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MARCH
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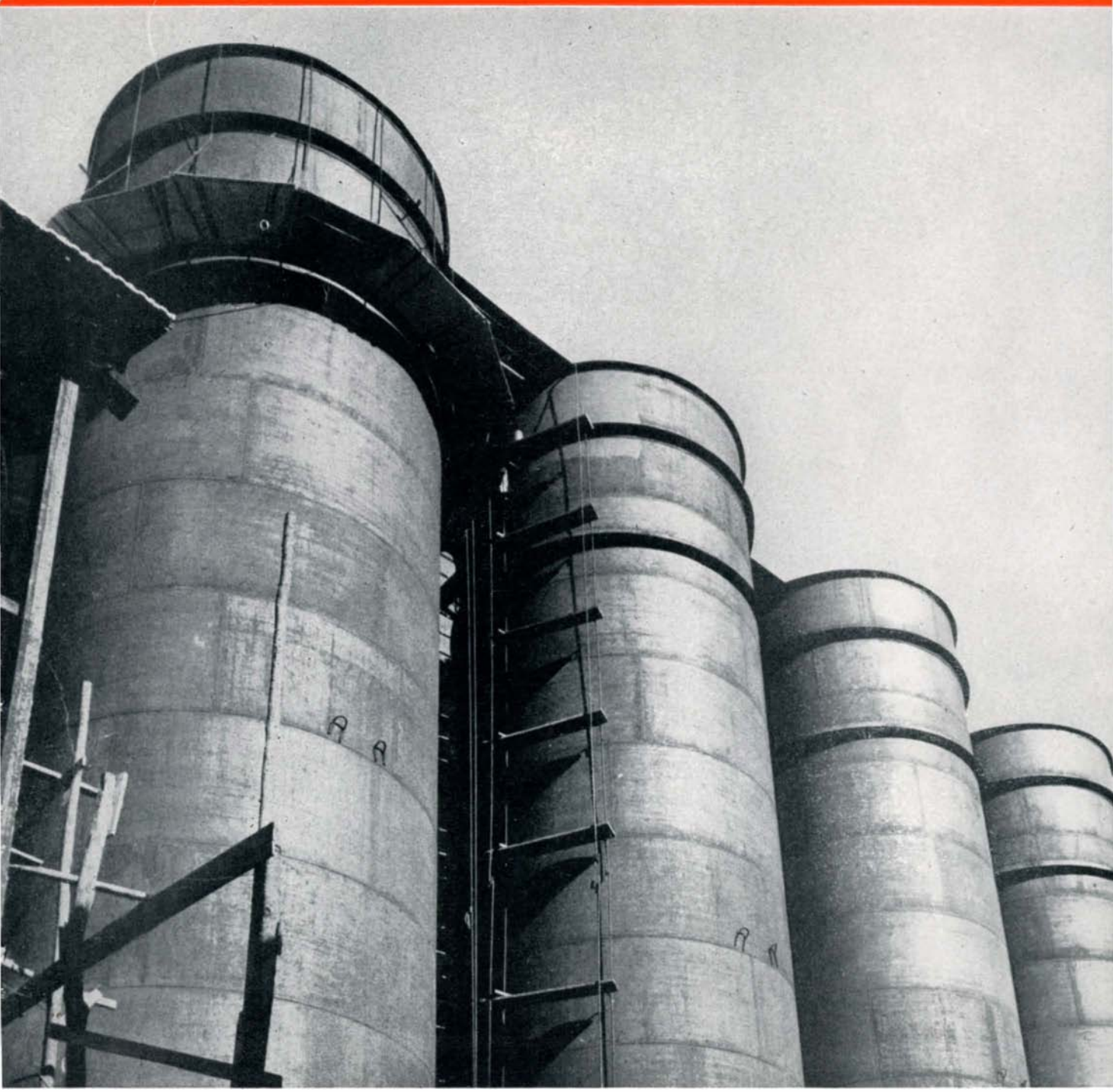
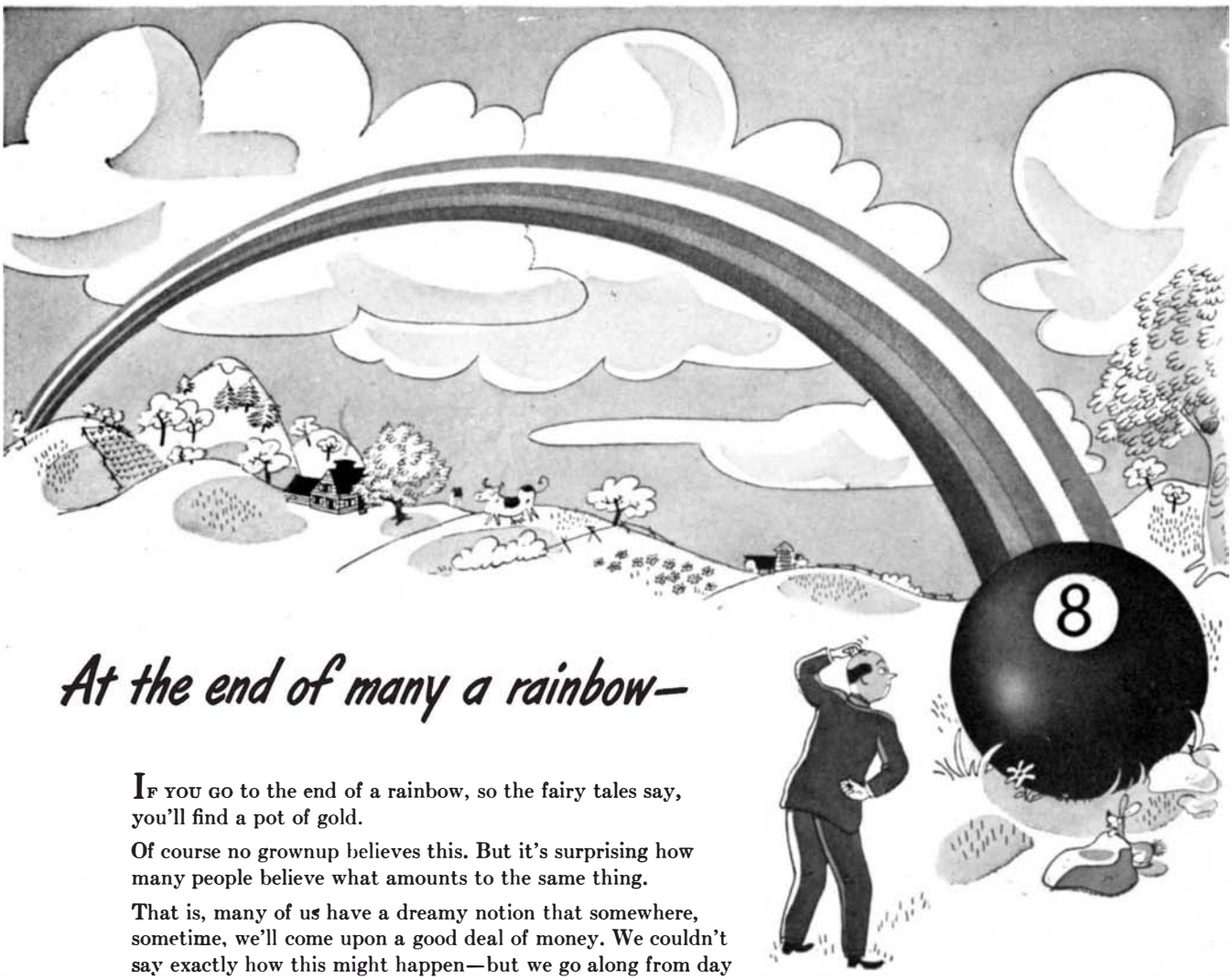


Brazilian Industry Reaches Skyward . . . See page 97



At the end of many a rainbow—

IF YOU GO to the end of a rainbow, so the fairy tales say, you'll find a pot of gold.

Of course no grownup believes this. But it's surprising how many people believe what amounts to the same thing.

That is, many of us have a dreamy notion that somewhere, sometime, we'll come upon a good deal of money. We couldn't say exactly how this might happen—but we go along from day to day, spending nearly all we make, and believing that *somehow* our financial future will take care of itself.

Unfortunately, this sort of rainbow-chasing is much more apt to make you wind up behind the eight ball than with a pot of gold.

When you come right down to it, the only sure-fire way the average man can plan financial security for himself and his family is through saving—*and saving regularly.*

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So isn't it just plain common sense to buy every U. S. Savings Bond you can possibly afford? You bet it is!

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Scientific American

Founded 1845

In This Issue • March 1947

INDUSTRIAL DRAMA: This view of part of the aluminum plant of Eletro-Quimica Brasileira S/A symbolizes the great growth of Brazilian industry as outlined and pointed-up in the article starting on page 100.

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

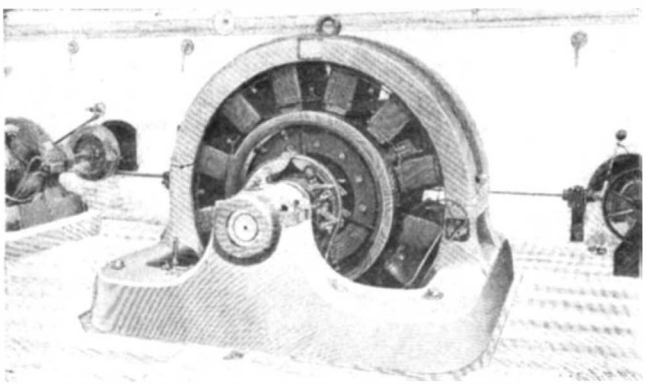
(Condensed from Issues of March, 1897)

WIRELESS — "Guglielmo Marconi has demonstrated the superiority of his system of telegraphy without wires. . . Mr. Marconi, in making use of the Hertzian waves, discovered that impulses set up in his apparatus were able to affect a receiver placed on the further side of a hill. Morse signals could be sent with ease through the larger part of a mile of earth and rock. He found he had discovered a new form of energy that did not exist in the Hertzian waves. The new wave could penetrate everything and could not be refracted or bent aside from a straight path. No description of Marconi's apparatus has been made public."

TRANS-SIBERIAN — "The Siberian Railway is making rapid progress. Sixty-two thousand workmen are employed. . . Towns are springing up in great numbers along the western section, which runs through a 'black earth' country."

POLAR ATTEMPT — "The government of Sweden has notified the Canadian government that Herr Andree will start from Stockholm about the end of June for Spitzbergen to attempt his balloon voyage to the North Pole."

POWER — "One of the latest and, in many respects, one of the most remarkable long distance transmission plants is that which has been built by the San Joaquin Electric Company to supply the town of Fresno with light and power. . . Water is taken from these rivers by wooden flumes. . . A pipe line leads from the reservoir down the side of the



One of the 350 K. W. General Electric generators

mountain to the power house, a distance of 4,000 feet, the total fall being 1,411 feet. . . There are three single jet Pelton wheels for driving the generators, two for driving the exciters, and two smaller wheels which operate the governor mechanism. . . The power house contains three 340 K. W. multipolar General Electric 3-phase generators, which deliver current at 700 volts to a low potential switchboard, from which it is carried to six 125 K. W. transformers, which deliver 3-phase current at 11,000 volts through a high potential switchboard to the line. . . The San Joaquin Electric Company has established a price of $64 per horse power per year for its electric power. The current for lighting purposes is furnished at fifteen cents per K. W. hour, measured by meter."

PROSPERITY — "Let me ask, says Mr. Andrew Carnegie in a recent address, under what conditions does the employer of labor make profits and become prosperous? Only when labor is prosperous, is his reply, and in great demand; when wages are the highest; and when the demand for his products are the greatest. Then, and then only, is the employer prosperous. On the other hand, when labor is not fully employed and can be obtained for the lowest wages, when there is little demand for his products, then the employer can never be prosperous."

NIAGARA — "The hydraulic and electrical installations at Niagara Falls were built for the purpose of supplying the new aluminum factory of the Pittsburgh Reduction Company and to supply power to other consumers. The company now furnishes power to the Niagara Falls & Lewiston Railroad and the Lewiston & Youngstown Railroad. . . The power house is 180 feet long and is arranged to eventually contain sixteen wheels of about 2,000 horse power each."

DISCHARGE LAMP — "Herr O. Schutt, of Jena, describes a new electric discharge phenomenon, which he terms electro capillary light. When the discharge of an induction coil is sent through a narrow capillary tube of about 0.05 mm. in diameter, provided with aluminum or copper electrodes and filled with air under ordinary pressures, an intense luminosity of the thread of air is obtained. . . The narrow capillaries deteriorated rapidly, roughening inside, and were blown into a series of spherical enlargements. Wider tubes gave less light, but were much more permanent."

GOOD ROADS — "The growing agitation in favor of building better roads has a deep significance and will have a more widespread effect than is generally supposed: for as soon as the people begin to realize that the question is an economic one that vitally affects our national prosperity, we may look for a thorough reform in the present methods of road building, so far, at least, as a large number of the States are concerned."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of March, 1847)

HOUSING — "A company with a large capital, is engaged in England in the erection of 1200 houses for the use of the laboring classes, who are to be conveyed back and forth from home to their daily toil by the railway."

MINERALS — "South Missouri abounds in Iron and Copper; in some places Lead is found; Zinc and other metals are also discovered. In the northern part of Shannon county, red porphyry abounds—it is very hard, and would admit of a high polish."

PEN MANUFACTURE — "Although millions of metallic pens are consumed in Europe and other parts of the world yet the manufacture of them is little understood, and carried on extensively only in England and the United States."

COTTON FACTORIES — "There are eighteen cotton factories in Georgia. It is thought that there is a capital of a million and a half invested in these factories, and that they pay a dividend of from 13 to 24 per cent on this capital."

WINDMILLS — "Master ship builder George Savage, of Bangor, has made some improvements in the mode of constructing windmills, which will, it is said, bring them into general use by mechanics who can apply machine power in their business. There is no question as to the feasibility of making use of the windmill in many mechanical pursuits."

Writing with your voice

Years ago Alexander Graham Bell dreamed of "a machine that should render visible to the eyes of the deaf, the vibrations of the air that affect our ears as sound." He never realized that dream, but his researches led to the invention of the telephone.

Today Bell Telephone Laboratories have turned the dream into a fact — translating the spoken word into readable pictures.

By this new invention of the Laboratories, the talker speaks into a microphone. Vibrations of the voice are unraveled through electronic circuits, and then are reassembled as luminous patterns which travel across a screen. Each syllable of sound has a distinctive shape and intensity.

Science unravels speech

Visible speech is still in its infancy, and is not yet available to the public. But educators of the deaf are now evaluating it. Indications are that the deaf can learn to read the patterns and, by comparing the patterns their own voices make with the patterns of correct speech, can improve their diction.

Patterns of visible speech also provide a means for analyzing and recording sound in the study of phonetics and of languages. Eventually, visible speech may make possible visual telephony for the deaf.

This is but one of many contributions by Bell Telephone Laboratories to the understanding and control of sound.

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

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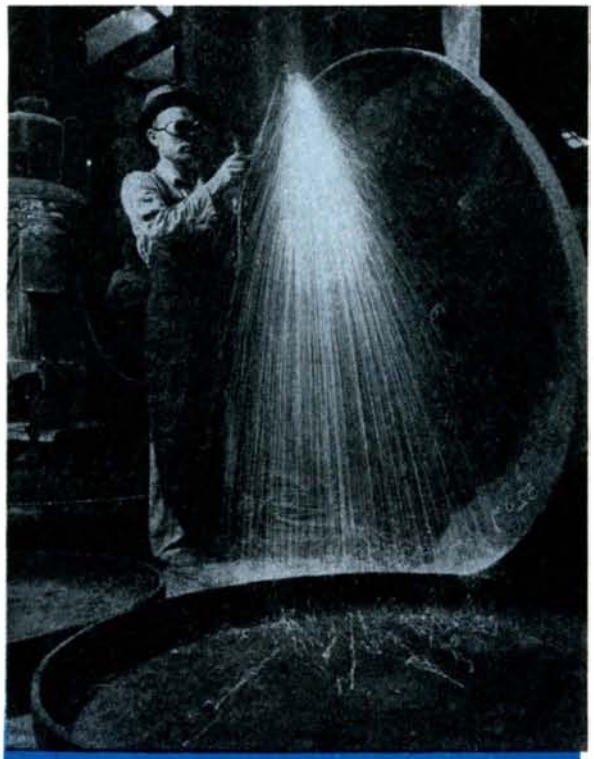
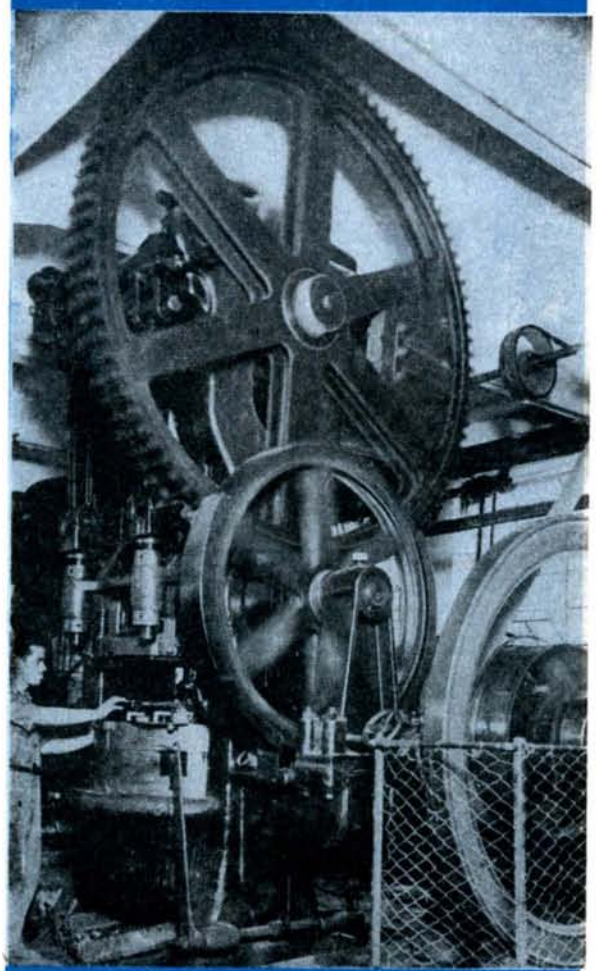
MARCH • 1947



Welding boiler parts in a Brazilian plant



A 600-ton press stamps tinned basins

BRAZIL: A Coming Industrial Empire

With an Industrial History Going Back Only a Relatively Few Years, this Huge South American Country Promises to Contribute Greatly to Technological Progress of the World. A Survey of Natural Resources, Present Industrial Achievements . . . and the Future

By A. P. PECK

SOUTH of the equator—extending, in fact, from north of "the line" to south of the Tropic of Capricorn—lies a land of tremendous industrial importance, particularly in the fields of metals and all their ramifications. Brazil, popularly known for coffee, the samba, and what happens on a rainy night in Rio, is these days being called a potential industrial giant, just awakening from an ages-long slumber, and wiggling a few of its fingers to see what will happen. And as these figurative fingers wiggle, things are happening, and happening rapidly—things that will have both direct and indirect influences on industry in the United States in the immediate future and for the long pull.

Depending upon the school of thought involved, Brazil is seen as a feared competitor—a cut-throat industrial competitor—of the United States, or as a friendly neighbor who can be depended upon for cheerful co-operation and healthy competition. That the latter is the most probable future course is the consensus of those who are in the best positions to trace trends; this opinion is borne out by a survey and analysis of a large segment of the Brazilian metals industry as it stands today.

Here are some of the mineral resources which Brazil, larger than the United States by the size of Texas, has at her disposal: Iron ore in vast quantities and of high grade; rich manganese deposits; nickel; cobalt; chromium; tungsten; bauxite; titanium; columbium; tantalite; beryl, from which is produced beryllium; cassiterite, the ore of tin; magnesite; zirconium; mica; quartz; and diamonds. With such an impressive list of industrial raw materials as a starting point, there is real reason to delve into the question of where

• LOOKING AHEAD •

Brazil as a proving ground for atomic power. . . Vast mineral deposits yet to be discovered and exploited. . . New highways and railroads to be built. . . Hydro-electric power development. . . An expanding market for equipment and experience from North America. . . Aluminum production on a large scale.

Brazil is going to fit into world industry of the future.

Before getting to facts and figures, it is well to give at least a brief glance at the background of Brazil —the only South American country where Portuguese is the national language. In this way it becomes possible to understand why such a potentially rich nation should have been so long in grasping the possibilities of this industrial age. For over three centuries the economic history of Brazil closely paralleled that of our pre-Civil War South. The country was virtually ruled by a relatively small number of wealthy plantation owners; the rest of the population was composed largely of slaves, drawn both from the natives of the country and from the Negroes of Africa.

The inevitable result was the perpetuation of a class system in which practically no middle class existed. Although slavery was officially abolished in 1888, the system continued to have its effect on the country, which was so widely separated from the growing and expanding technological knowledge of Europe and North America. In the meantime, however, the beginnings of a middle class started to establish itself in the southern part of the country, in São Paulo. Settled here were men who were neither landed proprietors nor slaves. They had to work for a living, to depend upon their own brawn and brains for their livelihood. Small wonder, then, that in the mild and kindly climate of the São Paulo region is found today the heart of Brazilian industry.

Coupled with the slave system to retard Brazilian development, was the ease with which the country could be made to produce riches. First it was gold, then sugar and rubber, and finally coffee and cotton. Seemingly all that was necessary was to scratch the surface and there was wealth! Remember cotton in our own South?

When the gold market was lost to Africa, Brazil turned easily to sugar. Then Cuba entered the picture and this market was gone. But why worry? Rubber could be had for the collecting. The Orient changed this. So coffee became Brazil's strong point and continued to be until over-production in the late 1920's glutted the market and beans were burned to dispose of the excess. Then there was cotton, and by 1940 the Brazilian production of cotton exceeded its total value of coffee.

All this points up the fact that, under its own system, Brazil was able to turn almost painlessly from one to another of its convenient natural resources, to roll with the punch, as it were, and to get along with a small part of its population in the wealthy class and most of the rest in dire poverty. But things were much different elsewhere. The rest of the world was progressing industrially. The great middle class of the United States was prospering, taking its own part in building the vast industrial empire of North America. And here was another country, inhabited by a relatively homogeneous people, which had all the natural advantages of the United States but which, up to a decade or two ago, had failed to take full advantage of them.

Present population of Brazil is concentrated along the coast from Belem in the north to the Uraguayan border on the south. The map shows specifically those cities and states which are playing most important parts in the present industrial growth of the country. Exploration of natural resources is being pushed into the vast interior

TRANSPORTATION IMPORTANT —So much for the background of Brazilian economics. What is going on today is far more important. But what is going on today is severely handicapped, from the North American standpoint, by the lateness with which Brazil has entered the industrial race.

Because of this lateness Brazil thus far has a very poorly integrated transportation system. Her roads are, generally speaking, inferior and in many cases are impassable during parts of the year. Railroads are short and of different gages that prevent interchange of freight cars. Only two railroads extend into the vast central and western interior, and much

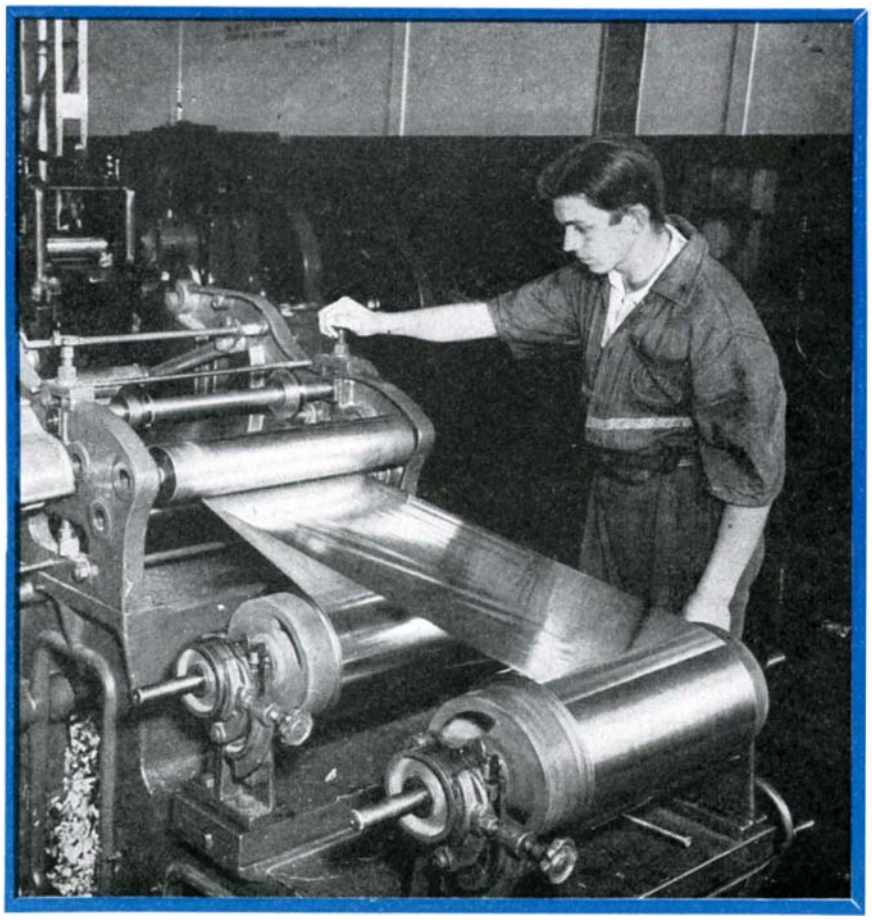
of her transportation is carried on by water—slowly and inefficiently. As a result, much of the economic life of Brazil is localized, as contrasted with the interconnected industrial picture of the United States.

Thus, although Brazil has estimated high-grade iron ore reserves of 15 billion tons, or 22 percent of the world's estimated reserves, transportation and mining facilities are said to hold the key to the reason why Brazil, as late as 1937, was importing almost half a million tons of iron and steel annually; in that same year local production was only 146,000 tons. Link this with the need for coal in iron and steel production, and the picture begins to clear. Brazil's proved reserves of coal are low, and those which are available are of poor quality or are so far removed from production centers as to be uneconomical to use.

It is estimated that, in the state of Santa Catarina, there are reserves of 500 million tons of minable coal and another three to six million tons in the state of Paraná. In both cases, transportation of the coal to the point of use is the bottleneck that can be broken only by extensions of railroads or highways or both. It must be remembered, however, that these figures are by no means final; intensive exploration of Brazil's coal and other mineral reserves is only beginning. The Instituto Brasileiro de Geografia e Estatistica (Brazilian Institute of Geography and Statistics) is now in the field, uncovering new indications of existing mineral wealth. Encouraging reports are being received of new coal deposits and of possibilities of new oil reserves as well as of uranium, manganese, tin, nickel, iron, and bauxite.

Partial view of a Brazilian plant producing aluminum utensils

Rolling aluminum foil



IRON AND STEEL — As has been indicated, iron heads the list of Brazilian minerals. And here is one of the cases where the country is doing something to banish an industrial paradox. At Volta Redonda, in the state of Rio de Janeiro, is a steel plant that was started in 1940 and opened in March, 1946. Costing $100,000,000, this plant will have an ultimate capacity of 1,000,000 tons of steel annually (average production of steel in the United States is 100,000,000 tons annually) and will be able to fill practically all Brazilian demands. However, the coal spectre comes in again; unless the fuel picture changes rapidly, Volta Redonda will be operated on imported coal, with consequent high cost of production. On the other hand, there is the possibility of using Brazilian coal here, as available, mixed with imported coal as needed to obtain the desired results in certain operations. Then, too, there is the opportunity for coal-carrying ships from the United States to Brazil to carry high-grade iron ore on the return trip, thus serving to balance-out the economics of shipping.

To the capacity of Volta Redonda must also be added the capacity of several small steel mills in Minas Geraes which, combined, will contribute an added 200,000 tons annually.

While the United States does not at present (but may in the future) have any real need for iron imported from Brazil, it does need cer-

tain other elements which Brazil has in abundance. Most important of all is manganese. Manganese ores available in the United States are lean, low in content, and only rich manganese ores are economically suitable for producing ferromanganese. Near the iron mines in the western part of Mato Grosso are huge deposits of high-grade manganese ore, estimated at 30,000,000 tons and containing from 45 to 47 percent manganese. Here, again, however, tapping of this rich and valuable mineral resource is handicapped by problems of transportation. Under present conditions the ore is hauled by truck to the Paraguay River and then towed in scows to ocean steamers at the port of Montevideo.

ALUMINUM — Although Brazil ranks 12th in world production of bauxite—and its major rich deposits are in open-cut mines which make for easy removal—Brazilian industry has until recently relied entirely upon imported aluminum! This is but another of the paradoxes that drives home the importance of the

"Zipper" production

industrial awakening of the country.

Major production of bauxite at present is from the rich mines on the Pocos de Caldas plateau in the state of Minas Geraes where the reserves are estimated at 120,000,000 tons. But that is not the whole story. There are some 80 other known localities where bauxite is to be had in quantity, and the probability that others still remain to be found. Most important of those so far explored includes the mines in and near Ouro Preto, where estimated reserves reach 2,000,000 tons; and the Muqui deposits in the state of Espirito Santo, not far from Rio de Janeiro, with estimated reserves of 1,000,000 tons. Large deposits of phosphorous bauxite in the state of Maranhao are believed sufficient to fill the domestic need for phosphatic fertilizers with alumina production as a by-product.

With these rich sources of bauxite to tap, Brazilian enterprise had, by 1940, gone only as far as the production of alumina and the exportation of the ore itself. Then the first plant for the reduction of aluminum was established by Eletro-Quimica Brasileira S/A; this plant, at Saramenha, in the state of Minas Geraes, is now reported to be producing sufficient aluminum for the needs of Brazilian market.

Industrial Expansion in Brazil (U. S. Dollars)	
1939	750,000,000
1942	1,378,400,000
1945	2,820,850,000

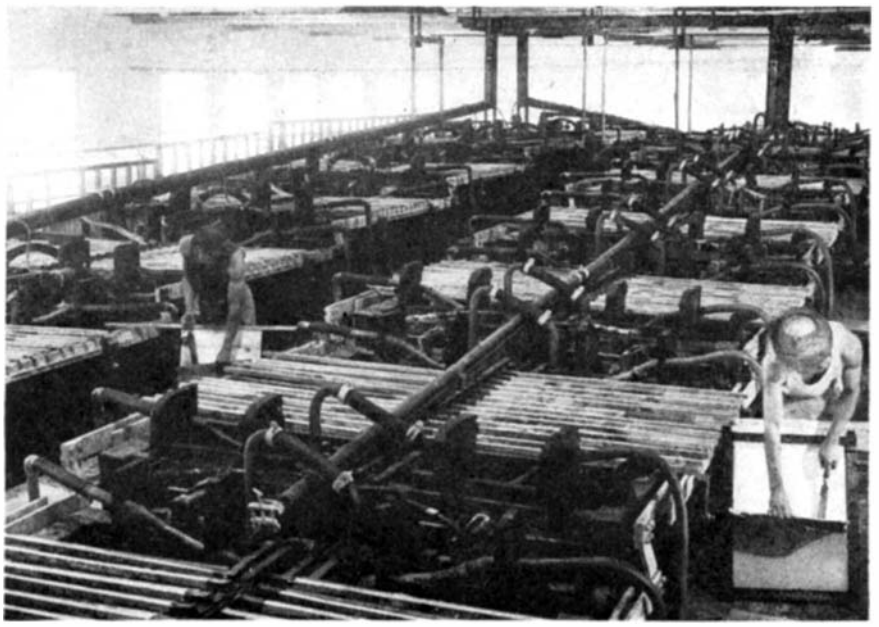
Total figures for industrial production, covering all of Brazilian industry, show the tremendous increase which has taken place over a six-year period

ELECTRICAL POWER — Closely allied with the production of aluminum, and with many an industrial process and production line, is the problem of power and especially of electrical power. Since Brazilian coal deposits and oil reserves have not been fully exploited and imported coal and fuel oil are expensive, Brazilian industry is looking to its rivers as a source of hydroelectric power. Here is a vast potential means of reducing aluminum, smelting ores, running railroads, building machinery, and doing a thousand and one other jobs that have to be done in an industrial economy.

Agricultural Expansion in Brazil		
Tons	1920	1940
Cotton	99,701	468,695
Oranges	77,000	1,206,000
Pineapples	18,000	138,678
Bananas	540,000	1,833,334
Coffee	788,488	1,001,813
Cocoa	66,883	128,616
Sugar cane	13,986,000	21,474,591
Potatoes	145,985	464,662
Brazil nuts	6,588	68,162

Industrial expansion in Brazil is not to be had at the expense of its agricultural pursuits, as evidenced by this tabulation of increases in production of important Brazilian crops

A relief map of Brazil shows that many of her rivers which flow directly into the Atlantic or feed such large rivers as the Paraná and the Amazon, plunge at times down vast falls that could readily be utilized for power production. In fact, by 1940, Brazilian hydroelectric plants had an installed capacity of about 1,000,000 kilowatts and were on the increase. One of the most ambitious projects, designed to level off power production during wet and dry seasons, is that established between São Paulo and its ocean port of Santos. Here a series of dams has been built to form great lakes extending into the nearby mountains to create what amounts to one huge connected reservoir capable of impounding all of the water that falls during the rainy season. This water, released through penstocks for a drop of 2200



In an electrolytic zinc plant

feet to the turbines located just above sea level, is utilized to produce power during the entire 12 months of the year.

In a similar manner, many of the water courses of Brazil can be developed for power production; our own Tennessee Valley Authority, Boulder Dam, and Grand Coulee have shown what can be done, and Brazil has proved that such lessons can be applied to her own problems. It is now a matter of spreading the application. With the crying need for rail transportation in Brazil, and with the materials available to extend her rail system but not enough coal to power the required locomotives, it is not beyond the realm of possibility to visualize hydroelecpower, efficiently carried by high-tension lines, as the motivating force of Brazil's future railroads.

Then, too, it should be noted that uranium is listed among the possible new mineral resources thus far reported by the Brazilian Institute of Geography and Statistics. As research in the potentialities of atomic power continues, such supplies of the radioactive element, when developed, will become increasingly important. In any event, here is a country that can make full use of atomic power supplied by small quantities of easily transported fuel —the great hope and ultimate goal of many workers in this field. Even if Brazilian uranium deposits do not prove out, Brazil should be an ideal proving ground for atomic power as applied to the solution of transportation and industrial power plant problems—of which she has plenty.

SPECIFIC INDUSTRIES — Despite the limitations placed upon it by such matters as great distances, present lack of adequate transportation facilities, inadequate coal supplies, and so on, already briefly sketched, Brazilian industry is proceeding apace. To give a perhaps kaleidoscopic picture of what is going on in the metals industry in particular, the following paragraphs are drawn from the writer's notes made during a recent tour of a number of plants in the southern part of Brazil.

Of the nonferrous metals producers and fabricators in Brazil, the firm of Laminacão Nacional de Metais S/A is said to do 60 percent of the entire business. This is divided as follows: Aluminum, 75 percent; brass and copper, 80 percent; zinc, 100 percent (producing 100 tons per month); silver, German silver, and so on, 50 percent. Employing some 1500 workers, this company is the biggest South American producer of plates, sheets, strips, circles, bars, tubings, extruded shapes, and wire of nonferrous metals, as well as

A foundry in Brazil

aluminum and bronze powders for use in paints and printing inks. In 1941 its total production had a sale value of $3,090,523; by 1946 this figure had climbed to $7,780,742 for the first nine months.

Then there is Companhia Brasileira de Artefactos de Metais, with plants in Utinga and São Paulo, manufacturing silver and other tableware as well as aluminum cooking utensils and kitchenware, kerosine lamps, tinned basins, and other metal utensils. In 1941 this company's production of other than aluminum products was valued at $703,600; for 1946 (to October) it had increased to $2,492,245. Aluminumware figures for the same periods are placed at $376,350 and $1,380,250.

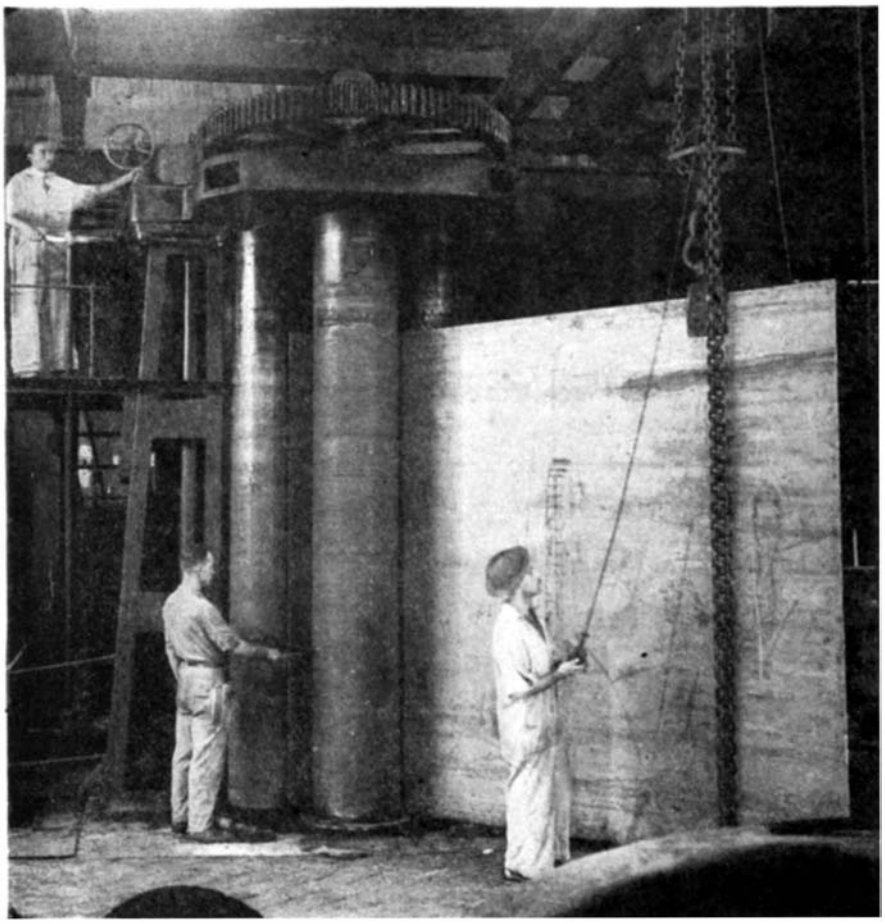
Not quite so startling at first glance, because they do not extend over such a long period of time, are the figures from the slide fastener ("zipper") factory of Companhia Brasileira de Metais. In 1944 this company, operating the largest slide fastener plant in South America, had a sales volume of $912,681; for the first six months of 1946 the figures climbed to $1,226,628.

Aluminum foil production in the only plant of its kind in Brazil—that of Laminacão Caravelas S/A jumped from $77,656 in 1941 to $434,892 for the first nine months of 1946.

In the plant of Companhia Brasileira do Zinco is produced electrolytic zinc that is entirely consumed by Laminacão Nacional de Metais, with the by-products such as sulfuric acid and copper sulfate sold to other Brazilian industries and to domestic agriculture. Sales volume of this company in 1943 amounted to $47,900; for the first six months of 1946 the volume was $119,599.

These compacted figures give a

(*Please turn to page* 128)



Brazilian workmen shape a boiler plate

Precision Forgings

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

Born As the Solution to a War Production Problem, the Precision Forging Process Makes Possible Mass-Production of Metal Parts to Precise Dimensions with a Minimum of Machine-Finishing Required

ANOTHER metal-working process has been added to the lengthening list of those which make possible the manufacture of metal parts to very accurate dimensions, without subsequent machining. Precision forging is now a reality, and takes its place beside stamping, screw machine work, die casting, impact extrusion, precision casting, and powder metallurgy as an alternative means of mass-producing parts that must be held to close tolerances.

Forging was one of the first metal-working techniques employed by early man, and has always been a leader in industrial importance among production methods. Until recently, however, forgings were never thought of as potentially precision parts. The nature of the process, with the scaling and warping of the forged piece that were attendant on the heating and cooling cycles in forging, were such as to limit commercial dimensional tolerances in forgings to ± 1/16 to 1/32 inch per inch. Tolerances as close as 0.016 inch could be held in special cases, but a fancy premium had to be added to the cost of such parts, and they were far from being mass-production items.

In many cases, however, the outstanding mechanical characteristics of all forgings—great toughness and load-bearing strength—necessitated their use for machinery parts that had to be manufactured to dimensional tolerances as close as 0.005 inch or better. In all such instances the forgings had to be subsequently machined to finished size and shape. Machined forgings are therefore among the most common of precision parts, and are able to compete on a cost basis with all the major metal-forms.

But of the many materials that can be forged, not all of them are also easily machined, and some are not machineable at all. It was this particular situation that led to the development of precision forgings by the Steel Improvement and Forge Company, primarily for the solution of a vital war production problem, but with possibilities far beyond strictly military applications.

Courtesy Tube Turns, Inc.

Large precision parts can be mass-produced by forging to close tolerances

• LOOKING AHEAD •

Higher production rates with lower production costs for many precision pieces. . . Hard-to-machine alloys brought to narrow tolerances easily and quickly. . . Conservation of materials accomplished by the elimination of much final machining.

FORGINGS REQUIRED—This company, one of the country's largest producers of drop forgings, was called upon earily in the war to produce turbine wheels for General Electric turbosuperchargers. Forgings (rather than castings, for example) were required because of the great service stresses involved. The material used (Timken 16 chromium, 25 nickel, 6 molybdenum, balance iron alloy, one of the "superalloys" developed for high temperature service) was very difficult to machine. But by using a specially developed two-step forging process, Steel Improvement and Forge was able to produce contoured wheel forgings requiring only a minimum of machining and grinding, and to tolerances closer than had ever before been achieved with forgings on a mass-production basis.

In the forging process developed, the first operation (blocking) is done at the usual forging temperature for the alloy in question, generally in the neighborhood of 2000 degrees, Fahrenheit. The second or finishing operation is carried out between 1200 and 1350 degrees, Fahrenheit. This "low temperature" operation (some engineers call it "cold forging" to distinguish the practice from forging at temperatures some 700 or 800 degrees higher) not only forms the part to its finished dimensions,

ALLOYS USED IN PRECISION FORGINGS

For Turbine Wheels

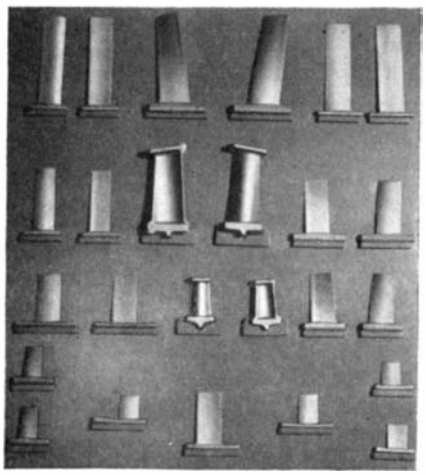
ALLOY DESIGNATION	ALLOY MANUFACTURER	NOMINAL COMPOSITION
16-25-6	Timken Roller Bearing Co.	16Cr, 25Ni, 6Mo, Bal. Fe
19-9DL	Universal Cyclops Steel	19Cr, 9Ni, 1Mo, 1W
N-155	Union Carbide & Carbon	20Cr, 20Ni, 20Co, 3Mo, 2.5W
S-590	Allegheny Ludlum	20Cr, 20Ni, 20Co, 4Mo, 4W, 4Cb
Inconel X	International Nickel Co.	73Ni, 15Cr, 6Fe, 4 (Ti plus Al plus Cb)

For Blades or Buckets

ALLOY DESIGNATION	ALLOY MANUFACTURER	NOMINAL COMPOSITION
Hastelloy B	Haynes Stellite Co.	65Ni, 30Mo, some V
S-816	Allegheny Ludlum	40Co, 20Cr, 20Ni, 5W, 4Mo, 3Cb
N-155	Union Carbide & Carbon	20Cr, 20Ni, 20Co, 3Mo, 2.5W
Inconel X	International Nickel Co.	73Ni, 15Cr, 6Fe, 4 (Ti plus Al plus Cb)
16-25-6	Timken Roller Bearing Co.	16Cr, 25Ni, 6Mo
K-42-B	Westinghouse Elec. Corp.	.....

but cold works it at the same time, thereby greatly increasing its strength and hardness.

DIE DESIGN CRITICAL — Both operations are done in large steam drop hammers. The success of the process depends heavily on proper design of the first, or blocking die, for by correctly designing the first die it is possible to control the amount of cold work that is done in the finishing die and thus to assure uniform hardness across the section of the wheel. Improper die design



Courtesy Steel Improvement and Forge Company

will result in forgings that lack the requisite strength and which vary in cross-section hardness.

Even more difficult of development and of more potential importance industrially is the production of precision drop forgings in parts as small as turbine blades or buckets. Here the problems were infinitely greater. Because the blades (especially those for jet engine turbine wheels, as distinct from supercharger turbine blades or compressor blades) must operate at higher temperatures than the wheels, even more refractory alloys are used. The best alloys of this type contain large proportions of cobalt and are correspondingly difficult to forge. The geometric shape of turbine buckets, with their sharply varying thicknesses in the same piece, their necessarily small-radius fillets, and their devilishly difficult contouring, has always been one of the most difficult to obtain via the forging process. And finally the dimensional tolerances that have to be held are even closer than those required for wheel or rotor forgings. Even hand grinding is not feasible because of the practical impossibility of maintaining the delicately designed contours.

For example, normal tolerances used on turbine blade forgings are about + 0.010, — 0.000 inch, while the variation from the true contour of the blade must be held to + 0.005, — 0.000 inch. These are so much closer than the forging industry has been accustomed to facing that a wholly new attitude and approach was required for this production job.

SPECIAL OPERATIONS — The actual forging of the turbine blades requires a great number of operations. Forging temperature is rapidly lost after one to three hammer blows (because of the thinness of the parts) and a series of reheatings must be made as the forging progresses. On some parts, in the final stages of forging, the metal is so thin that only one blow per heating is possible.

And there are many other deviations from the usual forging process that are essential to success. For example, die impressions have to be sunk to within 0.002 inch, while unorthodox die materials must be used

The four gas turbine buckets of "super alloy" in the center of the group, and the surrounding stainless steel compressor blades, are precision forged

Aluminum precision forgings are used primarily for parts subjected to extreme fatigue and impact, or where space limitations do not permit the use of castings

Courtesy Aluminum Company of America

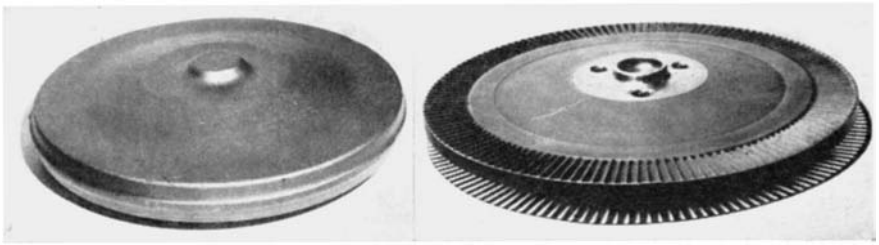
at unconventional hardnesses to minimize die wear and loss of shape. Special forging furnaces are required to prevent excessive scaling or decarburizing during the many heatings required on these small parts before they reach finished size, and improved die swabbing compounds are needed to prevent forgings from sticking in the dies. It has also been learned that "process grinding" between forging operations proves beneficial.

The development of this process, of course, originated as the solution of a war problem and has been almost entirely concerned with forgings made of the super-alloys for jet engines and superchargers. In addition, the engine manufacturers wished to do as little machining or grinding on the parts as possible; for them, the nearest thing to perfection on the part of the blade producers would be none too good. This would, at first glance, seem seriously to limit the breadth of applications of these new techniques and their use in peace-time production.

But already the situation is opening up. Experience in producing blade forgings in stainless steels has been extensively applied in compressor design and manufacture, where the blades need not operate at anything like the severe service conditions required of supercharger and jet engine blades. In addition, the jet engine and gas turbine manufacturers (custodians of a great peace-time industry in itself) have already relaxed their stringent tolerances on thickness and shape. Under these circumstances precision forgings are much cheaper to produce, and part of the resulting saving may be used to machine-finish the blades.

This combination of trends makes precision forgings more attractive to the general product manufacturer. If costs can be brought down they will be more competitive with castings and machined parts to be made in more common materials than the super-alloys. So far, for example, the alloys chiefly used for precision forgings have been those listed in the accompanying table.

LOWER COSTS NEEDED — The drop-forging industry's experience with the 12 percent chromium stainless steel for compressor blade forgings is being followed with much interest, for it may well be the forerunner of precision forgings made in lower alloy steels as well as in non-ferrous metals. If costs can be lowered, the potential field for such forgings is large; innumerable machine parts that must be strong and tough



Courtesy Steel Improvement and Forge Company

A precision-forged turbine wheel (left) requires very little additional machining. The same wheel (right) after finishing, with the blades in place

(and therefore are forged), but which have heretofore involved much machining to accurately reproduce final dimensions, may in the future be almost entirely forged, with only light final machining operations. This practice may be especially advantageous when the material is somewhat difficult or expensive to machine.

The Steel Improvement and Forge Company is not the only manufacturer of precision forgings. For example, the Utica Drop Forge and Tool Corporation and other forging producers took important parts in the precision forged turbo-parts program. Indeed, much of the work currently being done with press forgings in light metals by a number of manufacturers may be easily classed as precision forging, for the tolerances reached approach those achieved in the manufacture of turbo buckets. Increasing use of light metals and especially the fast moving developments in forging presses indicate a bright future for precision forged light metals as well.

But whether the trend will be toward precision forged light metals, or low alloy steels, or just to the original super-alloys, the precision-forms field has a new member and engineers another way of making their products.

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ROLLING MAGNESIUM

On Continuous Strip Mill Proves Mass-Production Possible

Most important step in the industrial development of a "young" material is the transition from manual handling to automatic production in its manufacture. Steel was long ago introduced to the continuous rolling mill, which made possible the low-cost mass-production of sheet, strip, rails, and rod now so widely used throughout all industry. Aluminum, too, has recently passed through this same important phase, aluminum slabs weighing 2000 to 3000 pounds each now being rolled and coiled on automatic equipment without hand labor.

Magnesium may now be ready for this all-important step. Very recently the adaptability of magnesium to mass-production methods was demonstrated by rolling some of it on a continuous strip mill designed for steel. Cast slabs of Dow FS alloy were put through a reversing breakdown mill with enough speed and power that the magnesium actually became hotter rather than cooler while being rolled from seven inches down to 0.4 inch in two minutes.

On the conventional magnesium rolling mill, the 200-pound slabs are expensive to cast and scalp in the first place. The small slab is broken down so slowly in the rolling mill and handled so much that it cools off and must be reheated several times. On the continuous mill, however, the magnesium was passed on hot to the tandem mill, came out a moment later as 0.050 inch sheet and was automatically coiled at 1200 feet per minute.

CONTACT ALLOYS

Substitute for Precious Metals, May Prove Superior

Faced with shortages of some of the precious metals that have been essential ingredients of high-grade electrical contact alloys for a number of years, the Germans, during the war, developed several satisfactory substitutes that are much cheaper than the originals, and which are believed to have interesting potentialities for American electrical-product manufacturers. In place of the expensive iridium-platinum combination, the Germans successfully used alloys of gold and zirconium, of platinum and beryllium, and of tungsten and platinum as overlays or inlays with base metals. For example, they employed a combination of 95 percent platinum and 5 percent tungsten for ignition and magneto contacts. Another useful substitute was an alloy of gold with 3 percent zirconium, which had a hardness of over 300 Brinell.

JOB RATING FOR

Through Objective Study, Every Job in a Plant May be Accurately Evaluated. With an Incentive Created, the More Experienced Worker Selects a More Difficult Task Where His Superior Skill and Knowledge Pay Off. The Inevitable Results are Higher Wages for the Worker and, at the Same Time, Larger Profits for the Employer

A SMALL manufacturer of chemicals in the east is having an agreeable surprise. His highly skilled senior employees are demanding the toughest jobs in the plant, and production per man per day is going up, sometimes as much as 100 percent. Pay roll costs are going up too, but not as rapidly as profits.

This plant has both plush jobs on which instruments and automatic controls do most of the work, with the man just standing on watch, and hard ones where liquids must be stirred, powders shoveled, or heavy barrels moved. The dirtier jobs mean hard physical work, soiled clothing, and some exposure to fumes and heat, but they also need plenty of skill and judgment if they are to be run well.

Older and more skilled employees used to take advantage of their seniority rights to get those easiest jobs, the unpleasant tasks on which high skills were most needed being left for the newer men who had learned the least about the plant processes. And the first ambition of every new man was to accumulate seniority and get into line for the softer jobs.

What happened, on the surface, was that an industrial engineer was consulted and he instituted a job-rating plan. Under this plan, instead of weekly pay being based entirely upon hourly rates which are established by seniority alone, there are also incentives; the tougher the job the higher the incentive. The senior worker still gets a higher hourly base rate than the newcomer, and still can take his choice of jobs in the plant. But if he wants really high pay, if he wants to double his base pay, he has to take one of the harder tasks and run it well.

• LOOKING AHEAD •

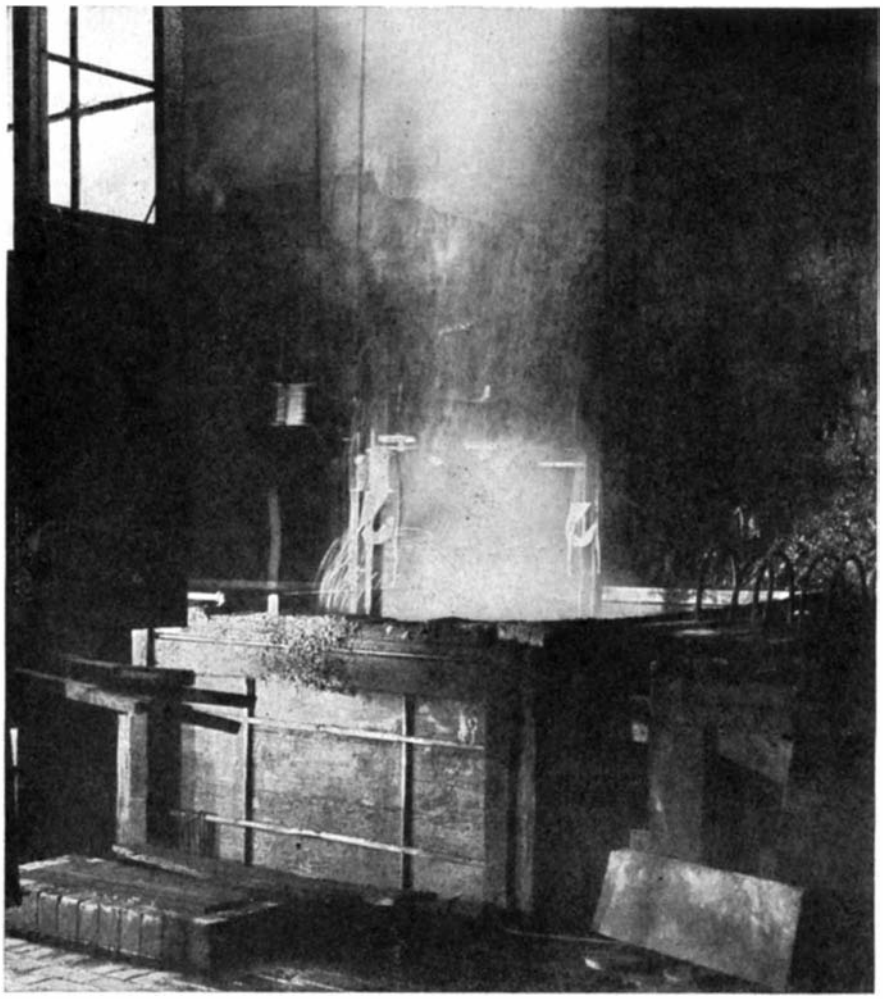
More consideration given to what constitutes fair working conditions within the plant. . . Closer understanding between Labor, Management, and Union. . . Long-lasting harmony and co-operation among the three.

The chemicals maker expected this incentive system to level out his pay roll somewhat and to solve some of the problems of attracting untrained labor to the plant. But he did not think that it would cause his best men to seek the jobs on which their skills could do the most for his company.

What he had missed was the deepest instinct the American worker has: the desire for a square deal for everybody. The average American worker wants all hands to be treated fairly. "Right Is Right" comes as close to his credo as any words could. Every survey made by any unbiased source finds this to be true. He wants good pay for himself, but he thinks it is right and proper that the boss should make a fair profit. He wants to buy at fair prices goods made by men who also received fair pay. He likes sports like baseball and bowling where he can see for himself that the playing and the scoring are fair.

Fixing matters so that the man who licked the toughest job automatically got the highest pay was right in line with this sense of the square deal. It made the best men want to show the others how their skills could pay off.

DRAMATIC FAILURES — Job-rating systems geared to fair pay and incentive rates have had similar effects in so many plants that the rush to adopt them amounts to a boom, a boom that is tempered by



Working Conditions

SQUARE DEALING

By EDWIN LAIRD CADY

Courtesy Machlett Laboratories

Supervision Exercised

the fact that the failures of these systems have been as dramatic and bewildering as their successes.

One such failure was suffered by a prominent electrical company. Here the job-rating system had been ten years in the development. So well did the executives like it that they said: "Our men will never strike. They like our job-rating set up too well." The last of these boasts was heard just 24 hours before the men walked out on what was to become the most prolonged and disastrous strike in the company's history.

Behind these failures is one of the most exasperating facts in business management. A good and fair job-rating system looks like the easiest thing in the world to work out, but actually is the hardest. It seems as if any high-school boy could handle the simple factors involved, but the smartest of executives fail at them. In fact, almost all good job-rating systems are worked out by consulting engineers. It is very rare for an executive to develop one for his own company.

Seven simple factors are the bases of nearly all job-rating or "task evaluation" systems. They are:

1. Experience
2. Skill and Aptitude
3. Personal Responsibility
4. Physical Effort
5. Working Conditions
6. Supervision Required
7. Supervision Exercised

This list can be expanded, and different words can be used to express the same ideas. With "aptitude," for example, can go a subhead of "educational requirement," or "personal responsibility" may be called "initiative." But all such lists boil down to just about the same factors.

Take that number 5, "working conditions," as an example of the difficulties involved. Its interpretation has to vary with nearly every industrial community. What a worker in the textile community of Fall River would regard as impossible conditions of heat and fumes, would seem mild to his brother in the melting room of a steel mill in Pittsburgh.

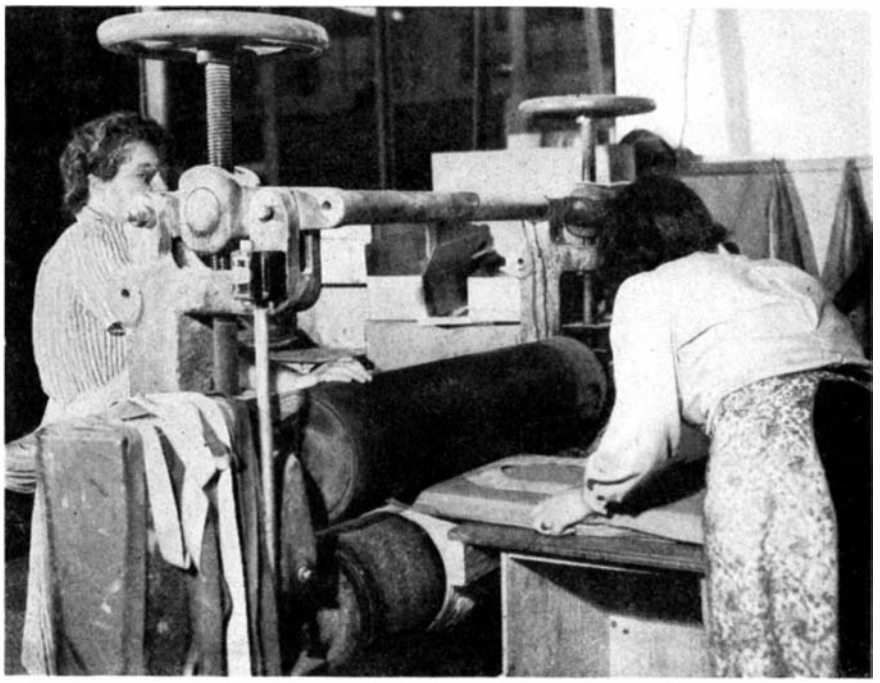
Interpretation of the same term would vary also from plant to plant in the same industry and even in the same community.

BAD WORKING CONDITIONS — Two steel stampings and kindred products plants in New England were bothered by bad plant conditions. One put in modern wash rooms, made sure that all machines were as quiet as practical, installed good cafeterias and play rooms, did everything it could to make work conditions pleasant.

In the other plant the boss called his men into a meeting. "Boys," he said, "I will buy all of that stuff for you, or I will put the cost of it into your pay envelopes. It is up to you." He had risen from the ranks and many of his workmen had known him when he was a machine operator. They knew he would keep his word. The great majority voted "down with the luxuries and up with the pay envelope."

Obviously, what would be considered bad working conditions in the first of these plants would be quite acceptable in the second.

This problem becomes still more complex when personal opinions are considered. The boss has one idea of what constitutes good and bad in



Courtesy Hodgman Rubber Company

Skill and Aptitude

working conditions, the worker a second, and the labor union a third. Much depends upon who has done what work in what plant in what other community and is using this previous experience—good or bad—as a measuring stick. Much more depends upon whether the boss wants to improve all bad conditions while the worker secretly wants them kept and called bad so he can be paid more for facing them. How many ramifications has human nature?

UNBIASED VIEW NEEDED — Amid all this welter of emotions and of subjective opinions somebody has to take a calm, detached, intelligently skeptical viewpoint. The man best able to do this is the industrial engineer who, as a consultant, has his reputation for unbiased honesty as his only stake in the business which he is studying.

In making a study of this kind the consultant has to dig very deeply. First of all he must know the nation-wide working conditions prevailing in the industry he is studying. Workers, especially the best workers, tend to migrate to the communities and plants which will offer them the best conditions. Gossip of migrants tells all workers where those conditions are. He must make sure that the plant he serves will keep as many of its best men as it can.

Next he studies the community. Some towns contain many "luxury" shops with chrome-plated fixtures in the cafeterias, with wash rooms and everything else to match. Others are "rough shop" towns. The worker knows about the shops in which his neighbors work. Shops having worse conditions must pay higher wages or require lower skills. Otherwise their workers will not believe that they are getting square deals.

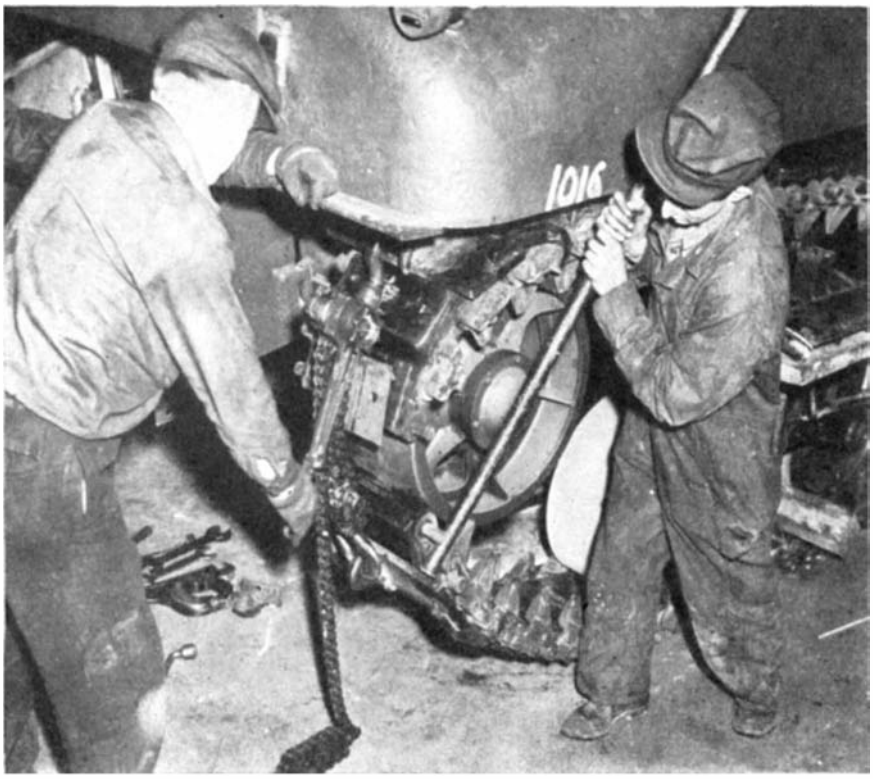
At this point the consultant is ready for his open discussions. As early as possible the labor unions are brought into these if any unions figure in the picture.

The union leaders almost always are suspicious. They usually are told that they need only observe, know what is going on, and make sure that management is not hiding any cards up its sleeves. But it seldom takes very long for the union men to join discussions in which the welfare of the workers is the topic.

The union leaders always like the fact that the job-rating plan will clear the roads for their own future discussions. The very emotional and subjective thinking which shows up at the job rating council table is the cause of management-labor conferences spending days on matters which ought to be settled in hours. Once the relative values of the various tasks in the plant are established, management and labor have a common yard stick with which to measure. And when measurements are clear a great many controversies can be avoided.

Courtesy Lincoln Electric Company

Supervision Required



Physical Effort

Personal Responsibility

TACTICS VARY — Different consultants use different tactics in the job-rating conferences. Many of the best engineers work themselves into positions where they act as impartial arbiters as quickly as they can. Their main responsibility is to make sure that everybody assigns the same meanings to the same terms. And those meanings are "as used" in that plant or that community. What is "personal responsibility for results" in one shop will be "initiative" in another; the "exercise of supervision" by a machine shop workman might be called "ability to secure co-operation" in a nearby foundry. The important point is that all concerned shall speak the same language in such terminology.

Individual tasks in the plant are discussed. Everybody at the table has a different opinion as to how the seven factors should be weighed and applied to each job. The consultant calmly and impartially finds a middle road—an average of all the opinions.

Common sense is important. Everybody in the shop knows that the conference is not going to arrive at a different pay rate for every individual task but, rather, that there are going to be grades or levels of jobs and pay rates, and that the levels are going to be averages.

Courtesy Curtis Lighting, Inc.

Experience

In those averages will be the square deal that the workman wants.

Every man also knows that there are jobs on which incentives would be foolish, since the man cannot improve the performance of the machine he runs, and others at which the machine does only what the man makes it do and incentives for his extra efforts are the very essence of the square deal.

The engineer works all this out. If a job is rated a little above the average for its grade he brings it down a little; if below average, he brings its pay scale up. Thus the man with a better job gives a little, and the man with a poorer one gets a little more than he would have had. And this is the square deal that the American worker likes, that he joins unions and goes on strike to get.

When job rating works it gets wonderful results. And it works when thought out with the common sense which consists of the unemotional judging of highly emotional situations—of the completely impersonal application of the seven terms which all men find highly personal in their implications.

FLEXIBLE-SHAFT LIFE

Increased Greatly by Stainless-Steel Layer

FOR ROTARY brushes, files, screw drivers, and other small tools, flexible-shaft drives have long competed with tools directly driven by tiny motors for the same purposes. In favor of the flexible shaft has been the small space needed at the work point, and low cost per tool. Against it has been a shorter working life than sometimes is economical.

Shaft life is now being increased by making them out of two kinds of wire. The inner core is piano wire such as has long been used for flexible shafts. The outer part is one or more layers of stainless steel, usually type 302.

The stainless-steel outer layer has a low coefficient of friction and therefore submits itself to less frictional heat, is able to withstand heat better than is piano wire, and is not likely to be damaged if not kept lubricated while the tool is in storage. Formerly the shaft usually wore out when the outer part failed. Now the stainless-steel outer part commonly outlasts the core.

FRICTION SAWING

Operates on Unknown Bases

THE FACT that a soft metal or other substance moving at high speed, and free to get rid of the heat of friction, will cut through a harder substance without itself being worn very rapidly, has been known for centuries. Diamonds, the hardest known substances, are cut by soft iron plates with diamond dust as an assistant.

Strange to say, nobody yet knows just why this technique works. Away back in the Revolutionary War it was known that a soft iron disk cut from a stove pipe could be mounted in a lathe, caused to turn at high speed, and then used to cut through a hard file without the soft disk showing any evidence of wear.

Modern applications are blossoming everywhere. They concern themselves largely with the contour cutting of stainless steels and other hard-to-cut alloys.

The band saws used for this purpose are run at speeds up to 20,000 feet per minute and the speeds may go higher. The saws can be advanced 128 inches a minute, or even more, if cutting in a straight line across a quarter-inch thick plate of extremely tough and hard stainless steel, or they can make 84 or more inches a minute around the curves when doing contour sawing. And the speed of this cutting is more dependent upon the surface speed of the saw blade than upon the thickness of the plate; plate thickness makes surprisingly little difference.

Actual contact between the saw and the work would wear such blades out in no time; therefore the best guesses are that practically no such contact takes place. Somewhere in the experiences being had with these saws are laws of friction which, when worked out, may revolutionize some of our applications of bearings and lubricants.

INDUSTRIAL DIAMONDS

Now Selected With Critical Eye to Abilities

A FEW YEARS ago, almost any diamond which was not satisfactory for jewelry could be sold to industry. Selection of industrial diamonds was not especially careful. For a while their use seemed to be more of a fad than anything else.

Ideal conditions for diamond selection

Today, the industrial diamond, like any other tool, is used right up to the limits of its abilities. And the selecting of diamonds for any particular application is a job for the highly-trained expert who uses in his work a powerful magnifying glass plus scientifically focussed, shadow-free fluorescent lights.

Previews of the Industrial Horizon

By A. P. Peck

LONGER PIPE LIFE

PLASTICS-COATED steel pipe, proved for corrosion-resistance in oil-field work, promises extended life for piping in industrial and domestic uses. In oil-well drilling, drill pipe often fails because of corrosion pitting of the inside of the pipe; a thermo-setting plastics covering prevents corrosion and halts the all too familiar corrosion fatigue failures.

BUSINESS BY RADIO

HUGE industrial plants covering many acres of ground, and companies whose plants are far-flung throughout the nation, will find a new means of rapid communication in the radio-linked teletype now on the horizon. Through networks involving almost any number of transmitter-receivers it will become possible to relay orders, instructions, changes in production schedules, and the like, without delay and with immediate acknowledgment of receipt.

BETTER VISION PAYS OFF

ONE out of four workers was found to have faulty vision in a recent check of 831 employees in an eastern factory. That this condition was largely responsible for plant accidents was shown when, after a visual efficiency program was instituted, there was a sharp drop in accidents and an equally significant decrease in lost work time. Many of the workers so examined were fitted with prescription safety goggles.

Whether or not occupations involve eye hazards, good eyesight is normally a requisite to good workmanship. When management realizes this, it will go far to find a better investment in "production equipment" than installation of a standardized procedure of eye examination and correction.

BETTER HOUSE WARMINGS

THOSE interested in the housing problem—and who isn't these days?—have much to look forward to in the realm of home heating. First there will be miniature oil-burning units that take up but a couple of square feet of floor space, yet can heat small and medium-size homes; then there is further development of radiant heating systems, including the "radiant baseboard" and built-in piping types described in these columns many months ago; finally, there is the "heat pump," also not new in principle but just showing its real promise over the horizon. The heat pump is a home refrigerator in reverse. The refrigerator pulls heat out of food stored within it and dissipates it; the heat pump pulls heat out of the ground, the air, or a convenient water source, and uses it to warm the house. (Remember that heat is a relative matter, and the method will become clear.) The heat pump will circulate, compress, and decompress a liquid or gas in a heating cycle similar to the cooling cycle in the refrigerator.

Coupled with these advances in home heating—many of them can be applied to industrial processes as well—will be new developments in thermostatic and similar controls. Notable among these are the types that take recognition of the outdoor temperature to boost or reduce the temperature indoors, with resulting greater uniformity of heat and comfort.

THERE'S A LOT IN A NAME

WHEN new materials are pouring from the laboratory, there would be a lot less confusion if many of the synthetics were not linked by name with some already known material, but were made to stand on their own feet. Synthetic rubber is a good case in point: Synthetic rubbers are *like* rubber but actually are entirely *different* from rubber. The same applies to many plastics: All too often they are thought of as substitute materials—and hence inferior to materials which they replace.

It's about time that a new view was taken of many materials now available to industry. Let them prove themselves, take their rightful places in production, free from the stigma of "synthetic," "substitute," or "alternate." Above all, let them be used where their properties can be fully exploited, rather than forced for purposes of economy or otherwise to do a job for which they are not fitted.

ROLLER-BEARING FREIGHT CARS

A NEW era in freight cars is seen in the application of roller bearings to 1000 Chesapeake and Ohio freight cars of 70 tons capacity each. Although anti-friction bearings have been applied to passenger cars and locomotives, this is the first mass step toward reduction of friction in heavy load-carrying railroad cars. It points inexorably toward rail transportation economy through both higher sustained speeds and lower maintenance and hauling costs.

STRAWS IN THE WIND

AUTOMOTIVE ENGINEERS also are fighting friction; the average passenger car, traveling 50 miles an hour, now requires 21 horsepower for driving the car and another 21 horsepower to overcome internal friction. . . Hens kept under ultra-violet lamps produce over 10 percent more eggs than without irradiation. . . Moving fixtures, as well as traveling welding equipment, are being tested on assembly lines involving sheet-metal assembly, in a successful attempt to speed-up fabrication processes.

WHAT PLASTICS mean to Plywood

All But Unknown Twenty Years Ago, the Plastics-Bonded Plywoods Are Taking Their Place Along Side Conventional Structural Materials, Equalling or Surpassing Them in Strength, Durability, and Beauty

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

IN THIS day of building-material shortages of all types, there is hardly a single material that has not come in for discussion as to its possible usefulness to the construction industry. Plastics are no exception.

In these discussions, there are those who question the extent of the rôle that plastics are prepared to play *now* in the building field. They point to the hold-up that certain manufacturers of plastics honeycomb structures have experienced in putting their products into the framework of homes because of local building codes. They mention the relatively limited production of some of the new plastics materials as against the staggering need. And, finally, they cite the higher initial cost of the plastics materials at this time when set in direct comparison with the traditional building supplies.

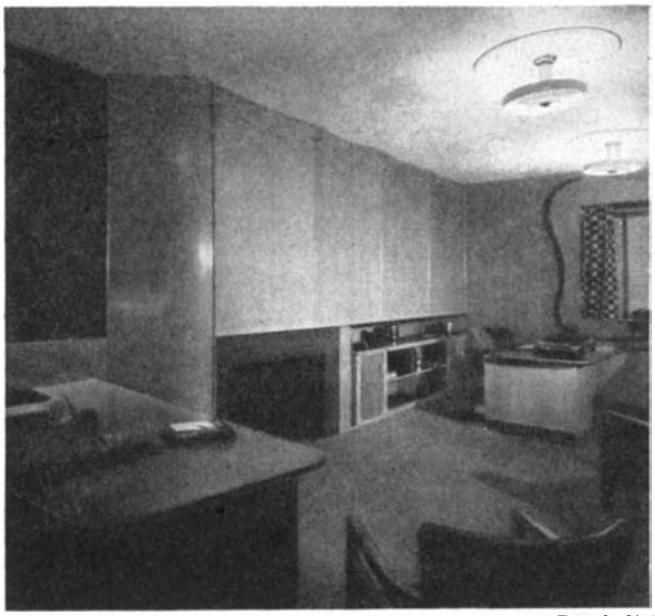
But there is one thing that many of these doubters forget. They forget that the word *plastics* appears more and more frequently as a linkage with the word *plywood.* In fact, there are still too many people who have no idea that the two materials are at all related. As for any doubt of the rôle that plywood is playing —and will continue to play—in our building program, there is the assistance granted the industry by the Government in the shape of a subsidy to obtain more logs from the woods, in return for which plywood companies must set aside 50 percent of all production for building.

The right of *plastics* to be linked with *plywood* is clearly evidenced by the figures shown in Tables I and II on the relative use of different glues by the softwood and hardwood plywood producers. In the case of softwood plywood, approximately 45 percent is made with synthetic resin. Only about 41 percent of the hardwood plywood is made with these resins and it is estimated that the demand for the type of hardwood plywood produced with synthetic resins will never amount to more than 60 percent of the total volume. This is due to the fact that this type plywood is not used so largely for exterior purposes.

The volume of plywood made with synthetic resins is even more impressive when set against the total absence of commercial use of these resins in the plywood industry in the United States as late as 1927. Developments which seem about ready for full-scale production in 1947 suggest that the synthetic resins will continue to grow in importance and will serve to make plywood even more important to the building trades.

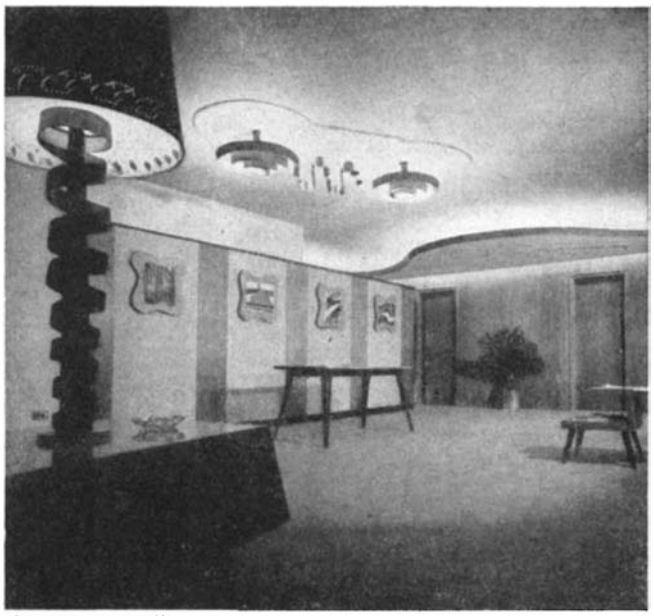
INCREASES UTILITY — The real value of plastics to plywood lies in the fact that it has made plywood a more satisfactory material for all-round use. It has added to the uniformity and quality of plywood and has expanded its usefulness.

A case in point is the work now



Courtesy United States Plywood Corporation

The flexibility of standard quarter-inch plywood is demonstrated by its use in the four concave panels. Eighth-inch stock was required to construct the sharply curving surface



With wood-metal laminates as used in the table lamp and ceiling fixture, and hardwood plywoods for paneling and furniture, interior decorators can achieve effects never before possible

being done with the bonding of phenolic resin laminated paper to plywood to give a weather-resistant material that should last for years and prove adaptable to home construction. This process would enable the softwood plywood industry to use its imperfect veneer as the outside ply since it would be covered and protected by the phenolic surfacing material. This would save the most valuable—the unblemished—veneer sheets for more exacting jobs; and it would also cut down on the waste that is caused today by the industry's inability to utilize the imperfect sheets.

Another promising development is the United States Plywood Corporation's Flexwood, a thin wood veneer bonded to fabric with synthetic resin glue for use as a wall covering. Production was very limited in 1946 due to a lack of fabric for the backing, but it is presumed that this situation will be remedied early in 1947. Other developments of this company with a chance for great expansion in 1947 are Armorply, a plywood bonded to aluminum, and Flexmetl, another veneer bonded to metal. Both of these metal-combinations give a panel of considerable structural strength and are dependent on the use of synthetic resin adhesives.

Another possibility is prefinished plywood to be sold to the customer completely finished in every respect including grooved edges so that panels may be fitted snugly together. It may be that such large inventories would be required to keep different finishes in stock that this development will be held up in 1947. But it holds a definite promise for the future.

Belief in plywood as a structural material is evidenced by the action of one large company in building two all-plywood homes in Canada which will meet all kinds of weather conditions and which are expected to be permanent. One will have a plywood fir outer surface coated with paint; the other will have an outer surface of varnished birch plywood. This company feels that if boats can be made of plywood to withstand constant soaking, a plywood house should be able to take punishment of a similar nature under varying conditions of exposure to moisture, heat, and cold.

• LOOKING AHEAD •

Greater permanency and more effective weather-proofing for the prefabricated home. . . Simpler, stronger, lighter construction for a great variety of objects from box-cars to gliders. . . More attention to water-resistance and temperature stability. . . . Wiser selection of plastics for plywood construction.

STRONG AND LIGHT — The fundamental advantage of plywood does not necessarily lie in its decorative effect or in the fact that it can be made in large uniform panels. It lies rather in the average strength-weight ratio, in the rigidity factor, in the minimized variation in directional strength, and in the dimensional stability of the material. By using layers of thin selected veneers the non-uniformities of solid wood are minimized so that the average strength-weight ratios are greater than for solid wood. This fact is amply confirmed in freight cars constructed from plywood where it is found possible to reduce the dead weight of each car by one ton.

In the days when the timber stands in this country were still largely untouched, it was economically possible to produce a wall-board grade of plywood bonded with a cheap non-weather resistant adhesive and sell it into non- or semi-structural markets at a very low cost. But with the depletion of both our soft and our hardwoods, the wood became more difficult and more expensive to cut—being located in less accessible sections at considerable distances from the mills. If plywood were to be produced at a profit it became essential that it be manufactured to meet the requirements of those wanting structural materials and therefore in a position to pay a better price. The economics of the situation also lead to research on composite plywoods and composite laminates. The recent announcement of an oak barrel made by gluing white oak veneers inside the more available red oak is an illustration of this trend. Another approach is the successful use of Avwood—a composite laminate of mahogany veneers and plastics—in structural work during the war.

In the face of this economic situation is was inevitable that the industry should turn more and more to synthetic resins for the improved qualities it sought.

TWO TYPES — Softwood is obtained from coniferous trees such as fir, spruce, and hemlock, and is the type most generally used for housing. It is processed by either the hot or cold press method with various types of glue such as casein, soy bean, dried blood, urea, and phenolic. When intended for permanent outdoor use it is generally processed with phenolic or urea. Moisture-resistant types, of the kind used for concrete forms and various interior jobs may be processed with urea, casein, or soy bean glues which sometimes contain dried blood.

Hardwood plywood is the type which utilizes wood from deciduous or broad-leaved trees. It also may be processed by either the hot or cold press method and, in general, employs all types of adhesives. According to census figures, a far greater poundage of urea than of other glues was used during the war years. A considerable amount of this

Table I — Softwood Plywood Glue Used for First Three Quarters 1946

Month	Casein	Soy bean	Phenolic	Other glues	Total
Jan.	336,000	1,761,000	1,818,000	213,000	4,128,000
Feb.	300,000	1,700,000	1,900,000	190,000	4,090,000
Mar.	294,000	1,737,000	2,008,000	159,000	4,198,000
April	403,000	1,878,000	2,051,000	158,000	4,490,000
May	519,000	2,010,000	2,390,000	187,000	5,106,000
June	502,000	1,879,000	2,001,000	172,000	4,554,000
July	438,000	1,617,000	1,531,000	145,000	3,731,000
Aug.	603,000	2,059,000	2,164,000	148,000	4,974,000
Sept.	527,000	2,287,000	2,194,000	185,000	5,193,000
Total	3,922,000	16,928,000	18,057,000	1,557,000	40,464,000

Table II — Glue Used in Hardwood Plywoods[a]

Year	Casein	Soy bean	Phenolic	Urea	Tapioca	Other glues	Total
1944	1,000,000	10,000,000	5,000,000	18,000,000	9,000,000	9,000,000	52,000,000
1943	1,000,000	10,000,000	6,000,000	16,000,000	12,000,000	9,000,000	54,000,000

[a] No statistics available for 1945 or 1946.

war work was done in furniture plants. This activity necessitated the installation of hot press equipment, a fact that may possibly cause them to switch over to synthetic resin glues in their future work. In the past, starch and animal glues have been more commonly used by the furniture trade, synthetic resins not being particularly necessary.

It is also possible that all West Coast operations will eventually use synthetic resins in nearly all their output since this would make possible the use of the finished plywood either inside or out. At present the cost of synthetic resins is higher than that of other types of glue, an important factor in their industry position.

Among the finished products made from hardwood plywood are boats, gliders, airplanes, cabinets, interior trim, radios, store fixtures, boxes, and baskets.

WHAT RESINS? — In selecting a resin to give the highest quality of finished plywood panel, the first prerequisite is water resistance—resistance over a wide range of temperature to loss of strength in moist conditions. Thoroughly cured phenol-aldehyde, melamine-aldehyde, and urea-aldehyde resins meet the water-resistance test.

A second resin requirement for high-quality plywood is stability over temperature ranges from − 40 to + 250 degrees, Fahrenheit. By stability is meant not only retention of tensile and impact strength but also resistance to volumetric contraction or expansion.

The third requisite for a resin is that the glue line be free of chemicals injurious to lignocellulose. Acid-catalyzed resins inevitably weaken the wood as time passes. This effect is small in many cases and of no importance in furniture or wall-board panels, but is very bad in structural work. Alkali, however, apparently has little if any harmful effect.

Present glue-line costs run about $2 per 1000 square feet of double glue line for interior type panels, about $3.75 to $4 for moisture resistant concrete-form types, and about $5 for exterior grades. The cost of the exterior glue lines can be reduced appreciably by better mill practice.

It seems safe to predict that during the next few years the volume of resin-glued plywood should more than double. It also seems probable that when the pent-up demands are filled and the markets become competitive, the trend will be more and more to the bonding of all grades of American plywood with resins, and that the newer types of wall boards will consume more plastics than ever. Authorities both in and out of the industry believe that plywood potentialities are far greater than presently realized and that 1947 will see a rapid increase in the adoption of new and enlarged applications.

MOTTLED SHEETING

Is Made from Salvaged Plastics

SCRAP acrylic, much of which is available from airplane domes and blisters, is being turned into a sheeting called Mottletone, which, approximating the figuration of onyx, can be either formed or fabricated, and is available in a wide range of colors.

To produce the sheet, the acrylic scrap is first cleaned in a tumbling apparatus. Then the plastics goes to an air oven where it is heated to a temperature of approximately 250 degrees, Fahrenheit, and sent on to a mixing mill for grinding. The mixture is peeled off the rolls of the mixing mill and placed in an hydraulic press. Under heat and pressure the acrylic flows into semi-positive molds and is cooled. During these processes, dye and plasticizer are added.

The machining, forming, and general care of the resulting Mottletone is much like that of regular sheet acrylic. A jig saw, band saw, or circular saw can be used to cut this sheeting, and saw blades with from six to nine teeth per inch give the best results. Drum sanders have been found the most satisfactory for curved edges, disk sanders for straight edges, and belt and vibratory sanders for surfacing. If care is taken not to remove too much material at one time and if the plastics is kept at a low temperature, there is no obstacle to the tapping and threading of this sheet.

The material should not be used for articles having compound curvatures, but it can be easily fashioned into a simple curve. For this forming, the sheet is heated most satisfactorily in an air oven; but the temperature should not exceed 225 degrees, Fahrenheit.

Some uses of salvaged plastics scrap

PLEXIGLAS CANOPY

Covers and Protects Convertible's Top

SOMETHING different in the way of plastics automobile applications is a full-vision acrylic top for convertibles. The Wright-Austin Company is responsible for this usage, and markets the top clear, or in transparent tints of red, green, and blue. Formed from a ¼ inch sheet Plexiglas, there are no seams to obstruct the view, and the top is easily installed, fastening to the body of the car at four points. The Plexitop can be left on permanently, the regular top which it covers and protects being raised or lowered according to the amount of light that is wanted.

PLASTICS MOUNTINGS

Hold Metal Specimens Flat For Laboratory Examination

IN METALLURGICAL examination work where a metal specimen is inspected under a microscope, it is important that the metal be perfectly flat over its entire surface, even to the edges. This type of surface cannot, however, be achieved if the test specimen is unmounted.

In looking for a suitable mounting material for their metal testing specimens, M. W. Kellogg Company found that the material they sought had to have the following three qualities: low cost, since the mounting is only a means to an end, not the end itself; ease of use, since the laboratory would not be justified in establishing special equipment or special operators to accomplish the mounting; and availability in color, since each type of metal specimen is mounted in a differently colored material to simplify identification. The answer to all three conditions seemed to be Plaskon urea material.

In mounting specimens, the company cuts a small "button" from the metal under test and places it in a cylindrical die. The urea molding powder is then poured around it. Placed in a laboratory press, the assembly is subjected to several thousands pounds pressure and a relatively low temperature until the plastics is cured. Upon removal from the die the metallographer polishes one face of the molded-urea cylinder so that the exposed end of the metal "button" will be flat.

METALS PLUS Hydrogen

Produced Commercially Only During the Last Ten Years, the Metal Hydrides are Rapidly Gaining Stature Among Industry's Most Versatile Compounds. Although Their Full Potentialities are Still Uncertain, They Have Already Found Many Applications in Such Varied Roles as a Copious Hydrogen Producer and an Amazingly Effective Drying Agent

• LOOKING AHEAD •
Improved packaging for products subject to corrosion or decay. . . Many new alloys made possible. . . Vigorous reducing agents developed, providing many new and otherwise impossible methods for exploitation by chemists and metallurgists.

By HOWARD C. E. JOHNSON, Ph.D.
Chemical Editor, *Chemical Industries*

METALLIC hydrides have been known to chemists for a long time, but it is only recently that an intensive study of these interesting compounds has revealed their importance from the standpoint of their industrial applications. New uses are being discovered continually and the demand for them is growing. As a result, production of the hydrides is increasing; for example, in a period of 20 months, Metal Hydrides, Inc., made 1,500,000 pounds of calcium hydride alone.

It is often difficult to tell whether the hydrides are fish, flesh, or fowl. Some of them, like the hydrides of sodium, potassium, lithium, and calcium, are true chemical compounds containing a definite ratio of hydrogen to metal. The melting points, densities, appearance, and chemical properties are different from those of the metals themselves. Sodium, for example, is a good conductor of electricity, but when it absorbs sufficient hydrogen it is converted into a crystalline material which is a nonconductor.

But other metals seem to soak up hydrogen as a sponge soaks up water—physically, without chemical change. The hydrogen apparently fills the "holes" between the metal atoms in the crystal structure and is easily "squeezed" out again by heat. The hydrides of titanium and zirconium, for example, look exactly like the pure metals, but they gradually dissociate into hydrogen and the pure metals at temperatures above 350 degrees, Centigrade.

RICH HYDROGEN SOURCES — In fact, all the metallic hydrides decompose upon heating into the metals and extremely pure hydrogen. Some of them, such as calcium hydride, react with water to give twice as much hydrogen as is contained in the metal hydride. The reason for the 100 percent bonus is apparent upon examination of the relatively simple equation for the reaction:

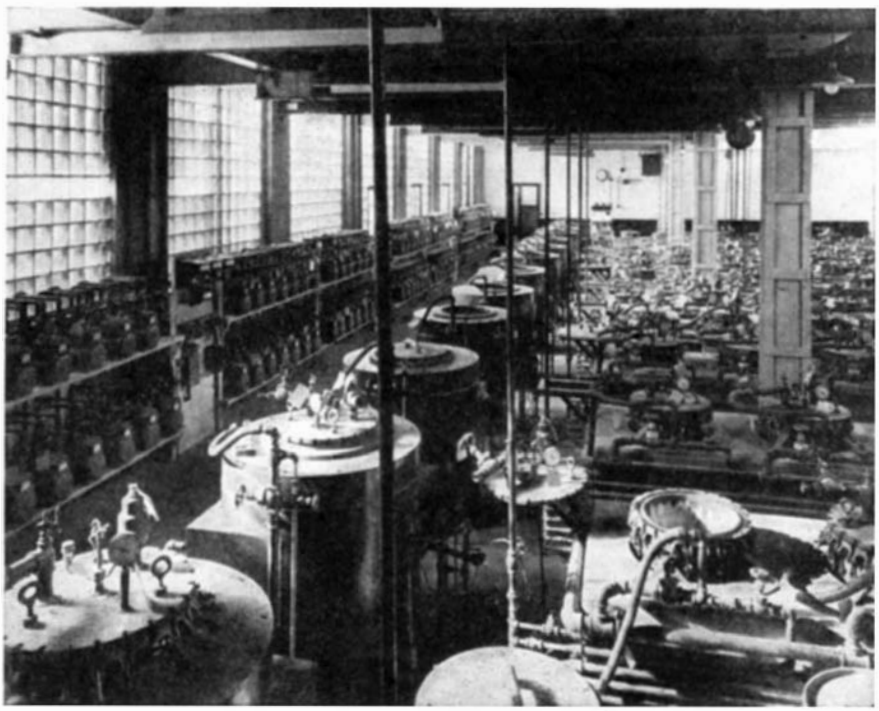
$$CaH_2 + 2H_2O \rightarrow Ca(OH)_2 + 2H_2$$

The reaction is safe and rapid, and the by-product is not corrosive. There is no danger of ignition, for calcium hydride does not inflame when moistened nor does it ignite readily on heating in air to a dull red heat. Precautions must be taken, however, because the heat of reaction with water is very great; calcium hydride is like lime in generating heat when moistened.

Calcium hydride is a very efficient source of hydrogen. A gram of it will produce 1060 cubic centimeters of hydrogen, while a gram of zinc, in the familiar reaction with dilute hydrochloric acid, gives only 160 cubic centimeters. For this reason it is widely used to inflate meteorological and antenna-supporting balloons in localities where other sources of hydrogen are inaccessible. Forty pounds of the hydride, easily carried by one man, can generate over 700 cubic feet of hydrogen.

In addition to specialized large-scale uses, laboratory generation of hydrogen is made very convenient by the use of calcium hydride. This application was mentioned in the February 1946 issue of Scientific American.

Under certain conditions calcium hydride is so powerful a reducing agent that it can free the alkali



Gas fired furnaces designed especially for calcium hydride production

metals—sodium and potassium—from their salts; and hot calcium hydride will reduce carbon dioxide to methane.

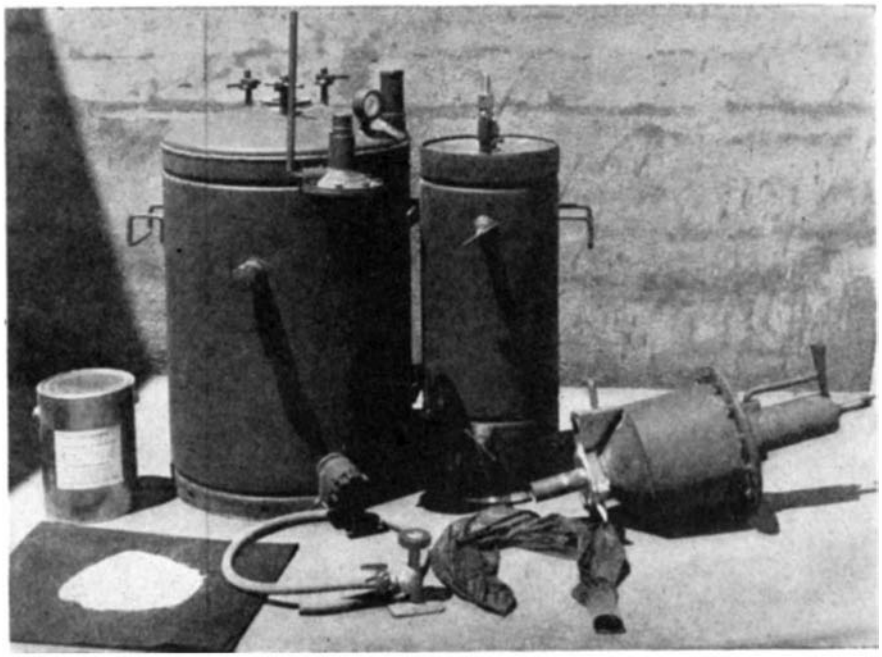
IN ALLOYS—This remarkable reducing action is utilized practically to win such metals as titanium and zirconium from their difficulty reducible oxides, and also to reduce mixtures of oxides to metal alloys.

The use of a mixture of oxides permits the preparation of alloys where powder metallurgy techniques are ordinarily impossible. In attempting to prepare chromium alloys, for example, from mechanical mixtures of metal powders, the chromium particles oxidize and make the mixture difficult to alloy by the usual sintering operation. The 100 to 300 mesh powders produced by reduction with calcium hydride are true alloys, on the other hand, and the sintering process is greatly simplified.

Pure metals or their hydrides are simply made by heating the metal oxide with calcium hydride in a hydrogen atmosphere, giving the metal (or its hydride) and lime. If the metal is the desired product, the mass is cooled in a vacuum; if the hydride is wanted, the hydrogen atmosphere is allowed to remain. Metals produced in this way are especially good for powder metallurgy; every particle has fused, giving discrete spheres which are more stable and have better physical properties than powders prepared by other means.

Metal powders now being produced include permanent magnet alloys of titanium and nickel, zirconium hydride for "getters" (residual gas adsorbents) in electronic tubes, a zirconium-magnesium alloy to refine the grain and lessen the corrosion of magnesium, and a titanium-copper alloy used to add titanium to nonferrous alloys for porosity reduction. An experimental zirconium-lead alloy promises to be of use in the manufacture of "flints" for cigarette lighters.

COATS COPPER — Titanium hydride is used for a novel surface treatment of copper called "titanizing." Titanium has the ability to spread in a thin layer over a copper surface at 900 degrees, Centigrade, like oil over the surface of water. It forms a thin coating of titanium-copper eutectic alloy of much greater hardness than copper itself. Iron and nickel objects can be similarly "titanized" by first copper-plating and then treating the surface with titanium. The process consists of brushing an alcohol or carbon tetrachloride emulsion of titanium hydride on the object to be treated, which is preheated to 80 degrees, Centigrade. The object is then heated to 950 degrees, Centigrade, for 15 to 30 minutes with enough additional titanium hydride to provide a hydrogen atmosphere, and then cooled. Mixture of titanium hydride with titanium carbide, titanium nitride, or tungsten carbide gives coatings of different properties.



Portable hydrogen generator with supply of calcium hydride in small can at left

The value of this process for surface protection is still being evaluated. Eventually it may prove to be practicable as a substitute for tinplate.

Both titanium and zirconium hold great promise for the manufacture of special alloys. Zirconium hardens copper without appreciably lowering the latter's heat and electrical conductivity, indicating its possible use in radiators, switches, and the like. Titanium also forms useful alloys with copper, and the pure metal lends itself readily to powder metallurgy for the fabrication of small articles where lightness, high melting point, or corrosion-resistance is desired.

Another application of the reducing properties of metal hydrides was described in the November 1946 issue of Scientific American. E. I. du Pont de Nemours and Company announced a process for descaling metals with sodium hydride dissolved in fused sodium hydroxide. It is said to be particularly valuable for stainless and other alloy steels. Among the advantages cited are these: There is no costly loss of metal; no harm can result from overtreatment; no special construction material is required for the tank; no electric current is used; the low working temperature (700 degrees, Fahrenheit) does not harm the metal structure; there is no hydrogen embrittlement; different alloys can be descaled interchangeably; time and space are saved; and disposal of waste is simplified. The process is also effective on nickel, cobalt, and copper.

SUPER-DRYER — It is claimed that air dried with calcium hydride contains less than 1×10^{-23} milligrams of water per liter of air. Phosphorous pentoxide, one of the better common drying agents used in the laboratory, leaves two billion billion times that much water in the same amount of air! The figure given above is equivalent to one molecule of water rattling around in a cube approximately four feet eight inches on a side.

Because of its intensive drying action and moderately high capacity for water—seven parts of calcium hydride will absorb six parts of water—calcium hydride is expected to be used widely both in the laboratory and in industry. A major advantage is the fact that it reacts at high temperatures as well as at room temperature, in contrast to most of the regenerative types of desiccants, and that the reaction is maintained until the hydride is practically exhausted.

A large demand for the hydride is foreseen for drying transformer and vacuum-pump oils as well as for reconditioning dry-cleaning solvents. Since the hydride reacts with acids, aldehydes, mercaptans, methyl ketones, and low molecular weight alcohols as well as with water, the drying agent exerts a "sweetening" effect on such liquids. Other materials which can be dried

by calcium hydride include various hydrocarbon oils, ethers, amines, chlorinated solvents, paint vehicles, plastic monomers such as styrene and vinyl chloride, and (at low temperatures) alcohols, phenols, and esters.

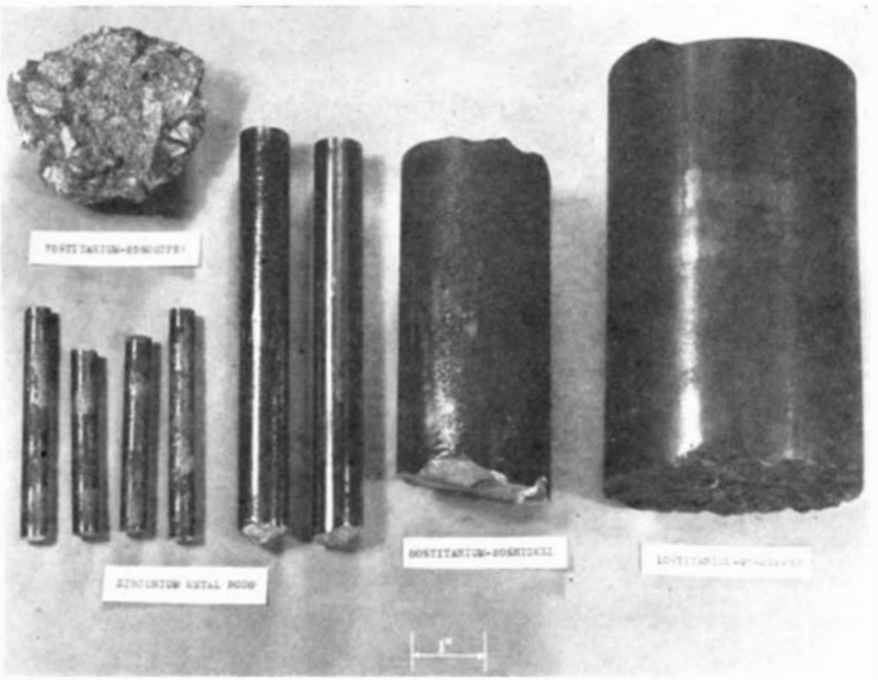
In the packaging field—particularly in packaging pharmaceuticals—calcium hydride may have a potential application, since it is a source of an inert hydrogen atmosphere as well as a dessicant. In packaging metal equipment for preservation against atmospheric corrosion, calcium hydride will maintain a completely dry atmosphere within a plastics bag or other air-tight wrapping; the small amount of hydrogen formed by reaction with moisture may be desirable since it assures a slight positive pressure within the container.

MILD REAGENT—Calcium hydride has advantages over other condensing agents in reactions of the type used to prepare isophorone from acetone or crotonaldehyde from acetaldehyde. It is a mild reagent which does not generally cause repetitive condensations with attendant resin formation, and it may be used wherever aqueous or alcoholic solutions are to be avoided. Moreover, its use prevents significant loss of products through reduction or reversal.

Condensation of esters, in the acetoacetic ester type of reaction, are also promoted by calcium hydride. Its use is considered advantageous since no alcohol need be present, and the reactions can be carried out in the absence of solvents or with high-boiling ethers or hydrocarbons. These reactions have not been studied intensively, but there are possible advantages in using bivalent calcium derivatives in reactions with dihalides.

Other organic reactions of interest take place with calcium hydride. Nitrobenzene, for example, is reduced to nitrosobenzene, or even further to azoxybenzene—both of which are useful intermediates in dye chemistry. Promising reagents can be made by allowing calcium hydride to react with alcohols. Monocalcium ethylene glycolate, for instance, is an excellent condensing agent for the type of reaction described in the preceding paragraph.

Among the inorganic chemicals, too, metal hydrides do many interesting and unexpected things. Potassium fluoride or zinc fluoride, for example, can be reduced to the respective metals by heating to 500 degrees, Centigrade, with calcium hydride; and many other oxides, chlorides, fluorides, and even sulfides



Several of the alloys made possible by the action of calcium hydride

may be reduced to the corresponding metals. Sulfates can be reduced to sulfides, and this procedure has been used to determine sulfates and sulfur in oils. Sulfuric acid is reduced to hydrogen sulfide and sulfur, nitric oxide is converted to ammonia, boric oxide and borax are reduced to boron—with the concomitant formation of calcium boride—and silica, glass, and porcelain are partially reduced to silicon. Indeed, there are few materials which cannot be reduced by calcium hydride under the proper conditions, although many of the reactions require further study before they can be applied profitably.

MADE BY HEATING — Calcium hydride of high purity is made by heating metallic calcium to 400 degrees, Centigrade, for 20 minutes in an atmosphere of hydrogen and cooling the resulting product below 200 degrees, Centigrade, before removing. The yield is a white, salt-like material. The grayish color of the commercial product is due to the presence of small amounts of metal and calcium nitride. The calcium for the process is obtained either by electrolysis of calcium chloride or reduction of quicklime with metallic aluminum, the hydrogen by hydrolysis of water.

A cheaper way of making impure calcium hydride is to heat quicklime with metallic magnesium in a hydrogen atmosphere. The product so obtained consists of 42 percent calcium hydride and the remainder magnesium oxide. No way has been found to separate the two components of the mixture.

Other metallic hydrides are prepared as described in a preceding section. The metal oxide is simply reduced by calcium hydride in the presence of hydrogen.

These reactions have been worked out successfully on a commercial scale, and in the near future these materials will turn up to do a good job in the metallurgical, chemical, and allied industries.

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FUNGUS ON OPTICS

Prevented by Radio-Active Metal-Foil Strips

FOULING of lenses and other optical parts of instruments used in the tropics was until recently, a serious problem, particularly in the Pacific areas. The way that this blinding "disease" of essential aids to vision was checked by the use of radium has now been revealed. Metal foil is treated with radium compounds to give it an effective alpha-ray emission equivalent to about 15 micrograms of radium per square inch and narrow strips of the foil are mounted around the lenses.

This method was found effective in preventing the growth of most types of fungi responsible for the blinding effect on lenses up to about three inches in diameter. Moreover, the treatment requires such tiny total amounts of radium as to be economically feasible and negligible from the standpoint of hazards.

Possibly this will provide a valuable application for some of the newly available radio-active materials produced in connection with atomic bomb operations.

Electronic Insurance IN THE SHOP

Machine and Tool Jamming, in Addition to Endangering the Operator, Can Cause No End of Costly Destruction. But by Application of Simple Electronic Circuits, These Mishaps Can Be Virtually Eliminated

• LOOKING AHEAD •

Lower cost protection for machines and operators. . . An end to self-damage of machine tools. . . Hours of needless delay eliminated. . . Less wastage of materials because of malfunctioning equipment.

By JOHN MARKUS
Associate Editor, *Electronics*

IN MANY automatic punch presses or stamping machines, failure to eject the punched-out part before the punch descends for the next stroke is equivalent to suicide for the machine. Sometimes, if the cavity under the die is large enough, quite a few batches of slugs can pile up safely before the crash comes, but then there is a real mess and costly dies or punches will need replacement or repairs at the very least.

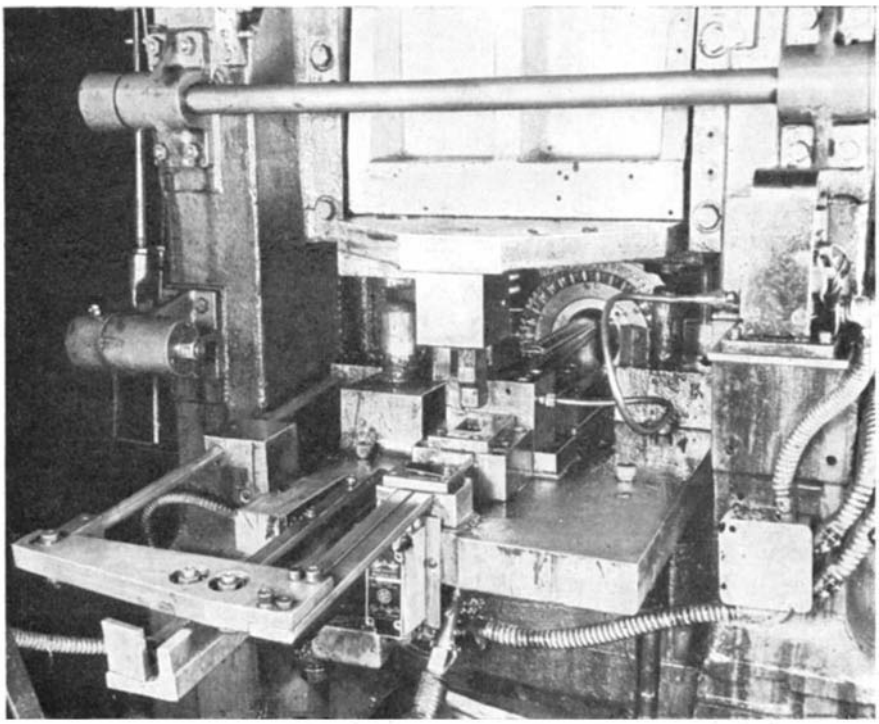
By sensing each ejection of the press electronically with an ingenious arrangement of coils, tubes, and relays developed by the Norris Stamping and Manufacturing Company, any punch press may be shut off the instant before damage is done, so the operator on guard can poke out the jammed parts. Only a few such safety shutdowns save enough in lost time and repair charges to pay for the entire cost of the electronic protector.

Although the system looks and sounds complex, it is actually made up of only two basic units—an amplifier that actuates a relay when a batch of steel slugs slides through the coil which surrounds the ejection chute, and an electronic timer that is restarted by the relay each time the slugs come through. If the slugs fail to arrive within the predetermined safety interval, the timer shuts down the press.

Where relatively large articles are being turned out by a huge press, even one jam would be disastrous and hence the timer would be set for slightly less than the time for one stroke of the press. With large objects, only the electronic timer is needed because sensing can here be achieved with a simple snap-action switch that closes each time the ejected part bounces against it on the way out.

One example of this nursemaid application of electronics is seen in the manufacture of cylindrical steel cases having almost a thousand holes punched through their walls. The punching is accomplished with the aid of an automatic indexing fixture installed in a regular punch press. Each stroke of the press punches a row of sixteen holes in the case. The fixture is then automatically indexed and the operation repeated, until the case has made one complete revolution. The small round slugs that are punched out fall into the hollow die where they collect and are blown out in batches with compressed air.

SENSING SLUGS— The exit hole in the die was of necessity rather small and sometimes the slugs, instead of ejecting when the compressed air was turned on, tended to jam in the die cavity. After about seven strokes of the press, the cavity would be completely filled and then the punches or the die, or both, would



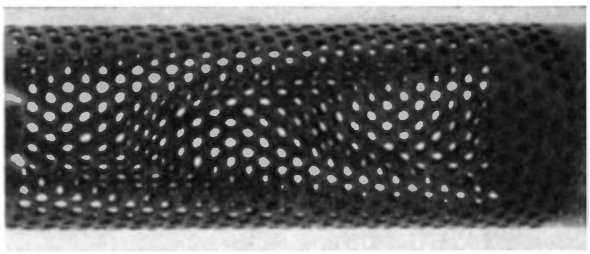
Ejected slugs fall down shoot at bottom center and pass through the detection coil, the only component of the sensing device actually mounted on the press

be damaged. On less frequent occasions, the compressed air supply failed and the slugs jammed similarly.

The solution to this all-too-common industrial problem required, first of all, the devising of some sort of sensing unit that would respond to the presence of the slugs as they were being ejected. The coil and funnel arrangement shown in the diagram was therefore contrived to make use of the magnetic properties of the slugs. This unit was attached to the press in such a manner that slugs pass into the funnel and through the coil after they are ejected from the die.

The coil is connected into a circuit that is normally balanced and carries no voltage, but is unbalanced in the presence of steel. A slug passing through the coil thus sets up a small voltage which is built up by a conventional two-tube amplifier.

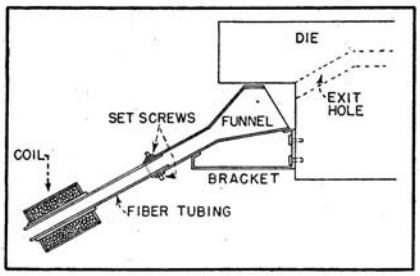
Since compressed air is used to blow the metal slugs from the die, they pass through the sensing coil at a relatively high velocity. The circuit is unbalanced for only a fraction of a second, so that an ordinary relay cannot be made to operate satisfactorily on the amplified voltage. An electronic relay circuit is therefore used, consisting of a thyratron tube that ionizes or "fires" even on a momentary pulse of voltage, then stays closed or conductive until its power circuit is disconnected by the punch at the beginning of the next cycle of operation. The relay in the output circuit of the thyratron stays closed for as long as this tube is conductive, and in this closed position the relay contacts allow the press to keep on running.

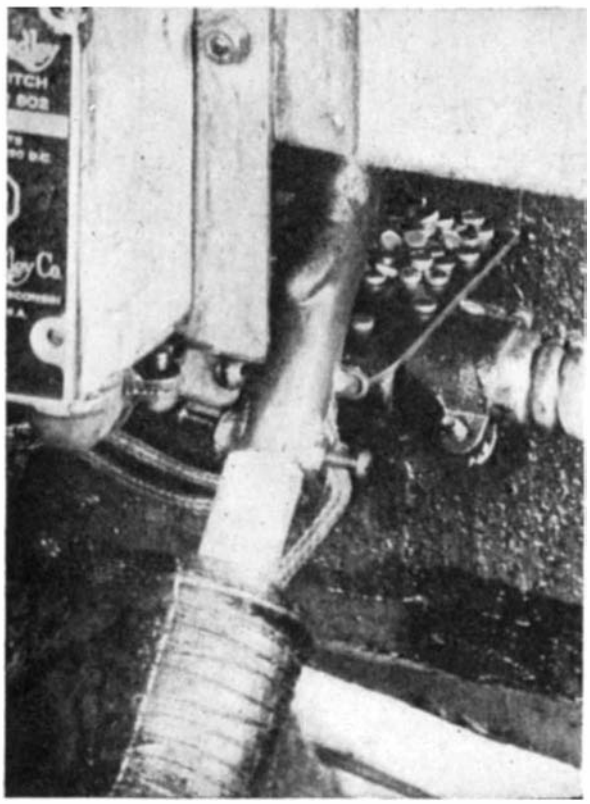


If not consistently cleared from the press, slugs stamped from this cylinder will cause serious jams

ELECTRONIC TIMING—It is essential in this application that the press be shut down if the die is not cleared within three strokes after a jam occurs underneath the die. This safety shutdown is accomplished with an electronic timer set for a time delay of about four seconds, which is the time required for three strokes of the press. The time is controlled by a resistor and capacitor in the grid circuit of a vacuum tube.

The cycle of the punch press begins with the punch at the top of its stroke and the steel cylinder clamped in position over the die. As the punch starts down, a switch operates the solenoid valve that controls the flow of compressed air into the die. This blast blows out the steel slugs left in the die from the previous cycle. The slugs pass through the sensing coil and induce therein a voltage pulse that fires the thyratron tube and energizes its relay, preventing the electronic timer from starting its count of four seconds. On the upward or return stroke the punch trips a switch that opens the thyratron circuit, clearing the decks for another cycle.





Ejected from the die by compressed air, the slugs pass through a fiber tube and sensing coil (above). The press is automatically stopped if slugs fail to pass through the coil (left) during three successive press cycles

If no slugs are ejected, however, the thyratron does not fire and its relay does not close, so the timer starts. If this no-slug situation continues for three full strokes of the press, the timer will complete its cycle and operate a power relay that stops the press.

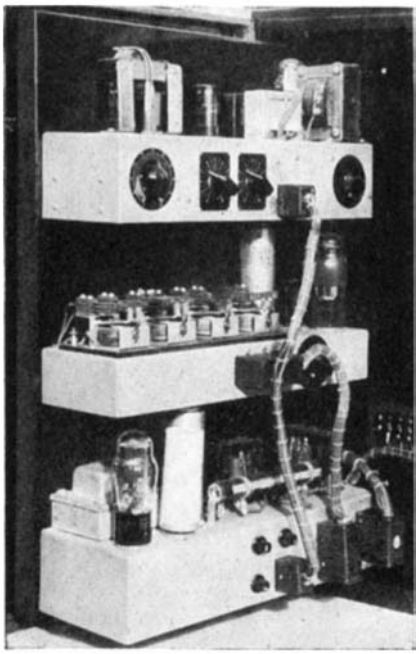
The mechanical construction of any piece of electronic equipment must receive prime consideration if it is to be used in an industrial plant. There is usually severe vibration in the vicinity of heavy machinery, especially a punch press of any size. Attaching the equipment directly to the machinery should be avoided if vibrations will affect its performance or reliability. The electronic units are therefore mounted in a separate cabinet, and are connected together by plugs and flexible cables so that any one of the units can be quickly and easily replaced by an inexperienced technician if it becomes defective.

A switch is provided so that when it is closed the press protector has no effect on the operation of the press. This is necessary so that the die setters can make adjustments on the press without having it shut off because no steel plugs are being ejected.

INCREASED RELIABILITY — This one example illustrates how valuable machine tools can be protected from self-damage by carefully designed and simple electronic controls that do not interfere in any way with efficient operation of the machine. Although systems employing elaborate arrangements of light beams have been used for this purpose in the past with a measure of success, they called for mounting

of sensitive tubes and optical components right on the press. Consequent increased maintenance problems and more frequent failures of the electronic protection equipment soured management in many instances on the feasibility of bringing tubes into the factory itself.

The combining of electronics with simple electrical and mechanical



Removed a safe distance from the vibrations of the stamping press, the electronic brain of the sensing device permits the press to operate as long as the slugs are properly ejected

units as illustrated here gives practically foolproof protection, however, at both lower initial cost and lower upkeep. Electronics thus takes on the role of insurance for owners of machine tools.

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AUDIO FILTER

Supresses Static And Needle Scratch

PROVIDING the long-sought suppression of static noise in radio reception and needle scratch or turntable rumble in record reproduction, a new electronic circuit has been invented by H. H. Scott, president of the Technology Instrument Corporation. In a recent demonstration of the new circuit, records of Caruso's voice sounded like new, even though the records were so badly worn that the characteristic phonograph needle scratch came through with a loud roar when the suppressor was cut out.

The principle of operation is based on the fact that a musical program rarely, if ever, occupies the full audio spectrum of approximately 20 to 20,000 cycles at any given instant. Rather, at one instant a bass viol might predominate and require a bandwidth of only 40 to 1000 cycles to cover fundamentals and harmonics up to the fourth, and at another instant the piccolo with fundamental notes from 500 cycles to 4000 cycles may be featured. For the bass viol, then, the electronic circuit narrows the amplifier bandwidth automatically to the range from 40 to 1000 cycles in which is the desired music at that instant. All rumbling sounds below 40 cycles are suppressed, as also are radio static crashes, phonograph needle scratch noise, and other undesired sounds above 1000 cycles. However the high-frequency response can be wide open at the next instant for reproducing the harmonics of a high piccolo note or the sound of a Chinese gong. Extraneous noise within the frequency range being passed at any instant is scarcely noticed because it is only a small percentage of the total noise and is therefore much weaker in intensity than are the desired sounds.

ELECTRONIC EYESIGHT

Allows Blind to Read Letters By Sound Signals

AN ELECTRONIC reading aid that converts the shapes of printed letters into characteristic sounds has been developed so that a blind person may interpret the sounds as letters in much the same manner that a radio operator reads the dot-and-dash code. In use, a light beam from a scanning stylus is moved up and down vertically while being moved gradually from left to right along a line of type.

In synchronism with the motion of the light spot, the frequency of an audio oscillator is varied from a high pitch at the top of a letter to a low pitch at the bottom. The light reflected from the page is picked up by a phototube that operates an amplifier which allows the audio tone to reach the reader's ear only when the spot is on black. The frequency then heard tells the reader the vertical position of the black spot. A minimum of five complete up-and-down scans of a letter is generally necessary to assure complete identification by tone.

Reading by sound

Before the instrument is perfected and made available commercially, however, many more tests will be made by Radio Corporation of America with substantial numbers of blind subjects under controlled conditions.

BLINKING LAMPS

Count Operations by Electronics

THE RCA electronic time interval counter used during the war for measuring projectile velocities has

Up to 1,000,000 counts per second

been redesigned for peace-time applications. It can now count from 1 to 1,000,000 within the breathtakingly short time of one second, with numbered neon lamps flashing on and off to show the progress of counting. This means that it can handle any industrial counting job no matter how fast the objects are moving. If dials are set beforehand to a desired count, the instrument will automatically start, stop, or shift operations when the predetermined number of items has been counted. By this means, any process can be controlled on the basis of a preselected figure. When that figure is reached, the counter triggers an electrical impulse which stops the operation, shifts the package to another conveyor, and starts the counting operation over again.

Time intervals longer than one second can be measured by using an external timer to record the number of times the counter repeats its operation.

Instrumentation, Measurement, and Control

Papers Presented at the First National Instrument Conference Set the Pace for Profitable Research by All Industry

By ALEXANDER KLEMIN
Aeronautical Consultant; Research Associate, Daniel Guggenheim School of Aeronautics, New York University

MODERN industry calls for ever greater and greater refinement in instrumentation, measurement, and control. Engineers have recognized the needs of the times and accordingly have formed the Instrument Society of America (I.S.A.). Under the joint auspices of the American Society of Mechanical Engineers (Industrial Instruments and Regulators Division) and of the I.S.A., the First National Instrument Conference was recently held in Pittsburgh.

The sessions covered many topics and industries, with dozens of papers presented. Almost all the papers had this in common: They called for greater accuracy and refinement in instrumentation, automatic action or control, and ease of remote indication. There also appeared a new tendency: Consideration is being given to the human limitations of the observer and operator of instrument controls.

How should an engineer deal with the information presented at such a conference? First, by reading intensively certain papers in one's own specialty. Second, by studying abstracts of those papers which may have application to one's own field. Third, by noting what fields of knowledge were covered and in which more information might at some time be sought. Men in industry will find the present article similarly helpful.

INSTRUMENT PHILOSOPHY—The First National Instrument Conference paper likely to have the widest influence offered more philosophy than technical achievement. Presented by Rear Admiral Luis de Florez, of the Navy Office of Research and Inventions, a successful petroleum engineer and personal flier, it emphasized the following points, applicable in all industrial instrumentation:

1. Reading of instruments has to be reinterpreted, experience and judgment are required to obtain useful results from any instrument.

2. In response to the demands of industry, instrumentation is so complex that it is hard for a man to utilize the information which pours in on him from a maze of dials. The limit of human powers has been reached in the cockpits of bombers, in the combat information centers of aircraft carriers, in the control rooms of modern cracking plants or solvent separation units.

3. Reliability and accuracy of modern instruments can be taken for granted. Now new ways of presenting information to the operator must be presented so that his senses are not overwhelmed by its volume and diversity.

4. Automatic control is desirable, but conditions always arise which make complete automatic control impractical or undesirable.

5. A trend is developing to the use of vertical reading instruments where a number of factors can be compared by a glance at the vertical height of the indicators.

6. By choosing a suitable scale for each instrument, operation will be correct when all vertical readings are on one horizontal line. It will help the operator of a chemical pilot plant if he knows that everything is going well by simply looking for one horizontal line.

7. Because of atomic fission, instruments and controls may be triggered by more subtle forms of energy than heat, pressure, or light. But even such equipment will follow a pattern similar to that of present devices.

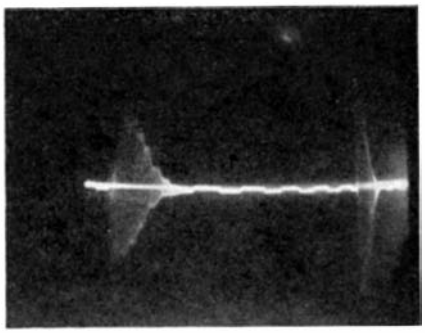
8. To meet human limitations, physiological and psychological studies should be undertaken.

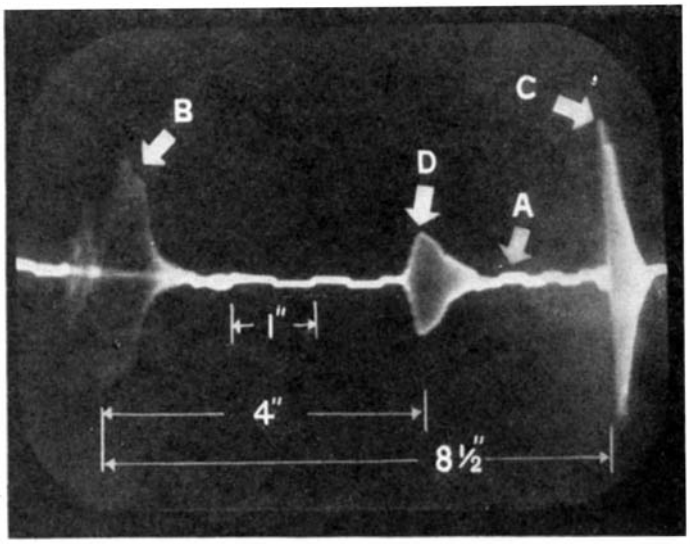
INDUSTRIAL CONTROL — While the Admiral's paper was the most philosophical, other papers also took a broad view of industrial control problems. Thus, H. C. Frost, Chemical Division, Corn Products Refining Company, in his paper, "Some Considerations in the Control of Continuous Processes," dealt with specific chemical processes, but the principles he set forth applied to industrial processes generally. The benefits of modern instrumentation can be obtained, said Mr. Frost, only if automatic controls function continuously; information is supplied continuously without lengthy chemical or other analyses; instruments are carefully adapted to the task in hand; controls and instruments are so designed that they bring closer the ideal of a straight pipe line with the raw material introduced at one end and the finished product flowing continuously out of the other end.

How can these desirable objectives best be attained? In the case of the very largest companies a group of specialists may be organized to take charge of instrument and control problems. If a specialist group is impractical, then there must be frank, systematic, and complete co-operation with suppliers. It is important to look at problems both from the users' and the suppliers' viewpoints and to make sure of the type of information which each should have from the other. Finally, technologists should acquaint themselves with the many new and little-known devices which modern progress has brought.

COMPLEX DESIGN—Other speakers agreed also on the desirability of automatic control systems, servomechanisms, and regulators. But

The Reflectoscope sends supersonic waves through the castings (left). A flaw's presence is revealed on oscilloscope screen by pip, D, on trace (lower right). If the piece is not defective, trace (upper right) is undisturbed





• LOOKING AHEAD •

Greater attention to the human factor in industrial controls. . . More emphasis on the philosophy of instrumentation. . . Reduction of mathematical studies to simplified and more widely useful bases.

when the automatic system involves many interacting indicators, its design can be very complex. To use "feel" alone in design of a complex system involves costly and lengthy experimental set-ups. Mathematical studies become unwieldy and cumbersome and sometimes do not give a conclusive result.

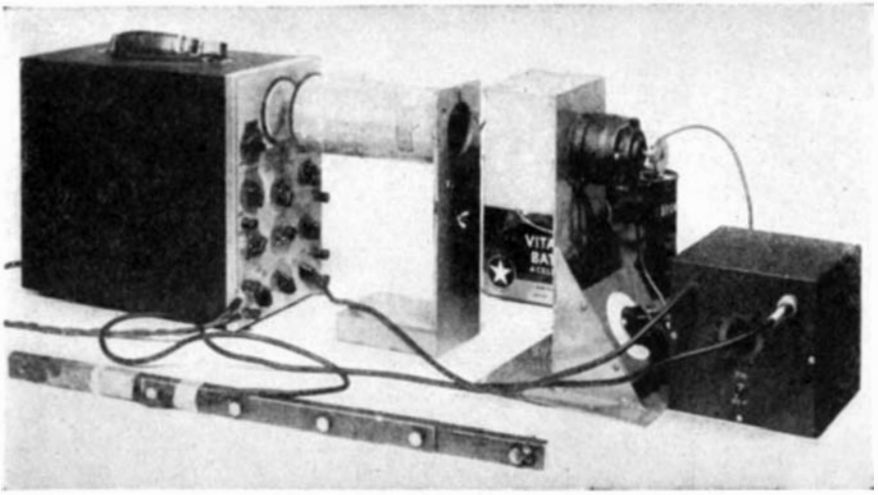
Joel D. Peterson of Bendix Aviation Corporation suggested a relatively new method in which mathematics play a subsidiary though important role. The mechanism to be controlled and the controller are broken down into their components, represented as boxes or blocks in a diagram. Each box has a simple formula, called an "operator," which gives the ratio of the output to input in the box. With the aid of these operators, physical ideas are quickly converted into quantitative ones, and the way in which one device interacts with another is visible at all times to the designer. End effects are quickly calculated, variations as quickly introduced, and the designer never loses his sense of physical reality. A typical application would be in the electrical remote control of the throttle valve on airplane engine. Almost any industrial control could be studied by this block method.

SUPERSONICS — Not all speakers at the Conference were concerned with the purely philosophical or mathematical aspects of instrumentation. Others dealt with ingenious applications of physics. As an example, J. W. Dice of Sperry Products, Inc., presented the Supersonic Reflectoscope.

"Supersonic" has become a popular word because it defines the speed of airplanes which travel faster than sound. Its more prosaic use is in defining short sound waves which have a greater frequency than the sound waves which human ears can hear. The Reflectoscope sends vibrations, which are supersonic in accord with this definition, through a material under test. It measures the time it takes these vibrations to penetrate the material, to reflect from the opposite side, or from an internal defect, and to return to the sending point; a pattern on an oscilloscope screen indicates the location of defects.

Inside a portable cabinet a generator produces electrical impulses of the order of one-half million to twelve million cycles per second. These electrical impulses come out through a television coaxial cable to a quartz crystal scanning unit. The quartz crystal has the peculiar ability to expand or contract with application of electrical impulses. If a million cycle electrical impulse is put back of the quartz crystal scanning unit, a sound beam of one million cycles comes out. This beam travels in a straight line, just as a flashlight beam, and is reflected like light. The sound goes out and bounces back from any defect in the material under test. The same crystal receives the returning sound wave and transfers it into the unit where it is amplified and sent to the oscilloscope screen.

There are some tricks to be learned, such as spreading a film of oil over the surface of the material to obtain good supersonic coupling, but there is ample reward in quickly obtained information. One of the illustrations shows the Reflectogram of a good material. The line through the center is the sweep line. Each square wave indicates a measure of distance from one inch to two feet. At the left is the initial pulse, at the surface of the quartz crystal, which remains on. At the right the sound is reflected from the far side of the test piece. Another illustration shows the Reflectogram of a defective material. The depth of the defect can be determined by counting the square waves. By moving



Picked up by the strain gage, undesirable vibrations may be amplified and then sent to the deflection plates of the cathode-ray tube in the oscilloscope

the scanning unit over the surface of the material and watching the oscilloscope screen, it is easy to trace out the pattern of cracks or other defects. The operator can scan the interior of a casting as quickly as he can move the crystal over the outside surface. The Reflectoscope has been selected for detailed mention as being typical of modern industrial instruments.

Other papers presented at the Conference dealt with such topics in inspection and gaging as: Surface Roughness Instrumentation and Factory Inspection; Surface Finish Measurement Instrumentation; Recent Trends in Electric Gaging Methods; Training in Inspection and Gaging.

INDUSTRIAL PHYSICS — In the light of Mr. Dice's paper it is not remarkable that courses in industrial physics are now offered at many colleges. H. A. Leedy, of the Armour Research Foundation, was also dealing with applied physics when he discussed Sound and Vibration Measurements. His introductory paragraph is one for all industry to ponder. "The subject of the control of sound and vibration is of extreme importance to industry today. Unwanted sound or excessive vibration is generally associated with poor workmanship or poor mechanical design. Excessive office or factory noise often results in lowered efficiency. The consumer is becoming increasingly conscious of noise and vibration and is more critical about these disturbances than ever before. It behooves all of us to learn more about methods of controlling these undesirable and frequently unnecessary disturbances."

Since sound is a vibratory motion, the measurement of vibrations includes the measurement of sound. The only distinction between the two lies in the effect on hearing. Either subsonic vibrations of low frequency, sonic or audible vibrations, and ultrasonic vibrations above the threshold of hearing can be measured. The measurement of loudness is difficult because it depends on pitch as well as intensity, and physiology as well as physics has to be considered.

Mr. Leedy recalls usefully that there are several quantities involved in vibration measurements: frequency; displacement; velocity; and acceleration. On which of these four quantities should attention be focused? If it is desirable to determine the source of the vibration such as an unbalanced wheel or gear, the frequency is measured; in the design of vibration isolation supports, a knowledge of the frequency of the source is also required. If vibratory stresses in machinery are feared as likely to produce failure, amplitude is measured. Velocity is of less interest, but if the comfort of passengers in an automobile is to be studied, then acceleration is measured.

Because of electronics, vibration instruments are no longer of the bulky "seismic" type where a large mass placed in contact with the vibrating part often changes the vibration. Today an electronic vibration instrument consists of a piezoelectric pickup, an electronic amplifier, and a calibrated output meter. The pickup consists of a small square crystal rigidly mounted at three corners, the fourth corner being free to vibrate. The natural frequency of this crystal is such that the voltage output is proportional to the vibration acceleration. By suitable electrical integrating networks, it is possible to measure velocity and amplitude. Thus one modern instrument can combine three functions. Because the pickup is small and light, it can be mounted anywhere and can give indications at a distance. If the crystal pickup is too fragile, the engineer or designer can use a strain gage. Because information is so readily obtainable, there is no longer any excuse for unpleasant vibration anywhere.

WORTH WHILE—Space considerations will not permit even a listing of the names of all the Conference papers in certain other vital fields which included: Controllability of Combustion Processes; Flow Measurement and Control; Automatic Control Terminology; Instrument Research; Measurement and Control; Atomic Energy Research; Instrument Components and Materials; and Naval Ordnance.

It will be agreed that the First National Instrument Conference was thoroughly worth while. It gave added evidence of the tremendous advances brought about by the war effort, and offered valuable information to every American industry.

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ATOM-POWERED CITY

Predicted by Chemist In Ten Years

OPERATIONS of an entire city on atomic power within the next ten years was forecast by Professor Milton Burton of Notre Dame University, former head of the Radiation Chemistry Section of the atomic bomb project at Oak Ridge, Tennessee, at a meeting of the American Chemical Society.

"We are not far from the atomic energy power plant of the future," Professor Burton declared. "There is every expectation that the first power pile will be operating within two years.

"It is reasonable to expect that within the next ten years we shall have a federally subsidized experiment in which a whole city may operate on atomic energy.

"Such a municipal atomic energy plant," he continued, "may be used in the future as the principal unit in the city's sanitation system, purifying its water supply, sterilizing its waste, and producing new products at the same time that it generates power.

"This development will be made possible by proper application of the vast amounts of radiation energy produced as a by-product by an atomic energy pile," explained Professor Burton. "In the atomic piles of the future," he predicted, "provision will be made for use of the radiations in new chemical processes. New materials, low-temperature cracking of petroleum oils, and

more effective chemical utilization of some natural resources now inefficiently employed are among the benefits to be expected.

"Here we refer to materials like coal, natural gas, and clays," Professor Burton explained. "Studies of the effects of radiation on these materials in contact with various substances, to the action of which they are usually inert, may lead to the development of industrially important processes."

PORTABLE INDUCTION PHONE

Permits Constant Communication Between Railroad Men

TRAINMEN inspecting their trains or otherwise working about them can now talk with other members of the crew, the crews of other

Complete unit weighs only 29 pounds

trains in the area, and with operators of distant wayside control towers, through the use of a recently developed portable telephone. This instrument, the Carryphone, transmits and receives messages through the air, operating in connection with the railroad's inductive telephone system for communication between trains, between trains and control towers, and between the ends of trains.

Carried by means of a shoulder sling, the new unit weighs 29 pounds and is housed in a cabinet measuring only 16½ by 12¾ by 5 inches. With it, a trainman can leave his cabin car and still maintain constant communication with other members of the crew in the cabin car or on the engine, and can talk, as well, with the operators in control towers up to 15 miles distant. He can converse with the operator of another Carryphone, or with the crew of another train, up to three miles distant.

Used by the Pennsylvania Railroad, the new device has proved valuable to crews making train inspections, enabling trainmen to keep in touch with the engineman, and providing a quick means of reporting any unusual circumstance. It is also expected to be valuable to crews of work trains, to track maintenance forces, and to forces patrolling and protecting the railroad.

Essentially a miniature version of the telephone transmission and receiving unit installed on trains, the Carryphone can be compared with a radio "walkie-talkie," except that instead of radio waves it transmits and receives messages through the air by induction, using the track and wayside wires on poles as its communication channels. Thus, its messages are confined entirely to the limits of the railroad, and there is no interference with radio operations in the vicinity.

In using the Carryphone, trainmen need only lift the hand piece to place the unit in operation. Tiny storage batteries provide power for approximately two hours of continuous service. When not in use, the Carryphone rests in a receptacle in the cabin car, which automatically connects its batteries, for charging, with the larger batteries of the car's train telephone unit. Lifted from the receptacle, it is ready for immediate use.

AUTO VENTILATING

Systems Provide Even Heat With No Drafts

ALREADY applied on aircraft, two methods of heating and ventilating new to the automotive industry are under consideration in Detroit. Both systems are said to keep the atmosphere within a car at approximately 70 degrees, Fahrenheit, to hold humidity at reasonably constant levels, to eliminate drafts, to prevent windshields and windows from fogging, and even to protect allergy-prone passengers from pollen by filtering incoming air. With one system, air enters an intake scoop, passes through filter and heater, flows through the side panels, warms the interior by radiation and convection, and leaves through floor vents. In the second system, a heater mounted at the rear of the car forces air from vents downward over the windows and out through floor vents. It is said that these concepts of weatherproofing automobiles, while admittedly theoretical, still are sufficiently practical to invite an early start on developmental work.

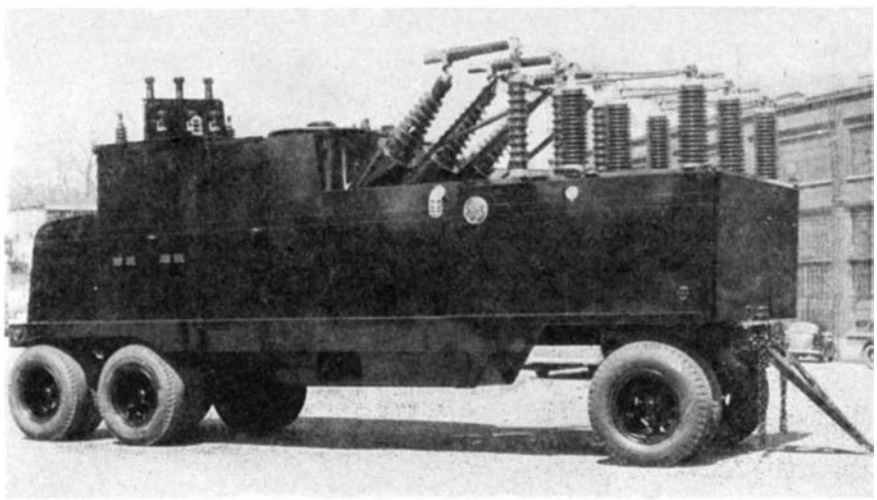
MOBILE SUBSTATION

Compact Emergency Unit for Domestic Utilities

FIFTEEN mobile unit substations—every one for a domestic utility—are now under construction by the General Electric Company. This apparatus is recognized as essential equipment on modern electric systems, not only for emergency service but equally for use during maintenance or rebuilding of regular substations, system changeovers, relieving seasonal overloads, or supplying the power requirements of temporary loads.

Typical of the 15 units now under construction is the 2500 kilo-volt-ampere unit for Ohio Power Company, which General Electric engineers state is representative of the type that has more or less set the standards for future mobile unit substation designs. The 22-ton unit is low-slung and streamlined, a style which not only presents a pleasing appearance, but also serves to reduce cleaning upkeep and provides a definite safety factor by shielding operators from high voltages. Only necessary bushings and certain operating parts are exposed. All other apparatus is concealed behind the panels.

The unit has an over-all length



Standards set for future mobile substations

of 25 feet and a width of 8 feet, which is within the maximum dimensions permitted by the highway laws of most states.

WEED-KILLING SPRAY

May Be Safe for Corn If Used Carefully

TESTS with the weed-killer known as 2,4-D as a spray to weed corn have given satisfactory results against certain weeds with little or no injury to young corn plants in preliminary trials at the New York Agricultural Experiment Station at Geneva. Using the 2,4-D at a concentration of 1000 parts per million, tests were made with corn eight to ten inches high and in plantings where the tassels were just beginning to show. In those fields where an effort was made to direct the spray away from the upper part of the corn plants, very little, if any, injury of the corn was observed. However, where the spray was intentionally applied to the top of the corn, severe injury resulted.

REMOTE VIEWER

Represents Television's Entry into Industry

PROVING itself practical in its first industrial application, a device embodying the basic principles of television permits close observation of dials and indicators, or even of an entire process, where it would be otherwise impossible due to inaccessibility or danger to an observer.

This device, the Utiliscope, has been in operation for several months at Consolidated Edison's Hell Gate Station Power Plant in New York, where it is used to show the water level in a boiler remotely located from the main control room. A photo-electric camera which is focused on the water-level gage continuously transmits the picture to a control panel where the image is reproduced on a screen similar to that of a home television receiver. This permits observers in the control room to keep a constant check on the boiler 325 feet away. Not only are the boiler and main control room separated by a distance greater than an average city block, but also by eight floors, a building wall, and various other obstructions.

The use of the Utiliscope in large power plants such as the Hell Gate Station is only one of numerous applications for which it is suitable. It is expected to be valuable in the conducting of dangerous research where it would permit close viewing of the progress of experiments from a safe distance, and observing processes involving radioactive substances in atomic power plants. It is said also to be ideal for use in observing such operations as the coal feed to pulverizers or stokers; the presence of smoke in stacks; conditions within steel furnaces; the inside of oil wells; the condition of pipelines and their pressure pumps; temperature gages in large warehouses, especially those involving refrigeration; and readings on electric meters at remote points.

The Utiliscope, developed jointly by the Farnsworth Television and Radio Corporation and the Diamond Power Specialty Corporation, is compact as well as simple in construction. The complete installation, which weighs only 121 pounds, includes four units—camera with deflection unit, two small power units, and the monitor or viewer. It has fewer tubes than a good radio set, and except for the camera pickup tube—the Farnsworth Image Dissector—all its electronic tubes are standard types easily available.

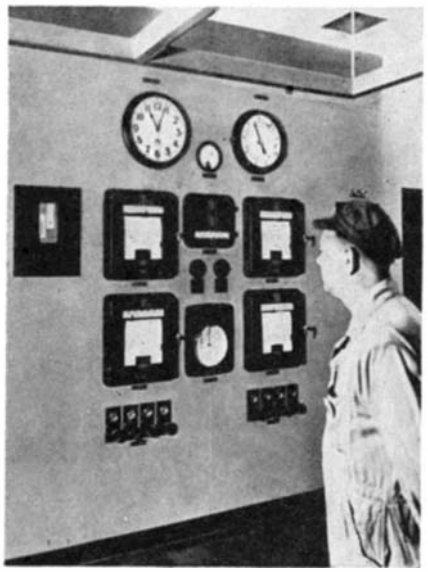
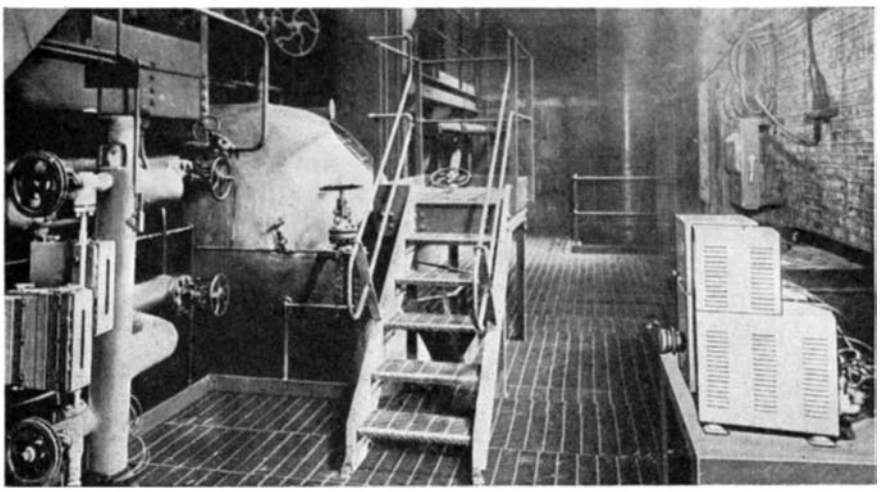


Photo-electric camera focused on gages in boiler room (below) sends a continuous picture to indicator at extreme left of control panel (above)



OVERLOAD CLUTCH

Disengages Rotating Elements By Introduction of Lubricant

EQUIPPED with a novel means for overload disengagement, a new type clutch is intended for use where a problem of overloads in the transfer of torque exists.

The new device, called the Wolff clutch, is said to be suited for installation in automobile transmissions to make the shifting of gears entirely automatic; as a safety release in the propeller shaft of a motorboat; as a devise for controlling torque in power driven tools such as screw drivers and tapping machines; as a safety coupling in printing presses; and in other types of automatic machinery.

The clutch brings about complete disengagement of two connected rotary machine parts through the automatic introduction of a lubricant between the frictional surfaces as soon as one of the parts is overloaded. In one form, the Wolff clutch consists of a cylindrical shell attached to a hub, multiple shoes mounted on another hub in such a way that they bear against the internal cylindrical surface of the shell, a means for controlling the pressure between the shoes and the shell, and a lubricant within the shell. This arrangement encourages the formation of a separate fluid layer whenever overloading occurs. Torque may be transmitted from either hub and in either direction of rotation.

The torque is transmitted by the static friction between the shoes and the shell. When the transmitted torque becomes excessive, slippage occurs. Since the shoes are free to tilt slightly, a film of lubricant is formed between the shoes and the shell, resulting in substantially complete disengagement of the clutch. As long as there is relative motion between the shoes and the shell, the fluid film is maintained and the

clutch remains disengaged. The instant that the relative motion ceases, the film is broken and the clutch is re-engaged. Thus the clutch may be re-engaged by bringing both shafts to rest or to the same speed. The disengaging torque may be controlled by the pressure loading on the shoes.

In one application of the clutch to a flexible coupling, the shoes are molded into a rubber-like core which, after being fitted within the shell, is put in compression by spring loading, thus expanding the shoes against the shell. The core is made of the rubber-like material because it has the ability to adapt its shape to the formation of a fluid film. Also, it can damp out torsional vibrations and can compensate for misalinement.

The Wolff clutch can be applied to an automatic gear-changing mechanism. Here, it is arranged to take the place of the sliding-jaw clutch in a conventional transmission. An over-running clutch is mounted on the countershaft. On starting, the load is carried through the over-running clutch and gears because the automatic-clutch shoes are so lightly loaded at low speeds that they will not transmit torque. When the load is up to speed, a momentary deceleration of the driving shaft to the speed of the driven shaft will engage the clutch. The drive is now direct but if the load becomes excessive the Wolff clutch disengages and the gear train again picks up the load.

PLANES ON FARMS

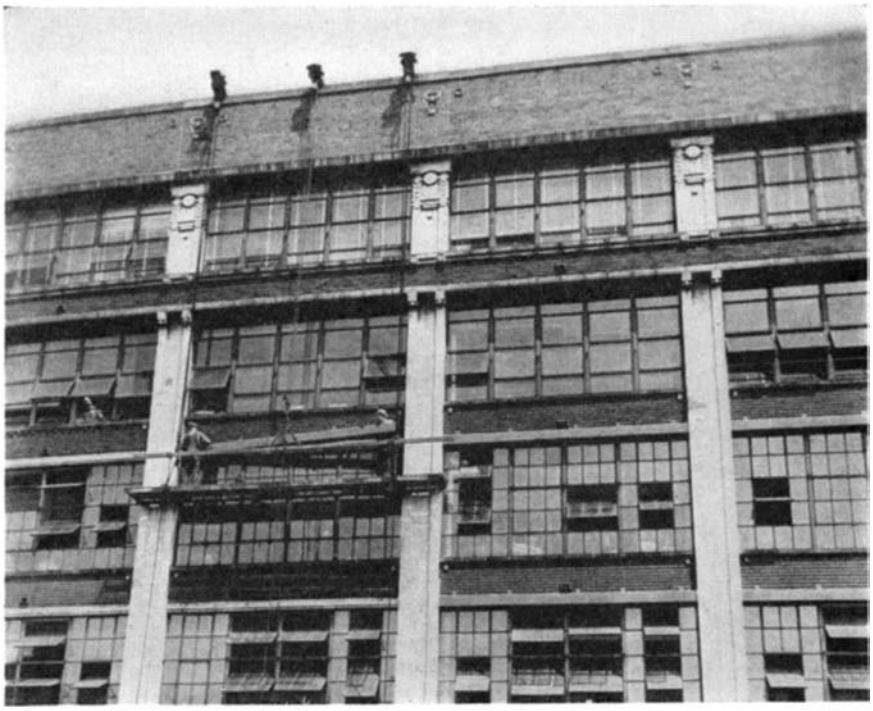
Predicted as Major Factor in Rural Life

ACCORDING to Edward A. O'Neal, President of the American Farm Bureau Federation, "the advent of the low-cost, safe, and easily flown plane means a lot to farm and ranch people. Farm boys, most of whom are mechanically minded to a notable degree, take to air travel as a duck takes to water. Planes are now in use for dusting, seeding, range patrol, coyote hunting, and many other uses. Plane transportation of high-quality, perishable foods offers some interesting possibilities. It's my guess that 10 years from now farmers will be using air transportation to a degree that few people envision today."

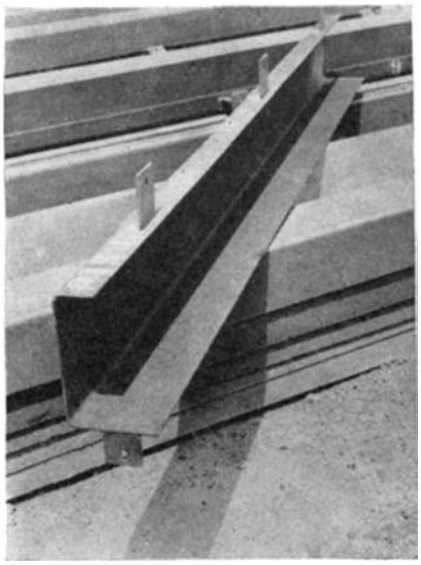
CONCRETE PROTECTION

Afforded by Capping With Wrought-Iron Channels

INSTALLING protective covers, fabricated of wrought iron plate, over spalled concrete spandrels is the latest technique devised for this type of building maintenance. A consulting engineer theorized that such an installation would be more feasible than to attempt repair of concrete spandrels between the columns of an eight-story building. The spandrels were severely spalled by atmospheric attack and in need of immediate attention. Recalling how wrought iron plates are installed on submerged concrete piers and similar structural members which are subject to damage from water and ice, the engineer designed "channels" of 3/16 inch wrought iron plate to cover the building spandrels. Mortar was chipped out over each spandrel to a depth of 1½ inches and the channels were slipped into place, being well caulked with a high grade mastic and secured by expansion bolts.



Channels are slipped into place, caulked, and secured by expansion bolts



The extended lower edge of cover fits beneath the underside of the spandrel

Besides improving the exterior appearance of the building, this type of maintenance construction provides additional structural strength, according to the installing contractor. Since the standard maximum width to which wrought iron plates are rolled is less than 18 feet, 6 inches—the length of the spandrels—it was agreed that the channels should be fabricated of four lengths of 3/16 inch plate, each 55-1/2 inches in length, welded together. The channels were cold bent so that the lower leg was 4 1/2 inches wide, forming the underside. The top leg, fitting over the top of the spandrel, was 1 3/4 inches wide, while the channel web was about 9 1/4 inches deep.

POWDERED-COAL LOCOMOTIVE

Now Starting Construction, Promises Economy and Efficiency

SOME idea of how the first American gas-turbine locomotives ("Powdered Coal Feeds A Turbine," Scientific American, August 1946) will be built has now been revealed. Bituminous Coal Research, Inc., recently accepted an Allis-Chalmers contract for a gas-turbine power unit designed to run on powdered coal. The former organization's Locomotive Development Committee, representing railroad and coal companies co-operating in a project to build a better coal-burning locomotive, expects to have the new type locomotive on rails within two years.

Supporting predictions for high

efficiency, low operating cost, and easy maintenance will be several specific advantages inherent in the locomotive's power generating equipment. The 3750-horsepower gas turbine is to be a packaged unit, with a single base common to all parts—the gas turbine, its axial compressor, a generator driven through gears, and the regenerator. This power plant will be installed in a single cab no larger than used for present-day standard locomotives.

Using electric drive, the locomotive will have a generator operating at high rotative speed, so that a relatively small diameter will allow for auxiliaries or other equipment to be mounted above the generator. The gas turbine's control system will be at least as simple to operate as other locomotive types.

It is promised that this railroad gas turbine will be the most efficient single-shaft gas-turbine plant in this country. The design includes an axial-flow compressor to compress air which will then be heated to 1300 degrees, Fahrenheit, before entering the gas turbine. This will result in a shaft efficiency of approximately 24 percent.

When eventually produced in quantities, gas-turbine locomotives can be expected to compare favorably in cost with other types of locomotive power, according to Allis-Chalmers engineers. An outstanding fuel-cost advantage comes from the use of powdered coal, which at the same time eliminates smoke and

The new locomotive will need no cinders.
water. It will take on the same size coal as carried by the steam locomotive, but the coal will be prepared for burning with special equipment developed by John I. Yellott, director of research for the Locomotive Development Committee. This new coal-handling system will make use of a "coal atomizer" for powdering the fuel as well as a unique separator for removing fly ash from the heated air stream.

SUPER ELECTROMAGNET

To Probe Remaining Mysteries of Magnetism

PACKING into a space the size of a saucer enough magnetic strength to lift an automobile, a "mighty midget Hercules" magnet has been developed as a tool for probing the unsolved mysteries of magnetism.

Designed by Dr. J. E. Goldman of the Westinghouse Research Laboratories, the U-shaped electromagnet is capable of exerting a concentrated pull of 4000 pounds, a force strong enough to make possible new studies of how metals react in magnetic fields.

"By gaining such information," Dr. Goldman explains, "we not only help unravel the mysteries of magnetism which still is a phenomenon only partially understood, but we also can help advance the work of atom-scientists and other research investigators." Also, he says, permanent magnets made with this electromagnet make possible lighter and smaller magnetic indicating instruments.

As a fundamental research tool, various metals are placed within the

Contains 6000 turns of copper wire

influence of this powerful magnet; it is then possible to study the relationship between the crystal structure of the metals and their magnetic properties. Although it is known that the crystal structure of metal affects the magnetic qualities, the basic processes that cause magnetism still are matters for research investigation.

The U-shaped iron core of the new magnet is wound with 6000 turns of square copper wire. Five feet long and two and one-half feet high, the electromagnet weighs one and a half tons. The two ends of iron at the top of the squat U act as the two poles of the magnet. When electricity flows through the copper wire which circles the ends of the core, an intense magnetic field is set up between these two poles. The air-space can be varied in size by moving the ends of the iron core closer together or farther apart and by using tapered pole pieces, depending upon the size of equipment to be placed in the magnetic field and the strength of field required.

The maximum width of this space is 12 inches; for tiny specimens such as silver and platinum alloy magnets, the gap is shortened to as little as one half inch.

BRAZIL: A Coming Industrial Empire

(*Continued from page* 104)

quick glimpse of the progress that Brazilian industry is making. And it must not be thought that they represent merely war-time expansion. As a matter of fact, the combined industries of Brazil, with a few exceptions, cannot yet begin to supply the needs of their own country. For generations the agricultural economy of Brazil has made it necessary for its people to import many of their required manufactured products; it has been only within the last 15 years or so that a start has been made toward providing Brazilians with goods made in Brazil.

Since Brazil is industrially still a young country, it is not at all surprising to find that many of the guiding geniuses of her industries are young men. Typical of these is Francisco Pignatari, just 30 years old, who heads up Laminacão Nacional de Metais S/A, and whose zeal expended in behalf of Brazilian industry makes a story strikingly similar in many respects to those so familiar in the development of American business.

In 1933, Dr. Julio Pignatari, father of Francisco, founded a modest industry in the rolling of aluminum foil and the production of aluminum and bronze powders. This small beginning grew into Laminacão Nacional de Metais which slowly but surely established itself as a Brazilian industry in competition with imported materials. When Dr. Pignatari died in 1936, Francisco assumed the leadership of his father's company. From that date onward, the young industrialist's vision expanded until, at the present time, his company controls all of the nonferrous metals producers and fabricators whose growth has been briefly outlined in previous paragraphs. Under young Pignatari's guidance, a vast amount of pioneering work has been done in developing Brazilian resources and building up the production ability of Brazilian industry.

WHAT BRAZIL WANTS — In its industrial expansion Brazil needs, first and foremost, machinery of all kinds. Her present industrial development has been built largely through the use of second-hand and obsolete equipment imported from abroad. She needs rolling mills, stamping machines, forging equipment, electric motors and electrical

equipment of all kinds, lathes, presses, boring machines, and so on. Up to now there is practically no machine-tool production in the entire country; all must be imported. Switzerland and England are getting a bite of the business, business that, for the long pull, can be of great benefit to industry in the United States if the opportunity is grasped before it is too late.

In addition to machinery and equipment, Brazil needs brains, trained brains that can forward with dispatch and efficiency the up-surge of industry that is only just starting. This is not to say that Brazilian industrialists lack this essential ingredient; it is rather to emphasize the fact that American companies who want to do business with Brazil must do more than send salesmen into that country; they must send trained specialists who have a sufficiently broad grasp of international requirements to understand and appreciate the growing pains of a nation passing through a transition period, and to proceed accordingly.

Another thing: This observer did not see a single piece of safety equipment on any machine in all the plants visited. It was impossible to obtain substantiated figures on industrial accidents in Brazil, but the rate must be high. Stamping machines of many kinds were watched in operation; hand fed, the worker's fingers were constantly exposed to injury with no protection of any sort whatsoever. Here, then, is a fertile field for the safety engineer who has done so much to reduce accidents in plants in the United States. Not only should safety equipment be presented to Brazilian industry on the basis of what it can do to increase production and decrease accidents, but safety instruction in all its phases should be "sold" to them as a humanitarian—and profitable—"must" in their development program.

Materials handling is another phase of industrial production that engineers from the United States can well promote. It seemed strange to see in Brazilian plants the mixture of antiquated machinery with a few up-to-the-minute machine tools—and back-breaking manual labor furnishing the motive power for moving materials and partially fabricated parts between the points of work. Not one conveyor line was seen, and only a very few power trucks. Wheel-barrows and hand trucks did most of the actual transportation, while the sight of men and boys carrying materials in their hands was not at all uncommon!

All-in-all, despite a few faults apparent to the American eye, here is a country with the will to do, imbued with the spirit of this industrial age, emerging from a background of what amounts to a single-crop agricultural economy to a healthy and balanced economy in which agriculture and industry will complement each other. With Brazil's vast storehouse of natural resources—and her people's eagerness to make the most of them—her industrial development should be not too far different from that of the United States. The large majority of Brazilian workers have been proved ideally adaptable to industrial pursuits, to jobs requiring intelligence and developing skills. They take readily to the electrolytic plant, the foundry, the machine shop . . . and exhibit initiative and interest in their work. They have all the requirements for the development of a group similar to that of the labor which is the backbone of industry in the United States.

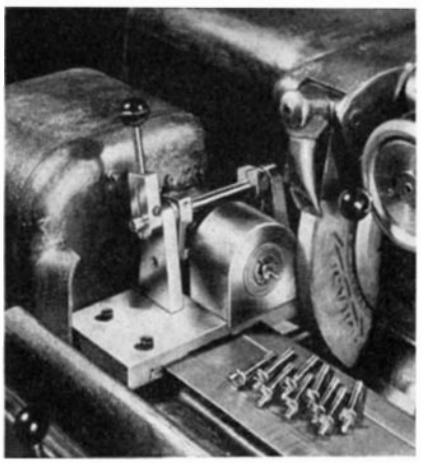
Best of all is the friendliness which exists between the two nations. The United States has much to offer Brazil in the form of industrial know-how, machinery, and so on; Brazil, in turn, offers a fertile field for trade in both directions. Through international co-operation there can be an even greater acceleration of Brazilian industry to the benefit of her own people as well as those of the United States.

New Products and Processes

COLLET FIXTURE

Speeds Operations on Plain Grinder

USED TO grind parts without centers, but which can be held in collets, a special collet fixture increases the usefulness and steps up production of a standard plain grinding machine. This tool runs on its own ball bearings and is driven by the headstock of the machine. The collet can be opened and closed while the grinder is running, and because the collet does not move lengthwise, it is possible to hold over-all dimensions.



Will fit any model grinder

Manufactured by Zagar Tool, Inc., the fixture is easily adaptable to any make or model of grinder. Quickly installed or removed, its use involves no extra or special attachments.

HEAT-STABLE RESIN

Provides Waterproof Binding For Inorganic Materials

DEVELOPED and produced as a heat-stable bonding material for inorganic fabrics in the production of rigid electrical laminates, a thermosetting resin also serves as a bonding for finely divided particles such as powdered metals or mica, silica, or carbon. This material, produced by Dow Corning and known as DC 2103, is unique among thermosetting resins for its high heat stability, very low water absorption, excellent dielectric properties over a wide frequency range,

and for its resistance to carbon tracking. DC 2103 is an organo-silicon polymer material built on an inorganic skeleton of alternate silicon and oxygen atoms. Its unique properties are due largely to the inherent stability of this inorganic skeleton.

As furnished, DC 2103 is a 60 percent solution of silicone resin in toluene. Without the addition of a catalyst, this solution air dries in about an hour at 77 degrees, Fahrenheit, and 50 percent relative humidity, depositing the resin in a hard and track-free form which has an initial melting point of about 70 degrees, Centigrade, (158 degrees, Fahrenheit).

The use of this material to bond inorganic fabrics of asbestos or glass results in rigid laminations ideally suited for many electrical applications, but because of its exceptional heat-stability, waterproofness, and excellent dielectric properties, this product has many uses other than that of a bonding resin. It can be used, for example, as the resin binder in the production of heat-stable and waterproof cement for sealing light bulbs or radio transmitting tubes to metal bases. DC 2103 can be used also for bonding finely divided particles such as powdered metals, carbon, carborundum, silica, asbestos, or mica, in the fabrication of a wide variety of products including friction-producing materials, abrasive compositions, and electrical resistors.

QUANTITY COMPUTER

Aids Mixing
Or Diluting Oils

SIMPLE and accurate, a pocket calculator makes it possible to compute quantities in a matter of seconds when mixing or diluting oils. Given the recommended mixing proportions and the capacity of the tank, the calculator, called the Dilut-O-Graph, shows precisely how much base oil to use. It is circular, measuring 4½ inches in diameter, and is made of a special composition board.

TRANSPARENT MIRRORS

Permit Vision in
One Direction Only

VALUABLE wherever seeing without being seen is an advantage, transparent mirrors function as normal reflecting surfaces when viewed from one side, and simultaneously as windows when viewed from the other. These mirrors are surfaced by molecular bombardment with metal—in this case chrome alloy, although many other metals may be used—through thermal evaporation in a high vacuum. Inside the vacuum chamber the chromium particles are suspended on a filament. The glass to be "silvered" is placed in the chamber, and after the high vacuum has been drawn, an electric current is passed through the filament. The heat produced immediately evaporates the metal, molecules of which bombard the interior of the chamber and, of course, the glass. The resulting deposit on the glass, although only ten-millionths of an inch thick, is so stable that it cannot be scratched or damaged by ordinary means, and no common chemical can attack it. The mirrors are unusual also in that the metal coat is applied to the face, rather than to the back.

Of the many applications for such mirrors, perhaps the most important is as observation windows in child-behavior clinics, or in psychiatric wards where surveillance of the patients without their knowledge is essential. Jewelers, banks, or brokerage offices should find the mirrors a great aid in that they make close observation of customers possible with embarrassment to no one. Also, the mirrors should prove convenient in restaurants and

Courtesy Acra-Lite Company

The woman, clearly visible to the man, can see only her own reflection

night clubs where they would enable the waiter to watch his patrons, serving their every wish, without that annoying hovering-about.

The mirrors, developed to be used in various types of equipment for the army and navy, are now being produced commercially by both the Acra-Lite Company, and Libbey-Owens-Ford Glass Company.

ADHESIVE LABELS

Cannot be Removed In One Piece

SELF-DESTROYING labels which cannot be reused once they are removed were especially designed for trade-marks, underwriter's approval seals, and similar factory-applied data; they cannot be removed from the genuine product and placed on substitute merchandise. Their unusual self-destroying feature is accomplished by die cutting the label

Fraudulent re-use impossible

so that it can be removed only in segments. The die marks, however, are impressed in such a manner that they are virtually invisible and in no way affect the design on the label.

Manufactured by the Avery Adhesive Label Corporation, labels may be applied to metal, plastics, wood, varnish, glass, or cellophane, and unless their removal is desired, they will adhere permanently despite intense heat, cold, or humidity.

RAYON LAMINATES

Have High Strength, Great Versatility

UTILIZED in the molding of articles such as cabinets, table tops, trays, machine parts, and household utensils, an increasing variety of rayon laminated plastics are being manufactured by the American Viscose Corporation.

Rayon laminated plastics which have good tensile and high impact strengths consist of a number of layers of resin-treated fabrics or fibrous mats laid together and pressed into a compact bonded plate or molded article. For special applications where major strength is needed in one direction in the laminate, unidirectional high-tenacity rayon fabrics possess particular merit. For different applications a square or twill weave will be found more desirable. Other forms in which rayon is used for laminated plastics are carded batts, ribbon lap, loose fiber, or thin sheets of non-woven fabric, depending upon the particular character-

istics needed and the method of handling or molding.

Rayon, when used as a resin treated batt or in the form of a ribbon lap, is readily molded into various forms and it is then possible to obtain a uniform, smooth, and attractive surface. Heavy laminated plastics sections made from resin treated rayon staple batts have also been developed for gear-wheel stock and other machined reinforced plastics parts. It is also possible to make laminated plastics from rayon fiber blends, dry processed on textile equipment or wet processed on paper-making equipment with the suitable addition of resin.

AUTOMATIC TYPEWRITER

Prints Form Letters
With Personal Touch

THE PROBLEM of giving automatically reproduced form letters that individually typed look has found another solution in a device which enables one person to prepare as many as 600 personalized letters in a single eight-hour day. This device, called the Flexowriter Automatic Letter Writer, operates by means of a perforated paper tape, and consists of an electric typewriter, an automatic perforator, and an automatic writer.

The chief advantage of this new system lies in the fact that it is impossible to detect any variation between the manually typed fill-in and the automatically typed body of the letter. This is the result of, first, the fact that in using an electric typewriter, the pressure of the type-face against the ribbon is the same, regardless of the pressure applied to the key, so that the impression is the same, whether the typing be done manually or automatically, and, secondly, of writing the letter from start to finish on the same machine without its having to be removed during the entire operation.

Guided by holes in tape, letters are typed automatically, leaving the operator free to check her mailing lists

The master copy of the letter to be reproduced is recorded by the perforator on a paper tape ⅞ inch wide. The perforating is done at the operator's normal typing speed, and if any error in typing is made, the correction is completed by simply back-spacing and x'ing out the mistake. The automatic writer will disregard any characters so crossed out.

In preparing the form letter, the operator types manually the date and the name and address of the recipient. Then a switch is thrown, and the automatic writer takes over, controlled by the previously prepared tape, and finishes the letter in less than half the time required for manual typing. While one machine is on automatic, the operator can be preparing the personal data on another; the average operator can handle a battery of four machines without difficulty. Using this procedure, a great many letters which defy detection from those individually typed can be prepared in a very short time.

FIRE BLANKET

Is Versatile
Safety Aid

A VALUABLE safety and emergency aid to industrial plants, laboratories, hotels, and fire departments, is a new fire blanket now being manufactured by United States Rubber Company.

The blanket can be used as an emergency wrap should a person's clothing be aflame; as an auxiliary fire extinguisher, to put out flames from vents, manholes, small containers, or tanks; as a fire shield so that fire fighters can approach within effective range of liquid fires; as a welding screen against sparks; and as a salvage blanket to protect valuable materials from water, chemicals, and heat.

It is 60 by 80 inches in size and made of high tensile strength glass cloth, impregnated on both sides with synthetic rubber. Hems and seams are vulcanized and folds are heat creased. It is equipped with large brass grommets at the top and a weather-resistant bracket so it can be hung up outdoors or indoors and easily removed or replaced. For quick identification, it is red in color and marked with the words, "fire blanket."

Qualities claimed for the fire blanket are that it is flame-proof, heat re-

Controlled by the electric typewriter, the automatic perforator at extreme right records on a narrow paper tape the body of a letter to be reproduced

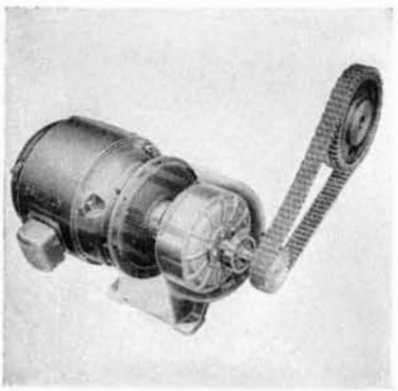
sistant, chemical resistant, water resistant, mildew proof, vermin proof, non-shrinkable, non-stretchable, and unaffected by heat or cold.

ELECTROFLUID DRIVE

Provides Smooth Power Flow While Protecting Equipment

CONSISTING of a general-purpose A.C. induction motor, flange-mounted on a sturdy housing that contains an hydraulic coupling, the new Electrofluid Drive is a neat, compact power unit now available for many industrial uses. The hydraulic coupling, operating on a long established principle, consists of a primary and secondary element; the primary is similar to a centrifugal-pump impeller and the secondary, or output element, is not unlike a water-wheel or runner in function. The coupling is filled with a light mineral oil of steam-turbine quality. When the motor drives the impeller, it causes oil to flow through the runner buckets back to the impeller, thereby rotating the runner through the medium of the oil. There is no mechanical connection between the two elements of the fluid coupling.

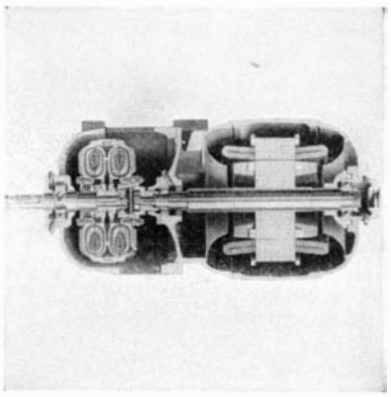
In effect, the fluid coupling inserted between the motor and its load serves as an automatic clutch, with the fluid



Power unit in operation

acting as a "cushion" between prime mover and driven machine.

Without need of any complicated starting control or special type of motor, Electrofluid Drive solves the problems of inadequate torque and excessive high starting current peaks. Regardless of the characteristics or inertia of driven machine or connected load, the motor of the Electrofluid Drive



Cross section shows induction motor (right) and hydraulic coupling (left)

starts at no-load, because at zero speed the torque-transmitting capacity of the fluid coupling is zero. The motor accelerates quickly, developing torque in the fluid coupling in the ratio of the square of the speed, until sufficient torque up to the maximum running torque of the motor is developed to start the driven load.

Should the driven machine become stalled, the Link-Belt Company's Electrofluid Drive will pull to the maximum torque capacity of the motor, thereby drawing sufficient current to cause the thermal overload protective device to function within a few seconds. Thus the drive will overcome a momentary demand which might otherwise shear a pin or stop the power source completely. This cushioning effect protects both the motor and the driven equipment.

GLOWING TUBE

Serves as Marker In the Dark

HIGHLY flexible luminous tubing, originally produced for specialized war-time use, offers interesting possibilities for peace-time applications. Made by the United States Radium Corporation, the tubing comprises a tough, semi-transparent, moisture- and acid-resistant plastics ¼ inch outside diameter and 3/16 inch inside, uniformly coated on the inside with a radioactive material which is clearly and continuously visible at a considerable distance in complete darkness.

In its original specifications, the tubing was prepared in five-foot lengths and equipped at the ends with snap-clip fasteners. The armed forces used it as a marker for night parachute drops, as a marker for ship passageways during blackouts, and for other similar purposes.

REMOTE THERMOMETER

Transmits Readings by Air-Pressure Medium

CONVERTING temperature to air pressure and transmiting this pressure to a receiving indicator, recorder, or controller, a new type thermometer operates on a pneumatic "null" balance principle in which the pressure in a gas-filled thermal element is balanced by air pressure. The instrument pro-

vides high-speed pneumatic transmission of the measured temperature over distances of 1000 feet or more and eliminates the need for long lengths of capillary tubing.

The gas-filled thermal element is said to be of an entirely new design, consisting of a bulb, double-armored capillary only 24 inches long, and a sealing bellows. Thermal elements are interchangeable. The pressure of the gas fill does not determine the operating range of the instrument, called the Nullmatic Thermometer. Standard thermal elements with either of two filling pressures serve for temperatures as low as minus 150 degrees, Fahrenheit, and as high as 800 degrees, Fahrenheit.

The low filling pressures used result in an instrument which has high overload protection, hence thermal elements for sub-zero applications require no special provision for shipment or storage. Because the transmission is pneumatic, the 30 pounds per square inch supply-air pressure is the highest pressure to which the transmitter and receiver are subjected.

The operating range of any Nullmatic thermometer may be reset over wide limits by the use of a suppression adjustment in the transmitter, which is also used for setting zero. There are no linkages or bearings in the transmitter. Standard instruments are furnished to operate over Fahrenheit spans of 100, 150, 200, 300, 400, 500, 600, and 800 degrees, Fahrenheit, or in Centigrade spans up to 450 degrees.

The instrument responds to temperature changes as small as 0.01 degree, Fahrenheit, and detects and transmits temperature changes with a lag coefficient of only 2.4 seconds—bare copper bulb in a well-agitated liquid. The speed is not affected by transmission distances up to 75 feet. The addition of each 100 feet of line results in a transfer lag of approximately one second.

Long capillaries unnecessary

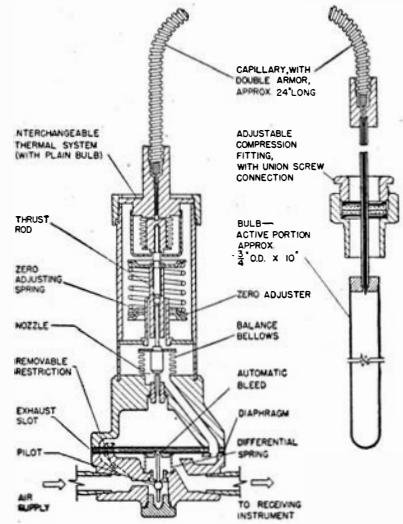
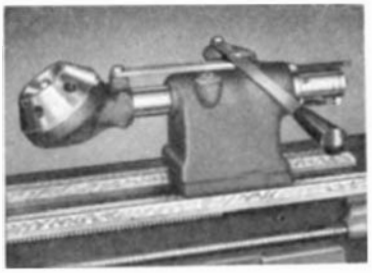


Diagram of working parts

SIX-STATION TURRET

Increases Efficiency of Lathe Operation

DESIGNED to give turret-lathe efficiency to nine-inch South Bend lathes on jobs which require a number of successive operations is a new tailstock-type Hand-



Accommodates 5/8 inch diameter shanks

lever Turret which mounts on the inside ways of the lathe bed in place of the tailstock. This six-station turret head accommodates tools with 5/8 inch diameter shanks. The length of the cut at each station is regulated by an adjustable set screw, and the stop mechanism is geared to operate automatically in unison with the indexing of the turret head. The index lock releases automatically at the end of the turret slide's return stroke and indexing is done by hand. Operations can be repeated, or skipped, at will, and the turret slide has a maximum stroke of 3¼ inches.

FLEXIBLE GLASS CUTTING

Facilitated by Use Of Carbide Saw

DIFFICULTIES in keeping sharp the saws used for cutting out shapes for ice-resistant propellers and wing tips has been solved in a simple manner by one manufacturer. The material used —1/16 inch thick sheets of Flexible Glass (a glass-impregnated fabric)—proved so abrasive that ordinary saws averaged only 20 minutes between regrinds. In an effort to put the operation on a production basis, the manufacturer tried a saw tipped with Carboloy Grade 905, a cemented carbide possessing extremely high wear-resistance. Service life between grinds increased several hundred times over that previously obtained from the high-speed steel saws.

Cutting was performed with a Black and Decker hand-guided power saw at a speed of 20,940 feet per minute without coolant, using hand feed. The Carboloy tipped saw was used in this manner in regular production for 90 days without re-grinding. In this time, it is estimated, some 60 high-speed steel saws would normally have been consumed. Thus, the change-over resulted

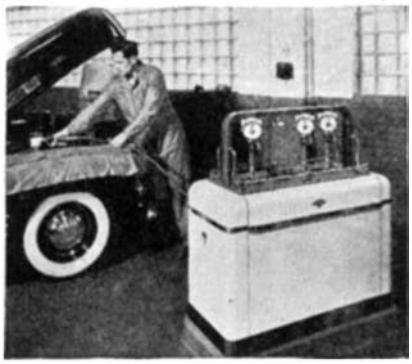
not only in the elimination of down time and re-sharpening time, but also in a material saving in the purchase price of the new saws.

LUBRICANT HANDLING

Speeded with Metered Delivery Installation

To ELIMINATE double handling of oil, and reduce contamination and waste, as well as to speed up service and save time, a new installation dispenses motor oil direct from 55-gallon original refinery containers to the automobile or truck crankcase without the use of measures, funnels, or can openers.

Called Lubreel installations, the system employs pumps and containers placed in out-of-sight or remote locations, and oil is piped direct to the Lubreel which can be located along side of or between vehicle lifts.



Oil servicing simplified

All hose assemblies are mounted on individual, air-operated, automatic retracting reels. Each control valve is equipped with an easy-to-read, totalizing meter which accurately registers the amount of oil being dispensed, according to the manufacturer, Lincoln Engineering Company.

AUDIO VOLTMETER

Is Highly Sensitive Over Wide Frequency Band

DESIGNED to measure A.C. voltages over ranges of frequency and amplitude far beyond the limits of ordinary meters, a highly sensitive vacuum tube audio voltmeter makes it possible to measure the electrical conductivity of switches, circuit-breakers, relays, buses, and grounds, as well as transmission losses in lines and circuits and the response of special filters and compensators. Covering a range from 20 cycles to 20 kilocycles, the instrument is applicable for testing radio receivers and sound systems and is used to measure gain and noise level in power amplifiers and ripples voltages in power supplies. The meter is also used to locate sources of frequency distortion and faulty amplifier components in receivers, phonographs, and public address systems.

Other applications of the new audio voltmeter, manufactured by the Radio Corporation of America, include: use as an audio amplfiier which gives high gain with high fidelity, and whose

Amplifier or voltmeter

sensitivity makes it especially adaptable for use with microphones having low output; bridge measurements which readily indicate the null point at either high or low audio frequencies; measurement of the output of a phototube with sensitivity that will indicate extremely slight variations in light intensities to which the tube is exposed; and measurement of currents as low as one one-thousandths of an ampere, or, if a 0.1 megohm external resistor can be used, currents as low as 0.0001 milliampere.

WOOD-METAL LAMINATES

Are Light, Rigid, And Fire-Resistant

LIGHTER planes, fireproof office partitions, and desks which resist cigarette burns are all made possible by combining metal and plywood layers, according to Thomas D. Perry of Resinous Products and Chemical Company. Plymetal is a relatively new product which combines the good qualities of both wood and metal, and compensates for the less desirable qualities of each. It is made by gluing layers of metal to sheets of veneer with a resin adhesive, to which heat and pressure are simultaneously applied. Among Plymetal's many applications is a table-top construction developed for office desks, bank counters, and smoking stands, where an inserted sheet of aluminum is provided to absorb and distribute the heat from lighted cigarettes so that the outer wood surface is not disfigured.

Kitchen equipment, table tops, and drainboards are much improved by metal surfaces for cleanliness and wear, backed by a light-weight plywood for stiffness and heat insulation. Here both steel and aluminum are employed. Many types of hospital equipment benefit by the same Plymetal constructions and are easily kept surgically clean.

Plymetal has proved valuable also for interior enclosures in zoned areas of cities where a fireproof or non-combustible barrier is required by code; for instance, in elevator cabs, stair wells, and office partitions.

In aircraft, where strength to weight ratios are of maximum importance, sandwich constructions with aluminum-alloy surfaces and low-density interiors have developed remarkable stiffness and have been a great boon to aircraft designers in floors, cockpits, and bulkheads.

The transportation industries have

used Plymetal in locations where the metal face resists wear and abrasion, and adds strength, while the plywood backing contributes stiffness and keeps down the weight. Examples of such applications are the floors, sides, and operator cabs for trucks; walls and roofs for buses; and many parts for light-weight streamline railroad cars. In these, steel-plywood constructions were employed.

SOLAR TIMER

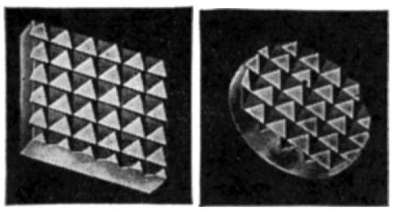
Throws Switches at Rise and Set of Sun

CLOCKS with "astronomic dials" turn lights or other electrical equipment on at sunset and off at sunrise throughout the year automatically without any attention. They may be set to operate exactly at sunset and sunrise or up to 40 minutes before or after. Provision is also made for them to turn off at a fixed time, if desired, anywhere between 11 P.M. and 1 A.M. The dial is equipped with a calendar wheel showing the month and day as well as exactly when the switch will operate. These clocks, manufactured by the Tork Clock Company, operate on Standard Time throughout the year and are set for the exact time correction (the variation from a Standard Time Meridian) for the city or town where used.

GRIP INSERTS

In Disks or Squares Used for Holding, Clamping

NOW in production is a line of durable gripping inserts for various holding, clamping, and feeding devices. Called Kengrips, they are made in the forms of disks and squares, with diamond-serrated surfaces. Four sizes are now available; in either form—½ by ⅛ inch thick; ⅝ by ⅛ inch thick; ¾ by 5/32 inch thick, and 1 by 5/32 inch thick.

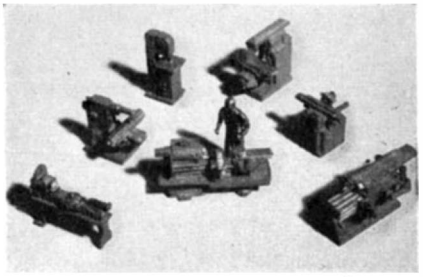


Available as disks or squares

SCALE TOOL MODELS

Aid Planning Engineers in Achieving Efficient Lay-Out

GIVING planning engineers a truly three-dimensional view of plant layout, and enabling them to arrange equipment in such a way as to insure faster production, greater safety, and reduced material handling, newly designed scale models are readily distinguishable as representing machines or equipment. Scaled to ¼ inch to the foot, these models, produced by the Triometric Engineering Company, make possible the close study of a manufacturing process to observe where, by the relocation of tools or machines, procedures may be simplified and speeded. With such models various arrangements can be tried quickly and easily. And by photographing different arrangements, comparisons can be made without the time and expense required by ordinary methods. Models of all standard plant and office machines, in addition to many special machines, are available.



Permit closer study of plant set-up

ATOMIC WELDING

Preserves Characteristics of Stainless Steels

DEVELOPMENT of the jet engine which powers the Lockheed P-80 Shooting Star might not have been accomplished had it not been for new and highly perfected methods of welding, according to engineers of the General Electric Company. The I-40 jet engine, report the engineers who developed it for the Army Air Forces, contains more than 500 joints, all of them welded so securely that they are able to withstand the extremes of heat and strain which prevail as the P-80 travels at speeds of around 600 miles per hour.

In designing this engine, it was necessary to find a construction material that was both light in weight and heat-resistant. The need for light-weight construction is self-evident, and the heat-resistant qualification is needed to withstand the operating temperature of about 1500 degrees, Fahrenheit, created by the intense heat of combustion. Heat-resistant alloys in sheet form, some only 1/50 of an inch thick, embody both these qualities, and are used extensively in the engine.

Heat-resistant alloys in general are classed as stainless steels, and are likely

Alloys welded in hydrogen atmosphere

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. **$7.10**

HIGH FREQUENCY INDUCTION HEATING — *By Frank W. Curtis.* Answers many questions concerning induction heating and its utility in industrial processes. Thoroughly practical in scope. **$3.10**

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. **$4.10**

POTTERY PRODUCTION PROCESSES — *Edited By J. J. Svec.* For amateur and professional alike, this compact volume gives specific instructions. Particular attention is called to troubles most likely to develop. **$2.10**

YOUR HAIR AND ITS CARE — *By Oscar L. Levin, M.D., and Howard T. Behrman, M.D.* Scientific facts about hair—how to save and beautify it, treat infections, and so on. Real facts—not a "cure-for-baldness" screed.

NORTON'S STAR ATLAS AND TELESCOPIC HANDBOOK — *By Norton and Inglis.* New tenth edition of a standard work, with main charts redrawn for epoch of 1950. Standby for amateurs past the cradle roll. **$5.10**

PLASTICS — *By J. H. DuBois.* Third edition, again revised and enlarged, with two four-color plates. This is an important book on the whole general subject of plastics, plus much brand new material on synthetic rubber, manufacturing processes, and plastics moldings. **$5.10**

REVISED LAPIDARY HANDBOOK — *By J. Harry Howard.* Practical instructions in gemstone cutting and polishing, for both beginner and the advanced hobbyist. **$3.10**

SIMPLIFIED PUNCH AND DIE MAKING — *By Walker and Taylor.* Comprehensive reference book for tool engineers as well as those just getting started. Emphasis is on what-to-do and how-to-do-it, from the simplest to the most complex dies. **$5.10**

THE MEANING OF RELATIVITY — *By Albert Einstein.* Second edition with added chapter describing advances since publication of first edition some 25 years ago. Requires knowledge of advanced mathematics and physics; not a popular exposition. **$2.10**

TECHNIQUE OF GLASS MANIPULATION IN SCIENTIFIC RESEARCH — *By Julius D. Heldman, Ph.D.* Text covers properties of glass, glass-working equipment, basic operations, seals (including metal-to-glass), and exercises aimed at perfecting technique. **$3.70**

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. **$4.10** including a slide rule; for book alone. **$2.85**

ELECTRIC MOTOR REPAIR — *By Robert Rosenberg.* Practical instructions, with excellent drawings and text separately bound so that book can be left open to a certain drawing while following the printed instructions. **$5.10**

MACHINERY'S HANDBOOK — *13th Edition.* "Bible of the mechanical industry." 1911 pages of latest standards, data, and information required daily in shop and drafting room. **$6.10**

THE EINSTEIN THEORY OF RELATIVITY — *By L. R. and H. G. Lieber.* An intermediate book from which engineers and the like can get close to an understanding of relativity. Partly in language but largely in mathematics of college grade, mainly calculus. **$3.10**

ATOMIC ARTILLERY AND THE ATOMIC BOMB — *By John Kellock Robertson.* Standard best seller for years, describing electrons, protons, positrons, photons, cosmic rays and the manufacture of artificial radioactivity—now with a chapter added on the bomb and the difficulties of its production. **$2.60**

FINISHING METAL PRODUCTS — *By Simonds and Bregman.* Stress is directed toward commercial aspects of product finishing from the standpoint of sales, costs, and product function. Specific guidance for those faced with selecting finishing methods, materials, and equipment. **$4.10**

PRINCIPLES OF PHYSICS, VOL. III — OPTICS — *By Francis Weston Sears.* One of the most modern works on physical optics available today. At college level, it covers the subject with emphasis on physical principles rather than practical applications. **$5.10**

MEN, MIRRORS, AND STARS — *By G. Edward Pendray.* Third edition, with much new material, including a chapter on the Schmidt camera. Treats telescope evolution, famous American telescope makers, telescope uses and accessories, and so on. **$3.10**

TESTING PRECIOUS METALS—*By C. M. Hoke.* This guide for those who buy and sell precious metals describes testing methods and gives important facts that such people should know. **$2.10**

FUNDAMENTALS OF OPTICAL ENGINEERING — *By Donald H. Jacobs.* This 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. **$5.60**

WITH THE WATCHMAKER AT THE BENCH — *By Donald DeCarle.* Simple, practical, straightforward instructions on the repair of timepieces, with direct implications to the manufacture and repair of delicate instruments of all kinds. **$3.10**

THE PROLONGATION OF LIFE — *By Dr. Alexander A. Bogomolets.* Competent evaluation of present knowledge of the mysteries of human aging, including full discussion of ACS—anti-reticular cytotoxic serum. **$1.60**

FEATURES OF THE MOON — *By J. E. Spurr.* New volume that includes all of the former "The Imbrium Plain Region of the Moon," plus an extended study of the whole Moon. 453 large pages, 14 Mt. Wilson photographs, 95 drawings. **$5.10**

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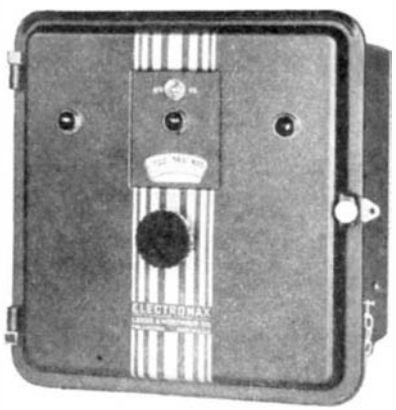
to lose some of their corrosion resistance if the rate of welding is too slow. For this reason, atomic-hydrogen welding and resistance-welding processes are used, rather than the slower oxy-gas method.

Atomic-hydrogen arc-welding is a method which employs an alternating current arc between two tungsten electrodes in an atmosphere of hydrogen gas, while engineers describe resistance welding as a high-speed method of joining metals by using pressure and electric heating under accurate control, and without the addition of any welding material. Of the two processes, the selection of one for a particular joint depends upon such factors as weight, stresses, distortion, joint contour, gas flow restriction, accessibility, and thickness.

TEMPERATURE CONTROLLER

Is Inexpensive, Needs Little Maintenance

FOR CONTROLLING the temperature of ovens, stills, baths, presses, and coolants, and filling the need for an inexpensive unit which has high sensitivity and versatility and needs practically no attention, an instrument called the Electromax was especially designed for those



applications where indicating and recording are not required. Electromax signals and controls only, although temperature readings can be taken manually with it at any time.

This new instrument consists of a Wheatstone bridge circuit with a vacuum-tube amplifier as the detector. Vacuum tubes are standard, easily-purchased types which require no matching, balancing, or other special selection. The unit is completely A.C. operated and needs no dry batteries or standard cells. The lack of indicating or recording mechanism makes it practically a "zero maintenance" instrument.

Temperature-sensitive elements used with Electromax are standard Thermohms, resistance thermometer bulbs. The length of lead wires does not affect calibration, and the location of Thermohms can be changed whenever desired. Standard ranges of the instrument, which is manufactured by Leeds and Northrup Company, are 0 to 250 and 0 to 1000 degrees, Fahrenheit, or the corresponding ranges of 0 to 150 and 0 to 550 degrees, Centigrade.

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.)

MALTA CARBIDE AND T AND V CAST ALLOY. Tools, dies, and wear-resisting parts made of the cemented carbide and cast nonferrous alloy are described in this 24-page catalog, and specifications are given. *Jessop Steel Company, Washington, Pennsylvania.—Request this catalog on your business letterhead.*

FINE CERAMICS BY CENTRALAB. Containing 28 pages of information on standards, design criteria, body characteristics, and some established shapes and sizes, this booklet is based on ceramic insulating materials. Types explained include Steatite, Cordierite, Zirconite, and a wide range of dielectric materials. Request Form 720. *Centralab, 900 East Keefe Avenue, Milwaukee 1, Wisconsin.—Gratis.*

TYPE "W" WATERPROOF CONNECTORS. Complete with sizes, dimensions, and cross-sectional views, this four-page bulletin presents Cannon's line of waterproof electric cable connectors. Designed for submarine geophysical exploration, they are also adaptable for use in swamps, lakes, rivers, docks, with underground cable, or in any outdoor applications where moisture conditions require a thoroughly sealed fitting. Request Bulletin W-146. *Cannon Electric Development Company, 3209 Humboldt Street, Los Angeles 31, California.—Gratis.*

A TRIP THROUGH HERCULES LAND is a 20-page booklet explaining how Hercules products are utilized in the following industries; adhesives, protective coatings, synthetic fibers, plastics, soap and disinfectants, insecticides, rubber, ink, construction, textiles, paper, and mining. Also included is a list of 41 industries and the products utilized in each. *Hercules Powder Company, Wilmington 99, Delaware.—Gratis.*

SHIELD THEM FROM DANGER is a 20-page booklet on fire prevention and fire protection. Included are chapters on home fire protection planning, methods of keeping fire hazards under control, elimination of hazards through proper fire hygiene, and what to do until the fire department arrives. *The General Detroit Corporation, 2270 East Jefferson Avenue, Detroit 7, Michigan.—Gratis.*

BLUEPRINTS FOR MEDICINE'S TOMORROW—INDUSTRIAL AND SOCIAL MEDICINE. This 32-page booklet is one of a series of booklets on specific projects in the plan for the development of the New York University-Bellevue Medical Center. Essentially a prospectus for an Institute of Industrial and Social Medicine at this center, it covers the past and future of preventive medicine, New York University's record in public health, plans for the proposed Institute, and the initial research program. *New York University Book Shop, Washington Square, New York, New York.—$1.00.*

M.S.A. CARBON MONOXIDE ALARM. Designed for efficient protection against dangerous concentrations of carbon monoxide, the alarm described in this four-page bulletin requires only connection to a proper rated source of power; it then will give audible and visible warning when carbon monoxide concentration in air reaches a predetermined level—as low as .02 percent. Request Bulletin DR-3. *Mine Safety Appliances Company, Braddock, Thomas, and Meade Streets, Pittsburgh 8, Pennsylvania.—Gratis.*

BASIC WATER-SOFTENING METHODS FOR INDUSTRIAL, INSTITUTIONAL, AND MUNICIPAL USE. This booklet is based on information about ion-exchanging water softeners of both pressure and gravity types, which feature automatic equipment to control backwashing, brining, and rinsing processes. *The Permutit Company, 330 West 42nd Street, New York 18, New York.—Gratis.*

ELINCO TYPE "FB" MOTORS AND GENERATORS is a 12-page booklet covering typical Elinco units in the "FB" frame which allows both frame and base mounting. To aid in selection of the proper unit, dimensional and cut-away views are given in addition to performance curves. *Electric Indicator Company, Stamford, Connecticut.—Gratis.*

DUSTKOPS STOP DUST AND LINT FROM POLISHING AND BUFFING. This two-page bulletin deals with suggestions for installing individual units at the point of work for collecting dust, lint, and rouge from polishing, buffing, and metal coloring operations. Typical installations, dimensions, and prices are included. *Aget-Detroit Company, 602 First National Building, Ann Arbor, Michigan.—Gratis.*

THE GEIGER-MUELLER X-RAY SPECTROMETER. Explaining the history and construction details of this instrument, this eight-page reprint continues with data on circuits and correct usage. Practical applications, specimen preparation, and methods of identification are covered in detail. *North American Philips Company, Inc., Publicity Department, 100 East 42nd Street, New York 17, New York.—Gratis.*

THE PREMISES OF THE DECLARATION OF INDEPENDENCE AND THEIR CONSEQUENCES, by Arthur Graham Glasgow. An analysis of "We hold these truths to be self-evident, That All men are created equal . . ." and suggestions as to how to rectify the ensuing consequences, all leading toward a plan for a Home Government which, the author holds, would set a model for world unity, welfare, and peace. *The Secretary, 1900 Monticello Avenue, Norfolk 10, Virginia.—Gratis.*

Our Book Corner

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

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The Editor

GAS TURBINES AND JET PROPULSION FOR AIRCRAFT

By G. Geoffrey Smith, M.B.E.

EXHAUSTIVE treatment of the gas turbine as applied to aviation is presented here in a greatly enlarged (fourth) edition of an already famous book. Because of its thorough treatment, this new edition has been adopted for educational use by the United States Army Air Forces and is ideally suited for use as a textbook. The author, editorial director of *Flight* and of *Aircraft Production*, London, England, is an international authority on jet propulsion, rated as the greatest development in aviation since the first flight of the Wright brothers. Included in the text of his comprehensive book are specific details covering the design of existing turbines and jets, as well as projected units for commercial planes. (256 pages, 6 by 9 inches, over 200 excellent illustrations.)—$5.10 postpaid.—*A.P.P.*

MICROCALORIMETRY

By W. Swietoslawski

MASTERS of their subjects can usually make their presentations deep, while keeping them simple. And this author has proved himself a great master of his in the creation of this not-too-complex work on the scientific measurement of extremely small amounts of heat. Colleges and research laboratories will find the work invaluable. And any scientific-minded reader will find it highly stimulating to his imagination—broadening to his store of information. (208 pages, 9¼ by 6¼ inches, illustrated.)—$4.85 postpaid.—*E.L.C.*

THE PREPARATION AND USE OF VISUAL AIDS

By Kenneth B. Haas and Harry Q. Packer

CONCURRENT with industrial specialization, job classification, and vigorous attempts to train unskilled help to be efficient producers, have grown the educational techniques emphasizing visual rather than oral or written instructional material. Expensive research, and often expensive mistakes have boiled visual education down to well-established rules and practices This book explains and details these practices. Motion pictures, stripfilm slides, opaque projectors, maps, charts diagrams, and many other forms of visual presentation are discussed in clear, factual, to-the-point style. An amazing appendix that lists, on classified plan, the sources of visual aid material in this country, is worth the price of the book itself. Thoroughly illustrated with half-tones, line drawings, and tables. (224 pages, 6 by inches, index.)—$4.10 postpaid.—*E.F.L*

CAREERS IN AVIATION

By Samuel Burger

A COMPREHENSIVE account of the opportunities which exist in every phase of aviation—manufacture, air line operation, industrial use, government activities, teaching, research, and fixed base operation. The book is written in a way to awaken the interest of any young man who reads it. It constitutes an introduction to the problem of getting a job in aviation, but detailed information will have to be sought elsewhere. (209 pages.)—$2.6 postpaid.—*A.K.*

COMMUNICATION THROUGH THE AGES

By Alfred Still

TRACING man's progress in communication from the signal drum to television, Alfred Still has recorded man's unceasing attempts to express hi

thoughts beyond the limit of his voice, presenting a complete and concise work of definite interest to all those interested in communications. Far from being simply an historical outline, this warm review of human achievement also presents an interesting picture of man's philosophical development in relation to his scientific progress. The chapters concerning the advances in electricity and radio are told simply, in non-technical language, offering no difficulty whatsoever to the layman, making the entire book a clear, easy-to-read work of unquestionable value. (201 pages, 6 by 8½ inches, illustrated.) —$2.85 postpaid.—*N.H.U.*

LINCOLN'S INCENTIVE SYSTEM

By James F. Lincoln

WIDELY commented upon, both pro and con, is the much publicized incentive system developed by the author of this book and applied in his own manufacturing plants. To spread the gospel of this successful management plan, the fundamentals and methods of application have been gathered into one book as a demonstration of the extreme practicality of sensible co-operation between management and labor. The text delineates the details of the system, step by step. (192 pages, 6 by 9 inches, 20 illustrations.)—$2.10 postpaid.—*A.P.P.*

GAS IN LIGHT ALLOYS

By L. W. Eastwood, M.S., Ph.D.

FROM the very beginnings of the commercial casting of aluminum and magnesium there has been constant research to find the causes and cures of pinholes and other voids in the castings. In a book of only 99 pages Dr. Eastwood has digested the existing knowledge of the subject, shown the strengths and weaknesses of various preventives and eliminators of voids caused by hydrogen, and given all the latest theory with some data regarding practices. This book should be a "must" for every foundryman, metallurgist, and product designer who makes use of aluminum and magnesium. (99 pages, 6 by 9 inches, illustrated.)—$2.60 postpaid.—*E.L.C.*

PHOTOGRAPHY BY INFRA-RED

By Walter Clark

A SECOND edition of a book originally published in England in 1939, this text has benefited by the research and applications of the past several years. In its present form it contains genuinely valuable information for the laboratory worker, experimenter, or industrial user of infra-red. Contents range from techniques and purely photographic principles through the application of the knowledge in several fields. These fields include textiles and graphic arts, medicine, botany, palaeontology, photomicrography, camouflage, and a considerable number of others of a more generalized nature. Although the general tone is quite technical, the reports of infra-red applications in the crime and art realms are more than interesting reading. Three appendices contain lists of materials available; weights, measures, and conversion tables; formulas and processing solutions. Indexed by name and subject. (472 pages, 6 by 9 inches, 93 line drawings and half-tones, numerous tables, graphs, and charts.)—$6.10 postpaid.—*E.F.L.*

SCIENCE SINCE 1500

By H. T. Pledge

SHORT, compact history of mathematics, physics, chemistry, biology, omitting the inexact sciences sociology, anthropology, psychology, economics. This book is not for general readers but for scientists; it is not elementary. On the other hand, readers already having solid background in science will prefer its kind of treatment, which takes some things for granted. (357 pages, 6 by 9½ inches, 29 illustrations.)—$5.10 postpaid. —*A.G.I.*

CURRENTS IN BIOCHEMICAL RESEARCH

Edited by David E. Green

COMPRISING 31 papers by 34 leaders in biochemical research, this book sets forth current views and trends in an active and rapidly advancing field. While these specialists have endeavored to present their views as simply as possible for the benefit of others not specialists in biochemistry, the volume will be somewhat beyond the interest of laymen, but it will prove fascinating to those having an interest in and knowledge of the subject matter short of the pioneering specialists here represented. All research workers whose activities are at all related to living matter will find the volume both fascinating and stimulating to the imagination. (494 pages, 6 by 9 inches.)—$5.10 postpaid.—*D.H.K.*

THE CONCENTRATION OF ECONOMIC POWER

By David Lynch

INDUSTRIAL giantism and its effect on small business is the subject of this book. The material which the author used is derived from testimony given before the Temporary National Economic Committee, set up in 1938 at the instigation of President Roosevelt. The author's objective analysis is an effective contribution to the study of the relationship between industrial monopoly and prosperity. Whoever wishes to inform himself on the degree to which economic power is concentrated in relatively few corporations will find this book a valuable aid. (422 pages, 6½ by 9½ inches, tables and index.)—$5.60 postpaid.—*J.C.*

REFERENCE DATA FOR RADIO ENGINEERS — SECOND EDITION

Compiled by the Federal Telephone and Radio Corporation

CONCISE and complete, the second edition of this well-known handbook of radio engineering tables and formulas has been completely reor-

ganized with all of the material brought up to date, and many chapters greatly enlarged. The section on vacuum tubes and amplifiers, for example, has been spread over two full chapters with the addition of a great deal of new information, including considerable data on cathode-ray tubes. Others among the numerous additions and revisions are the chapters on wave guides and wave propagation, both of which have been greatly augmented. And the section on non-sinsoidal and modulated wave forms now includes many new formulas for amplitude, frequency, and pulse modulation. (322 pages, 5½ by 8½ inches, illustrated.)—$2.10 postpaid.—*N.H.U.*

PRINCIPLES OF PHYSICS II — Electricity and Magnetism

By Francis Weston Sears

AIMED at the second year college level, this book completes a three volume set, the other two covering mechanics, heat, and sound, and optics. Reviews of the other two volumes have appeared previously in these columns. Because the present book is designed to be used after the student has mastered analytical geometry and calculus as well as the mechanics-heat-sound aspects of physics, the subject of electricity and magnetism is developed to a somewhat greater degree than in the usual college course in general physics. (434 pages plus tables, logs, natural trigonometric functions. (6½ by 9½ inches, well illustrated.)—$5.10 postpaid.—*A.P.P.*

THE MAGIC OF NUMBERS

By Eric Temple Bell

ULTIMATE truth can be arrived at by sitting down and reasoning. Ultimate truth can be arrived at only by experimentation. Which is correct? Pythagoras and Plato and later many others voted for reasoning. Galileo and our whole scientific age vote for experimentation—until a few years ago when Eddington, Milne, and others swung back 25 centuries. The author, a pure ("Caltech") mathematician, here explores in popular style, not in mathematical symbols, the whole history of this age-old argument, which pertains mainly to the philosophy of science. (418 pages, 5½ by 7 inches, one illustration.)—$3.60 postpaid.—*A.G.I.*

ENZYMES, AND THEIR ROLE IN WHEAT TECHNOLOGY

Edited by J. Ansel Anderson

THIS volume initiates a series of monographs being prepared under the auspices of the American Association of Cereal Chemists to overcome the tremendous difficulties faced by everyone in the field who attempts to keep up to date on his specialty. The eleven chapters of this book treat, first, each of the enzymes important in wheat technology, and then the applications of each in the field. Each chapter is written by a recognized expert in his subject. (371 pages, 6 by 9 inches.)—$4.60 postpaid.—*D.H.K.*

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"

LAST June this department contained an account of what Russell Porter did to help win the war, and showed a photograph of him lying on a sofa reading *The Los Angeles Astonisher* while his newly made polishing machine slaved directly beneath him in the cellar. The war over, he was enjoying a little well-earned rest.

Now we have asked him to tell the telescope-making fraternity about that machine and here is his reply, illustrated with some of his incomparable drawings. He writes:

Long past retiring age (75 last December) I still find myself fascinated with working optical surfaces. So I obtained three 8″ Pyrex blanks and went down cellar where at odd moments I tried to make them flat.

The machine used (Figure 1) embodies the Scotch yoke principle which favors compactness. Its base is a plank one foot wide and two feet long and it has a capacity up to 12″ work. The ⅛ horsepower driving motor has a worm directly attached to the end of its armature shaft. To the top of the large worm wheel is attached a flat, circular plate, its upper face carefully faced and lubricated. In that plate, extending from center to the edge, is a single radial slot. Locked at any desired position along the slot, by means of the nut shown in the drawing, is a shouldered stud. Loose on that stud is a roller which fits the inside of the shouldered slot of the Scotch yoke shown. As the worm wheel rotates, the Scotch yoke unit is forced to reciprocate, constrained as it is by its guide rod. The other rod, the upper one, which carries the pin that pushes and pulls the work, has a rocker which confers freedom of action over any convex or concave surface.

With the adjustments set as shown, a straight-over-center (radial) stroke of about 5″ is given (the slot, 3″ in length, permits a 6″ maximum stroke). A complete stroke is made in about two seconds.

A thumb-nut on the upper rod—the push rod—affords quick change of stroke range. If now it is desired to change to an off-center (tangential) stroke it is necessary only to loosen the little clamping lever near the base of the main casting, rotate the entire unit a little, and re-tighten the clamp. Thus the tool may be made to operate over any part of the glass.

The vertical shaft has a sprocket pinion which, by means of a sprocket chain, rotates the work table at a reasonably slow speed. An idler takes up any slack. There are no creeping belts. I have noticed no tendency to produce periodic errors on the glass being worked. The only casting required is the one embracing the Scotch yoke.

Now for the figuring of the 8″ flats. I first tried the interference method described in "A.T.M.," page 52. The fringes were normally observed some 10′ away by introducing a sheet of window glass at 45° just over the disks. The illumination is from a 2′ mercury tube suspended from the ceiling, with tissue paper below it for scattering the light.

The three disks slowly approached flatness, with an error of the order of half a fringe, or a quarter wavelength. Then, as an independent check and after considerable urging by Dr. Anderson, I made an 8″ concave mirror of about 10′ radius of curvature. With this set-up and a newly made knife-edge stand (Figure 2) I checked the flatness as described in "A.T.M.," page 42. As is called for in the figure on that page, three motions were provided, one vertical (*A*), one transverse (*B*), and one longitudinal.

At *a* is an enlarged view of the knife-edge window. With the pinhole image as shown, near the upper left-hand corner of the window, only a slight turn of the screws *A* and *B* will give the vertical and horizontal cutoffs. All three movements are controlled by gibs, and the screws (standard 1¼″ diameter, 20-pitch) act against coil springs to prevent backlash by preloading.

The illuminant is a grain-of-wheat lamp bulb covered with a wafer of finely ground glass. There are four pinholes in the little diaphragm shown, of varying sizes, to choose from. The bulb runs on two 1½-volt flashlight batteries. The trough shown below the window is for an eyepiece, used when studying extra-focal images. It can be swung out of the way when observing the Foucault shadows.

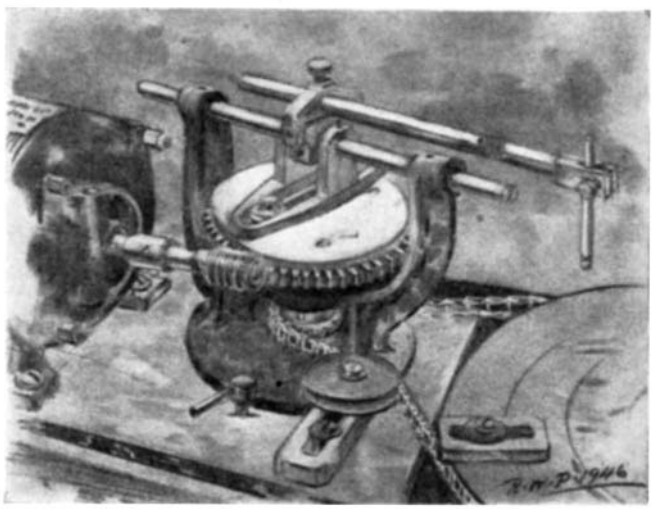
Comparison between the interference and concave mirror methods of testing indicates that there is about the same degree of sensitivity, and the two are mutually consistent throughout. At present all three disks are flat to 1/20 fringe, or 1/10 wavelength, which means departures from flatness of two millionths of an inch. They are not as good as those described by Selby, since they all have turned down edges of about one fringe.

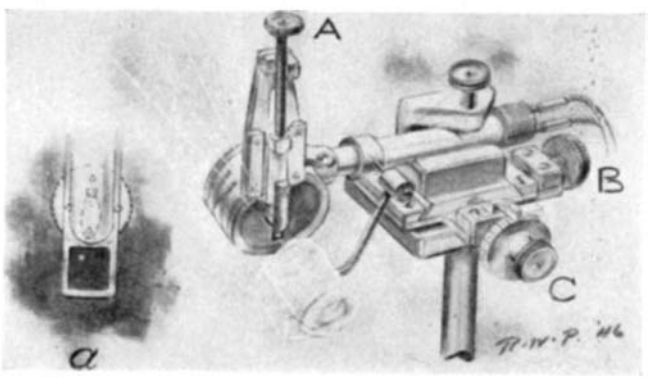
Porter was asked about scale drawings of the knife-edge stand, since readers will inquire. None exist. The drawing is practically self-explanatory. Dimensions need not be identical with those of the original. Pick your own. Porter added, "Yes, made it myself, filed all the gibs."

RUMORS about inexpensive mirrors and lenses of plastics for astronomical telescopes persist. You'll soon be able, so 'tis said, to buy standard mirrors made in simple master molds and precise to 1/20 wavelength, figure perfect, for about five dollars. And, of course, after that you may feel a bit foolish working long hours over glass mirrors made individually.

Many puzzled amateurs have asked about these rumors. Are plastics optics then that good? Or are they likely soon to be that good? Let's look at the evidence.

In 1940, N.R.D.C., in final analysis the Government, awarded the Polaroid Corporation, Cambridge, Mass., a contract to do research on and develop plastics optics. Polaroid investigated 140 organic plastics and chose two as best for optics. To correspond with crown glass they selected polycyclohexyl methacrylate, or "CHM" (Nd =





Left: Figure 1: Porter's slavey. Right: Figure 2: Knife-edge stand made by Porter

1.50645, v = 56.9) and to correspond with flint glass they picked polystyrene (Nd = 1.59165, v = 31.0). These plastics may be poured, in molasses-like consistency, into molds made from glass masters made by conventional precision optical methods—hand work. Bake the filled molds in ovens and you have mirrors, prisms, or lenses.

The optics made from these materials weigh only half as much as glass, are homogeneous, tough, substantially free from color, haze, and strain, and are stable under temperature extremes. They are, however, soft and more easily scratched than glass.

Such optics were useful in the War, as they could be made by inexperienced help, and this released precious optical glass for other purposes. Today the largest use for plastics optics is in the projection systems of television sets. Here the Schmidt camera is used, reversed. This application affords an opportunity to compare plastics optics with glass optics.

A 12" telescope mirror, precision grade (1/10 wavelength), will resolve objects 0.38 second of arc apart, by the Dawes' formula. The corresponding 12" Schmidt with plastics optics as used in television resolves objects 2 minutes of arc apart. Ratio, 300 to 1, though for lenses, which have only one fourth as stiff a tolerance as mirrors, this ratio softens 75 to 1. (But of course, this says nothing against plastics Schmidts for television, where the 2-minute resolving power is sufficient and where increased production costs due to needless refinement would therefore be sheer waste. Simply, the 2-minute resolution approaches the 1-minute resolving power of the human eye.) In astronomical work it is pretty well established that a circle of confusion of 100 microns (1/250") diameter is adequate. The 12" plastics mirror of 12' radius, mentioned above, would give a circle of confusion 1.2 mm, or about 1/20", in diameter—hopelessly large for a star image.

Thus is has proved possible to make and use telescopes and binoculars of plastics magnifying about three or four diameters. To supplant glass precision optics, better than this will have to materialize. Far, far better.

In a paper read before the Optical Society of America, Edwin H. Land, Director of Research of the Polaroid Corporation, objectively assessed the usefulness of plastics optics, making no attempt to claim, or imply, more than observable facts justified. He answered the question, can optical plastics be formed into elements sufficiently homogeneous, accurate, and stable to meet the requirements of precision optics? The following is written with that paper as its basis.

A plastics material in liquid form is poured into molds consisting of accurately ground and polished Pyrex reverses assembled with flexible tape so that the halves may approach each other during baking, and baked. The optical elements thus produced prove to be constant in refractive index within ± 0.0015, most of them being considerably better. Over a subsequent period of eight months this index may change four or five parts per million.

In other experiments, disks 1" thick and 6" in diameter, cast between two optical flats, flexured 6 to 20 fringes after removal from the mold. In four CHM lenses of 169cm focal length and 12 styrene lenses of 144cm focal length cast in reverse molds the variations in radius of curvature affected the focal powers over a range of something under 0.4 percent.

In casting prisms from flat molds there was greater trouble. The facets came out of 5 to 10 fringes from flat, with angle accuracy ± 15 minutes.

In plastics optics it is as easy to cast aspherical elements such as Schmidt corrector plates good enough for television as it is to cast a sphere. Another advantage is the lightness of the optical elements. Some samples which were sent to this department seemed, by unconscious comparison with glass, almost ready to blow away; they do almost float in water. Plastics optics can be drilled, tapped, turned, shaped, planed, or milled with ordinary metal-working tools. And they can be aluminized. They take a precision optical polish and are highly transparent.

In an objective lens, CHM combined with flint glass permits removal of nearly all the secondary spectrum.

Regarding plastics camera lenses: An experimental aerial camera lens of *f*/2.8 and 7½" focal length was made with four elements of styrene and CHM and one thin element of barium crown glass. It was tested at the Mt. Wilson Observatory beside an excellent *f*/2.5 all-glass lens of 7.1" focal length. The performance of the two lenses was found to be practically equal for half-field angles smaller than 14° but the glass was better at greater apertures. The plastics lens has negative astigmatism and curvature of field up to 15° from the axis, the astigmatism rapidly increasing thereafter. The distortion curve is of unusual shape, flattening out for large field angles. Spherical aberration and its chromatic variation is smaller for the plastics objective than for glass, and the color curve is better adapted to the use of pan film with a yellow filter.

The coefficients of linear thermal expansion of CHM and styrene are 7 to 8 times that of common glasses, and their change of index with change in temperature is about 45 times as much. Protection from non-uniform temperature changes is necessary in systems containing massive plastics elements because of their low thermal conductivity, which is about one tenth that of glass. In reflecting devices such as Schmidts, temperature compensation may be had by making the mountings of material having the same thermal coefficients as the mirror.

In sum, then, the plastics optics named provide accuracy equal to the demands made by telescopes magnifying about four diameters and by camera objectives up to about 10" focal length. The prisms are far from good enough.

Plastics have a long road to travel before they come within even distant sight of existing precision optics. What of the future? Nobody knows the future.

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