the machine is to be changed to a new task, the team is shown a film of the operation as performed by a crew that has been long acquainted with it. They are encouraged to talk with each other as the film progresses, making their own plans for best team play as well as asking questions of the instructor.

Soldering teams, welding teams, inspection teams—dozens of different crews are handled in the same way.

Taking Steel's Temperature

By Means of a Newly Developed Thermocouple Pyrometer, the Temperature of Molten Steel Can be Rapidly Determined Before It is Poured, Thus Making Possible Accurate Control of Quality and Uniformity of Finished Steels

THE FIRST practical and accurate way of measuring temperatures of molten steel up to 3200 degrees, Fahrenheit, in an electric arc melting furnace has been developed and put to everyday use by adapting and improving upon a British device. Metallurgical engineers at Rustless Iron and Steel Corporation have devised a platinum thermocouple pyrometer which measures the temperature of a steel bath before the heat is tapped from the melting furnace. The reading is recorded by an electronic instrument.

The new pyrometer goes a step beyond the optical pyrometer, which is limited to the measurement of temperature when the liquid steel is visible in the open and being poured. It measures the temperature of the steel in the melting furnace—even though the steel itself is covered with a layer of slag—at a time when steps can be taken to regulate and control the temperature. After the steel is tapped from the melting furnace, little or no temperature control is possible. The development thus makes possible an improvement in the quality and uniformity of steels.

The pyrometer consists of two interchangeable parts—an immersion head (a platinum and platinum-rhodium thermocouple encased in a fused silica tube mounted in a block of graphite) and a handle which is a 12-foot insulated pipe containing the wires leading to an electronic recorder.

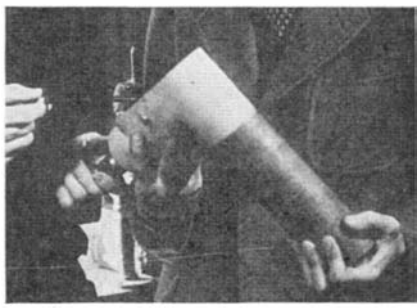
A worker checks the big dial of the electronic device which records temperatures ranging from 2200 degrees up to 3200 degrees, Fahrenheit, at the Rustless Company's Baltimore plant

The operator of the device simply manipulates the immersion head, mounted on the pipe handle, through the door of the electric furnace and dips it into the steel bath. The exposed tip of the silica tube, which contains the thermocouple wires, is immersed in the bath and the graphite block is in contact with the metal, the slag layer, and the hot atmosphere of the furnace. The whole operation, which is automatically recorded, takes about 45 seconds.

At a safe distance, the operator of the thermocouple pyrometer inserts the immersion head into an electric arc furnace where, in 45 seconds, it makes an accurate temperature record

The instrument by which the measured temperature is recorded is equipped with a large pointer and dial calibrated in degrees Fahrenheit. This recorder is mounted conveniently near the furnace where it is easily visible to the melter responsible for the manufacture of the steel and to the man operating the thermocouple.

The new thermocouple, making possible the accurate measurement of steel temperature, provides the steel melter with the means of controlling one of the most important variables in the manufacture of steel. The practicability of the device, working as it does at temperatures so high that most materials are either softened or completely destroyed, lies in the speed with which the equipment measures and records the molten steel temperature. The electronic instrument responds so quickly to the temperature of the thermocouple that it is possible to immerse the unit into the molten steel, obtain a reading of the temperature, and remove the equipment from the melting furnace before the device is melted or destroyed by the intense heat.



Research engineers worked for five years to develop this thermocouple of platinum for recording the temperatures of molten metal accurately

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WOOD WASTE MATERIAL

Seen as Basis of New Chemical Industry

THE future prosperity of the wood industry depends upon the degree to which the raw-material wastage can be transformed into the manufacture of profitable chemical products. A chemical industry based on wood will have a greater chance of success if it is closely integrated with a complete forest products industry, including ownership of the forests as sources of basic raw material. This opinion was expressed recently by Dr. J. A. Hall of the United States Forest Service in *Chemical and Metallurgical Engineering.*

"Important wartime developments have shown new ways of utilizing lignin from the alkaline pulping processes

in the production of lignin-filled compressed paper goods with rather remarkable properties," says Dr. Hall. "This may develop into an outlet for large tonnages of recovered alkali lignin.

"Post-war developments may be expected to be in the direction of widely diversified uses for coniferous wood sugar in chemicals production and the use of hardwood sugar for similar purposes. Lignin from wood hydrolysis is promising material for the production of some chemicals already in mass production.

"The whole future of the industry based on impregnation of wood and paper with resin-forming chemicals depends upon cheap resin-forming chemicals," continues Dr. Hall. "Wood itself may prove to be such a source, especially if costs can be distributed over a broadly differentiated wood industry, integrated with the forest and within itself. Lignin also offers promising possibilities along other lines leading toward coating specialties and similar products.

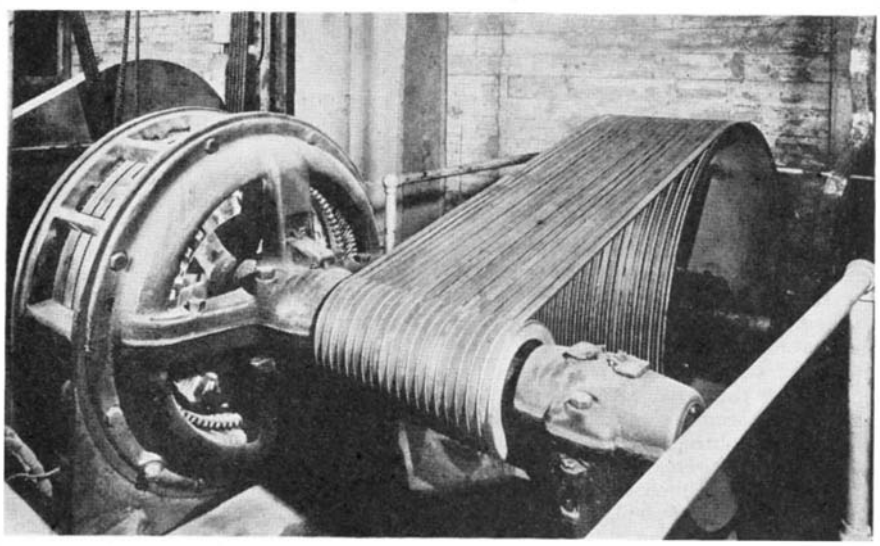
"Three characteristics that distinguish wood as a raw material for chemical engineering are (1) It is a perpetually renewable resource, of the same kind and in the same place. (2) Chemical wood can be a by-product of forestry, the principal product being lumber. (3) The methods used in harvesting the wood crop determine the nature of future crops."

V-BELTS

Replace Chain Drives In Grain Elevators

ONE OF the newest utilizations of the wire grommet V-belt is its installation in one of the leading grain elevators of Duluth, Minnesota, where it has replaced a chain drive. Operators of the elevators wanted to change the drive to V-belts, but installation of the conventional types would have required cutting out the floor to permit larger diameters or moving machinery and concrete bases to allow wider sheave face widths, according to the B. F. Goodrich Company.

Using wire grommet V-belts, no more space is required than for the chain drive. All chain drives on the elevator are being replaced by wire grommet V-belts as they wear out.



A typical small-space installation of wire grommet V-belts

SYNTHETIC POLARIZERS

Made from Sodium Nitrate By Use of Mica

A METHOD for manufacturing certain optically important crystals larger than any nature has ever been known to produce involves an ingenious manipulation of atoms which provides a new and important tool for optics engineers. Key to the new method is the use of mica as a means to control the atomic arrangement required for the production of large optical crystals.

The design of most military and other optical instruments is today based principally on the fact that a beam of light bends when it passes from one optical material to another. The new method, developed by Dr. Cutler D. West and his associate, Frederick J. Binda of the Polaroid Corporation's research staff, permits large-scale production of an optical crystal which can be cut in such a way as to split a single beam of light into two bent beams, thus making the familiar optical phenomenon of double refraction widely available to optical engineers.

Polarizing prisms can be made of these crystals. The prisms polarize light over a wider range of the spectrum than most other synthetic polarizers.

Scientists have known for years that large crystals with the optical properties of calcite might be produced synthetically from molten sodium nitrate. The problem, however, has been to devise a means for controlling the arrangement of the atoms of the molten mass when the temperature is reduced and it starts to harden. With such control, the crystal ends up in an optically useful form. But with no control exerted on the atoms of the melt, it has a natural tendency to harden in an optically impractical form. No efficient control was known before West disclosed that mica provides the key to the problem of how to arrange the first atomic layer. Once the first atomic layer of the melt has hardened in the correct orientation, subsequent layers orient themselves automatically in the desired manner.

Mica is used because its atomic surface, dimensionally like the atomic surface of a sodium nitrate crystal, fits like a peg and hole arrangement with the atomic surface of the melt. Another advantage of mica is that the potassium atoms on its surface, arranged like the sodium atoms on the surface of the melt and similar in size, presumably dissolve when mica

Dr. West and Mr. Bunda measuring a large crystal of sodium nitrate produced by a new manufacturing method

is placed on top of a sodium nitrate melt. When they dissolve, holes occur in their place. The sodium atoms of the melt then fall naturally into these submicroscopic holes. Under controlled temperature the surface of the melt in contact with the mica starts to harden first. Here, the mica corresponds to the thin skin of ice which forms first on the surface of a pond and then slowly grows downward into a single crystal. With the sodium atoms thus controlled in their arrangement on the surface of the mica, the rest of the atoms of the melt are oriented in the form of a large optically useful crystal as soon as the entire melt hardens. The area of the crystal which can be grown by the new method is limited substantially only by the size and quality of the mica obtainable. Mica of good surface quality is often found in areas three feet in diameter.

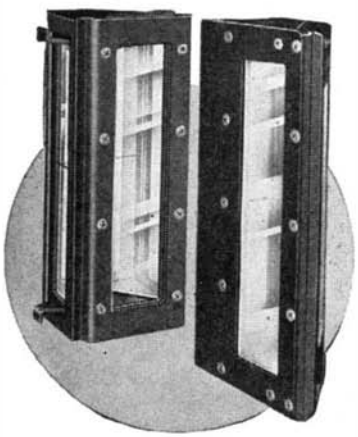
MADE FROM PEANUTS

New British Fiber Blends with Wool

ARDIL, a new substitute fiber, is not merely a substitute fiber competitive with wool, but has complementary uses, enabling lighter woolen fabrics to be manufactured. Preliminary experiments were conducted by the Bradford (England) Technical College, and trials were then arranged on a commercial basis with textile firms.

The vegetable protein used in the production of Ardil is extracted from the peanut with dilute alkali. It is then precipitated and made into a spinning solution which is extruded through minute holes of a spinnerette into a

TERRIFIC BARGAINS IN WAR SURPLUS LENSES AND PRISMS



TANK PERISCOPE

Complete Set Mounted Components

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

Stock #700-S . . $3.00 Complete Set Postpaid

TWO SETS (4 Units) ..... SPECIAL $5.50 Postpaid

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

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Telescopes, Magnifiers, Photographic Gadgets and Hundreds of Experiments with these Low Cost Lenses.

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

8 MM. MOVIE PROJECTING LENS SET — Stock #4011-S . . . $1.20 Postpaid. Consists of 2 Achromatic Lenses, diameter 18 mm. and a focal length when combined of one inch.

35 MM. FILM ENLARGING LENS SET

Consists of 2 Achromatic Lenses to use at a speed of about F.8. These make a good substitute until Anastigmat Enlarging Lenses again become available.

Stock #6096-S ..... $1.50 Postpaid

SCOOP! CONDENSING LENS SET FOR 35 MM. PROJECTORS OR ENLARGERS

Crown optical glass, aplanatic, diameter 52 mm. F.L. 88 mm. Set comprises 2 lenses.

Stock #4019-S ..... $2.00 Postpaid

ACHROMATIC OBJECTIVE LENSES with F.L. of 193 mms. Have wider diameter than those used in Army's 7 power binocular. Excellent for telescopes. Diameter of edged lenses are about 52 mms.

Stock #6064-S—Edged and Uncemented—Price $1.75

SILVERED TANK PRISMS

90-45-45 degree, 5¾" long, 2⅛" wide, finely ground and polished. Would normally retail from $24 to $30 each.

Stock #3004-S ..... $2.00 each Postpaid

(Illustrated booklet on Prisms included FREE)

PLAIN TANK PRISM

Same dimensions as above. This one is excellent for projecting all the colors of the spectrum. Worth $24 to $30.

Stock #3005-S ..... $2.00 each Postpaid

(Illustrated booklet on Prisms included FREE)

FOUR TANK PRISMS — SPECIAL $7.00 Postpaid

This is the most sensational bargain we have ever been able to offer.

ATTENTION ALL AMATEUR TELESCOPE MAKERS

An exceptional opportunity to secure a large variety of optical pieces (seconds) in varying stages of processing — from raw optical glass to partially finished. Most pieces have been molded, some finished on one side. Diameters up to at least 3 inches. Good variety of prism blanks included, bulk packed. Refractive indexes from 1.5110 to 1.6490 but not identified. Most crown glass — some flint. Sold "as is" but with our usual guarantee of full satisfaction or money refunded. Excellent for educational uses; for practicing and learning optical grinding and polishing. Stock #703-S 5 lbs. (minimum weight) $5.00 Postpaid. (Most shipments average weight over 7 lbs.)

LENS SET #120-S — "The Experimenter's Dream" — 60 Lenses and New 50-Page Booklet "Fun with Chipped Edge Lenses." **$10.00 Postpaid.** The variety of lenses in this set will enable you to conduct countless experiments, build a great variety of equipment.

MICROSCOPE OBJECTIVE LENS SET — Stock #6093-S . . . $2.00 Postpaid. 2 Cemented Achromatic Lenses (color corrected) which may be combined to make a microscope objetive lens with a focal length of ½ inch. Use these to make a microscope for micro-photography.

COMPLETE SET OF LENSES AND THE PRISMS TO MAKE A MONOCULAR (TELESCOPE)

These are from the Navy's 7 Power Binocular with 2" diameter objective lens.

Stock #5100-S . . . Monocular Set — $5.00 Postpaid

PERFECT MOUNTED ACHROMATIC LENS WITH THREADED MOUNT

Stock #6090-S ..... $2.00 Postpaid

Lens has diameter of 1¾ inches; focal length 5½ inches. Excellent Telescope objective or combine two of these to make a 3 inch focal length projecting lens for a 35 mm. Slide Projector.

NEW 50 PAGE IDEA BOOK "FUN WITH CHIPPED EDGE LENSES"

Contains wide variety of projects and fully covers the fascinating uses of all Lenses in sets listed above . . . only **$1.00 Postpaid.**

PERFECT ACHROMATIC (CEMENTED) TELESCOPE OBJECTIVE LENS Diameter 1¾ inches. Focal length 20 inches.

Stock #6091-S ..... Price $5.00 Postpaid

REDUCING LENS SET

Stock #1004-S ..... $1.20 Postpaid

Two big Lenses, 1¾" and 2" in diameter. Will make objects look smaller than they actually are.

WAR SURPLUS ACHROMATIC LENSES

Stock No.	Dia. in mms.	F.L. in mms.	Comments	Price
6017-S	12	80	Cemented	50c
6019-S	15	41	Cemented	60c
6021-S	18	49	Cemented	60c
6023-S	25	95	Cemented	75c
6094-S	16	75	Cemented	$1.00

USES: —Use these Lenses for making Projecting Lenses, Low Power Microscope Objectives, corrected Magnifiers, substitute enlarging Lenses, Eye-Piece Lenses, Microphotography, gadgets, optical instruments, etc., etc.

PENTAGON PRISMS

Originally produced for Army-Navy Gunsight. 90-45-45 degree, finely ground and polished optical glass.

Stock #3016-S ..... 75c each Postpaid

WAR BARGAINS IN LENSES USED IN NAVY'S 7 POWER BINOCULARS

KELLNER EYE-PIECE LENSES with F.L. of 27.5 mms. Comes uncemented with free cement and easy directions. Edged Field Lens has diameter of 26 mms. and edged Eye Achromat a diameter of 17 mms. These are excellent for all sorts of telescopes.

Stock #6061-S—Uncemented but Edged—$1.25 Postpaid.

ORDER BY SET OR STOCK NO. • SATISFACTION GUARANTEED

EDMUND SALVAGE COMPANY

27 W. CLINTON AVENUE **DEPT. 7, P. O. AUDUBON, NEW JERSEY**

coagulating bath. The resulting fine filaments can be cut to any required length and may be mixed with wool, cotton, or rayon, and yarns may then be made on the worsted, woolen, or cotton systems according to the type of fiber desired.

When mixed with cellulose, Ardil is said to add warmth, fullness of hand, resilience, and crease resistance to the finished fabric. It dyes like wool and has an added advantage in that moths will not attack it.

OXYGEN CYLINDERS

Are Now Explosion-Proof When Pierced by Cannon Shell

OXYGEN cylinders designed to withstand cannon fire without exploding are now being used on American war-planes throughout the world. These cylinders, developed and now being made in mass-production by The Firestone Steel

Production line for non-exploding oxygen cylinders made of stainless steel

Products Company, are designed for use on every type of military aircraft from the Superfortress to the smallest fighter ship.

Designed after the fire power of fighter planes was increased to include cannons, the stainless-steel cylinders will not explode even when pierced by a 20-millimeter shell. The protection against shattering built into the new cylinders is of vital importance, for if the cylinders were not explosion-proof the oxygen which preserves life during flights and aerial duels at high altitudes might become a deadly enemy.

An ordinary cylinder filled with oxygen compressed to 400 pounds to the square inch exploded with terrific force when pierced by bullets during tests at the beginning of the war.

HEAT SEALING

Expedited by Use of Vacuum Cleaner

AN ORDINARY household vacuum cleaner is being used in the shipping room of an electrical manufacturing company to help wrap vital war products going to all parts of the world. The special sealer consists of an electric heating element inserted on two sides of a vise-like clamp. When the heat is applied to the specially processed vapor-proof bags, the seal is quickly and effectively made.

Before heat is applied, all air is withdrawn from the package by an Apex cylinder type cleaner with a reduced nozzle. Then the scissors-like clamps seal the open edge.

NEW LABORATORY

Built for Study of Jet-Propulsion Fuels

DESIGNED specifically for the study of fuels and lubricants for jet-propelled aircraft, a new laboratory has been built and put into operation at Wood River, Illinois. Combustion of such a radically new character as takes place in a jet unit requires new basic research, and completely new studies of burning characteristics of possible fuels have been undertaken. In addition to surveying fuel requirements, and determining characteristics and qualities of fuels most efficient for jet-combustion, the laboratory is also at work developing new experimental apparatus for further use in this type of research.

ALL-WELDED ENGINE

Proves Economical in Oil Field Service

AN EXAMPLE of the benefits possible through changeover to welded design is found in a new all-welded gasoline engine for oil-field service which has over 25 percent less weight, lower initial cost, easier portability, and lowered maintenance as compared with engines of cast-iron construction. According to The Lincoln Electric Company, suppliers of the welding equipment used in fabricating the newly designed engine, the unit is a four-cylinder type operating on either natural gas or gasoline and is used for drilling oil wells by the cable tool method. It is operated at a speed of approximately 500 revolutions per minute when drilling and 1500 revolutions per minute when bailing a well or

A vacuum cleaner withdraws the air: the heating unit seals the package

pulling tools. The unit has a rating of 120 brake horsepower at 1200 revolutions per minute. Cylinder bore is 4⅞ inches with a piston stroke of 7 inches.

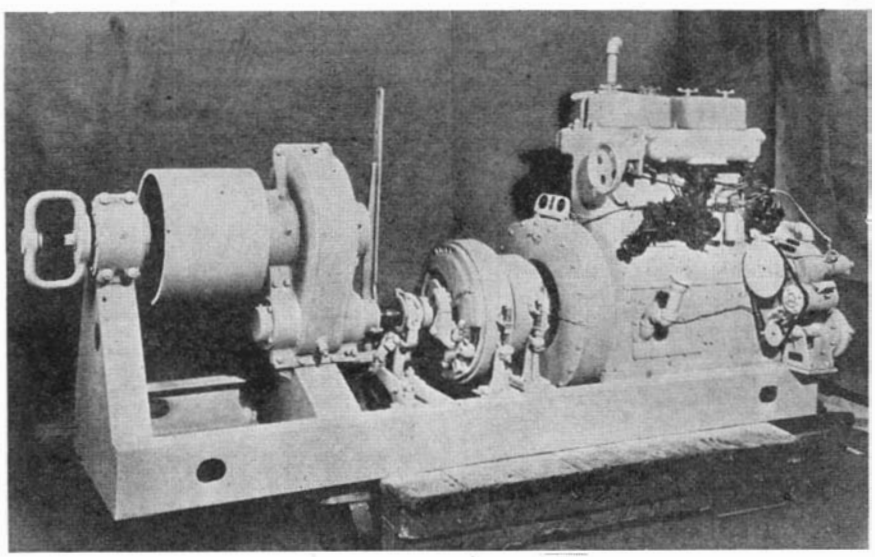
According to the manufacturer, Buffalo Gasoline Motor Company, welded construction offered them manufacturing advantages that eliminated costly foundry delays and expensive pattern making and maintenance.

ULTRA-VIOLET RAYS

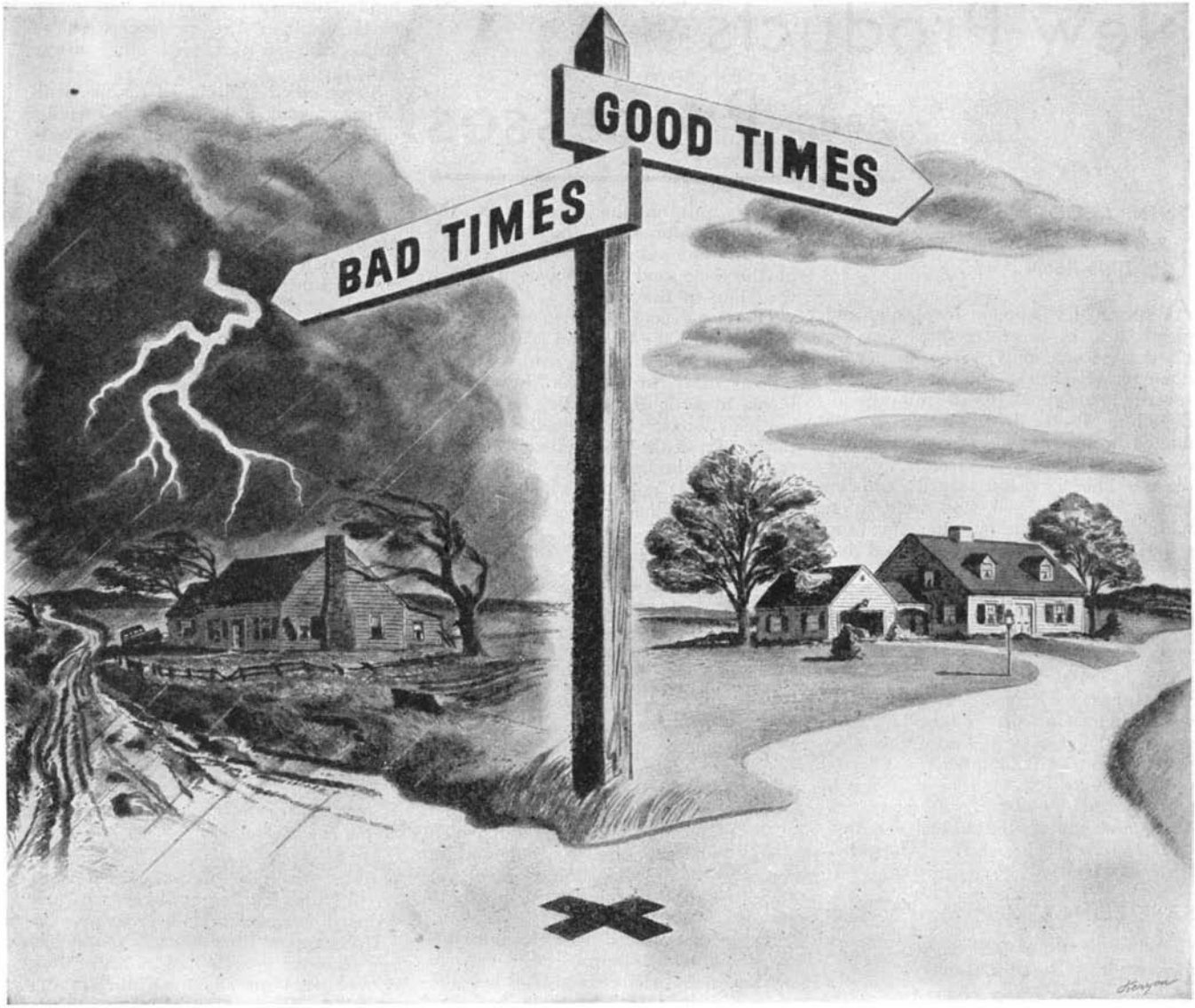
Absorbed by Chemical Used in Goggle Lenses

MORE than 99.9 percent of the ultra-violet radiation of the sun is absorbed by a synthetic chemical used in the manufacture of plastics goggle lenses. The chemically treated plastics is distinguished by the combination of stability, high transmission to visible light, high ultra-violet absorption, and non-fluorescence when ultra-violet light strikes it.

Discovery of the ultra-violet absorbing properties of the chemical is noteworthy because the chemical can be used in conjunction with the manufacture of plastics now employed as goggle lenses and as filters in military visual instruments such as range-finders and gunsights. The chemical is classified as an azine.



Designed for welded construction, this engine has manufacturing advantages



Here's where you stand today!

Look ahead a year or two...for your own sake.

Over on the dark side is this: Every unnecessary thing you buy helps shove the country one step nearer inflation and the bad times that come in inflation's wake.

Over on the bright side is this: Every single cent you save helps move you and your country one step nearer the kind of prosperous, happy, post-war America you want.

Okay—you're human. You're thinking mainly about yourself.

YOU SHOULD. Because if every man Jack (and every girl Jill) buys nothing he can get along without . . . (avoids Black Markets and "just-a-little-above-the-ceiling" like the plague!) . . . pays off the mortgage or any other debts . . . takes out more insurance . . . builds a healthy sock of savings . . . buys and holds more War Bonds—inflation will stay away from our door.

And Jack and Jill will be in a sound position no matter what times come.

Maybe you ought to clip this signpost and paste it in your pocketbook as a reminder that you can BUY your way to bad *times. Or you can SAVE your way to* good *ones.*

That's where YOU stand today.

4 THINGS TO DO to keep prices down and to protect your own future!

1. Buy only what you really need.

2. When you buy, pay no more than ceiling prices. Pay your ration points in full.

3. Keep your *own* prices down. Don't take advantage of war conditions to ask more for your labor, your services, or the goods you sell.

4. *Save.* Buy and hold all the War Bonds you can afford—to help pay for the war and protect your future. Keep up your insurance

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

New Products and Processes

THIN RECORDS

Run 15 Minutes, Take Up Little Room

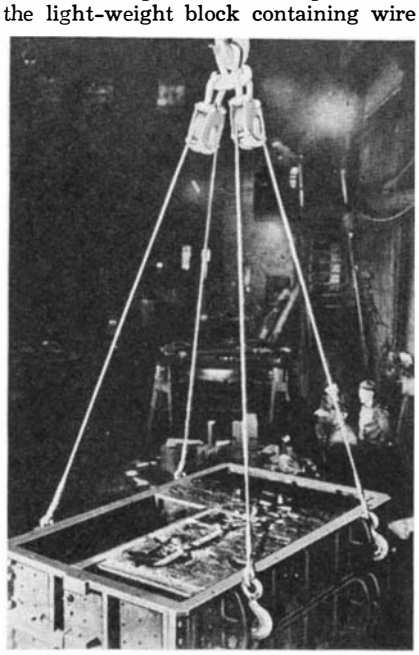
A RECENT development in plastics and electronics is a wafer-thin Vinylite plastics record, only seven inches in diameter. Each side of the disk will record approximately 15 minutes of dictation. It is light enough to be mailed in an envelope at regular letter postage rates. Made from Vinylite plastics sheets, these records can be bent, rolled, dropped, and written on with a pencil without harming the sound track. They can be stored indefinitely, without warpage, breakage, or distortion, in an ordinary filing cabinet—100 disks to the inch—and played back at least 100 times.

The Army and Navy use the equipment in vital communications work and it has been used extensively by government bureaus, in hospitals, and radio stations. After the war, this new development of Sound Scriber Corporation can be expected to take much of the drudgery out of salesmen's reports, and out of the clerical requirements of field men, investigators, inspectors, reporters, and the like.

SAFE SLINGS

Automatically Adjust Themselves to Load

THE COMPLETE line of Macwhyte Caldwell "Level-Lift" slings now includes ¾ ton, 1½ ton, 3 ton, and 6 ton capacities. Their operation is simple. After the light-weight block containing wire rope is put on the crane hook, the crane operator spots the crane hook over the approximate center of gravity of the load and the floormen attach the sling to the load.



A Level-Lift sling in the foundry

The crane operator then applies the power to lift the load and, as the crane hook is lifted, the rope automatically adjusts itself through the "Level-Lift" block. In so doing, one sling leg of rope becomes longer than the other and, as the weight of the load pulls on the wire rope, the sheave in the block pulls down against a brake which prevents slippage. The load is then lifted level.

TOUGH FILM

Can Be Used in Sheer Fabrics or Shoe Soles

RAINCOATS so light and thin that they can be slipped into a woman's hand-bag and inexpensive awnings that neither fade nor wear out are two of hundreds of post-war products to be made from a unique new material announced by The Firestone Tire and Rubber Company.

The material is a plastics film which can be made as thin as a hair and as soft and flexible as fine clothes, yet which is comparable in strength to metals.

Lampshades that can be cleaned with soap and water, aprons that can be washed and dried exactly as are the dinner dishes, and portable bathtubs that can be folded like Army cots, are a few of the other additional products that can be made from the new substance.

The film is the latest member of the Velon plastics family, which already has been used in dozens of important war jobs ranging from screening for American jungle fighters to lenses for gas masks. Eventually it will be used for a wide variety of products ranging from woven fabrics sheerer than the finest silk to shoe soles tougher than leather.

The film is elastic, flexible, odorless, tasteless, non-soluble in water, and particularly resistant to scuffing, snagging, and tearing.

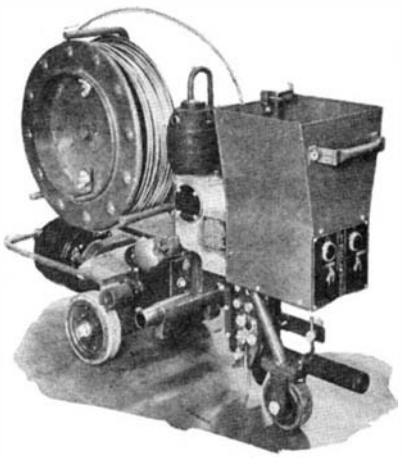
IMPROVED WELDING

Said to be Faster Than Other Automatic Methods

AUTOMATIC arc welding equipment developed to meet the need for a more fool-proof and easier applied process, has established its practicability over a period of several years. During this time many units have been successful in welding a variety of products, including machinery bases and beds, motor and generator frames, ventilating fans, tanks and pressure vessels of all kinds, LST landing craft, and many parts used in the prefabrication of ships, railroad cars, and other heavy equipment.

The method is designed for use with direct current, utilizing a bare metallic electrode which is fed through a granular flux deposited on the joint to be welded. Sufficient flux is applied to completely blanket the arc and the molten metal. The unfused flux is reclaimed for further use.

The new process, called Lincolnweld by the Lincoln Electric Company, uses extremely high current densities. For example, ⅛-inch diameter electrode may carry as much as 650 amperes. This produces greater penetration and permits smaller cross section of weld metal with resulting saving in cost and reduced warpage and distortion.



Motor-driven tractor unit that uses the new high-current welding process

Users report that the new method is less sensitive to scale and moisture than conventional automatic welding methods. This eliminates or reduces plate cleaning prior to welding. In extreme cases of scale, buffing with a power wire wheel usually provides sufficient edge cleaning; grinding and sandblasting might have been required formerly.

ELECTRONIC CONVERTER

Used for Industrial Induction Heating

DEVELOPED to fill out the low frequency range of electronic equipment required in the growing field of induction heating applications, a new mercury-arc converter electronically changes power at commercial frequencies of 60 to 25 cycles into 1000 to 2000 cycle power. The mercury-arc type of frequency changer is particularly suitable for supplying power for forging, melting, and metal treating applications where large masses of metal or metal parts must be efficiently heated with this power at kilowatt capacities of 250, 500, 1000, and higher.

Two highly successful applications of the new converters have been made in the past year, one being a 300 kilowatt unit in a forge plant, and the other a 250 kilowatt unit in use in the melting

section of a brass foundry. The units, made by Allis-Chalmers, are quiet in operation and require no ventilation or air-filtering, since they are water-cooled. In addition, high capacity mercury-arc converters offer no vibration problems, making heavy and expensive foundations unnecessary.

ODORS

May be Combatted In Nine Ways

THERE are many different ways of attacking problems of offensive odors in the air, and no one of these provides the answer to every odor problem, according to an article appearing in *The Givaudanian*, organ of Givaudan-Delawanna, Inc., manufacturers of aromatic materials and pioneers in the field of odor chemistry.

The article points out that numerous problems arising out of a desire to overcome the objectionable odor in different buildings have been studied in the past, and it is expected that, in the post-war world, this will become a field of increased interest to many industries.

The methods for deodorizing air in buildings are based upon nine separate theories. They are listed as oxidation, alkalization, adsorption, antisepsis, washing action, chemical combination, electrostatic precipitation, catalysis, and reodorization. Each of these methods is usable for a different purpose and no one method is usable for all purposes. A short summary of each theory is given:

Oxidation: This involves converting an odor of unpleasant character to a pleasant or neutral one by oxidizing the chemical substance responsible for the bad odor. Typical oxidizing agents are potassum permanganate, hypochlorous acid, and ozone.

Alkalization: Alkaline reacting substances such as borax, ammonium carbonate, lime, and trisodium phosphate are frequently suggested as components of solid mixtures, possibly with the thought that the unpleasant odor to be overcome is a volatile acid. Thus alkalies are helpful in dealing with butyric acid of limburger fragrance or with caproic acid, which smells like a goat.

Adsorption: Gases and vapors responsible for unpleasant odors can frequently be caused to collect at the surface of porous materials. The three most important adsorbents are activated carbon, activated alumina, and silica gel. The activation consists in providing these materials with a maximum surface area. Carbon and silica gel are often used to adsorb odorous gases in refrigerators and in air conditioning systems.

Antisepsis: This is based on the fact or belief that the unpleasant odor is generated by microorganisms such as bacteria, molds, or fungi. Phenol, metallic salts, and formaldehyde are typical examples of substances employed to accomplish deodorization by destroying the organisms responsible for the odor.

The germicidal action of formaldehyde depends also on its exceptional chemical reactivity. It represents an intermediate stage of oxidation between methyl alcohol and formic acid and could therefore play the part of either a reducing or of an oxidizing agent. It combines with amines and related substances to form odorless compounds known as Schiff bases. Sometimes it acts as a methylating agent.

Washing action: When air laden with odorous particles is forced to traverse a solvent such as water, alcohol, glycerin, or mineral oil, the odorous particles may dissolve in the liquid, leaving the emergent gas odorless. This is a washing or "scrubbing" action.

Chemical combination: Special cases of chemical combination have been mentioned as in the case of formaldehyde and alkalis. Many reactions which would take place very slowly, or not at all, under laboratory conditions may be realized under conditions of extreme dilution such as prevail where large quantities of air are deodorized. For this reason reactions which strike a chemist as unlikely, or even unreasonable, may actually come to pass in actual practice.

Electrostatic precipitation: This is primarily a dust removal operation, but since the dust may itself be odorous or may carry odorous gases by adsorption, it can be readily seen that electrostatic dust removal is an efficient way to get rid of certain odors.

Catalysis: According to electronic chemical theory, catalysts are looked upon somewhat as members of a bucket brigade passing along the electrons

(buckets) and thereby speeding up chemical reactions.

Reodorization: This approach may take the form of overpowering an existing unpleasant odor with a pleasant odor; or, more subtly, it may involve utilizing the unpleasant odor itself as a component part of a complex mixture, the total effect of which is pleasant. Sometimes a considerable number of different essential oils and odoriferous chemicals are used to accomplish this. Perfumed deodorants in the form of wall disseminators, hand sprays, and wicks have long been used. The successful job done in the insecticide field with aerosol bombs suggests that, after the war, perfumed deodorants may possibly be dissolved in Freon and sprayed by merely turning a nozzle.

WELDED TRUSSES

Are Easily Adaptable To Different Loadings

A NEW design for welded trusses of standard 50, 60, 70 and 80-foot lengths, in which, for the first time, H-sections with their webs in a vertical plane are used throughout without gusset plates, has been adopted by The Austin Company.

This truss is readily adaptable to different loadings by simply changing the weights of the beams used for the various truss members, according to J. K. Gannett, Austin vice president and director of engineering. By keeping the depths of the individual members constant, these variations require no changes in shop details or fabricating jigs.

As the top chord is a wide flange beam, it can carry purlins at a variety of spacings without regard to panel points, and is also adaptable to continuous uniform loading. Similarly, the bottom chord can carry loads at any point and can be used, itself, as a monorail.

A "natural" for welding, shop fabrication on a 50-foot truss requires a total of 41 lineal feet of fillet weld, all of which is accomplished by down welding. The H-sections are assembled in a jig, tack-welded, and welding is completed with the truss in a vertical position.

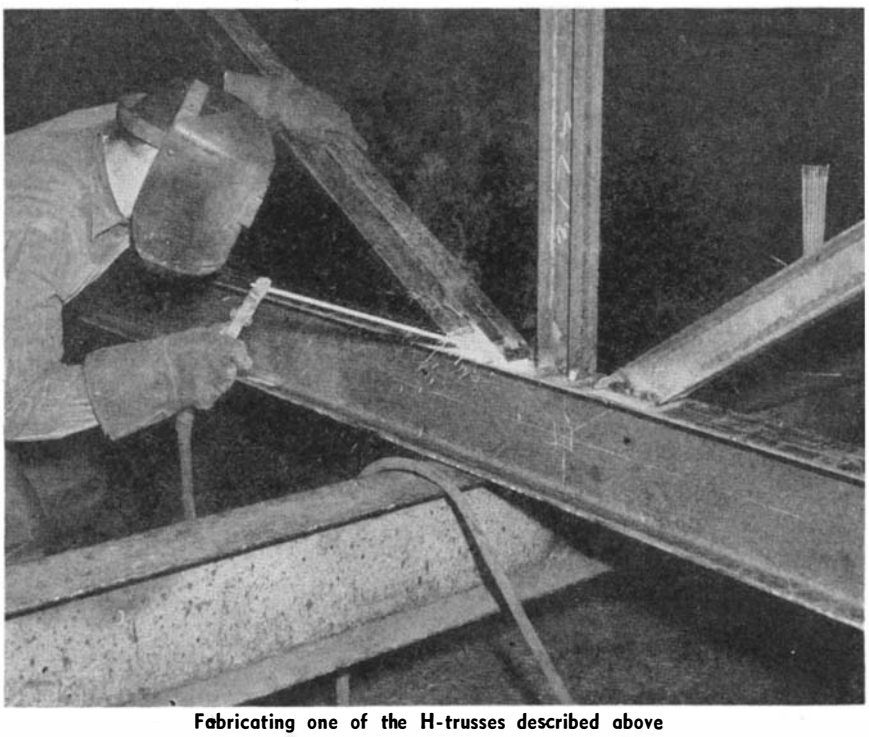
Because it is fabricated completely from rolled members which are simply cut to desired lengths, no splitting, blocking, slotting or chipping is necessary. The only raw cut edges are closed by the welds, so that only the smooth, hard, rolled surfaces are exposed, which gives the truss a maximum of corrosion resistance.

In full-size load tests on two 50-foot trusses of this new design made at the fabricating shops of The Austin Company more than a year ago, failure occurred under a load which was 253 percent of the design load, at which point an end vertical buckled. Despite the distortion of the truss when it collapsed, not a single welded connection failed.

The behavior of the truss under a heavy overload was impressive and is attributed in large part to the fact that the lines of action of all members lie in one plane, as well as to the concentricity and symmetry of the end connections of the truss members.

Following the tests, trusses conforming to the spans in widest use were designed and jigs set up for their manufacture. During the final quarter of 1944, trusses of this type were fabricated and shipped to plants in five widely separated localities, one of which involved an area of 100,000 square feet.

Experience in the field demonstrated that the new trusses are much stiffer than other welded trusses, and that they make steel erection work much safer. Structural iron workers, for instance, found that they could work much more easily on both top and bottom chords. This was particularly true of the bottom chord, where the flat upper flange provides a safer and more comfortable surface than the cut vertical edge found in most trusses. The flange not only provides an excellent walking surface but also a good seat for men while working on bolted, riveted, or welded connections.

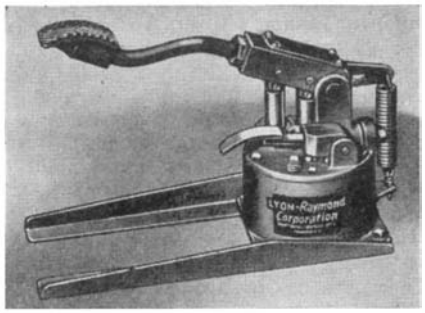


Fabricating one of the H-trusses described above

HYDRAULIC PUMP

Has High- and Low-Speed Pistons

A TWO-SPEED foot pump for pressures up to 10,000 pounds per square inch has as an advantage an automatic change speed feature. The pump has two pistons—one a high-speed, low-pressure piston; the other a small, slow-speed, high-pressure piston. Up to 1000 pounds pressure both pistons pump oil; at 1000 pounds the high-speed, low-pressure piston automatically cuts out and higher pressures (up to 10,000 pounds) are easily developed by the small high-pressure piston.



Self-contained hydraulic pump

Many applications calling for hydraulic pumps require first that a large volume of oil be delivered, and second that high pressures be developed. A typical example is the furnishing of power to a hydraulic cylinder where the ram must be extended a large portion of its total travel before it contacts the work and then high pressure must be applied for the final operation. This pump will provide the fast travel at low pressure, thus minimizing the delay in bringing the ram to the work and, without an increase of effort on the part of the operator, will develop high pressures for the actual work. Maximum pressure can be pre-determined by the adjustment of a relief valve.

GAS PURIFIER

Utilizes Palladium as Catalyst

IN LABORATORY tests and under practical working conditions a gas purifier that utilizes the precious, but unrestricted, metal palladium as a catalyst has shown its efficiency in removing oxygen from such gases as hydrogen, nitrogen, argon, and neon. Gases of extremely high purity—that is, with less than 20 parts of impurity in a million—are thus obtainable, it is claimed.

While uses of the new Deoxo purifier are many, it is expected to be especially valuable in the manufacture

of radio and radar tubes. It is also useful for heat treatment of alloys, in powder metallurgy, and in research laboratories using pure gases.

The unit will be produced in two sizes. Both are compact, containing the catalyst encased in metal cylinders provided with intake and outlet valves through which the gas is passed. One, with a capacity of 200 cubic feet of gas an hour, is designed for laboratory and limited production use. The other, for general plant operation, is constructed for wall mounting. Its capacity is 1000 cubic feet of gas an hour. Both units will handle pressures up to 50 pounds a square inch.

The new Deoxo unit requires no external heating since it employs a new type of palladium catalyst efficient at room temperatures. It requires no warming up or cooling down period before and after use. Flow resistance is almost negligible and, it is claimed, will not change with use. It requires no maintenance and present indications are that, when used on cylinder gas, it should last indefinitely.

RUST-PREVENTING

Oil Keeps Radiators and Cooling Systems Clean

A COMPOUNDED oil and rust preventive which emulsifies quickly with water or any anti-freeze is claimed to keep radiators, water jackets, and cooling systems clean and to prevent rust and corrosion. The new oil, called Gibraltar "Rad-Treat," will also lubricate packing glands in pumps, and at the same time prevent shrinking and glazing of packing. When caustic solutions are used to flush out a radiator, it is recommended that Rad-Treat be added afterward in order to neutralize any acid condition produced by the caustic.

THIOKOL POWDER

May Be Molded And Vulcanized

MOLDED synthetic rubber parts with good resistance to solvents, greases, oils, fuels, sunlight, ozone, and atmospheric oxidation are now possible through the use of a new molding powder. Vulcanizing at 300 to 360 degrees, Fahrenheit, to form a resilient elastic solid, the new powder has proved itself an excellent material for compounds which are required to remain flexible at temperatures below —50 degrees, Fahrenheit. It remains serviceable to temperatures in excess of 220 degrees, Fahrenheit.

Believed to be an excellent material for a wide range of industrial parts such as washers, valve seat disks, diaphragms, gaskets, grommets, and so on, the new Thiokol molding powder can be compounded to obtain finished parts with a wide range of hardness.

In considering the properties of articles molded from this powder, they should be thought of in terms of soft vulcanized rubber rather than of hard rigid plastics. For example, rigid plastics display tensile strengths of from 1000 to 10,000 pounds, with elongations up to 1 percent, while soft rubber goods fall into the tensile range of 200 to 3000 pounds per square inch with elongations of from 100 to 1000 percent. The physical properties of the compounds made with the new molding powder are within the range normally considered satisfactory for most rubber mechanical goods applications.

PEANUT MEAL

Has Wide Potential Use If Properly Processed

NEW studies opening broader potential industrial uses for peanut meal are described in a recent issue of *Industrial and Engineering Chemistry.* Pressed peanut meal now is used almost exclusively as feed. The new work indicates that by proper control the peanut oil can be removed without destroying the protein values of the meal, thus making the product available for new industrial uses.

The work was done by T. D. Fontaine, Carolyn Samuels, and George W. Irving, Jr., of the Southern Regional Research Laboratory, United States Department of Agriculture.

"For many potential industrial uses," they said, "it is essential that the protein constituents of peanut meal be readily extractable, and that the extracted protein be substantially undenatured."

Customary treatments of removing the oil by commercial hydraulic pressing vary in severity, "but are usually

sufficiently drastic to denature the protein considerably."

Their studies indicated that "critical denaturing temperatures for peanut protein are above 118 degrees, Centigrade, (dry heat) and above 80 degrees at 100 percent relative humidity. Since there appears to be little need for excessively high temperatures and moisture contents to rupture the oil cells of the peanut, it would seem advisable to employ in the mill the lowest moisture content and lowest temperature compatible with adequate oil removal."

FLUORESCENT FIXTURE

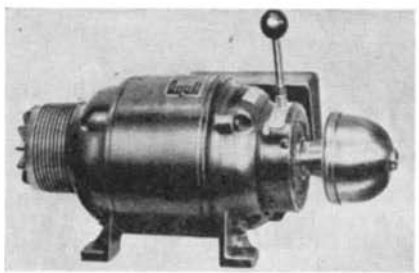
Has 93-Inch Lamp
That Does Not Flicker

COMMERCIAL lighting fixtures employing 93-inch fluorescent cold cathode low voltage lamps are now available along with assemblies for continuous line lighting. These "Simplicity" units are equipped with the 10,000 hour "Colovolt" lamps which are instantaneous in starting and do not flicker. The General Luminescent Corporation, which makes these units, states that long life expectancy may be realized, even when the lamps are constantly turned on and off.

POLISHING LATHE

Holds Odd-Shaped
Parts by Vacuum

SUCH parts as oil-can bodies, spun shapes, and flat stampings, which cannot be held by chuck or collet, are held firmly in a new polishing lathe which generates its own vacuum, without piping or glands; starts, holds the work,



A vacuum pump is the secret of this polishing lathe for odd-shaped parts

stops instantly, and releases the work rapidly for low cost production. All work is held firmly for polishing, burnishing, and many other operations. This "Vacuum Grip" lathe is made by the Crozier Machine Tool Company.

SAND IN GREASE

Is Important Ingredient
Of Silicones

IN ITS natural state sand is the cause of millions of dollars worth of damage to electrical equipment. Combined with coal, brine, and oil to create materials called silicones it has become a vital component of soft greases that neither harden at —40 degrees nor melt at 400 degrees, Fahrenheit. It has also become an intrinsic part of fluids with similar properties, yet as thin as water, and a basic ingredient of resins and varnishes which, when used as insulation, stand up under tremendous heat.

In testing silicone resins and varnishes, Westinghouse engineers found three possible major benefits: (1) because of silicone insulation, resistance to heat and reduction in size and weight of electrical equipment can be made for a given output; (2) greatly increased life can be obtained in the same size and weight; (3) machines with silicone insulations may be placed in operating locations where surrounding temperatures are higher than heretofore possible.

Discussing the silicone greases, the engineers said that "a translucent silicone grease of petrolatum-like consistency has been developed for use as a lubricant for ignition cables to reduce cutting of the insulation by electrical overcharges and permit easy wiring of ignition harnesses. Although a soft grease, it has the unusual property of not melting under heat. This material is inert and oxidation resistant, has no solvent effect on synthetic insulations or rubber and tends to prevent the hardening of these materials when heated in contact with air.

"Other silicone greases under development are being used for lubricating ball and roller bearings. One type can be used at temperatures as low as —76, Fahrenheit, and has high temperature stability at least as good as the best available organic greases. Another type is showing stability in lubricating ball bearings several times as great as organic greases at the same temperatures."

HOT CROPPER

Uses Oxy-Acetylene Torches
To Effect Economics

MADE-TO-MEASURE alloy steel blooms and billets are now being shipped from A. M. Byers Company, as a result of the installation of a new hot cropping machine at one of the company's plants. The machine, especially designed by Air Reduction Corporation, cuts blooms and billets by means of twin water-cooled torches using the oxy-acetylene process.

Previously, shearing on sizes up to nine by nine inches was practicable, but on larger sizes the entire bloom or billet was shipped. This created a special cutting operation at fabricating plants as well as a scrap disposal problem there. The hot cropper can cut to length all sizes up to 24 by 24 inches, achieving economy in shipping and permitting Byers to retain scrap of known analysis for its own use.

PLASTICS SLIDE RULE

Is Circular in Form
And Long-Wearing

A SLIDE rule that will remain accurate under extremely rough handling, which can be immersed in water, or exposed to greases and oils, without impairing its usefulness, is fabricated from "Vinylite" plastics by Tavella Sales Company. Virtually unbreakable and dimensionally stable even after long periods of time, the rule is circular in form, contains all of the features of the traditional oblong rule within its six inches of diameter, and, in addition, permits a multiplication-division table 13-1/8 inches long as against 10 inches on the regular type rule.

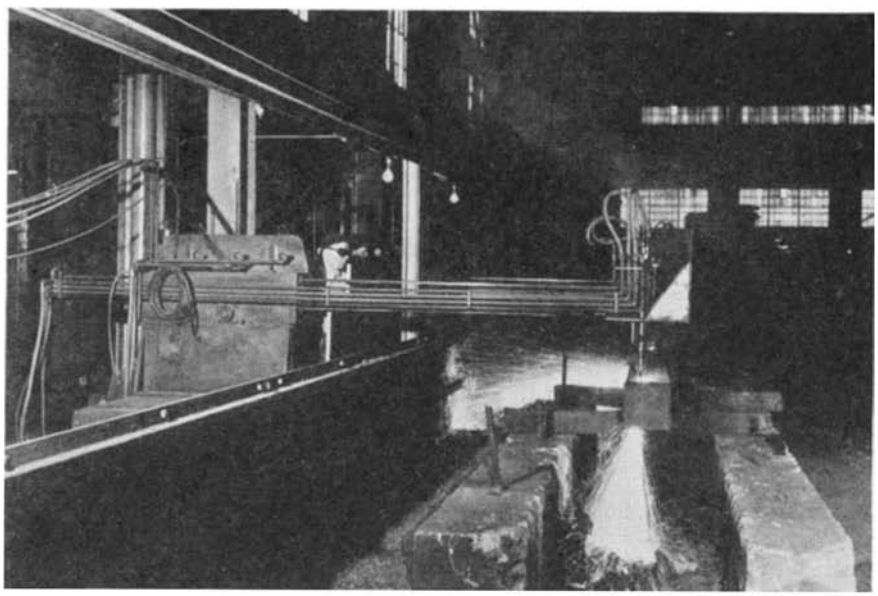
CROOKED GUN BARRELS

Straightened by Skilled
Hand Operation

DURING machining and drilling, some of the barrels used in Garand rifles and Winchester carbines become slightly curved. Others develop a number of curves. Unless such "kinks" are removed, the gun is so inaccurate as to be useless.

Barrels are straightened in a hand-operated press in which the curved section of the barrel is held between two dies and the kink literally pushed out by a third die. This die is controlled by a heavy spoked iron wheel similar in appearance to a ship's steering wheel.

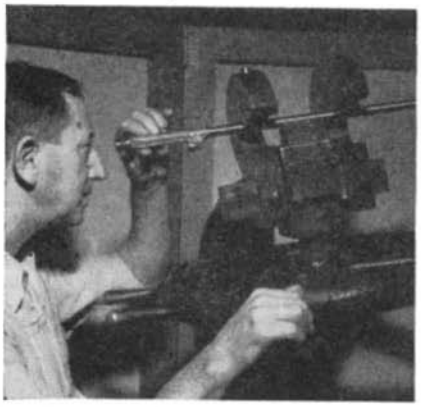
The operation, although it seems



Twin oxy-acetylene torches cut huge billets quickly and economically

simple, is extremely difficult and is entrusted only to experienced barrel-straighteners who have been doing this work for many years. At the Winchester Repeating Arms Company, a division of Western Cartridge, a skilled man can straighten a barrel in one minute.

The test for straightness is to sight through the gun barrel at a horizontal line some 15 feet distant. If the barrel is straight the horizontal line will be reflected on the sides of the gleaming



A high degree of skill is required for straightening crooked barrels

interior of the barrel as two straight lines converging to a point somewhat in the way the two rails of a track seems to join in the distance.

If the barrel is not straight the two lines will take all kinds of shapes and the operator must determine what point of the barrel is curved, in which direction or directions, and apply just enough pressure to take out the kink. Vision of a high order and the greatest delicacy of touch are required for this exacting work.

PLASTICS FOR NAVY

Resistant to Flame And Shock

COMBINING the qualities of fire- plus shock-resistance and easy molding properties, a new plastics has been developed for the Navy. Intensive research begun in General Electric's plastics laboratory has produced a product that can withstand fire and its resultant toxic effects during battle action, as well as the concussions and vibrations of battleship broadsides.

The Navy's specifications called for a plastics that was relatively fire-resistant and non-toxic, and had good electrical properties, high impact strength, and easy moldability. The laboratory men learned that it was impossible to use any appreciable amount of organic filler in a laminated plastics or molding compound to fit these specifications, regardless of what kind of resins were used, without obtaining a material that gave off toxic gases fatal to human beings, depending on several factors including the size of the room and length of burning.

The chemists then turned to the use of inorganic filler-type of materials, such as asbestos and glass. At the end of the long research road they selected asbestos as the type of inorganic filler they wanted because it embodied all of the specifications—relative high flame-resistance, low toxicity, easy moldability, and shock resistance. The researchers then bound the asbestos fibers together with certain phenolic resins to make a series of plastics with various shock resistances that would do the required jobs.

FLICKERING FLUORESCENTS

Now a Part of the Past of Lighting

ELECTRICAL engineers have written finis to the flickering of fluorescents. Incandescent lamps, their normal service given, blink out abruptly. Fluorescents, after many hours of bright and steady service, yielded grudgingly to the debilities of old age and flickered annoyingly as they passed through their death throes.

But no longer.

Engineers now have devised a tiny "electrical brain" which fits in a fluorescent lamp receptacle and automatically shuts off the current when the lamp has passed the stage of usefulness, according to information published in a recent issue of the *Westinghouse Engineer*.

All fluorescent lamps have a "starter," a small glow-discharge tube which provides a higher voltage initially to speed electrically-charged particles of gas into glowing action. By adding a resistor which heats when the lamp

begins to function unevenly and with this heat activates a bimetal switch, operation of the tube is halted almost immediately. It ceases without the flickering which interferes with the lighting values of other nearby lamps and also causes damage to the associated equipment.

The new "starters" which contain the anti-flickering equipment are interchangeable with those in present fluorescent light receptacles, the magazine reports.

WHIRLING POWER

High-Speed Extractors Squeeze Dyes from Textiles

ALMOST three miles per minute is the rate of speed at which extractors are now used to squeeze dye liquors out of textile materials before final drying. These machines, made by the Fletcher Works under the trade name Whirlwind, are equipped with a hydraulic brake similar to that in an automobile, except that the braking is automatic and the momentum of the revolving basket builds up the pressure so that it actually stops itself.

Sheer fabrics can be handled safely in these extractors because the interior of the revolving basket is smooth. Both side plates and reinforcing bands are of stainless steel, selected because it withstands the corrosive attack of the various acids and other chemicals used in the dyeing processes and has sufficiently high tensile strength to permit high basket speeds with safety.—*Electromet Review.*

TWIST DRILLS

Made With Welded Chrome-Nickel Shank

SAVINGS in the manufacture of twist drills have been effected by the flash welding of high-speed steel stock to a chrome-nickel shank.

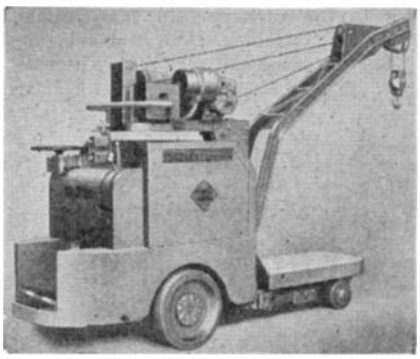
The photograph illustrates this process of welding an exceptionally large sized drill. The drill stock is welded to the shank before twisting—an excellent example of the strength of such a weld, in that it must be as strong as the parent metal to stand the twisting operation. After twisting, the drill is hardened and finished.

The water-cooled clamping dies for holding the stock and shank during the welding operations act as electrodes for the transmission of current to the parts being welded.

CRANE TRUCK

Serves as Load-Carrier And Tractor

A COMBINATION crane truck that can be used as a lift-truck, load carrier, crane, and tractor, loads itself either by picking up skid loads with the lift platform, or by lifting heavy parts



Four-use industrial crane truck

and placing them on the platform for transport. As a tractor it pulls trailer cars, which may be loaded by means of the crane. The crane may be made available for heavy lifting at points where there are no overhead cranes.

Manufactured by the Elwell Parker Electric Company, the model has a capacity of 6000 pounds on the platform, 2000 pounds on the hook at 42-inch radius, and 1000 pounds on the hook at 84-inch radius. It will travel at six miles per hour with no load and five miles per hour with full load under normal conditions. The platform is deeply flanged to insure rigidity and has three-point positive support that assures load stability.

FELT

Processes Revealed by Development Engineer

MODERN methods used in the manufacture of felt were revealed recently in a technical paper read before the American Society of Mechanical Engineers by W. H. Lehmberg, chief of engineering and development of the American Felt Company. Felt, one of the oldest and most widely used textile products, was originally made by crude methods but is today produced in the United States by machinery under close control, turning out standardized products and meeting a constantly widening market. Until recently, however, its technology has been a closely guarded secret.

Though felt is basically fabricated from wool, felt manufacture today embraces expert knowledge and use of more different kinds of fibers than any other branch of the textile industry, Mr. Lehmberg disclosed. Among other fibers blended with wool for special felt purposes are cotton, hair, jute, kapok, and ramie; also synthetics, such as rayon, vinyon, and aralac. A majority of felt products are all wool, however, and wool accounts for nearly 70 percent of the total fibers processed by the industry.

DUST COLLECTOR

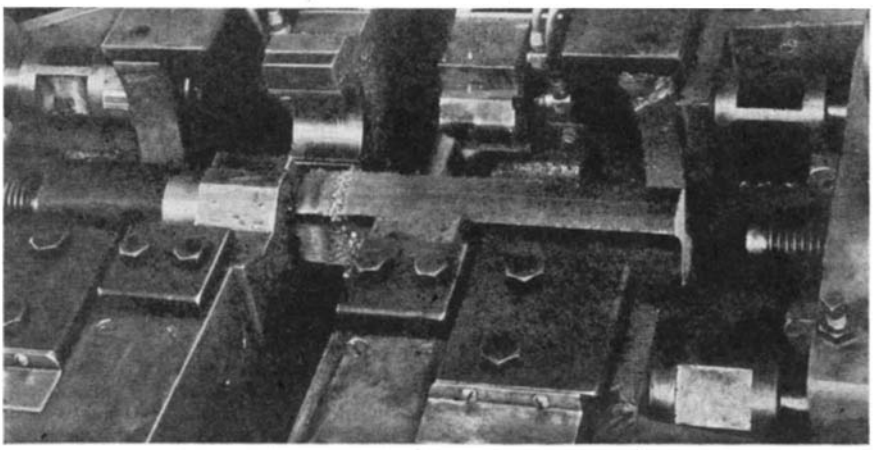
Uses Compound Action In Portable Unit

MANUFACTURED in four sizes, Dustex portable dust collector is designed to meet the need for an efficient and economical means of removing from the

Filters (inset) remove dusts that arise in many industrial operations

air dangerous and obnoxious dusts—lint, shavings, grindings, and so on—arising from industrial operations.

The principle underlying the unit is compound action on the air-borne dust, first by centrifugal separation from the air stream and, second, by impingement on the filter surface. The unit maintains constant static air suction of



Welding drill stock to shank before twisting

more than 4 inches at a velocity of over 5000 linear feet a minute. Units weigh from 75 to 200 pounds, and are 30 to 51 inches high.

The filter assembly consists of two corrugated layers of wire mesh covered with 60-mesh filter cloth. Filtered air is discharged through a muffler to deaden air noise.

HOT DOPE

Eliminates Need for Expensive Thinners

A NEW method of spraying aircraft "dopes" by heating them until thin enough to spray, rather than diluting

No thinner needed when dope is heated

them with costly thinners, has been perfected by the aviation finishes laboratories of The Sherwin Williams Company. Cutting the number of coats required from seven to three, the new method reduces doping time by more than half and has tremendously speeded up the production of expendable gliders for Allied airborne armies. It can also be used on light plywood planes and on control surfaces of transport and combat planes. Major post-war use, aside from plywood plane production, is expected to be in the application of tougher finishes to household appliances, automobiles, and so on.

CELLOPHANE

Keeps Grease In and Water Out of Metal Parts.

GREASE-PROOF cellophane, which now goes into a special cellophane-cloth wrapping for ordnance parts, will find increasing use as a peace-time packaging material for machine parts and fittings to keep them from rusting while in transit or storage.

In addition to being impervious to grease, this cellophane is also water- and moisture-proof, and is neutral, having neither acid nor alkaline characteristics. Sylvania Industrial Corporation, which makes this material, reports that this last qualification calls for rigid production controls.

In packaging certain ordnance parts, a sheet of this cellophane is laminated with cloth, a special wax being used to seal the two together. The cellophane side of the wrap is then applied to the surface of the ordnance part, which has been coated with a thin film of oil. When the part has been completely wrapped the package is dipped in wax to seal it. The tough, durable cellophane-cloth wrapper is effective in keeping air, moisture, and water out and the grease in, and in that way prevents rusting.

GEAR PRODUCTION

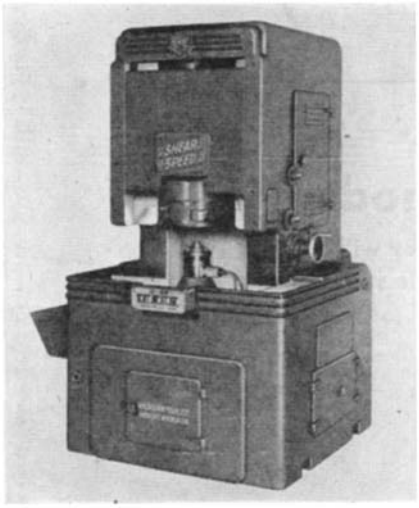
Speeded by Cutting All Teeth Simultaneously

A NEW gear-cutting machine for the production of spur and helical gears, splines, and so on, has been announced by the Michigan Tool Company. The machine cuts all gear teeth simultaneously with radially fed form-tool blades having a shear-cutting action.

The new "Shear-Speed" is capable of rough and semi-finish cutting as many as 60 to 100 or more gears an hour, depending on the job.

The machine is exceptionally easy to operate and requires no particular skill. Gears are placed on the work holder, chucking being part of the automatic machine cycle. The operator has only to press a button to start the machine. When the machine has completed its cycle it returns to loading position automatically and releases the finished gear for removal and loading of another blank.

The cutting action of the machine is as follows: When the gear is automatically clamped, the head of the machine,



Above: Gear cutting machine with cutter head in loading position. Left: Interior of the cutter head, showing assembly of individual tool blades

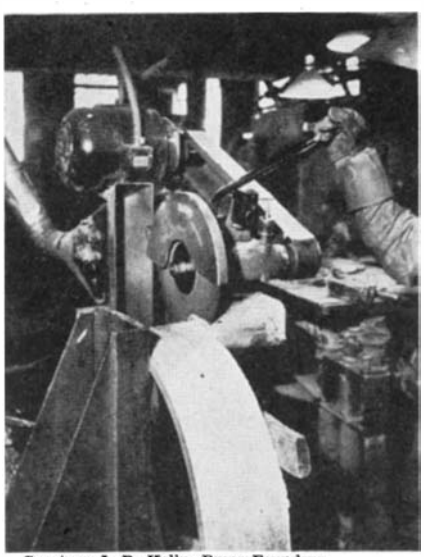
containing the cutter head, automatically lowers into cutting position and automatically locks there. The work now reciprocates vertically. At the beginning of each up-stroke, all blades are advanced radially (fed into the work) an equal amount. On the return stroke, the blades are retracted slightly as on conventional gear-shapers to provide clearance for the tools. The amount that blades are fed into the work on each stroke is adjustable. Correct sizing of the work is also automatically controlled and adjustable.

ABRASIVE WHEELS

Are Bonded With Synthetic Rubber

RECENT reports from abrasive wheel manufacturers say that a special-purpose synthetic rubber has been developed which permits the manufacture of fast-cutting, long-lasting abrasive wheels for the metal working trades.

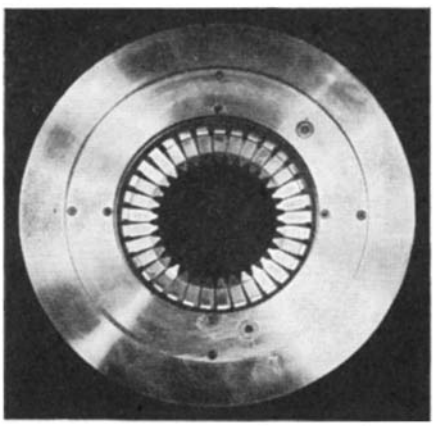
A single wheel will do the work of 15 metal bandsaws in cutting gates and risers off non-ferrous castings. Multiply this one illustration by the thousands of other applications for abrasive wheels in industry to get an idea of what they mean to production.



Courtesy J. P. Kelly, Brass Founders

Hycar bonded wheels cut fast

Tests of abrasive wheels were conducted by West Company, Inc. To Hycar Chemical Company, makers of synthetic rubber, the results were reported as follows: "Manganese bronze castings were cut with a natural rubber-bonded wheel making 50 cuts for a total of 562½ square inches. A Hycar-bonded wheel on the same work



made 99 cuts for a total of 1013¾ inches, practically doubling the output. Each wheel was 16 inches in diameter by ⅛-inch thick, operating at 16,000 surface feet per minute, 3800 revolutions per minute spindle speed."

The same company's tests on aluminum bronze castings were to take 10 cuts each with a natural rubber wheel and the special-purpose synthetic rubber wheel. The results reported were that the wheel bonded with Hycar cut 141 square inches and that the wear was .43 square inches per square inch of metal cut, in comparison with the natural rubber-bonded wheel which cut 112 square inches and showed a wear of .627 square inches per square inch cut.

ELECTRONIC COUNTER

Tallies Rates Exceeding Ten Cycles a Second

DESIGNED for industrial and laboratory uses, a new two-decade electronic counter is actuated by a closing contact, sine wave, or pulse input, as from a photo-cell, at rates up to 1000 cycles per second. Each decade divides by ten, giving a scaling factor of 100. The count for 0 to 99 appears on two banks of neon lamps.

A telephone-type relay is connected to the counter output and the contacts of this relay close once for each 100 input cycles. These contacts are connected to an output terminal. A conventional electro-mechanical counter may be connected to the output terminals to extend the count to as many places as desired.

One important application of the unit is in counting rates exceeding 10 cycles a second, which are generally too fast for conventional counters. Another is in installations where a conventional counter wears out prematurely from high-speed continuous operation or is unreliable. The new electronic counter, made by the Potter Instrument Company, makes it possible to increase the counting rate 100 times.

RUBBER CEMENT

Bonds Metal, Wood, and Plastics

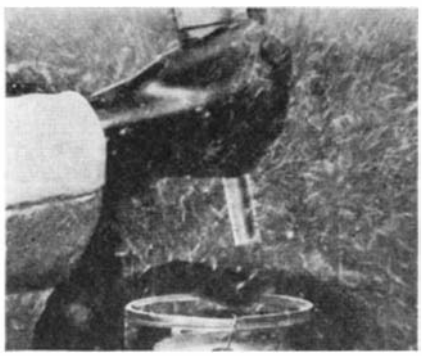
NON-THERMOPLASTIC and water and aromatic oil-resistant, a new adhesive for bonding metals, wood, plastics, and ceramic material to themselves or to each other, is said by The B. F. Goodrich Company to provide superior bonding qualities in any of its applications. In some cases, it is claimed, this new rubber cement can be used in place of rivets or screws. Best results are gained by applying heat with pressure, although heating alone will give some degree of adhesion. The purpose of pressure is to obtain good surface contact. The bond strength varies with the materials being adhered.

The new adhesive, named Plastilock 500, has shown a shear strength of 3250 pounds per square inch. Tension strengths of 4000 pounds per square inch have been reached. Tests made after the bonding of wood and plastics to aluminum, which presents extremely difficult problems of adhesion to other materials, have resulted in the wood and plastics being torn because the strength of the bond was greater than that of these materials.

CELLULOSE PELLETS

Clean Engine Parts Quickly and Efficiently

A TIME-SAVING supplementary treatment has been developed for the successful chemical processes now in use



Carbon removal from a piston, using cellulose pellets and compressed air

for removing carbon from aircraft, automotive, and Diesel engine pistons and other parts. While prolonged soaking in specialized chemicals is normally required to remove tenacious deposits completely, a comparatively short-time bath is said to suffice if the new product, called Carboblast, is used. It removes residual carbon, oxides, and gums. Its pellets of ligno-cellulose are softer than any metal used in engine construction and cannot scratch or mar mirror-like surfaces. Because of this, and by reason of the fact that the pel-

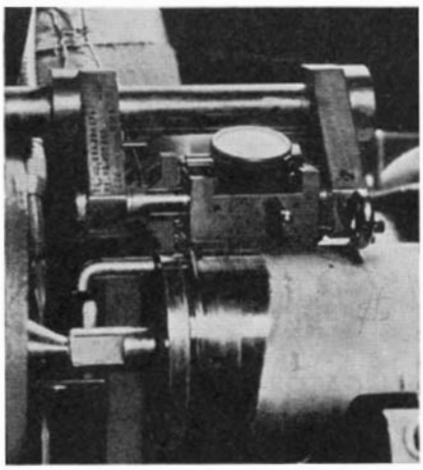
lets are essentially non-adherent as well as smooth and non-abrasive, there is no need to mask off bearings or bronze bushings, or to plug spark plug holes.

The narrowest recesses, such as piston-ring lands, cylinder fins, waffle underpiston structure, valve parts, and screw threads are readily penetrated and thoroughly cleaned by the pellets. Conventional sandblasting equipment is adaptable to Carboblasting.

GAGE FINGERS

Used in Grinding Aircraft Cylinders

USE OF carbide gage fingers has insured accurate gaging during grinding at a large aircraft engine plant, under conditions which would wear steel



Cemented carbide gage fingers make automatic gaging practical and materially increase machine production

fingers away so rapidly that the operator would be forced to continually reset his gage.

The job where these fingers are used consists of grinding the outside diameter of aircraft cylinder sleeves to extremely close tolerances. The gage fingers—made of Carboloy cemented carbide where they contact the rotating work—are so set that when the gage reads "O" they automatically shut off the machine feed, thereby saving an appreciable amount of time on long production runs.

Because no lubricant can be used on these gage fingers for obvious reasons, it is impractical to employ steel for this purpose. The Carboloy fingers, however, stand up under these conditions and are reported to have made this type of gaging fixture practical with a resultant material increase in production.

TRANSMISSION RINGS

Made of Long-Lived Vinyl Resin Derivative

ORIGINALLY developed to prevent gear breakage in the event of jamming, a unique type of power transmission involving rubber rings that mesh with metal gears on revolving turret machinery was in use in the eastern plant of a large radio manufacturer before rubber became scarce. In the course of a rubber conservation program, it was found that when the rings were made of compar, a vinyl resin derivative compounded by Resistoflex Corporation, their service life was increased several times. The tough, long-lived ring is molded of the same basic material used as the core of Resistoflex oil and gasoline-proof hose assemblies. The material is compounded to give the exact degree of flexibility, elasticity, and abrasion resistance required for each particular application.

PLATE RECTIFIERS

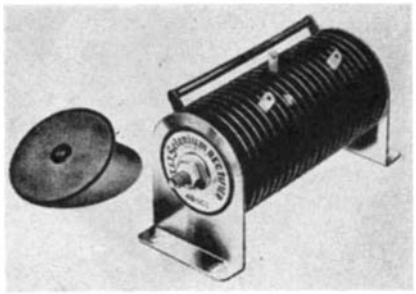
Coated to Protect Against Corrosion

A PLATE construction in metal-plate rectifiers which allows complete coating protection against destructive atmospheres, now available, permits a new method of applying the protective coatings. Where the standard petal contact is sprayed with a protective

Synthetic rubber rings, meshing with metal gears, provide positive transmission and give long service life

coating, Center Contact is especially adapted to the application of a heavier and better coating to protect the rectifier from fungus-bearing, salt spray laden, or corrosive atmospheres.

The Center Contact construction, a



Center contact in selenium rectifier plates permits better unit protection

product of Federal Telephone and Radio Corporation, is available in the same range of sizes and capacities as the standard petal-type contact. It retains the features of high voltage per plate, ability to withstand heavy temporary overloads, and operates at high efficiency over a wide range of capacities with no maintenance expense.

SCREENS

Made of Stainless Steel For Process Industries

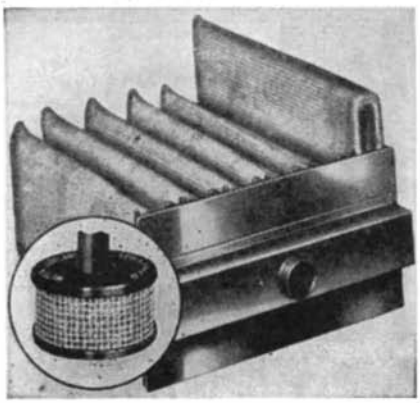
FOR USE with all types of process water, a new stainless-steel screen has proved satisfactory, according to the manufacturer, in installations in paper mills, textile mills, and other process industries. The face of the screen is a fine mesh stainless-steel wire fabric which is backed up by a heavy gage screen of about one inch square mesh. Behind this backing are the horizontal back struts of the frame itself, thereby providing maximum resistance to bellying and buckling of the fine strainer under water pressure.

The unit, made by the Rodney Hunt Machine Company, is light in weight and easily removed for quick cleaning. It is available in any dimension desired and can also be supplied with specially designed frames and quick acting hoisting apparatus for removing frames for cleaning.

OIL STRAINERS

Easily Installed On Machine Tools

USED on machine tools for straining cutting oils and coolants and for other installations using flood oiling, a new Metex strainer has the following features: No strainer housing is required. The strainer is installed in the tank and the oil or coolant is piped direct from strainer to pump. Strainer units are a unique combination of wire and cotton, inter-knitted into a mesh by machines especially developed and designed for this purpose. This makes a strong, non-collapsible strainer unit. All have a large strainage area. Exceptional capacity to hold dirt, grit, and chips can be provided in the larger units where there is sufficient space for installation. These strainers are made by the George Butler Company.



No housing required for this strainer

GOGGLES

Kept Free of Moisture By Wearer's Breath

NORMAL breathing has been harnessed to make a natural ventilating "pump" for a new goggle which cannot cloud up or fog, regardless of how much the wearer perspires. Fitted with a bulbous nosepiece, the new fog-free goggle is powered by ordinary lung action. Normal breathing sweeps a complete change of fresh air in front of the wearer's eyes many times a minute. This action removes moisture from within the goggle before there is enough of it to condense as fog on the plastics goggle lens.

Air is drawn through intake ports of the goggle as the wearer inhales

The new goggle, designed by Polaroid Corporation engineers, has flow channels built into the goggle frame to guide air circulation efficiently.

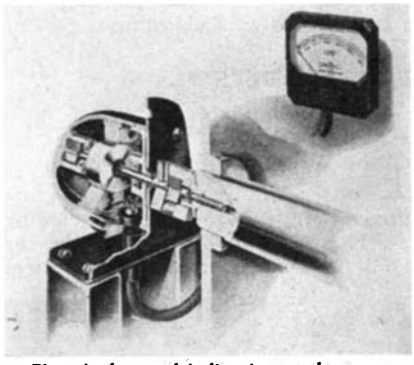
Inhalation draws air through the intake ports of the goggle. The air then sweeps across the inside of the lens, and passes through an inlet valve into the nose. Exhalation closes the inlet valve and opens the outlet valve in the base of the protruding nosepiece.

MACHINE SPEEDS

Determined with New Electric Indicator

STURDY and accurate, a new electric speed indicator makes it possible to determine and to set proper operating speeds in a broad new field of applications.

The Reliance electric speed indicator, which gives accurate readings of speeds from 100 to 5000 revolutions per minute, consists of two units. The pick-up unit, a miniature six-pole alternator with a permanent magnet rotor, is mounted on the shaft whose speed is to be measured. The indicator, a permanent magnet, moving-coil type, meters the pick-up output on a 3¾ inch scale which covers 95 degrees of arc. The resistance of the indicator has been made sufficiently high so that the size or lengths of the leads connecting the units will have no effect on accuracy, and the indicator may be located at any distance from the pick-up unit. The indicator is not affected by other magnetic material, and there is no loss of accuracy due to length of service.



Electrical speed-indicating scale may be located remotely from the machine

ALLIGATOR-JAWED RIVETER

Exerts Powerful Bite, Acts as Own Backer-Up

IN MANY modern aircraft plants, alligator-jawed compressed-air riveters are exerting powerful bites in doing their jobs of fastening two metal parts together. Whether the job calls for ⅛-inch steel, 5/32-inch Duralumin, or 3/16-inch aluminum rivets, the 9½ pound hand riveter completely and firmly heads each rivet for safe flying.

Compressed air, of course, is a vital form of power in most every war plant, whether aircraft, shipping, or ordnance, but among the more common applications of riveting, drilling, brushing, and reaming, none is more dramatic and none answers a more difficult mass pro-

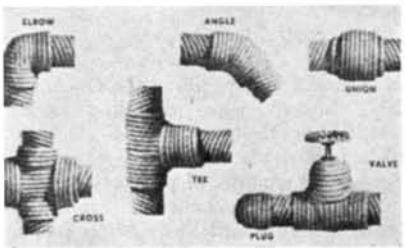
Compressed air squeeze riveter at work in speedy aircraft fabrication

action problem than the compressed r squeeze riveter. This modern development of air-powered tools acts as s own backer-up and riveter.

CORK-FILLED TAPE

Stops Drip From Cold Water Pipes

A CORK-FILLED, pliable tape is being manufactured for installation on water pipes to stop drip from condensation. Bearing the trade name Nodrip, the tape is said to be quickly and easily applicable without the need of



Tape that stops drip may be applied regardless of shape of pipe joints

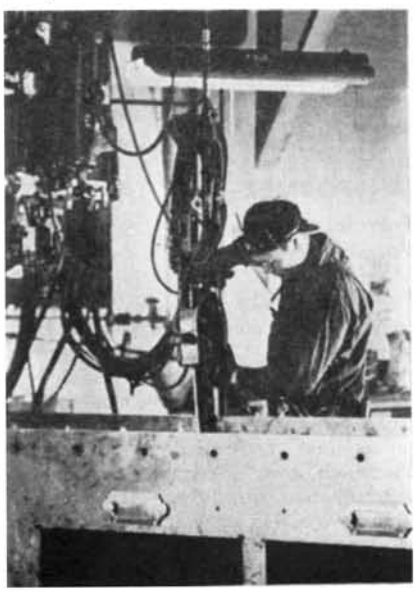
tools or special skill. Forming a sealed jacket around the pipe, it requires no maintenance and lasts a long time. The tape is normally brown in color but can be painted.

PORTABLE WELDING GUN

Solves Problems in Stove Assembly

HELPING to overcome manpower shortages and speeding the delivery of cooking ranges to the Army, Navy, and United States Maritime Commission is the production record of a heavy-duty portable spot-welding gun installation at the Washington Stove Works. The installation was developed and produced by the Progressive Welder Company.

These range assemblies were formerly riveted, the process requiring 1½ hours or longer. As the body of a large



A spot-welding gun, suspended above the work, solves production problems

range is too heavy to be spot-welded on conventional stationary equipment, a spot-welding gun—suspended by cables from above and counter-balanced so that it can be moved in any direction—is used. This permits the electrodes to be brought to bear readily on any desired point of the range body, cutting production time for this assembly operation to 15 minutes or less. Possibilities of either burning the metal or underwelding are eliminated by automatic time and heat controls.

RADIUS BRAKE

Specially Designed For Aircraft Steels

AN ENTIRELY new product, the Di-Acro radius brake was designed and developed at the request of aircraft manufacturers who required a precision machine capable of properly forming duraluminum, chrome molybdenum, rust resistant and spring tempered alloys, and various other low

Fracture of low ductile metals is almost impossible with this brake

ductile materials essential in the fabrication and production of aircraft.

This precision radius brake eliminates the possibility of fracture or disintegration developing at the line of forming, while working such materials.

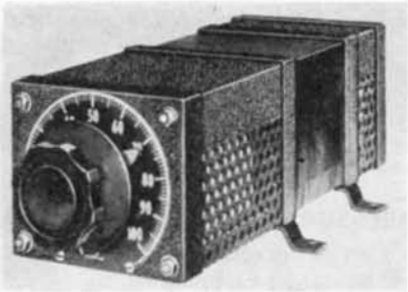
The extreme flexibility of the brake makes it an ideal unit for testing and determining ductile qualities of a wide variety of alloys and substances. It is adaptable for an almost unlimited range of laboratory and experimental research work, preparatory to selecting proper materials and developing the design of experimental or finished working models.

TRANSFORMER

Provides Continuously Variable Voltages

EXTREME flexibility in alternating-current voltage control is said to be a feature of the Gulow Vari-Former. Voltage is continuously variable—without circuit interruption—from zero to maximum values. A self-alining silver contact, controlled by a single knob switch, provides small increment voltage change throughout the range of the device. No carbon brushes are used. Incremented increase is on the order of 0.75 volts or less.

Standard units are auto-transformer type. All working parts and windings are protected by a ventilated shell



Smooth control of transformer voltage is provided in small increments

from dust and mechanical damage. Windings are on shell type core, impregnated for immunity to moisture and humidity.

PHENOLIC GLUE

Can Be Extended with Wheat Flour

A HOT-PRESS phenolic glue, Plaskon 810-12, extensible with wheat flour, permits unusual economy while meeting strict performance standards in plywood and furniture panel stock. Used without extension, the new glue meets the most rigid requirements in water and weather resistance. Plywood made with it can be used under prolonged or constant extremes of temperature and humidity. The glue line is more resistant than the wood to the effects of fungi, acids, alkalies, oil, grease, fumes, and aging. Under the most severe service conditions the unextended glue outlasts the wood itself.

At its maximum permissible extension with wheat flour—equal parts of resin and flour—the new resin assures a bond that will withstand a three-hour boil test without delamination.

BEARING WASHER

Makes Use of Lowly Orange Juicer

WHEN the problem of washing bearings for gyros came up at the Bay Manufacturing Division of The Electric Auto-Lite Company, engineers whipped it by reverting to a regulation orange

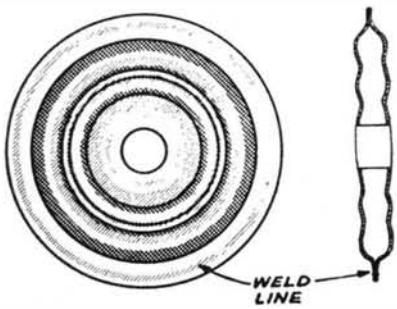
Leaving the kitchen, a fruit juicer becomes an instrument bearing washer

squeezer. The bearings are simply put in where the orange used to go, then a spray of oil is sent over them as they whirl around in the container. The bearings are taken out by tweezers, never handled by human hands. The cleaning fluid drains from the spout.

PRESSURE GAGE DIAPHRAGMS

Can be Successfully Welded, Eliminating Crimping

DIAPHRAGMS for sensitive pressure gages are now being produced by seam welding instead of the old method of crimping and soldering the edges. Formerly made of beryllium-copper, or phosphor-bronze, these diaphragms are now manufactured of stainless steel



A pressure gage diaphragm, showing welded seam that eliminates crimping

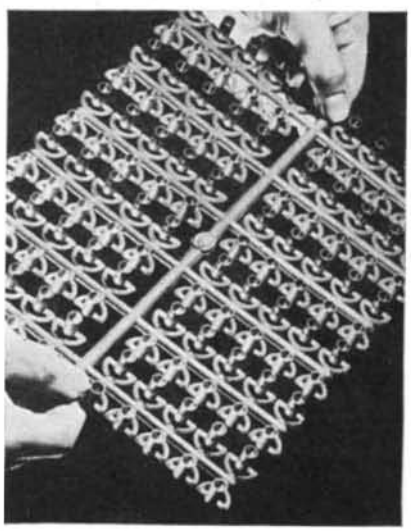
and Monel, ranging from 0.006 to 0.008 inch in thickness.

Before resistance welding was introduced, two separate stampings had to be made, allowing an extra flange on one stamping for crimping; now, two sections of the same stamping are seam welded together. This has produced a better diaphragm at less cost than was heretofore possible.

INJECTION MOLDING

Produces Plastic Parts Readily

AN example of what can be done by injection molding of Tenite plastics is shown in the accompanying illustration.



Pencil ferrules are made of plastics by molding 120 of them in one casting

Serviceable ferrules for pencils are produced rapidly by this process, 120 of them being made in a single casting. It is claimed that, since Tenite is resilient, such ferrules will grip both the pencil and eraser firmly without splitting or slipping.

CHECKING SET

Measures Accuracy of Hardness Equipment

A MASTER diamond checking set, for checking the accuracy of hardness testing equipment, consists of a gold-plated diamond penetrator and two test blocks. The penetrator is carefully made to exceedingly close tolerances to give the highly accurate measurements required

For checking hardness testers

for checking readings. Since it is designed to be used only for checking purposes, it retains its original accuracy for a long period of time. When checking, the master diamond penetrator replaces the regular penetrator in the machine.

The same is true of the two master test blocks. Held to extremely close limits, they are used only in connection with the master diamond. The resulting combination furnishes an accurate check of the machine, either as a periodical measure or whenever readings may be in doubt. The Clark Master Diamond Checking Set is furnished ready for use in a fitted case.

PICKING STICKS

Have Long Life When Made of Bonded Wood

THE Australian textile industry is using resin film with great success in bonding woods for the picking sticks which throw the shuttle back and forth across the loom. Acute shortages of hickory led to the development of the new type picking stick. The service life of these bonded sticks is reported to be from 1500 to 2000 continuous operating hours, contrasting with other wood sticks which gave an average loom life of 25 hours. No splitting or mechanical failure occurred during the periods of normal operation, and the laminated sticks are discarded only when completely worn out.

After Pearl Harbor, Australian supplies of hickory picking sticks from this country were cut off. Sticks made from woods which were brittle or of crooked grain broke after short periods and the stress concentrations in badly shaped or roughly finished sticks hastened failure. It was discovered that, in the manufacture of laminated and compressed woods bonded with resin, any desired mechanical properties could be obtained merely by increasing or reducing the amount of resin impregnation.

The resin film now being used is a special phenol-formaldehyde type manufactured by the Resinous Products and Chemical Company. In the bonding operation, wood veneers are permanently fused together with the film in a hydraulic press under heat and pressure, yielding plywood which withstands boiling water, mold, heat, and freezing.

BAILER'S GLOVE

Designed to Protect Wire Strappers' Hands

THE GREATLY increased use of wire and steel tape for preparing shipments has made imperative a special type of hand protection for the operator of the "strapping machines." To meet this need the Industrial Gloves Company produced a glove with a palm patch of chrome tanned cowhide for extra service. The base glove is grain leather, assuring comfortable fit. The fingers and thumbs are left open to increase flexibility and permit the easy picking up of tape, or wire, and small tools.

Proof against wire and steel tape

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**

STEEL SQUARE POCKET BOOK — *By Dwight L. Stoddard.* Practical methods for using the carpenter's steel square for layout work of all kinds. Time-tried methods used by two generations of carpenters and found both rapid and accurate. **$1.00**

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

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

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

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

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

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

EXPERIMENTAL SPECTROSCOPY — *By Ralph A. Sawyer.* Covers theory and types of spectroscopes and spectrographs, mounting and use of gratings, determination of wavelengths, infra-red spectroscopy, spectrochemical analysis, and so on. Somewhat elementary but requires knowledge of physics and some physical optics. **$5.10**

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

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

PLASTICS — *By J. H. Dubois.* Revised enlarged edition of an important work on the whole general subject of plastics, plus much new material on synthetic rubber, manufacturing processes, and plastics moldings. **$3.85**

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**

THE ELECTRON MICROSCOPE — *By Burton and Kohl.* A well-written account of this newest tool of science, with all technicalities explained for complete understanding by average person. **$3.95**

A COURSE IN POWDER METALLURGY — *By Walter J. Baeza.* A sound view of the overall subject of powder metallurgy which will serve as an excellent guide and reference book. **$3.60**

THE PHYSICS OF MUSIC — *By Alexander Wood, D. Sc.* Technical scientific treatise covering the border-line between science and music. Nature of sound, resonance, pitch, the ear, musical quality, and so on is its scope. It gets down to tangibles in a scientific sense. **$8.10**

PLASTICS, PROBLEMS AND PROCESSES — *By Mansperger and Pepper.* The whole story of plastics, including a resume of manufacturing processes and a number of thorough-going chapters devoted to plastics uses. **$3.10**

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

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

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

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

FUNDAMENTALS OF PERSPECTIVE — *By Theodore DePostels, A.I.A.* A method of showing the order, or sequence, in which lines of a perspective are drawn. Use of colors, numbers, and arrows eliminates much text found in other books on this subject. 20 loose sheets in binder. **$2.60**

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

The above prices are postpaid in the United States. Add, on foreign orders, 25¢ for postage on each book, except as noted.

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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.)

PRODUCTION MANAGEMENT AND HOW IT AFFECTS PRODUCTIVITY, COSTS, AND EMPLOYMENT is a 40-page booklet dealing with the problem of full employment or unemployment after the war. The aims that are outlined are based on experience in over a thousand plants and there are sections devoted to work measurement, method improvement, production control, job evaluation, and incentive wage plans for production workers. *Albert Ramond and Associates, Inc., 6300 Chrysler Building, New York 17, New York.—Available to executives only.*

THE INTERESTING STORY OF PLASKON RESIN GLUE is a 28-page illustrated booklet based on the story of this new and versatile production tool. This booklet covers the history of glue; the development of the new resin types; methods of using them in fabricating; and a great many present-day applications. *Libbey-Owens-Ford Glass Company, 2112-24 Sylvan Avenue, Toledo 6, Ohio.—Gratis.*

BELDEN ACID-PROOF BRICK FLOORS is a 16-page brochure describing a new, permanent, acid-proof brick floor designed as a universal working surface for all branches of industry. The following claims are supported by technical analyses made by three testing laboratories: minimum absorption and high resistance to sudden temperature changes, acids, and heavy impacts. *Belden Brick Company, Canton, Ohio. —Gratis.*

X-RAY DIFFRACTION — AN INDUSTRIAL TOOL is a reprint of a technical article describing the equipment and industrial applications of the analysis of raw materials by x-ray diffraction. *North American Philips Company, Inc., 100 East 42nd Street, New York 17, New York.—Gratis.*

INDUSTRIAL HEAT AND POWER CONSERVATION MANUAL is a 20-page manual based on simplified, practical methods for stretching fuel supplies. A "Heat Loss Estimate Sheet" is included to aid in step-by-step calculations for survey use in plants. *Industrial Mineral Wool Institute, 441 Lexington Avenue, New York 17, New York.—Gratis.*

GEARED TO YOUR TOMORROW is a 24-page booklet presenting a formal preview of the company's post-war plans for their mechanical division. Two major fields of endeavor are outlined: first, to produce precision devices for industry and to offer the services of its development and engineering staff

in devising new precision mechanical products; second, to present an entirely new concept of portable electric home appliances and home-making aids. *General Mills, Inc., Mechanical Division, Minneapolis, Minnesota. — Gratis.*

GEON LATEX—GENERAL PROPERTIES AND COMPOUNDING INFORMATION is a six-page technical bulletin dealing with the nature of Geon latex, its stability and physical properties, and giving compounding information on the latex. *B. F. Goodrich Company, Rose Building, Cleveland, Ohio.—Gratis.*

STOP, LOOK, LISTEN is a 20-page reprint of an address by E. D. Campbell, vice president of American Car and Foundry Company, that takes a realistic view of the present and future of railroading both from the standpoint of competition and from that of rolling stock design and construction. *American Car and Foundry Company, 30 Church Street, New York 8, New York, —Gratis.*

OIL FOR THE WORLD is a 16-page booklet that outlines succinctly a world oil policy which will serve the best interests of all nations. Interesting also are the drawings which supplement the text. *Standard Oil Company (New Jersey), Room 1626, 30 Rockefeller Plaza, New York 20, New York.—Gratis.*

KITCHEN OF TOMORROW is a single folded sheet prepared specifically to correct some of the erroneous notions that have grown up regarding the wonderous kitchen which the housewife may expect post-war. The treatment is light and humorous, which makes even more forceful the impact of the story which it tells. *The Schaible Company, Summer Street, Cincinnati 4, Ohio.—Gratis.*

SILVER ALLOY BRAZING, by Col. Harry R. Lebkicher, is an article discussing the methods and materials used in silver alloy brazing in the Chemical Warfare Service with an explanation of the procedure and preparation for low melting silver alloy brazing in large production lines. *Handy and Harman, 82 Fulton Street, New York 7, New York.—Gratis.*

RADIUM LUSTROLITE is a four-page folder covering the scope and advantages of radium paints and their applications. Some of the advantages claimed for radium paint are its self-activating characteristic, its ability to give off a steady glow, and freedom from encumbrance of wiring, electrical apparatus, bulbs, or fuses. *Lustrolite Cleveland Corporation, 6927 Carnegie Avenue, Cleveland 3, Ohio.—Gratis.*

COLD TREATING PRACTICE is a 40-page informative catalog, profusely illustrated, which deals with the process of industrial cold treating and the equipment required for it. Specific uses and procedures are dealt with in considerable detail. *Deepfreeze Division, Motor Products Corporation, 2314 Davis Street, North Chicago, Illinois.—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.

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NEW WORLD OF MACHINES

By Harland Manchester

DON'T BE mislead by the title; the subtitle—Research, Discovery, Invention—is far more descriptive of the text. The author, well known for his popular magazine articles on general science, has drawn on a vast knowledge of American industry, obtained first-hand, to paint with a broad brush an exciting panorama of practical applications. Electronics, polarized light, fluorescence, engine fuels, gas turbines, synthetic rubbers, plastics, powder metallurgy, air conditioning, and machines on the farm are all pigments for his palette. With breathless speed, as if to complete his work before it becomes antiquated, the writer rushes the reader through these fields, revealing enough to whet the appetite for more. Details are given of some of the developments described, yet not enough to slow up the tempo. A number of clear, simplified sketches supplement the text, and a comprehensive bibliography points the way for the reader who wishes to dig deeper. (313 pages, 6 by 9 inches, drawings, and 21 photographs in an insert.)—$3.10 postpaid.—*A.P.P.*

PLASTICS—SCIENTIFIC AND TECHNOLOGICAL

By H. Ronald Fleck, M.Sc., F.I.C.

WRITTEN by an English scientist who has kept close touch with plastics developments in America and Europe as well, this solid, meaty text represents, in the author's words, "a critical survey of the literature and a correlation of scattered data . . . of value both to chemists in the industry and to those whose professional duties necessitate a knowledge of the science of plastics." Descriptions of reactions and details of procedure are complete to the last proportion and degree of temperature. Raw materials, theoretical principles, the chemistry of plastics materials, and the manufacture of plastics are thoroughly covered, as are also rubber-like plastics, thermoplastic and thermosetting materials, synthetic fibers, wood and plastics combinations, the manufacture of dies and molds, the production of plastics articles, and so on. There is no glamor in this book; it is composed entirely of down-to-earth, work-a-day, factual material for those who need more than an elementary knowledge of the plastic industry. (325 pages, 6 by 9 inches, a large number of drawings and tables, completely indexed.)—$6.60 postpaid.

YELLOW MAGIC THE STORY OF PENICILLIN

By J. D. Ratcliff

THIS IS the first comprehensive story of the miraculous drug that is one of the greatest medical developments of the age. Beginning with the accidental discovery of penicillin, the author tells in an intensely interesting manner how the drug was coaxed and developed, slowly, through many years, by the patient, persistent work of such scientists as Alexander Fleming, Howard Walter Florey, and numerous others. Unbelievable are the examples of the miracles that this life-saving drug has accomplished, especially with those diseases hitherto thought to be incurable; even more incredible is the fact that it does not appear to be toxic or harmful to the patient. And now the great problem of mass production has been worked out so that it is available to both civilians and the armed forces. (170 pages, 5 by 7½ inches, complete index.)—$2.10 postpaid.—*A.P.T.*

PRACTICAL PHYSICS

By White, Manning, and others

THE WAR, which is bringing so many persons into technological work and other occupations connected with science, both in and out of the armed forces, has created a great demand for practical information on physics on the elementary level. This book was prepared specifically to meet such demand. The emphasis is placed on those physical principles that will give trainees the understanding necessary for their effective participation in the war effort. In essence, the book is a streamlined course in the major concepts of

physics for use in the hurry-up programs connected with fighting the war. As such, it is an outstanding job. Mathematics has been cut to an irreducible minimum and the style is simple and to the point. (365 pages, 6 by 9 inches, with many illustrations.) —$3.35 postpaid.—*J.C.*

TRIGONOMETRY FOR HOME STUDY

By William L. Schaaf, Ph.D.

EXTENSIVE and detailed, rather than sketchy, is this book written specifically for the home-study sufferer. It explains as it goes, supplying all but the perspiration. Numerous practical applications of trigonometry, such as machine shop problems, surveying, navigation, and spherical trigonometry are included. The author is Assistant Professor of Education at Brooklyn College. Of great value is the fact that tables of natural trig functions, a 5-place log table, and a 5-place table of logs of functions, with numerous smaller tables, are included. (404 pages, 5¼ by 7¾ inches, numerous figures.)—$.80 postpaid.—*A.G.I.*

YOUNG AMERICA'S AVIATION ANNUAL 1945

By David C. Cooke

ALL ABOUT the latest developments in aviation and studded with some of the most striking photographs of fighting planes ever printed, is the 1945 edition of this well-known book devoted to planes and the men who build and fly them. Growing boys who are interested in airplanes will treasure this book and pore over it for days; that is, if they can pry it away from their fathers, uncles, and big brothers. (222 pages, 6½ by 9½ inches, richly illustrated.)—$3.10 postpaid.—*J.C.*

A STORY OUTLINE OF EVOLUTION

By Charles W. Grimes

BECAUSE it is permeated with a religious atmosphere this book would be of use to two categories of readers: Those who can reconcile science and religion and who themselves wish a very elementary approach to an understanding of evolution; and readers who might present it to fundamentalists in order to plant a seed for scientific interest on otherwise unreceptive soil. It probably would please fundamentalists better than scientists. It does not attempt to go far into evolution. (244 pages, 5¼ by 8 inches, unillustrated.)—$2.10 postpaid.—*A.G.I.*

THE AVIATION ANNUAL OF 1945

Edited by Reginald M. Cleveland and Frederick P. Graham

THE Annual, edited by experienced and well-informed aviation writers, will do much to bring both professionals and public abreast of the range of developments in aviation as of today. It is divided into a number of important sections, each with a foreword by an authority. Post-war Employment and Conversion are treated in an authoritative manner. Commercial Air Lines are discussed with the aid of some striking photographs. Private Flying and Airports are given an excellent survey. The Epilogue deals with "Aviation and The American Public." A useful though brief directory is appended, dealing with organizations and associations, transport lines, and the like. Beautifully illustrated, the Annual gives a vivid and highly interesting picture of what our aviation is doing in various theaters of war, what it is doing in transportation, and what it may be expected to do in the near future. (200 pages, many illustrations.)—$3.85 postpaid.—*A.K.*

FUNDAMENTAL BUSINESS LAW

By J. F. Christ

ALL ASPECTS of business law are succinctly outlined and explained in this book in a way comprehensible to the ordinary man not encumbered with a legal education. Those who want to have at hand a source of information about the fundamentals of commercial law to help them in their business perplexities will find enlightenment in Dr. Christ's book. In addition to the usual headings that come under this department of law—contracts, negotiable instruments, sales of goods, agent and principal—there is as well a useful chapter on the law of insurance and another on employers' liability for injuries to employees. All in all, this volume might be described as a little encyclopedia of commercial law. (332 pages, 6 by 9 inches, many illustrations.)—$3.10 postpaid.—*J.C.*

PLASTICS CATALOG

1945 Encyclopedia of Plastics

BETTER rush your order for a copy of this monumental volume if you want to be sure of getting one. The supply is severely limited and many would-be purchasers were disappointed last year. The text covers recent progress in plastics, technical data, materials, engineering design, molding and extruding, plywoods, coatings, and so on, with an appendix consisting of a comprehensive bibliography and glossary. (1178 pages; 8½ by 11½ inches; lavishly illustrated with black and white and color reproductions; numerous inserted, folded tables; a complete index; bound in padded plastics covers.)—$6.00 postpaid in United States; $7.00 postpaid elsewhere.—*A.P.P.*

THE PSYCHOLOGY OF INVENTION IN THE MATHEMATICAL FIELD

By Jacques Hadamard

JUST EXACTLY how the superior mental machine of the advanced mathematician functions must ever remain to mere human beings a mystery, but this little book gives us at least an

inkling concerning what most of us don't ourselves experience. How Newton's mind worked is discussed, for example. How Professor Einstein thinks is told in a quoted letter by himself. Other mathematicians will especially enjoy these glimpses. The author is a French mathematician. (143 pages, 5¼ by 7¾ inches, unillustrated.)—$2.10 postpaid.—*A.G.I.*

PRINCIPLES OF MODERN INDUSTRIAL ORGANIZATION

By Walter Rautenstrauch

PROBLEMS that continually harrass students of industry and industrialists alike are here subjected to comprehensive study. The principles of industrial organization are analyzed by methods in which the activities of each department of a manufacturing business may be studied and evaluated, with improvements bound to result. The treatment is basic in approach yet is developed in detail when the author deals with problems of unit operations, the flow of work, internal relationships, design functions, repairs and replacements, and so on. Altogether, the text gives a clear picture of organized industrial activity. (312 pages, 6½ by 9½ inches, 56 charts and drawings.)—$3.85 postpaid.—*A.P.P.*

OUTLINE OF THE AMINO ACIDS AND PROTEINS

By Melville Sahyun, Ph.D., and others

THE PURPOSE of this book is to outline in simple and readable manner the essentials of the chemistry and biochemistry of amino acids and proteins. There are 12 chapters contributed by 11 authors of high standing in university circles. (251 pages, 5¾ by 9 inches, illustrated.)—$4.10 postpaid.

THE PHYSICS OF FLIGHT

By Alfred Landé

FOR THOSE who want to know precisely why an airplane flies, this carefully written exposition of the principles of flight will be immensely valuable. The author has designed the book to help those who are, or expect to be, engaged in operating, designing, or manufacturing aircraft. By shearing away all non-essentials he has managed to set out the fundamentals of aerodynamics briefly and with clarity. Students of physics and engineering will find his efforts a great help as a first step in attaining a thorough mastery of the subject. A chapter is devoted to the newer types of aircraft including jet-propelled planes, helicopters, and autogiros. (122 pages, 6 by 9 inches, with many illustrations.) —$2.60 postpaid.—*J.C.*

AN INTRODUCTION TO ELECTRONICS

By Ralph G. Hudson

CLEARLY AND concisely, yet with sufficient detail to give the reader something into which he can sink his teeth, this compact book explains the science of electronics and its modern applications. Only a very elementary knowledge of mathematics and physics is required to master the explanations. (97 pages, 6 by 9 inches, 72 drawings plus a number of photographs.)—$3.10 postpaid.—*A.P.P.*

YOUNG MINDS WITH OLD BODIES

By Melvin E. Page, D.D.S.

STUDY of body chemistry in relation to teeth, based on the thesis that civilization's poor teeth result largely from sugar eating. The author tells what society and the individual may do about it—discontinue sugar. Perhaps he rides this one horse too hard, or perhaps he is right, for there is elsewhere plenty of evidence against sugar. (183 pages, 5¼ by 8 inches, 20 figures.) —$2.60 postpaid.—*A.G.I.*

SHEET METAL, THEORY AND PRACTICE

By John C. Butler

FROM THE simplest hand tools and specialized devices for working sheet metal, through riveting, welding, and soldering, this text gives the reader a broad yet detailed knowledge of the overall subject of sheet metal working and shop practice. (173 pages, 9 by 11 inches, over 140 illustrations and 9 charts.)—$3.10 postpaid.—*A.P.P.*

SOUL OF AMBER

By Alfred M. Still

MAN'S persistent concern from the most ancient times down to the present with the mysterious energy called electricity is the subject of this unusual and interesting book. When a piece of amber was rubbed, the wise men of the ancient world noticed that it developed the property of attracting bits of chaff, and hence they called electricity "the soul of amber." Beginning with a discussion of what the early philosophers thought of electricity, the author traces the growth of interest in and knowledge of it down through the ages until, with the work of Faraday and those who came after him, electricity emerges as a great power in everyday life, making our age truly the age of electricity. (274 pages, 6 by 8½ inches, index and notes.)—$2.60 postpaid.—*J.C.*

FROM MICROBE TO MAN

By J. V. Wells

IN THIS book the author scientifically traces the human embryo from its origin through its fish, reptile, and mammal stages; treats of primitive man and then of the human brain, to show that our physical makeup is essentially animal; and then uses this scientific background as a taking off point for his thesis that, if we would only be more religious and less selfish, we could terminate wars and arrive at harmony. (106 pages, 5¼ by 7½ inches, illustrated.)—$2.10 postpaid.—*A.G.I.*

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 notes relate to the two-part article on making objective lenses by the test-plate method, by Patrick A. Driscoll of Rochester, in the March and April numbers.

In "A.T.M." page 71, the middle paragraph suggests a principle known as the "unit focus" principle: all the pertinent design data—focal length, diameters, thicknesses, radii of curves—in this instance of an eyepiece, may be divided or multiplied by any amount chosen (of course with due consideration to practical limitations), provided this remains throughout the same amount. These changes do not, of course, change the focal *ratio*.

When this fact was called to Driscoll's attention as a possibility for use in connection with his lens specifications he replied: "Now that you dig up one of the deep 'secrets' of our optical wizards that the amateur is not supposed to be let in on, I may as well let the cat out of the bag. An achromatic doublet can very easily be reduced in this way. For example, a 6" can be reduced to a 3", simply by dividing everything—except, of course, index and dispersion—by 2. It is as easy as that. I didn't put it in my story because if I'm makin' a lens, then by jeepers I'm makin' a big one—which by this method is as easy as a little one—and then the finished article is a man-sized hunk of apparatus. But I suppose the monetary outlay for large blanks is a consideration. If you reduce my 5¼" to, say, 3" or so, you reduce the aberrations; also the range of the figure of each surface is not quite so critical and the performance will be slightly better; but—a warning—do not *increase* the diameter unless willing to accept an increase of these same characteristics. At least, if you risk this, the surfaces must be very exact, else performance will suffer."

In weighing the matter of size, "A.T.M.A.", page 192, bottom paragraph, should not be overlooked.

This unit focus opportunity confers an added degree of freedom on the test-plating procedure, and if now we amateurs can between us collect and pool a variety of specifications for tried and good objective lenses, this method will enjoy still more freedom. Incidentally, there also is nothing about this method which forbids anyone from designing his own objective, just as in the other method, and in the most rigorous way if desired; yet it does make available to those who aren't too happy when tussling with design (as a few aren't, according to your scribe's mail) a chance to make and enjoy their own refractors. By this method the amateur's fear of the convex surface also is resolved, and it enjoys other advantages.

Specifications for two types of cemented and two of uncemented objectives, given on the unit focus basis, appear on page 29 of the newly published book, "Telescopes and Accessories," by Dimitroff and Baker. (This is the book which was given an advance review on page 466 of the 1941 printing of "A.T.M." — it has finally been published.)

Driscoll's specifications call for objectives of rather short focus (large focal ratio); that is *f*/12, and *f*/13. Ellison calls for *f*/15 or *f*/16 and so do some others. Questioned about this, Driscoll answered: "The 5¼" was computed for me as an ideal astronomical glass that would utilize easy *c* and *f* and not require too precise adherence to stated tolerances." Dr. D. Everett Taylor has made one and has reported it good, in the April number.

Patrick A. Driscoll

Driscoll's method of calipering the edge of the lens elements during preliminary work—tipped micrometer anvils and stop block—happily complements Ellison's always questionable if not inadequate method in "A.T.M." (pages 115, 117), for it is otherwise almost impossible to caliper a tapered surface twice alike to close tolerance. In "A.T.M." (page 250) Haviland describes an edge gage involving three steel balls and a dial gage (a similar rig is used at the Bureau of Standards and reads to 0.0002" as the lens is rotated in it, according to Ferson), and in Scientific American, February, 1940, D. Everett Taylor also described a very beautiful combined edge thickness gage and spherometer. Both of these contribute in large measure to precise work.

Any who give Driscoll's procedure or program a workout are urged to report all their experiences, impressions, opinions, and findings—its best, its worst. It is hoped that this flatless, test-plating method will result in a larger proportion of refractors being made.

THE REFLECTOR is a splendid telescope but in recent years more and more amateurs have quietly expressed their conviction, gradually arrived at, that on balance the refractor is even more satisfactory, giving steadier, better resolved, sharper, even if less brightly illuminated, images that stand higher magnification, especially for planetary and lunar observation. Here are some recent comments from amateurs who seem happy about their new refractors.

"I still use my 10" Cassegrainian, but the second-hand 5½" Brashear refractor I just bought has so much better definition and resolving power that there is little point in using the Cassegrainian. Almost any night I can use the quarter-inch eyepiece."

Another: "I have just finished a 2¾" objective lens, my first, and from here on I am on refractors. This telescope defines perfectly."

A third: "Refractors at times throw theoretical resolving power out the window."

Of course, these are warm statements reflecting new enthusiasms, and they may be subject to some discount. The reflector is an excellent telescope but the notion that there is something inferior about the refractor is all wrong. Maybe 'twas a rationalization, because making one called for a lathe and a flat. Pat Driscoll's program now lops off the flat.

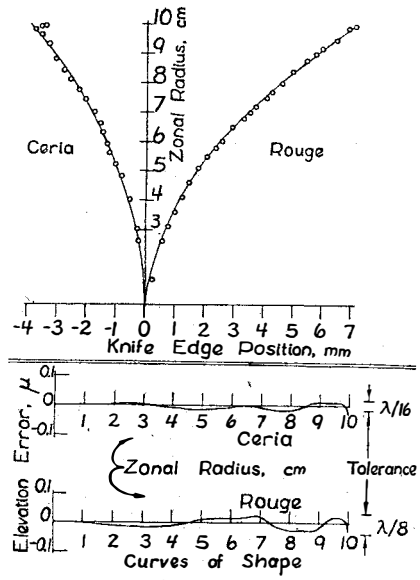
CERIUM OXIDE is now strongly competing with rouge in the optical industry. The following notes on that new polishing abrasive are by Frank Allen Lucy, 3427 W. Penn St., Philadelphia, Pa., who has contributed to this department before (July, 1943—notes and equations on Gee's method of figuring Cassegrainian secondaries by the test-plate method):

"People in increasing number have been recommending ceria (ceric oxide) in place of rouge for optical polishing. On the credit side, it is said to be cleaner and faster than rouge, less likely to cause sleeks, turned edges, or tarnishing on aging. On the debit side, it is said to cut so fast that it makes delicate figuring difficult, and to give a dull surface at first, which brightens only on long polishing; so that some think it unsuitable for final figuring, in which the periods are necessarily short.

"The writer's observations on the use of ceria may interest other optical workers. Ceria, being practically white, is certainly cleaner than rouge. Minimizing turned edge seems a matter more of technique than of agent. The commercial sample in our laboratory contains particles ranging widely in size. Probably, if used as received, it would give a dull surface at first, until the coarser particles were well driven into the pitch of the lap, after which

the surface would brighten. However, when shaken with water and a wetting agent (Duponol D happened to be the readiest to hand), this ceria was readily dispersed and levigated. The levigated material gives a brilliant polish on any glass from dense barium crown to Pyrex, and works, in my estimation, about twice as fast as rouge of similar scratchiness.

"The scratches here referred to are those necessary ones which remove material in polishing, the scratches which fuzz the edges of a knife-edge shadow. (A. W. Everest, on page 22, 'A.T.M.A.,' says, 'Also decide right here what you are going to *call* the shadow; probably the point where none of the remaining spiderwebs of light crosses the pin.' These spiderwebs are diffraction patterns of scratches, scratches usually too small to be seen by direct examination but nevertheless capable of diffracting light.)



Drawing by F. A. Lucy

Cerium oxide versus optical rouge

"Polishing speed was judged by the length of spells necessary to produce a given rate of approach to an aspherical figure, starting from a sphere. Thus, if 40 minutes with rouge produced 5 percent of the total correction, 20 minutes with ceria was found adequate, under the same conditions, to produce another 5 percent. Other workers have stated that ceria is faster than rouge by factors ranging from 1.3 to 4 times. Particle size and possibly shape, hardness of pitch, polishing speed, and pressure, proportion of water, rate of feed, and so on, all affect the rate at which glass is removed, making a truly scientific evaluation of this factor difficult. Further, a set of conditions which gives the best results with a given rouge sample is not the best set for any other rouge sample, and is most unlikely to be best for a given ceria sample. The consensus is, however, that properly handled ceria is decidedly faster than properly handled rouge.

"Some hold that ceria is good for coarse work but not for fine. To this, the writer cannot subscribe. For example, Dévé states, 'It is less recommended for precision polishing because, precisely on account of its "bite," it is less suitable for removing infinitely small layers of material.'

"Actually, the precision attainable in figuring with ceria seems to be at least equal to that attainable with rouge. The diagram shows the errors of two mirrors, one polished entirely with rouge, the other started with rouge but taken most of the way with ceria and finished with twice-levigated ceria. The curves of shape were determined by a method practically identical with that described by F. B. Wright in 'A.T.M.' (chapter on accuracy in parabolization). The knife-edge readings were made by Everest's shadow crest method, and the integration was done mechanically instead of numerically.

("Incidentally, these curves highlight the necessity of using a micrometer screw to move the knife-edge when a deep curve is to be measured. Although none of the discrepancies shown in the diagram would be detectable, let alone measurable, by the pencil mark and ruler technique, the mirrors are not actually exceptionally good, being only comfortably within the tolerances required for their intended applications.)

"In the upper graphs, observed knife-edge displacements (circles) are compared with the ideal values (curves). The lower graphs show the disparity between the observed and ideal cross-sections along radii from the center outward. The wavelength (λ) in terms of which the tolerance is expressed is the wavelength of maximum visibility.

"It will be seen that the ceria-polished mirror was brought much closer to perfection than the rouge-polished one. It would have been possible to have brought either closer still, but there is no sense in further working an optical surface which is within the assigned (Wright) tolerance."

CERIUM OXIDE may be had from the Universal Shellac and Supply Co., 401 Broadway, New York 13, N. Y., which, by the way, is not the supplier mentioned, in part adversely, by Lucy and, anyway, ceria has greatly improved.

Commenting on this new polishing abrasive, the Ferson Optical Co., Biloxi, Miss., which has been using it says: "It has a heavy drag in polishing, polishes faster than most rouges, seems to have less tendency to scratch, in our experience has more tendency to turn edges but not much more, and should be used with a hard lap."

Barnesite, a somewhat expensive polishing abrasive from the same source, is held to be even better than cerium oxide by many professionals. (Incidentally, while on abrasives, the new "garnet fines" developed for wartime optical uses, and now being obtained from the same source, are rapidly moving in on fine emeries as a finished abrasive for grinding.)

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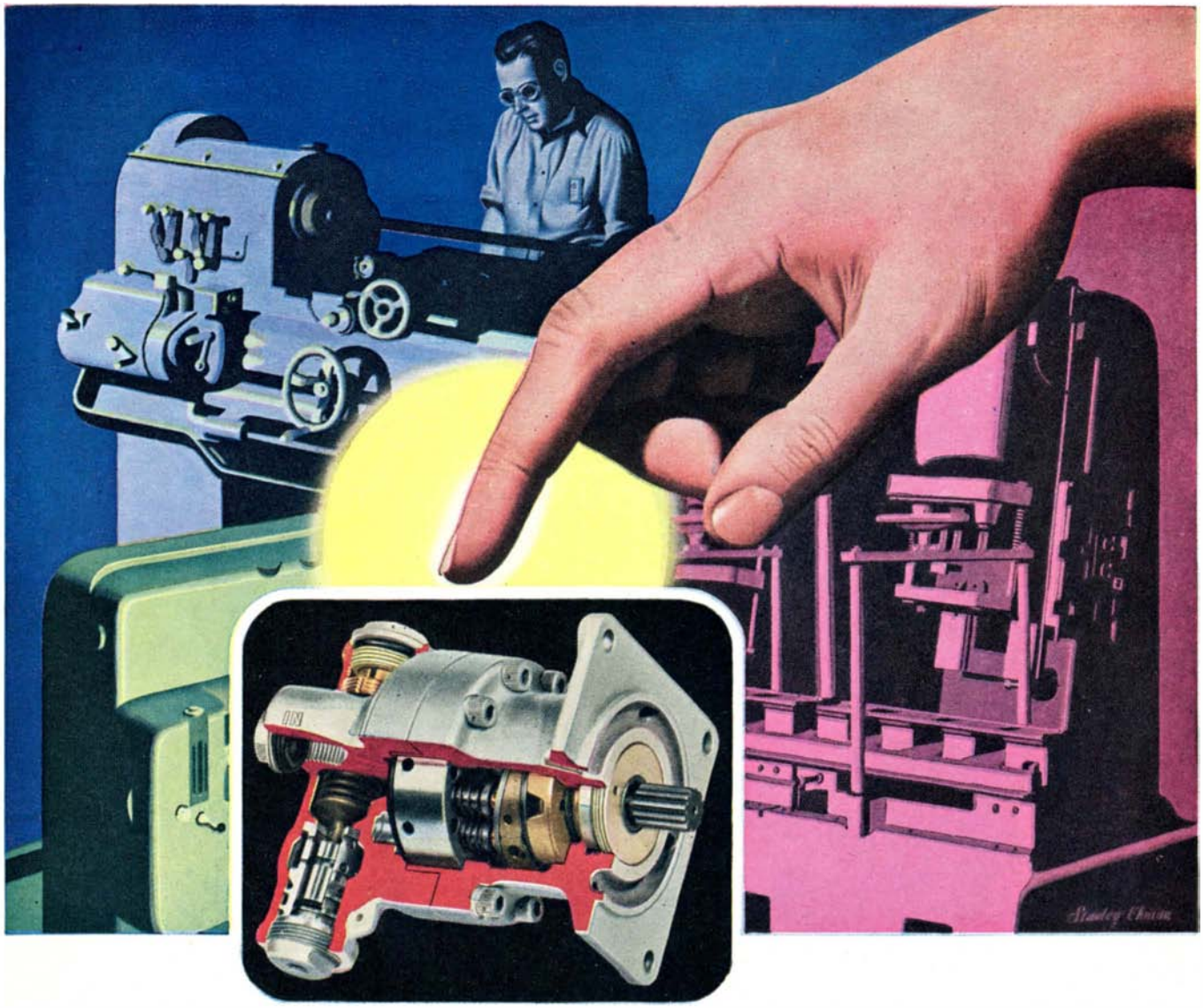

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